KCG

COLLEGE OF TECHNOLOGY

AFFILIATED TO ANNA UNIVERSITY | AUTONOMOUS

REGULATIONS - 2023

CURRICULUM AND SYLLABI

(2023-2024)

B.E. AUTOMOBILE ENGINEERING

KCG
COLLEGE OF TECHNOLOGY
AFFILIATED TO ANNA UNIVERSITY | AUTONOMOUS

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

VISION OF KCG

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

MISSION OF KCG

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

VISION OF AUTOMOBILE ENGINEERING

The Department of Automobile Engineering aims at achieving academic excellence in engineering, technology and research by providing unique educational experience which enables the students to cater to the needs of the society.

MISSION OF AUTOMOBILE ENGINEERING

- Impart effectual teaching – learning and training in automobile domain.
- Equip with State-of-the-art technology and equipment to manufacture automobile components.
- Encourage research relevant to automotive engineering technology for the advantage of the society.
- Inculcate engineering methods, knowledge and professional standards in automobile engineering.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

The graduates will:

PEO 1	Excel in their career at engineering industry, research or entrepreneurship.
PEO 2	Exhibit professionalism and team work in their chosen profession.
PEO 3	Adapt to current trends, technologies and industrial scenarios by pursuing life-long learning.
PEO 4	Design and develop solutions to meet the demand of the society with ethical and professional responsibility.

PROGRAMME OUTCOMES (POs)

Engineering graduates will be able to:

PO 01	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 02	Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO 03	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO 04	Use research based knowledge and methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 05	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO 06	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 07	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 08	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

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

PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO 01	Apply the concepts of design and development in automotive industry.
PSO 02	Model and simulate vehicle systems using modern tools.
PSO 03	Apply ethical principles in their career.

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KCG COLLEGE OF TECHNOLOGY
AUTONOMOUS
REGULATIONS 2023
BE–AUTOMOBILE ENGINEERING
CHOICE BASED CREDIT SYSTEM
CURRICULUM FOR SEMESTERS I TO VIII

SEMESTER–I

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

SEMESTER –II

Sl. No.	Course code	Course Title	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
THEORY								
1	23HS201/ 23HS202	Professional English/ Foreign language	HSMC	3	0	0	3	3
2	23MA203	Statistics and Numerical Methods	BSC	3	1	0	4	4
3	23PH206	Material Science	BSC	3	0	0	3	3
4	23ME201	Applied Mechanics	PCC	3	0	0	3	3
5	23HS203	Tamils and Technology	HSMC	1	0	0	1	1
THEORY AND PRACTICALS								
6	23EE281	Basics Electrical and Electronics Engineering	ESC	2	0	2	4	3
7	23ME211	Engineering Graphics	ESC	3	0	2	5	4
PRACTICALS								
8	23ME221	Engineering Practices Laboratory	PCC	0	0	4	4	2
9	23ME222	Applied Mechanics Laboratory	PCC	0	0	4	4	2
10	23ES291	Soft Skills	EEC	0	0	2	2	1*
TOTAL				18	1	14	33	25

SEMESTER-III

Sl. No.	Course code	Course Title	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
THEORY								
1	23MA302	Transforms and Partial Differential Equations	BSC	3	1	0	4	4
2	23AU301	Thermodynamics and Heat transfer	PCC	3	0	0	3	3
3	23AU302	Automotive Engines	PCC	3	0	0	3	3
4	23HS301	Universal Human Values and Ethics	HSMC	3	0	0	3	3
THEORY AND PRACTICALS								
5	23ME311	Manufacturing Processes	PCC	3	0	2	5	4
6	23AU311	Fuels and Lubricants	PCC	3	0	2	5	4
PRACTICALS								
7	23AU321	Computer Aided Design Laboratory	PCC	0	0	4	4	2
8	23AU322	Automotive Engines Laboratory	PCC	0	0	4	4	2
9	23ES391	Presentation Skills	EEC	0	0	2	2	1*
TOTAL				18	1	14	33	25

SEMESTER-IV

Sl. No.	Course code	Course Title	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
THEORY								
1	23MA401	Optimization Techniques	BSC	3	1	0	4	4
2	23AU401	Automotive Transmission	PCC	3	0	0	3	3
3	23AU402	Automotive Electrical and Electronics Engineering	PCC	3	0	0	3	3
4		Department Elective1	DEC	3	0	0	3	3
5		Department Elective2	DEC	3	0	0	3	3
THEORY AND PRACTICALS								
6	23CE412	Strength of Materials	PCC	3	0	2	5	4
PRACTICALS								
7	23AU421	Automotive Electrical and Electronics Engineering Laboratory	PCC	0	0	4	4	2
8	23ES491	Aptitude and Logical Reasoning - 1	EEC	0	0	2	2	1*
9	23AU422/ 23AU423	Mini Project – 1/In - Plant Training	EEC	0	0	2	2	1
TOTAL				18	1	10	29	23

SEMESTER-V

Sl. No.	Course Code	Course Title	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
THEORY								
1	23RE501	Research Methodology and Intellectual Property Rights	ESC	2	0	0	2	2
2	23AU501	Automotive Chassis	PCC	3	0	0	3	3
3		Department Elective 3	DEC	3	0	0	3	3
4		Department Elective 4	DEC	3	0	0	3	3
5		Open Elective – 1 (Emerging Technologies)	NEC	3	0	0	3	3
THEORY AND PRACTICALS								
6	23AU511	Introduction to Finite Element Analysis	PCC	3	0	2	5	4
PRACTICALS								
7	23AU521	Automotive Components Laboratory	PCC	0	0	4	4	2
8	23AU522	Mini Project – 2	EEC	0	0	4	4	2
9	23ES591	Aptitude and Logical Reasoning-2	EEC	0	0	2	2	1*
TOTAL				17	0	12	29	22

SEMESTER VI

Sl. No.	Course Code	Course Title	Category	Periods Per Week			Total Contact Periods	credits
				L	T	P		
THEORY								
1		Department Elective 5	DEC	3	0	0	3	3
2		Department Elective 6	DEC	3	0	0	3	3
3		Open Elective-2 (Management /Safety Courses)	NEC	3	0	0	3	3
THEORY AND PRACTICALS								
4	23CE611	Environmental Science and Engineering	ESC	3	0	2	5	4
5	23AU611	Automotive Engine and Chassis Components Design	PCC	3	0	2	5	4
6	23AU612	Two and Three-Wheelers	PCC	3	0	2	5	4
PRACTICALS								
7	23AU621	Project Work - Phase 1	EEC	0	0	4	4	2
8	23AU622	Technical Training	EEC	0	0	2	2	1
9	23AU623	Technical Seminar–1	ESC	0	0	2	2	1
TOTAL				18	0	14	32	25

SEMESTER -VII

Sl. No.	Course Code	Course Title	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
THEORY								
1		Open Elective-3 (Management Courses)	NEC	3	0	0	3	3
2	23AU701	Intelligent vehicle Technology	PCC	3	0	0	3	3
3	23AU702	Comprehension	EEC	2	0	0	2	2
THEORY AND PRACTICALS								
4	23AU711	Vehicle Maintenance	PCC	3	0	2	5	4
5	23AU712	Vehicle Dynamics	PCC	3	0	2	5	4
PRACTICALS								
6	23AU721	Project Work - Phase 2	EEC	0	0	6	6	3
7	23AU722	Technical Seminar - 2	ESC	0	0	4	4	2
TOTAL				14	0	14	28	21

SEMESTER -VIII

Sl. No.	Course code	Course Title	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
PRACTICALS								
1	23AU821/ 23AU822	Capstone Project / Internship cum project	EEC	0	0	20	20	10
TOTAL				0	0	20	20	10

TOTALCREDITS: 172

DEPARTMENT ELECTIVE COURSES: VERTICALS

VERTICAL 1: ELECTRIC VEHICLES

Sl. No.	Course Code	Course Title	Category	Periods Per Week			Total Contact periods	Credits
				L	T	P		
1	23AU031	Electric vehicle, Drive and storage system	DEC	3	0	0	4	3
2	23AU032	Batteries and Management system	DEC	3	0	0	4	3
3	23AU033	New Generation and Hybrid Vehicles	DEC	3	0	0	4	3
4	23AU034	Automotive Power Electronics	DEC	3	0	0	4	3
5	23AU035	Fuel cell Technologies	DEC	3	0	0	4	3
6	23AU036	Sensors and Actuators	DEC	3	0	0	4	3
7	23AU037	Automotive Embedded Systems	DEC	3	0	0	4	3
8	23AU038	Automotive Electrical Systems and Drives	DEC	3	0	0	4	3

VERTICAL 2: COMPUTATIONAL DESIGN

Sl. No.	Course Code	Course Title	Category	Periods Per Week			Total Contact periods	Credits
				L	T	P		
1	23AU039	Computer Aided Design and Manufacturing	DEC	3	0	0	4	3
2	23AU040	Integrated Computational Materials Engineering	DEC	3	0	0	4	3
3	23AU041	Vehicle design data characteristics	DEC	3	0	0	4	3
4	23AU042	Computational and Visualization Theory	DEC	3	0	0	4	3
5	23AU043	Computer Integrated Manufacturing in Automotive Sector	DEC	3	0	0	4	3
6	23AU044	CFD and Heat transfer	DEC	3	0	0	4	3
7	23AU045	Mechanics of Machines	DEC	3	0	0	4	3
8	23AU046	Machine Design	DEC	3	0	0	4	3

VERTICAL 3: VEHICLE RESEARCH AND VALIDATION

Sl. No.	Course Code	Course Title	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
1	23AU047	Advanced Automotive Materials	DEC	3	0	0	4	3
2	23AU048	Automotive Functional Safety	DEC	3	0	0	4	3
3	23AU049	Combustion Thermodynamics and HeatTransfer	DEC	3	0	0	4	3
4	23AU050	Alternative Fuels and Energy Systems	DEC	3	0	0	4	3
5	23AU051	Automotive Instrumentation	DEC	3	0	0	4	3
6	23AU052	Testing and Measurement Systems	DEC	3	0	0	4	3
7	23AU053	Vehicle Body Engineering	DEC	3	0	0	4	3
8	23AU054	IC Engine Process Modelling	DEC	3	0	0	4	3

VERTICAL 4: SPECIAL PURPOSE VEHICLES

Sl. No.	Course Code	Course Title	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
1	23AU055	Agricultural Vehicles	DEC	3	0	0	4	3
2	23AU056	Defence Vehicles	DEC	3	0	0	4	3
3	23AU057	Construction Vehicles	DEC	3	0	0	4	3
4	23AU058	Marine Vehicles	DEC	3	0	0	4	3
5	23AU059	Space vehicles	DEC	3	0	0	4	3
6	23AU060	Gas Dynamics and Jet Propulsion	DEC	3	0	0	4	3
7	23AE069	Drone Technologies	DEC	3	0	0	4	3
8	23AU061	Autonomous and Connected Vehicles	DEC	3	0	0	4	3

VERTICAL 5: PRODUCT AND PROCESS DEVELOPMENT

Sl. No.	Course code	Course Title	Category	Periods Per Week L	T	P	Total Contact periods	Credits
1	23AU062	Automotive Product Design	DEC	3	0	0	4	3
2	23AU063	Ergonomics in Automotive Design	DEC	3	0	0	4	3
3	23AU064	Automotive Control Systems	DEC	3	0	0	4	3
4	23ME031	Additive Manufacturing	DEC	3	0	0	4	3
5	23AU065	Automotive Aerodynamics	DEC	3	0	0	4	3
6	23AU066	New Product Development Process	DEC	3	0	0	4	3
7	23AU067	Automotive Product Life Cycle Management	DEC	3	0	0	4	3
8	23AU068	Dynamics of Ground Vehicles	DEC	3	0	0	4	3

VERTICAL 6: DIVERISIFIED COURSES GROUP

Sl. No.	Course Code	Course Title	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
1	23AU069	Hydraulics and Pneumatics	DEC	3	0	0	4	3
2	23AU070	Fundamentals of Nano science	DEC	3	0	0	4	3
3	23AU071	Road Vehicle Aerodynamics	DEC	3	0	0	4	3
4	23AU072	Lean Six Sigma	DEC	3	0	0	4	3
5	23AU073	Renewable Sources of Energy	DEC	3	0	0	4	3
6	23AU074	Vehicle Air – Conditioning	DEC	3	0	0	4	3
7	23AU075	Solar Energy Technology	DEC	3	0	0	4	3
8	23AU076	Digital Manufacturing of Automobiles	DEC	3	0	0	4	3

OPEN ELECTIVE – EMERGING TECHNOLOGIES

Sl. No.	Course code	Course title	Category	Periods per week			Total contact periods	Credits
				L	T	P		
1	23OAD971	Artificial Intelligence and Machine Learning Fundamentals	OEC	3	0	0	3	3
2	23OAE971	Aviation Management	OEC	3	0	0	3	3
3	23OCE971	Remote Sensing Concepts	OEC	3	0	0	3	3
4	23OCS971	Augmented Reality and Virtual Reality	OEC	3	0	0	3	3
5	23OCS972	Data Science and fundamentals	OEC	3	0	0	3	3
6	23OEC971	IoT concepts and applications	OEC	3	0	0	3	3
7	23OIT971	Blockchain Technology	OEC	3	0	0	3	3
8	23OMT971	Foundation of Robotics	OEC	3	0	0	3	3

OPEN ELECTIVE – MANAGEMENT COURSES

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

OPEN ELECTIVE – SAFETY RELATED COURSES

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

SEMESTER-WISE CREDIT DISTRIBUTION

SEMESTER	HSMC	BSC	ESC	PCC	DEC	OEC	EEC	Total
Semester I	5	11	5					**21**
Semester II	4	7	7	7				**25**
Semester III	3	4		18				**25**
Semester IV		4		12	6		1	**23**
Semester V			2	9	6	3	2	**22**
Semester VI			5	8	6	3	3	**25**
Semester VII			2	11		3	5	**21**
Semester VIII							10	**10**
Total	**12**	**26**	**21**	**65**	**18**	**9**	**21**	**172**

SEMESTER –I

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

COURSE OBJECTIVES:

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

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

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

<table>
<tr><td colspan="2">23HS101</td><td colspan="2">ESSENTIAL COMMUNICATION</td><td>L
3</td><td>T
0</td><td>P
0</td><td>C
3</td></tr>
<tr><td colspan="8">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="8">To help learners extract information from short and simple correspondence
To familiarize learners with different text structures by engaging them in reading, writing and grammar learning activities
To help learners write coherent, short paragraphs and essays
To enable learners to use language efficiently while expressing their opinions via various media.</td></tr>
<tr><td>UNIT I</td><td colspan="6">FORMATION OF SENTENCES</td><td>9</td></tr>
<tr><td colspan="8">Reading- Read pictures-notices- short comprehension passages and recognize main ideas and specific details. Writing- framing simple and compound sentences, completing sentences, developing hints, writing text messages. Language development- Parts of Speech, Wh- Questions, yes or no questions, direct and indirect questions. Vocabulary development– prefixes- suffixes- articles – countable and uncountable nouns</td></tr>
<tr><td>UNIT II</td><td colspan="6">NARRATION AND DESCRIPTION</td><td>9</td></tr>
<tr><td colspan="8">Reading – Read short narratives and descriptions from newspapers, dialogues and conversations. Reading strategies and practices. Language development – Tenses- simple present, present continuous, present perfect, simple past, past continuous, past perfect, simple future, future continuous, past participle, pronouns. Vocabulary development- guessing meanings of words in context. Writing – Write short narrative paragraphs, biographies of friends/relatives - writing- topic sentence- main ideas- free writing, short narrative descriptions using some suggested vocabulary and structures.</td></tr>
<tr><td>UNIT III</td><td colspan="6">COMPARING AND CONTRASTING</td><td>9</td></tr>
<tr><td colspan="8">Reading- short texts and long texts -understanding different</td></tr>
</table>

types of text structures, -coherence-jumbled sentences. Language development- degrees of comparison, concord- Vocabulary development – single word substitutes- discourse markers- use of reference words Writing - comparative and contrast paragraphs writing- topic sentence- main idea, free writing, compare and contrast using some suggested vocabulary and structures.		
UNIT IV	**SOCIAL MEDIA COMMUNICATION**	**9**
Reading- Reading blogs, social media reviews, posts, comments, process description, Language development - relative clause, Vocabulary development- social media terms-words, abbreviations and acronyms Writing- -e-mail writing- conventions of personal email, descriptions for simple processes, critical online reviews, blog, website posts, commenting to posts.		
UNIT V	**ESSAY WRITING**	**9**
Reading- Close reading non-technical longer texts Language development - modal verbs, phrasal verbs- Vocabulary development - collocation. Writing- Writing short essays- brainstorming – developing an outline- identifying main and subordinate ideas.		
		TOTAL: 45 PERIODS
COURSE OUTCOMES:		
After completion of the course, the students will be able to:		
CO1:	Summarize simple, level-appropriate texts of around 300 words recognizing main ideas and specific details.	
CO2:	Demonstrate the understanding of more complex grammatical structures and diction while reading and writing.	
CO3:	Use appropriate expressions to describe, compare and contrast people, things, situations etc., in writing.	
CO4:	Establish the ability to communicate effectively through emails.	
CO5:	Determine the language use appropriate for different social media platforms.	

CO6:	Use appropriate expressions for narrative descriptions and process descriptions.
TEXT BOOKS:	
1	Susan Proctor, Jack C. Richards, Jonathan Hull. Interchange Level 2. Cambridge University Press and Assessment
2	Susan Proctor, Jack C. Richards, Jonathan Hull. Interchange Level 3. Cambridge University Press and Assessment
REFERENCES:	
1	Dutt P. Kiranmai and Rajeevan Geeta. Basic Communication Skills, Foundation Books: 2013
2	Means,L. Thomas and Elaine Langlois. English & Communication for Colleges. Cengage Learning , USA: 2007

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

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

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

COURSE OBJECTIVES:

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

UNIT I	MATRICES	9

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

UNIT II	DIFFERENTIAL CALCULUS	9

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

UNIT III	FUNCTIONS OF SEVERAL VARIABLES	9

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

UNIT IV	INTEGRAL CALCULUS	9

Definite and Indefinite integrals - Substitution rule - Techniques

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

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

3	Bali. N., Goyal. M. and Watkins. C., ―Advanced Engineering Mathematics‖, Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 7th Edition, 2009.
4	Narayanan. S. and Manicavachagom Pillai.T. K., ―Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2009.

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

Recommended by Board of Studies	**02-08-2023**		
Approved	**1st ACM**	**Date**	**09-09-2023**

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

COURSE OBJECTIVES:

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

UNIT I	COMPUTATIONAL THINKING	9

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

UNIT II	INTRODUCTION TO PYTHON	9

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

UNIT III	FUNCTIONS AND STRINGS	9

Functions: Built-In Functions, Commonly Used Modules, Function Definition and Calling the Function, The return Statement and void Function, Scope and Lifetime of Variables, Default Parameters, Keyword Arguments, *args and **kwargs, Command Line Arguments. Strings: Creating and Storing

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

COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Develop algorithmic solutions to simple computational problems.
CO2:	Develop and execute simple Python programs using Control Statements
CO3:	Develop simple Python programs for solving problems using Functions and Strings
CO4:	Build a Python program using lists, tuples, dictionaries and files.
CO5:	Construct a code related to Object-Oriented Programming Concept

CO6:	Construct a code related to Functional Programming.
TEXT BOOKS:	
1	Allen B. Downey, ``Think Python: How to Think Like a Computer Scientist'', 2nd edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016 (http://greenteapress.com/wp/think- python/).
2	Karl Beecher, "Computational Thinking: A Beginner's Guide to Problem Solving and Programming", 1st Edition, BCS Learning & Development Limited, 2017.
REFERENCES:	
1	Learning To Program with Python. Richard L. Halterman. Copyright © 2011
2	Python for Everybody, Exploring Data Using Python 3. Dr. Charles R. Severance. 2016.
3	Paul Deitel and Harvey Deitel, "Python for Programmers", Pearson Education, 1st Edition, 2021.
4	G Venkatesh and Madhavan Mukund, "Computational Thinking: A Primer for Programmers and Data Scientists", 1st Edition, Notion Press, 2021.
5	John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data'', Third Edition, MIT Press , 2021
6	Eric Matthes, "Python Crash Course, A Hands - on Project Based Introduction to Programming", 2nd Edition, No Starch Press, 2019.
7	https://www.python.org/
8	Martin C. Brown, "Python: The Complete Reference", 4th Edition, Mc-Graw Hill, 2018.

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

23HS102	HERITAGE OF TAMILS	L	T	P	C
		1	0	0	1

COURSE OBJECTIVES:

- Explain the classical literature of Tamil and highlight notable Tamil poets.
- Explain the creation of traditional Tamil musical instruments.
- Explain the sports and games associated with Tamil heritage.
- Explore the education and literacy practices during the Sangam period.
- Explain the contributions of Tamils to the Indian freedom struggle.
- Explain the development and history of printing in Tamil Nadu.

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

TEXT BOOKS:

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

REFERENCES:

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

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

Recommended by Board of Studies	**02-08-2023**		
Approved	**1st ACM**	**Date**	**09-09-2023**

23PH111	ENGINEERING PHYSICS	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To make the students effectively achieve an understanding of mechanics.
- To enable the students to gain knowledge of electromagnetic waves and its applications.
- To introduce the basics of optics and lasers.
- To equip the students successfully understand the importance of quantum physics.
- To motivate the students towards the applications of quantum mechanics.

UNIT I	MECHANICS	9

Types of stress, Stress-strain diagram and its uses- factors affecting elastic modulus- tensile strength- Bending of beams, bending moment – theory and experiment: Uniform and non-uniform bending, Center of mass (CM) – CM of continuous bodies –rod, motion of the CM. Rotation of rigid bodies: Rotational kinematics – rotational kinetic energy and moment of inertia - theorems of M .I –moment of inertia of rod, disc, solid sphere – M.I of a diatomic molecule - torque -rotational energy state of a rigid diatomic molecule – M.I of disc by torsional pendulum

UNIT II	ELECTROMAGNETIC WAVES	9

Concept of field-introduction to gradient, divergence and curl of field – Stokes theorem (No proof)-Gauss divergence theorem (No proof) - The Maxwell's equations in integral form and differential form - wave equation; Plane electromagnetic waves in vacuum - properties of electromagnetic waves: speed, amplitude, phase, orientation and waves in matter - Energy and momentum in EM waves-Poynting's vector - Cell-phone reception.

UNIT III	OPTICS AND LASERS	9

Reflection and refraction of light waves - total internal reflection –

types of optical fiber, Numerical Aperture and acceptance angle - interference –Theory of air wedge and experiment. Theory of laser - characteristics - Spontaneous and stimulated emission - Einstein's coefficients(Qualitative) - population inversion - CO_2 laser, semiconductor laser (Homo junction) - Applications of lasers in industry.		
UNIT IV	**BASIC QUANTUM MECHANICS**	**9**
Photons and light waves - Electrons and matter waves –Compton effect - The Schrodinger equation (Time dependent and time independent forms) - meaning of wave function - Normalization – Free particle - particle in a infinite potential well: 1D,2D and 3D Boxes- Normalization, probabilities and the correspondence principle.		
UNIT V	**ADVANCED QUANTUM MECHANICS**	**9**
The harmonic oscillator(qualitative)- Barrier penetration and quantum tunneling(qualitative)- Tunneling microscope - Resonant diode - Finite potential wells (qualitative)- Bloch's theorem for particles in a periodic potential –Basics of Kronig-Penney model and origin of energy bands.		
		TOTAL: 45 PERIODS
PRACTICAL EXERCISES: (Any Seven Experiments)		
1. Torsional pendulum - Determination of rigidity modulus of wire and moment of inertia of regular and irregular objects 2. Simple harmonic oscillations of cantilever 3. Non-uniform bending- Determination of Young's modulus 4. Uniform bending–Determination of Young's modulus 5. Laser-Determination of the wavelength of the laser using grating 6. Airwedge- Determination of thickness of a thinsheet /wire		

7. a) Optical fibre-Determination of Numerical Aperture and acceptance angle b) Compact disc-Determination of width of the groove using laser. 8. Acoustic grating-Determination of velocity of ultrasonic waves in liquids. 9. Ultrasonic interferometer–determination of the velocity of sound and compressibility of liquids 10. Post office box-Determination of Band gap of a semiconductor. 11. Photoelectric effect 12. Michelson Interferometer. 13. Melde's string experiment 14. Experiment with lattice dynamics kit.
TOTAL: 30 PERIODS

COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Determine the mechanical properties of materials.
CO2:	Apply the principles of electromagnetic waves to real world system.
CO3:	Determine the thickness of thin wire and the characteristic parameter of an optical fiber.
CO4:	Apply the principles of lasers to real world application.
CO5:	Organize the quantum mechanical properties of particles and waves.
CO6:	Utilize the quantum mechanical principles towards the formation of energy bands.

TEXT BOOKS:	
1	D.Kleppner and R.Kolenkow, "An Introduction to Mechanics", McGraw Hill Education (Indian Edition), 2017.
2	Arthur Beiser, Shobhit Mahajan, S. Rai Choudhury, "Concepts of Modern Physics", McGraw-Hill (Indian Edition), 2017.

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

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

Recommended by Board of Studies	02-08-2023		
Approved	1st ACM	Date	09-09-2023

23CY111	ENGINEERING CHEMISTRY	L	T	P	C
		3	0	1	4

COURSE OBJECTIVES:

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

UNIT I	WATER AND ITS TREATMENT	9

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

UNIT II	NANOCHEMISTRY	9

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

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

principles; Fuel cells: H_2-O_2 fuel cell, microbial fuel cell and its advanced technology, supercapacitor.	
TOTAL: 45 PERIODS	
LIST OF EXPERIMENTS	**TOTAL: 30 PERIODS**
1. Determination of hardness causing salts in water sample by EDTA method. 2. Determination of alkalinity in water sample. 3. Determination of chloride content of water sample by argentometric method. 4. Determination of strength of given Barium chloride using conductivity meter. 5. Determination of strength of Acid using pH meter. 6. Determination of strength of FAS by potentiometer 7. Determination of strength of acids in a mixture using conductivity meter. 8. Preparation of nanoparticles (TiO_2/ZnO/CuO) by Sol-Gel method. **9.** Estimation of Nickel in steel	
COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Interpret the quality of water from quality parameter data and propose suitable treatment methodologies to treat water.
CO2:	Illustrate the basic concepts of nanoscience and nanotechnology in designing the synthesis of nanomaterials for engineering and technology applications.
CO3:	Estimate the knowledge of phase rule and composites for material selection requirements
CO4:	Choose a suitable fuel for engineering processes and applications
CO5:	Relate the different forms of energy resources and apply them for suitable applications in energy sectors.
CO6:	Explain the different types of batteries, fuel cells and working principles of Electric vehicles

TEXT BOOKS:	
1	P. C. Jain and Monica Jain, "Engineering Chemistry", 17th Edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2018.
2	Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2008.
3	S.S. Dara, "A Text book of Engineering Chemistry", S. Chand Publishing, 12th Edition, 2018.Grewal.B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 44^{th} Edition, 2018.

REFERENCES:	
1	B. S. Murty, P. Shankar, Baldev Raj, B. B. Rath and James Murday, "Text book of nanoscience and nanotechnology", Universities Press-IIM Series in Metallurgy and Materials Science, 2018.
2	O.G. Palanna, "Engineering Chemistry" McGraw Hill Education (India) Private Limited, 2nd Edition, 2017.
3	Friedrich Emich, "Engineering Chemistry", Scientific International PVT, LTD, New Delhi, 2014New Delhi, 2018.
4	ShikhaAgarwal, "Engineering Chemistry-Fundamentals and Applications", Cambridge University Press, Delhi, Second Edition, 2019
5	O.V. Roussak and H.D. Gesser, Applied Chemistry-A Text Book for Engineers and Technologists, Springer Science Business Media, New York, 2nd Edition, 2013

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

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

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

COURSE OBJECTIVES:

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

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

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

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

Exercise 2	**Programs to demonstrate usage of control structures.**

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

Exercise 3	**Programs to demonstrate the usage of Functions and Recursion**

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

d. To convert decimal number to Binary equivalent 8. Program with a function that accepts two arguments: a list and a number ‗n‘. It should display all the numbers in the list that are greater than the given number ‗n‘. 9. Program with a function to find how many numbers are divisible by 2, 3,4,5,6 and 7 between 1 to 1000.	
Exercise 4	**Programs to demonstrate the usage of String functions.**
10. Program that accepts two strings S1, S2, and finds whether they are equal are not. 11. Program to count the number of occurrences of characters in each string. 12. Program to find whether a given string is palindrome or not.	
Exercise 5	**Programs to demonstrate the usage of lists, sets, dictionaries, tuples and files.**
13. Simple sorting, Histogram, Students marks statement, Retail bill preparation 14. Write a program that combines lists L1 and L2 into a dictionary. 15. Program to display a list of all unique words in a text file and word count, copy file, Voter‘s age validation, Marks range validation (0-100).	
Exercise 6	**Programs to demonstrate the usage of Object-Oriented Programming**
16. Program to implement the inheritance. 17. Program to implement polymorphism	
	TOTAL: 60 PERIODS
COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Develop algorithmic solutions to simple computational problems.
CO2:	Develop and execute simple Python programs.

CO3:	Construct programs in Python using conditionals and loops for solving problems.
CO4:	Utilize functions to decompose a Python program.
CO5:	Analyse compound data using Python data structures.
CO6:	Interpret data from/to files in Python Programs

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

Recommended by Board of Studies	**02-08-2023**		
Approved	**1st ACM**	**Date**	**09-09-2023**

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

COURSE OBJECTIVES:

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

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

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

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

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

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

Recommended by Board of Studies	**02-08-2023**		
Approved	**1st ACM**	**Date**	**09-09-2023**

<table>
<tr><td rowspan="2">23HS201</td><td rowspan="2" colspan="2">PROFESSIONAL ENGLISH</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="7">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="7">
• To help learners extract information from longer, technical and scientific texts
• To familiarize learners with different text structures by engaging them in reading, writing and grammar learning activities
• To help learners write coherent, extensive reports and essays.
• To enable learners to use language efficiently while expressing their opinions in professional and business situations
</td></tr>
<tr><td>UNIT I</td><td colspan="5">WORKPLACE COMMUNICATION</td><td>9</td></tr>
<tr><td colspan="7">Reading – Reading brochures (technical context), advertisements, telephone messages, gadget reviews social media messages, digital communication relevant to technical contexts and business. Writing – Writing emails -emails on professional contexts including introducing oneself, writing checklist, writing single sentence definition, product description- advertising or marketing slogans, Language Development– Tenses, Concord, Question types: Wh/ Yes or No/ and Tags, imperative sentences, complex sentences. Vocabulary - One-word substitutes; Abbreviations & Acronyms as used in technical contexts and social media.</td></tr>
<tr><td>UNIT II</td><td colspan="5">EXPRESSING CAUSE AND EFFECT</td><td>9</td></tr>
<tr><td colspan="7">Reading - Reading longer technical texts– Cause and Effect Essays, and emails of complaint. Writing - writing complaint emails (raising tickets) and responses to complaints, writing Cause and effect paragraphs and essays. Language Development– Active, Passive and Impersonal Passive Voice transformations, Infinitive and Gerunds Vocabulary – Synonyms- contextual meaning of words, Same word acting as different parts of speech, causal expressions.</td></tr>
</table>

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

COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Summarize long technical and scientific text of not less than 500 words recognizing main ideas and specific details
CO2:	Demonstrate the understanding of more complex grammatical structures and diction while reading and writing
CO3:	Use appropriate expressions to describe process and product, compare and contrast data, analyze problems, provide solutions and prove an argument in writing
CO4:	Establish the ability to communicate effectively in professional environment through emails and reports

CO5:	Determine the language use appropriate for different social media platforms used for digital marketing
CO6:	Convert skills to assets and position themselves in job market through their own professional narratives
TEXT BOOKS:	
1	V. Chellammal, Deepa Mary Francis, K N Shoba, P R Sujatha Priyadharshini, Veena Selvam, English for Science & Technology I, Cambridge University Press and Assessment
2	V. Chellammal, Deepa Mary Francis, K N Shoba, P R Sujatha Priyadharshini, Veena Selvam, English for Science & Technology II, Cambridge University Press and Assessment
REFERENCES:	
1	Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., 2001, New Delhi.
2	Developing Communication Skills by Krishna Mohan, Meera Bannerji- Macmillan India Ltd. 1990, Delhi.

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

Recommended by Board of Studies	**02-08-2023**		
Approved	**1st ACM**	**Date**	**09-09-2023**

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

COURSE OBJECTIVES:

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

UNIT I	TESTING OF HYPOTHESIS	9+3

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

UNIT II	DESIGN OF EXPERIMENTS	9+3

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

UNIT III	SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS	9+3

Solution of algebraic and transcendental equations - Fixed point iteration method – Newton Raphson method- Solution of linear

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

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

TEXT BOOKS:	
1	Grewal. B.S. and Grewal. J.S., “Numerical Methods in Engineering and Science ", 10th Edition, Khanna Publishers, New Delhi, 2015.
2	Johnson, R.A., Miller, I and Freund J., “Miller and Freund’s Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.
REFERENCES:	
1	P. Sivarama Krishna Das “A Text Book of Statistics and Numerical Methods” Viji’s Academy.
2	Burden, R.L. and Faires, J.D. “Numerical Analysis” 9th Edition, Cengage Learning, 2016.
3	Devore.J.L “ Probability and Statistics for Engineering and the Sciences”, Cengage Learning, New Delhi, 8th Edition, 2014
4	Gerald.C.F. and Wheatley.P.O. “Applied Numerical Analysis” Pearson Education, Asia, New Delhi, 7th Edition, 2007

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

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

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

COURSE OBJECTIVES:

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

UNIT I	CRYSTALLOGRAPHY	9

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

UNIT II	ELECTRICAL AND MAGNETIC PROPERTIES OF MATERIALS	9

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

<table>
<tr><td>UNIT III</td><td>SEMICONDUCTORS AND TRANSPORT PHYSICS</td><td>9</td></tr>
<tr><td colspan="3">Intrinsic Semiconductors – Energy band diagram – direct and indirect band gap semiconductors – Carrier concentration in intrinsic semiconductors – extrinsic semiconductors - Carrier concentration in N-type & P-type semiconductors – Variation of carrier concentration with temperature – Carrier transport in Semiconductors: Drift, mobility and diffusion (qualitative) – Hall effect and devices – Ohmic contacts – Schottky diode – introduction to solid state drive (SSD).</td></tr>
<tr><td>UNIT IV</td><td>OPTICAL PROPERTIES OF MATERIALS</td><td>9</td></tr>
<tr><td colspan="3">Classification of optical materials – Optical processes in semiconductors: optical absorption and emission, charge injection and recombination, optical absorption loss and gain. Optical processes in quantum wells – Optoelectronic devices: light detectors and solar cells – light emitting diode – laser diode - optical processes in organic semiconductor devices –excitonic state.</td></tr>
<tr><td>UNIT V</td><td>NANOELECTRONIC DEVICES</td><td>9</td></tr>
<tr><td colspan="3">Quantum confinement – Quantum structures – quantum wells, wires and dots – Zener-Bloch oscillations – Resonant tunnelling – quantum interference effects - mesoscopic structures - Single electron phenomena – Single electron Transistor. Active and passive optoelectronic devices – photo processes – spintronics – carbon nanotubes: Properties and applications.</td></tr>
<tr><td colspan="3" align="right">TOTAL: 45 PERIODS</td></tr>
<tr><td colspan="3">COURSE OUTCOMES:</td></tr>
<tr><td colspan="3">After completion of the course, the students will be able to:</td></tr>
<tr><td>CO1:</td><td colspan="2">Apply the basics of crystallography and its importance in studying materials properties.</td></tr>
<tr><td>CO2:</td><td colspan="2">Compute charge carrier density of metals and fermi energy level.</td></tr>
<tr><td>CO3:</td><td colspan="2">Apply the knowledge of magnetic properties of materials in</td></tr>
</table>

	data storage
CO4:	Compute carrier concentration in intrinsic and extrinsic semiconductor.
CO5:	Build a sound grasp of knowledge in different optical properties of materials, optical displays and applications.
CO6:	Develop an idea of significance of nano structures, quantum confinement and ensuring nano device applications
TEXT BOOKS:	
1	V.Raghavan. Materials Science and Engineering: A First Course, Prentice Hall India Learning Private Limited, 2015.
2	Jasprit Singh, Semiconductor Optoelectronics: Physics and Technology, Mc- Graw Hill India (2019.
3	G.W.Hanson. Fundamentals of Nanoelectronics. Pearson Education (Indian Edition), 2009.
REFERENCES:	
1	R.Balasubramaniam, Callister's Materials Science and Engineering. Wiley (Indian Edition), 2014.
2	Wendelin Wright and Donald Askeland, Essentials of Materials Science and Engineering, CL Engineering, 2013.
3	Robert F.Pierret, Semiconductor Device Fundamentals, Pearson, 2006
4	Pallab Bhattacharya, Semiconductor Optoelectronic Devices, Pearson, 2017.
5	Ben Rogers, Jesse Adams and Sumita Pennathur, Nanotechnology: Understanding Small Systems, CRC Press, 2017.

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

Recommended by Board of Studies	**14-08-2023**		
Approved	**1st ACM**	**Date**	**09-09-2023**

<table>
<tr><td rowspan="2">23ME201</td><td rowspan="2" colspan="2">APPLIED MECHANICS</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="7">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="7">• Inculcate the ability to analyze any problem in a simple and logical manner.
• Learn the use of scalar and vector analytical techniques for analyzing forces in staticallydeterminate structures.
• Introduce the equilibrium of rigid bodies, vector methods and free body diagram.
• Learn the principles of friction, forces and to determine and apply the concepts offrictional forces at the contact surfaces of various engineering systems.
• To develop basic dynamics concepts such as force, momentum, work and energy.
• To apply the well understood basic principles for the real time.</td></tr>
<tr><td>UNIT I</td><td colspan="5">BASICS AND STATICS OF PARTICLES</td><td>9</td></tr>
<tr><td colspan="7">Introduction – Laws of Mechanics – Lami‘s theorem, Parallelogram and triangular Law of forces - vector representation of forces – Vector operations of forces -additions, subtraction, dot product, cross product - Coplanar Forces - rectangular components - Equilibrium of a particle – Forces in space – Equilibrium of a particle in space - Equivalent systems of forces, Free body diagram</td></tr>
<tr><td>UNIT II</td><td colspan="5">EQUILIBRIUM OF RIGID BODIES</td><td>9</td></tr>
<tr><td colspan="7">Principle of transmissibility - Varignon‘s theorem -Types of supports - Action and reaction forces - stable equilibrium - Moment of a force about a point and about an axis – Single equivalent force - Equilibrium of rigid bodies in two dimensions - Equilibrium of rigid bodies in three dimensions, Analysis of Trusses – Method of Joints and Method of sections</td></tr>
</table>

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

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Apply law of forces on particles.
CO2:	Calculate forces on rigid bodies.
CO3:	Determine reaction forces at the support
CO4:	Calculate area moment of inertia of planar body and mass moment of inertia of rigid bodies.
CO5:	Determine friction and its effects at the surfaces of contact for ladder, wedge, belt and bearings.
CO6:	Calculate dynamic forces on rigid bodies.

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

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

Recommended by Board of Studies	**14-08-2023**		
Approved	**1st ACM**	**Date**	**09-09-2023**

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

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

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

REFERENCES:	
1	Dr.S.Singaravelu ,"Social Life of the Tamils - The Classical Period", Published by: International Institute of Tamil Studies.
2	Dr.S.V.Subatamanian , Dr.K.D. Thirunavukkarasu, "Historical Heritage of the Tamils", Published by: International Institute of Tamil Studies

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

Recommended by Board of Studies	**14-08-2023**		
Approved	**1st ACM**	**Date**	**09-09-2023**

<table>
<tr><td rowspan="2">23EE281</td><td rowspan="2">BASIC ELECTRICAL AND ELECTRONICS ENGINEERING</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>2</td><td>0</td><td>2</td><td>3</td></tr>
<tr><td colspan="6">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="6">To introduce the basics of electric circuits and analysis
To impart knowledge in the basics of working principles and application of electrical machines
To introduce analog devices and their characteristics
To educate on the fundamental concepts of digital electronics, functional elements and working of measuring instruments
To demonstrate the load test on DC machines, working of PN Junction diodes, Zener diodes and rectifiers.</td></tr>
<tr><td>UNIT I</td><td colspan="4">ELECTRICAL CIRCUITS</td><td>6</td></tr>
<tr><td colspan="6">DC Circuits: Circuit Components: Conductor, Resistor, Inductor, Capacitor– Ohm ‘s Law-Kirchhoff‘s Laws -Nodal Analysis, Mesh analysis with independent sources only (Steady State)- Introduction to AC Circuits –Steady state analysis of RL, RC, and RLC circuits (Simple problems only).</td></tr>
<tr><td>UNIT II</td><td colspan="4">ELECTRICAL MACHINES</td><td>6</td></tr>
<tr><td colspan="6">Construction and Working principle of DC Generators, EMF equation, Types and Applications- Working Principle of DC motors, Torque Equation, Types and Applications. -Construction, Working principle and Applications of Single-Phase Transformer.</td></tr>
<tr><td>UNIT III</td><td colspan="4">ANALOG ELECTRONICS</td><td>6</td></tr>
<tr><td colspan="6">PN Junction Diodes, Zener Diode–Characteristics & Applications–Bipolar Junction Transistor, JFET, SCR, MOSFET, – Types, I-V Characteristics and Applications – Rectifier.</td></tr>
<tr><td>UNIT IV</td><td colspan="4">DIGITAL ELECTRONICS</td><td>6</td></tr>
<tr><td colspan="6">Review of number systems, Combinational logic (adder and subtractor) – representation of logic functions-SOP and POS forms, K-map representations and minimization using K-maps (up to 3 variables).</td></tr>
</table>

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

LAB COMPONENT

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

Total : 30 + 30 = 60 Periods

COURSE OUTCOMES:

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

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

TEXT BOOKS:	
1	Kothari D P and I.J Nagrath,—Basic Electrical and Electronics Engineering‖ , Second Edition, McGraw Hill Education,2020
2	Sedha R. S.,—A textbook book of Applied Electronics‖, S. Chand & Co.,2008
3	A.K. Sawhney, Puneet Sawhney ‗A Course in Electrical & Electronic Measurements & Instrumentation', Dhanpat Rai and Co, 2015.
REFERENCES:	
1	Kothari D P and I.J Nagrath, —Basic Electrical Engineering‖, Fourth Edition, Mc Graw Hill Education, 2019.
2	S.K. Bhattacharya —Basic Electrical and Electronics Engineering‖, Pearson Education, Second Edition, 2017.
3	Thomas L. Floyd,‗ Digital Fundamentals', 11thEdition,Pearson Education,2017.
4	Albert Malvino, David Bates, ‗Electronic Principles, McGraw Hill Education; 7th edition, 2017.
5	Mahmood Nahvi and Joseph A. Edminister, —Electric Circuits‖, 86 Schaum 'Outline Series, McGraw Hill, 2002.
6	H.S. Kalsi, ‗Electronic Instrumentation' , Tata McGraw-Hill, New Delhi, 2010
7	James A. Svoboda, Richard C. Dorf,— Dorf's Introduction to Electric Circuits‖, Wiley, 2018.

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

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

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

COURSE OBJECTIVES:

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

UNIT I	PLANE CURVES	9+6

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

LIST OF EXERCISES:

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

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

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

LIST OF EXERCISES:

1. Draw the projection of points when it is placed in different quadrants
2. Draw the projection of lines when it is placed in first quadrant
3. Draw the planes when it is placed in first quadrant.

UNIT III	PROJECTION OF SOLIDS AND FREE HAND SKETCHING	9+6

Projection of simple solids - hexagonal prism, pentagonal pyramid and cone inclined to the horizontal plane by rotating object method. Free Hand sketching: Visualization principles - Representation of Three Dimensional objects - Layout of views - Free hand sketching of multiple views from pictorial views of objects

LIST OF EXERCISES:

1. Practicing three dimensional modelling of simple objects.
2. Drawing of orthographic views from the given pictorial diagram

UNIT IV	PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES	9+6

Sectioning of hexagonal prism, pentagonal pyramid and cone when the cutting plane is inclined to the horizontal plane, Development of lateral surfaces of simple and sectioned solids – hexagonal prism and cone cut by a plane inclined to horizontal plane only.

LIST OF EXERCISES:

1. Draw the sectioned views of prisms and pyramids
2. Draw the development of hexagonal prism cut by a section

plane inclined to the horizontal plane		
UNIT V	**ISOMETRIC PROJECTION**	**9+6**
Principles of isometric projection - Isometric scale – Isometric view - Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions. **LIST OF EXERCISES:** 1. Drawing Isometric view and projection of simple solids. 2. Drawing three dimensional modeling of isometric projection of combination of solids.		
		TOTAL: 75 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Construct the conic curves, involutes and cycloids.
CO2:	Develop and Sketch the orthographic projections of points, lines and plane surfaces.
CO3:	Develop and Sketch the orthographic projections of simple solids.
CO4:	Construct the projections of sectioned solids and development of the lateral surfaces of solids.
CO5:	Develop and Sketch the isometric sections of solids.
CO6:	Develop and Sketch the orthographic projection 2D and 3D objects using Auto CAD.
TEXT BOOKS:	
1	Bhatt N.D. and Panchal V.M., ―Engineering Drawing‖, Charotar Publishing House, 53rd Edition, 2019.
2	Basant Agarwal and Agarwal C.M.,―Engineering Drawing‖, McGraw Hill, 2nd Edition, 2019
REFERENCES:	
1	Natrajan K.V., ―A Text Book of Engineering Graphics‖, Dhanalakshmi Publishers, Chennai, 2018.

2	Gopalakrishna K.R., —Engineering Drawing‖ (Vol. I and II combined), Subhas Publications, Bangalore, 27th Edition, 2017.
3	Luzzader, Warren.J. and Duff, John M., —Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
4	Parthasarathy N. S. and Vela Murali, —Engineering Graphics‖, Oxford University, Press, New Delhi, 2015. 5. Shah M.B., and Rana B.C., —Engineering Drawing‖, Pearson Education India, 2nd Edition, 2009.
5	Venugopal K. and Prabhu Raja V., —Engineering Graphics", New Age International (P) Limited, 2008.

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

Recommended by Board of Studies	**14-08-2023**		
Approved	**1st ACM**	**Date**	**09-09-2023**

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

COURSE OBJECTIVES:

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

PART I	CIVIL ENGINEERING PRACTICES	15

PLUMBING WORK

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

WOOD WORK a) Sawing b) Planning c) Making of T-Joint, Mortise joint and Tenon joint and Dovetail joint. **WOOD WORK STUDY** a) Study of joints in door panels and wooden furniture **b)** Study of common industrial trusses using models.		
PART II	**MECHANICAL ENGINEERING PRACTICES**	**15**
WELDING WORK a) Study of Welding and its tools. b) Welding of Butt Joints, Lap Joints and Tee Joints by metal arc welding. c) Study of Gas Welding. **BASIC MACHINING PRACTICE** a) Facing and Plain Turning b) Taper Turning c) Drilling and Tapping **SHEET METAL WORK** a) Forming and Bending b) Making of a square Tray **MACHINE ASSEMBLY WORK** a) Study of Centrifugal Pump b) Study of Air Conditioner **FOUNDRY PRACTICE** Demonstration on Foundry operations like mould preparation.		
		TOTAL : 30 PERIODS

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

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

Recommended by Board of Studies	**14-08-2023**		
Approved	**1st ACM**	**Date**	**09-09-2023**

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

COURSE OBJECTIVES:

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

LIST OF EXPERIMENTS:

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

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

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

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

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

COURSE OBJECTIVES:		
• To help learners improve their interpersonal skills and critical thinking • To familiarize learners with the attributes of a leader to enhance team performance • To prepare students to face job interviews • To help learners to know the importance of ethics in work place		
UNIT I	INTERPERSONAL COMMUNICATION	
Basic communication- verbal and non-verbal communication; passive, assertive and aggressive communication; presentation skills; giving feedback and responding to feedback.		
UNIT II	TEAM WORK AND LEADERSHIP	
Vision- setting realistic goals and objectives, collaboration, cooperation, dependability, empathy, sympathy, motivation, delegation of responsibilities, open mindedness, creativity, flexibility, adaptability, cross cultural communication and group dynamics.		
UNIT III	TIME MANAGEMENT AND STRESS MANAGEMENT	
Effective Planning, Planning activities at macro and micro levels, setting practical deadlines and realistic limits/targets, punctuality, prioritizing activities, spending the right time on the right activity, positive attitude, emotional intelligence, self- awareness and regulation.		
UNIT IV	CRITICAL THINKING AND WORK ETHICS	
Questioning, analysing, inferencing, interpreting, evaluating, solving problems, explaining, self-regulation, open-mindedness, conflict management- ethical dilemmas, appearance, attendance, attitude, character, organizational skills, productivity, respect.		

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

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Express their thoughts, opinions and ideas confidently to one or more people in spoken form
CO2:	Develop evolving competences required for professional success
CO3:	Demonstrate knowledge and skills in a group as team player and leader
CO4:	Compose a comprehensive resume reflecting qualifications, exposure and achievements
CO5:	Exhibit knowledge and skills confidently during job interviews
CO6:	Demonstrate ethical and professional behaviour at workplace in all situations
TEXT BOOKS:	
1	Soft Skills: Key to Success in Workplace and Life by Meenakshi Raman & Shalini Upadhyay. Cengage
REFERENCES:	
1	English for Job Seekers (Language and Soft Skills for the Aspiring) by Geetha Rajeevan, C.L.N. Prakash) Cambridge University Press pvt, Ltd.
2	Business Benchmark by Norman Whitby. Cambridge University Press pvt, Ltd

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

Recommended by Board of Studies	**14-08-2023**		
Approved	**1st ACM**	**Date**	**09-09-2023**

SEMESTER –III

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

COURSE OBJECTIVES:

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

UNIT I	PARTIAL DIFFERENTIAL EQUATIONS	9+3

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

UNIT II	FOURIER SERIES	9+3

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

UNIT III	APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS	9+3

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

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

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

2	Grewal.B.S., “Higher Engineering Mathematics”, Khanna Publishers, New Delhi, 44th Edition, 2018.
3	P.Sivaramakrishna Das and C.Vijayakumari “A Text Book on TPDE” Pearson Publications
REFERENCES:	
1	Kreyszig.E, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.
2	Grewal.B.S., “Higher Engineering Mathematics”, Khanna Publishers, New Delhi, 44th Edition, 2018.

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

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

<table>
<tr><td rowspan="2">23AU301</td><td rowspan="2">THERMODYNAMICS AND HEAT TRANSFER</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="6">To explain and apply the laws of thermodynamics and analyze air standard cycles.
To demonstrate Steam power cycles and Refrigeration and Air conditioning cycles.
To develop the ability to solve complex heat transfer problems using mathematical and analytical methods and design heat exchangers for efficient heat transfer.</td></tr>
<tr><td>UNIT I</td><td colspan="4">BASIC THERMODYNAMICS</td><td>9</td></tr>
<tr><td colspan="6">Systems, closed, open and isolated. Property, state, path and process, quasi-static process, Zeroth law, first law. Steady flow energy equation. Engineering Applications of Steady flow energy equation. Heat and work transfer in flow and non-flow processes. Second law, Kelvin-Planck statement – Clausius statement.</td></tr>
<tr><td>UNIT II</td><td colspan="4">AIR STANDARD CYCLES AND COMPRESSORS</td><td>9</td></tr>
<tr><td colspan="6">Cycle, Carnot cycle, Otto, Diesel, Dual combustion and Brayton cycles; Calculation of Air standard efficiency. Compressors, Classifications of compressors, reciprocating compressor- Rotary, Axial and Vane compressors.</td></tr>
<tr><td>UNIT III</td><td colspan="4">STEAM PROPERTIES AND CYCLE</td><td>9</td></tr>
<tr><td colspan="6">Formation of steam and its thermodynamic properties, T-s and h-s diagrams. Properties of steam, Dryness fraction, Quality of steam by steam tables and Mollier chart – Simple Rankine cycle, Efficiency, Steam Nozzles, Types of nozzles, Friction in nozzles (descriptive).</td></tr>
<tr><td>UNIT IV</td><td colspan="4">REFRIGERATION AND AIR-CONDITIONING</td><td>9</td></tr>
<tr><td colspan="6">Construction and working principles of refrigeration, Vapour compression system - Vapour absorption types, Comparison – Definition of Co-efficient of performance (COP), Properties of</td></tr>
</table>

refrigerants – Basic principle, summer, winter and year round Air conditioning.		
UNIT V	**INTRODUCTION TO HEAT TRANSFER**	**9**
Modes of heat transfer, Heat conduction in parallel, radial and composite wall – Heat conduction through hollow and composite cylinders. Basics of Convective heat transfer and Fundamentals of radiative heat transfer (descriptive only) – Types of heat exchangers, Logarithmic Mean Temperature Difference (LMTD).		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1:	Demonstrate the understanding of fundamental thermodynamic concepts.
CO2:	Interpret the laws of thermodynamics and its application to systems and cycles.
CO3:	Solve any flow specific problem in an engineering approach based on basic concepts and logic sequences.
CO4:	Compare and contrast between various types of refrigeration and air conditioning cycles.
CO5:	Categorize the modes of heat transfer and solve problems involving heat conduction through various materials.
CO6:	Examine the amount of heat transfer by heat exchanger.

TEXT BOOKS:

1	Chattopadhyay. P "Engineering Thermodynamics", oxford University Press, New Delhi, 2nd Edition, 2016.
2	Nag. P.K., "Engineering Thermodynamics", Tata McGraw-Hill, New Delhi, 6th edition, 2017.

REFERENCES:

1	Arora C.P, "Thermodynamics", Tata McGraw-Hill, New Delhi, 2003.
2	Holman. J. P., "Thermodynamics", 3rd Ed. McGraw-Hill, 2007.

3	Mathur & Sharma Steam Tables, Jain Publishers, New Delhi, 2013,
4	Merala C, Pother, Craig W, Somerton, “Thermodynamics for Engineers”, Schaum Outline Series, Tata McGraw-Hill, New Delhi, 2004.

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

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

23AU302	AUTOMOTIVE ENGINES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To acquire knowledge on the primary engine components and the subsystems of automotive engines.
- To understand spark ignition and compression ignition engines fuel systems in Automotives.
- To develop understanding of combustion process in SI and CI engines and the requirements of cooling and lubrication systems.

UNIT I	ENGINE FUNDAMENTALS	9

Engine types and their operation- classifications – Terminology- Four stroke and two stroke cycle- Engine components, working principle of SI and CI engines - Engine operating parameters- Fuel – air and actual cycle analysis – Engine emissions – valve and port timing diagram – firing order.

UNIT II	FUEL SUPPLY SYSTEM AND IGNITION SYSTEM	9

SI Engine: Air – Fuel ratio, Simple Carburetor – Injection systems – Single point and Multipoint fuel injection – Gasoline Direct Injection. Ignition System – Battery Ignition System – Magneto Ignition System – Electronic Ignition Systems. **CI Engine:** Jerk type fuel injection pump – Distributor type fuel injection pump. Common rail direct injection system – Fuel injector

UNIT III	COMBUSTION IN SI ENGINES	9

Combustion process – Stages of combustion, Flame propagation – Flame velocity and area of flame front – Rate of pressure rise – Cycle to cycle variation, Abnormal combustion – Effect of engine operating and design variables on combustion, Combustion chambers – Types, Factors controlling combustion chamber design.

UNIT IV	COMBUSTION IN CI ENGINES	9

Importance of air motion – Swirl, squish and tumble – Swirl ratio. Fuel air mixing – Stages of combustion – Delay period –

Factors affecting delay period, Knock in CI engines – Methods of controlling diesel knock. CI engine combustion chambers – Combustion chamber design objectives – Open and divided. Induction swirl, turbulent combustion chambers. – Air cell chamber – Combustion chamber.		
UNIT V	**ENGINE SUBSYSTEM**	**9**
Types of cooling systems and its working, Properties of coolants. Crankcase ventilation. Engine lubrication – Types of lubricating systems and its working – Supercharging and Turbocharging – Types – Working principle.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Outline the construction and working of IC engine and its cycle.
CO2:	Explain the various fuel system, injection system and ignition system used in SI and CI engines.
CO3:	Demonstrate the combustion process in SI Engine for understanding the performance and emission characteristics.
CO4:	Demonstrate the combustion process in CI Engine for understanding the performance and emission characteristics.
CO5:	Summarize the working of lubrication and cooling system.
CO6:	Apply the concept of turbo-charging and super-charging for engine performance enhancement.
TEXT BOOKS:	
1	Ganesan V, "Internal combustion engines", 4th edition, Tata McGraw Hill Education, 2017.
2	M.L. Mathur and R.P.Sharma, Internal Combustion Engine, Dhanpath Rai Publications (P) Ltd, New Delhi 110002.

REFERENCES:

1	Rajput R. K, "A textbook of Internal Combustion Engines – 2nd edition, Laxmi Publications (P) Ltd, 2017.
2	Heinz Hesiler, Advanced engine technology. Butterworth Heinmann publications, 1995.
3	Heldt, P.M., High Speed Combustion Engines, Oxford IBH Publishing Co., Calcutta, 1965.
4	K. K. Ramalingm, Internal Combustion Engines, SciTech publications, Chennai, 2018.

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

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

23HS301	UNIVERSAL HUMAN VALUES AND ETHICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To develop a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
- To understand (or developing clarity) the harmony in the human being, family, society and nature/existence.
- To strengthen the self-reflection.
- To develop commitment and courage to act.

UNIT I	COURSE INTRODUCTION	9

Need, Basic Guidelines, Content and Process for Value Education - Understanding the need, basic guidelines, content and process for Value Education -Self Exploration–what is it? - its content and process; 'Natural Acceptance' and Experiential Validation- as the mechanism for self exploration - Continuous Happiness and Prosperity- A look at basic Human Aspirations -Right understanding, Relationship and Physical Facilities- the basic requirements for fulfilment of aspirations of every human being with their correct priority -Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario - Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

UNIT II	UNDERSTANDING HARMONY IN THE HUMAN BEING	9

Harmony in Myself- Understanding human being as a co-existence of the sentient 'I' and the material 'Body' -Understanding the needs of Self ('I') and 'Body' - Sukh and Suvidha- Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer) -Understanding the characteristics and activities of 'I' and harmony in 'I' -Understanding the harmony of I with the Body: Sanyam and Swasthya; correct appraisal of Physical needs, meaning of Prosperity.

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

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Explain the need of value education.
CO2:	Interpret the difference between self and body.

CO3:	Demonstrate the need to exist as a unit of Family and society.
CO4:	Classify Harmony at all levels.
CO5:	Apply the values acquired in the professional front.
CO6:	Identify appropriate technologies for ecofriendly production systems.
TEXT BOOKS:	
1	R R Gaur, R Sangal, G P Bagaria,Human Values and Professional Ethics, Excel Books, New Delhi, 2010 3.
2	Mike W. Martin and Roland Schinzinger, ―Ethics in Engineering‖, Tata McGraw Hill, New Delhi, 2003.
3	Govindarajan M, Natarajan S, Senthil Kumar V. S, ―Engineering Ethics‖, Prentice Hall of India, New Delhi, 2004
REFERENCES:	
1	Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2	Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3	The Story of Stuff (Book).
4	The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi AICTE Model Curriculum in Humanities, Social Science and Management Courses (UG Engineering & Technology) 169 | Page .
5	Small is Beautiful - E. F Schumacher.
6	Slow is Beautiful - Cecile Andrews.
7	Economy of Permanence - J C Kumarappa 8. Bharat Mein Angreji Raj – Pandit Sunderlal.
8	Rediscovering India - by Dharampal.
9	Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi.
10	India Wins Freedom - Maulana Abdul Kalam Azad.
11	Vivekananda - Romain Rolland (English) 13. Gandhi - Romain Rolland (English).
12	Charles B. Fleddermann, ―Engineering Ethics‖, Pearson Prentice Hall, New Jersey, 2004.

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

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	-	-	-	-	-	3	3	3	3	3	-	-	-	-	3
2	-	-	-	-	-	3	3	3	3	3	-	-	-	-	3
3	-	-	-	-	-	3	3	3	3	3	-	-	-	-	3
4	-	-	-	-	-	3	3	3	3	3	-	-	-	-	3
5	-	-	-	-	-	3	3	3	3	3	-	-	-	-	3
6	-	-	-	-	-	3	3	3	3	3	-	-	-	-	3
Overall Correlation	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**3**
Recommended by Board of Studies	**08-04-2024**														
Approved	**2nd ACM**					**Date**					**25-05-2024**				

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

COURSE OBJECTIVES:

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

UNIT I	METAL CASTING PROCESSES	9

Sand Casting: Sand Mould – Type of Patterns - Pattern Materials - Cores –Types and Applications –Melting Furnaces: Cupola Furnaces; Principle of Special Casting Processes: Shell - Investment – Pressure Die Casting - Centrifugal Casting – Stir Casting – CO2 Casting; Defects in Sand Casting Process-Remedies.

UNIT II	PRINCIPLES AND APPLICATIONS OF JOINING PROCESSES	9

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

UNIT III	FORMING PROCESSES	9

Hot and Cold Working of metal – Forging processes- Open, impression and closed die forging - Rolling Mills – Rolling Operations - Principle of rod and wire drawing – Principles of

Extrusion – Types – Hot and Cold extrusion. . Sheet metal operations – Blanking, Punching and Working principle and applications – Hydro forming – Metal spinning and Explosive forming,		
UNIT IV	**MECHANICS OF METAL CUTTING**	**9**
Mechanics of Chip Formation, Forces in Machining, Types of Chip, Cutting Tools – Single Point Cutting Tool Nomenclature, Orthogonal and Oblique Metal Cutting, Thermal Aspects, Cutting Tool Materials, Tool Wear, Tool Life, Surface Finish, Cutting Fluids.		
UNIT V	**TURNING, GEAR CUTTING, SHAPING AND FINISHING PROCESSES**	**9**
Centre Lathe, Constructional Features, Specification, Operations - Taper Turning Methods, Thread Cutting- Capstan and Turret Lathes. Gear cutting, Gear hobbing and Gear shaping. Types of grinding Process – Cylindrical grinding, surface grinding and internal grinding, Shaper and Milling machines and operations		
		TOTAL: 45 PERIODS
LIST OF EXPERIMENTS:		
1. Preparing green sand moulds with cast patterns. 2. Taper Turning and Eccentric Turning on circular parts using lathe machine. 3. Knurling, external and internal thread cutting on circular parts using lathe machine. 4. Shaping – Square and Hexagonal Heads on circular parts using shaper machine. 5. Drilling using radial drilling machine. 6. Cutting spur and helical gear using milling machine. 7. Generating gears using gear hobbing machine. 8. Generating gears using gear shaping machine. 9. Grinding components using cylindrical grinding machine. 10. Grinding components using surface grinding machine		
		TOTAL: 30 PERIODS
COURSE OUTCOMES:		
After completion of the course, the students will be able to:		

CO1:	Explain the principle of different metal casting processes.
CO2:	Describe the various metal joining processes.
CO3:	Summarize various bulk deformation processes and sheet metal forming processes.
CO4:	Apply the mechanism of metal removal process and to identify the factors involved in Improving machinability.
CO5:	Explain the constructional and operational features of Centre lathe and other special purpose Lathes.
CO6:	Describe the constructional features of gear cutting and super finishing process.
TEXT BOOKS:	
1	Kalpakjian, S., "Manufacturing Engineering and Technology", Pearson education India, 4th Edition, 2009.
2	P.N.Rao Manufacturing Technology Volume 1 Mc Grawhill Education 5th edition, 2018.
REFERENCES:	
1	Rao. P.N "Manufacturing Technology," Metal Cutting and Machine Tools, Tata McGraw- Hill, New Delhi, 2009.
2	Hajra Chouldhary S.K and Hajra Choudhury. AK., Elements of workshop Technology, volume I and II, Media promoters and Publishers Private Limited, Mumbai, 1997
3	Sharma, P.C., A Text book of production Technology, S.Chand and Co. Ltd., 2004

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

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

23AU311	FUEL AND LUBRICANTS	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To study the world energy scenario in automotive sector and the conventional fuels for IC engines, its production, characteristics and additives.
- To impart the knowledge of alternate liquid fuels and gaseous fuels for engines with their compatibility, performance and emission characteristics.
- To know about the need of lubricants, factors influencing the lubricants and testing of fuels.

UNIT I	CONVENTIONAL FUELS FOR I.C. ENGINES	9

Petroleum based conventional fuels for SI and CI engine, Demand and Availability of crude oil – Production - National and International standards for conventional fuels. Crude Distillation, Chemical structure, desirable characteristics of SI Engine fuels – Petrol – Properties, Specification, Volatility characteristics, knock rating and additives. Desirable characteristics of CI Engine fuels – Diesel – Properties, Specification, Chemical structure, Ignition quality, Cetane rating and additives.

UNIT II	LIQUID FUELS	9

Need for alternative liquid fuels - Availability, Properties, Composition, Merits, Demerits, Performance and Emission characteristics of Methanol, Ethanol, Straight Vegetable Oil, Bio diesel (Esterification) and their blends.

UNIT III	GASEOUS FUELS	9

Need for alternative gaseous fuels – Availability, Properties, Composition, Merits, Demerits, Performance and Emission characteristics of Hydrogen, Compressed Natural Gas (CNG), Liquefied Petroleum Gas (LPG). Modifications required for LPG and CNG in the conventional engines.

UNIT IV	COMBUSTION OF FUELS	9
Stoichiometry – Calculation of theoretically correct air required for combustion of liquid and gaseous fuels – Volumetric and gravimetric analysis of the dry products of combustion, Mass of dry gas per kg of fuel burnt, Mass of carbon in the exhaust gas, Mass of carbon burnt to carbon monoxide per kg of fuel, Heat loss due to incomplete combustion.		
UNIT V	**LUBRICANTS AND TESTING OF FUELS**	**9**
Lubricants: Need for lubricants, engine friction, Effect of engine variables on friction requirements of automotive lubricants- Mineral & Synthetic, Classification of lubricating oils, Properties of lubricating oils, Additives and tests on lubricants – Grease, Classification, Properties, Testing of grease. **Testing of fuels:** Relative density, Calorific value, Distillation, Reid vapour pressure, Flash point, Spontaneous ignition temperature, Viscosity, Pour point, Flammability, Ignitability, Diesel index, API gravity and aniline point.		
		TOTAL: 45 PERIODS

LIST OF EXPERIMENTS:

1. Distillation test of liquid fuels
2. Aniline Point test of diesel.
3. Calorific value of liquid fuel.
4. Reid vapour pressure test.
5. Flash and Fire points of fuel and oil.
6. Copper strip Corrosion Test
7. Cloud & Pour point Test.
8. Temperature dependence of viscosity of lubricants by Redwood Viscometer.
9. Viscosity Index of lubricants by Saybolt Viscometer.
10. Ash content and Carbon Residue Test .
11. Drop point of grease and mechanical penetration in grease
12. Density determination of different fuels.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

CO1:	Explain the distillation process, additives for fuels and characteristics of fuels.
CO2:	Outline the need and performance characteristics of alternative liquid fuels for both SI and CI engines.
CO3:	Outline the need and performance characteristics of alternative gaseous fuels for both SI and CI engines.
CO4:	Analyze the correct air required for combustion of liquid and gaseous fuels.
CO5:	Explain the need for lubricants in automotives.
CO6:	Outline the testing procedure for various fuel properties.
TEXT BOOKS:	
1	B.P. Pundir, IC Engines – Combustion and Emissions, Narosa Publication, 2017.
2	S.S. Thipse, Alternative Fuels, JAICO Publishing House, 2010.
REFERENCES:	
1	EranSher ―Handbook of Air Pollution from Internal Combustion Engines-Pollutant Formation and Control, Academic Press, 2011.
2	Matthew Harrison, Vehicle refinement: controlling noise and vibration in road vehicles, Elsevier, Indian Edition, 2011.
3	Marco P Nuti, Emissions from two stroke engines, SAE Publication, 1998.
4	Sarkar, S, Fuels And Combustion‖, Oriented Longmann Press, 1990.

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

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

23AU321	COMPUTER AIDED DESIGN LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- To make the students understand and interpret drawings of machine components.
- To familiarize the students with Indian Standards on drawing practices and standard components.
- To gain practical experience in handling 2D drafting and 3D modelling software systems.

LIST OF EXPERIMENTS:

ENGINE DESIGN EXPERIMENTS

1. Design and modelling of piston, piston pin and piston rings.
2. Design and modelling of connecting rod assembly.
3. Design and modelling of crankshaft assembly.
4. Design and modelling of flywheel.
5. Design and drawing of the inlet and exhaust valves.
6. Design and modelling of cam and camshaft.

CHASSIS DESIGN EXPERIMENTS

1. Design and modelling of frame.
2. Design and modelling of clutch assembly.
3. Design and modelling of sliding mesh gearbox.
4. Design and modelling of propeller shaft with universal joint.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1:	Outline the drawing standards, Fits and Tolerances.
CO2:	Construct the part drawings, sectional views and assembly drawings as per standards.
CO3:	Utilize standard drawing layout for modelled parts with BoM.
CO4:	Interpret the importance of GD&T.
CO5:	Model various engine components.

CO6:	Model various chassis components.
TEXT BOOKS:	
1	Radhakrishnan P, Subramanyan S. and Raju V., “CAD/CAM/CIM”, 5th Edition, New Age International (P) Ltd, New Delhi,2023.
2	Mikell.P.Groover “Automation, Production Systems and Computer Integrated Manufacturing”, Prentice Hall of India, 2008.
REFERENCES:	
1	N. D. Bhatt and V.M. Panchal, “Machine Drawing”, 48th Edition, Charotar Publishers, 2013.
2	Junnarkar, N.D., “Machine Drawing”, 1st Edition, Pearson Education, 2004.
3	N. Siddeshwar, P. Kanniah, V.V.S. Sastri, ”Machine Drawing” , published by Tata Mc GrawHill, 2006.
4	S. Trymbaka Murthy, “A Text Book of Computer Aided Machine Drawing”, CBS Publishers, New Delhi, 2007.

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

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

23AU322	AUTOMOTIVE ENGINES LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- To associate various testing methodologies used in engine performance evaluation.
- To analyse and interpret test data obtained from engine testing and emission measurement.
- To display the regulatory framework governing engine emissions, including emission standards and testing protocols.

LIST OF EXPERIMENTS:

1. Study of Engine Dynamometers
2. Study of IC engine Pressure measurement systems for combustion analysis.
3. Performance study on petrol engine.
4. Performance study on diesel engine.
5. Determination of Frictional power on multi cylinder petrol/diesel engines.
6. Heat balance test on an automotive petrol/diesel engine
7. Measurement of HC, CO, CO_2, O_2 and NOx using exhaust gas analyser
8. Diesel smoke measurement.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1:	Identify the various emission measuring instruments.
CO2:	Demonstrate the various engine testing instruments.
CO3:	Explain the procedure to measure the emission.
CO4:	Examine the engine performance and emission characteristics.
CO5:	Summarize the available emission norms.

CO6:	Interpret data obtained from engine testing and emissions measurement.

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

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

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

COURSE OBJECTIVES:

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

UNIT I	BRAINSTORMING AND OUTLINING	6

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

UNIT II	STRUCTURING THE PRESENTATION	6

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

UNIT III	DELIVERY TECHNIQUES	6

Vocal variety, intonation, reducing filler words and improving articulation, inflection, engaging the audience. Body language- eye

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

COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Construct ideas for presentation through mind mapping techniques
CO2:	Organize ideas and structure the presentation with captivating introduction, body paragraphs illustrated with examples and reasons and compelling conclusion
CO3:	Apply vocal variety and body language techniques to enhance delivery
CO4:	Prepare engaging presentations by integrating multimedia elements
CO5:	Demonstrate proficiency in delivering presentations in remote platforms utilizing various technological tools and strategies to engage audience in Virtual environments
CO6:	Exhibit active listening skills by responding to questions with clarity and confidence and incorporating constructive feedback for professional development

TEXT BOOKS:

1	Nancy Duarte "Slide:ology: The Art and Science of Creating Great Presentations" O' Reilly Media.
2	Garr Reynolds "The Naked Presenter: Delivering Powerful Presentations with or Without Slides" New Riders.

REFERENCES:

1	Talk Like TED: The 9 Public-Speaking Secrets of the World's Top Minds" by Carmine Gallo.

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

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

SEMESTER –IV

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

COURSE OBJECTIVES:

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

UNIT I	LINEAR PROGRAMMING MODELS	9+3

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

UNIT II	TRANSPORTATION PROBLEMS AND ASSIGNMENT PROBLEMS	9+3

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

UNIT III	INVENTORY CONTROL	9+3

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

UNIT IV	PROJECT MANAGEMENT	9+3

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

UNIT V	CLASSICAL OPTIMIZATION THEORY	9+3

Unconstrained problems – necessary and sufficient conditions -

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

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

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

TEXT BOOKS:

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

REFERENCES:

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

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

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

23AU401	AUTOMOTIVE TRANSMISSION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To study the need and types of clutch and gearbox.
- To make the students understand the basic construction and working of hydrodynamic transmission systems and epicyclic gear.
- To realize about the importance of hydrostatic and electric drives.

UNIT I	CLUTCH AND GEAR BOX	9

Requirement of transmission system, Different types of clutches, Principle & Construction of single plate coil spring and diaphragm spring clutches, need and objectives of Gear box. Construction and operation of sliding mesh, Constant mesh and Synchromesh gearboxes. – Determination of gear ratios for vehicles. Performance of automobile such as resistance to motion, Tractive effort, Engine speed, Power and acceleration.

UNIT II	HYDRODYNAMIC TRANSMISSION	9

Fluid coupling – Principle - Constructional details. Torque capacity. Performance characteristics. Reduction of drag torque in fluid coupling. Torque Converter – Principle - Constructional details, Performance characteristics. Multistage torque converters and Polyphase torque converters.

UNIT III	EPICYCLIC GEARBOXES USED IN AUTOMATIC TRANSMISSION	9

Principle of planetary gear trains - Wilson Gear box, Simpson planetary gear train, Cotal electromagnetic transmission - Hydraulic control system for Automatic Transmission.

UNIT IV	AUTOMATIC TRANSMISSION APPLICATIONS	9

Automated Manual Transmission (AMT) - Need for automatic transmission, four speed longitudinally mounted automatic transmission – Chevrolet - Turboglide‖ Transmission,

Continuously Variable Transmission (CVT) – Types – Operations of a typical CVT.		
UNIT V	**HYDROSTATIC AND ELECTRIC DRIVE**	**9**
Principles of Hydrostatic drive, various types of hydrostatic systems. Advantages and limitations. Comparison of hydrostatic drive with hydrodynamic drive, Construction and working of typical Janny hydrostatic drive. Electric drive – types - Principle of early and modified Ward Leonard Control system - Advantages & limitations. Modern Electric drive.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Explain the construction and working of various clutch models.
CO2:	Select the gearbox based on the automotive performance requirement.
CO3:	Summarize the various hydrodynamic transmission systems based on the construction and working.
CO4:	Outline the working of epicyclic gears and its application in transmission.
CO5:	Examine the various automatic transmissions and its application.
CO6:	Outline the principles of hydrostatic and electric drives.
TEXT BOOKS:	
1	Heinz Hesiler, Advanced engine technology. Butterworth Heinmann publications, 2011
2	Devaradjane. Dr. G., Kumaresan. Dr. M., —Automobile Engineering, AMK Publishers, 2013.
REFERENCES:	
1	JackErkavec, Automotive Technology-A Systems approach, Cengage learning, Delmar, 2010.
2	Judge.A.W., Modern Transmission System, Chapman and Hall Ltd, 2000.

3	GarrettT.K., New ton. K., Steeds.W., —The Motor Vehicle Published: Butterworth Heinemann,13th Edition-2000.
4	Heldt, P.M., High-Speed Combustion Engines, Oxford IBH Publishing Co., Calcutta.

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

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

23AU402	AUTOMOTIVE ELECTRICAL AND ELECTRNOCS ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To provide students with a comprehensive understanding of vehicle electrical systems, including electrical circuits, power supply, and battery fundamentals.
- To provide students with a deep understanding of alternators, starter motors and automotive lighting technology in automotive applications.
- To provide students with a comprehensive understanding of automotive electronics, sensors, actuators, and vehicle networking.

UNIT I	INTRODUCTION AND AUTOMOTIVE BATTERIES	9

Introduction - Overview of vehicle electrical systems - Electrical circuits - Electrical power supply in conventional vehicle - Dimensioning of wires - Circuit diagrams and symbols - Electromagnetic Compatibility and interference suppression. Batteries – Battery design – Method of operation – Lead acid battery construction – Battery ratings and testing - Maintenance -Free batteries.

UNIT II	STARTING AND CHARGING SYSTEM	9

Alternators – Generation of electrical energy in vehicle - Physical principles - Alternator and voltage regulations versions – Power losses – Characteristics curve - Alternator operation in the vehicle - Alternator circuitry. Starter Motors – Development and Starting requirements in the IC engines - Starter motor design – Starter motor control and power circuits.

UNIT III	LIGHTING AND AUXILLARY SYSTEM	9

Automotive lighting technology – Technical demands – Development of lighting technology - Light sources – Physical principles – Front and rear lighting system - Interior lighting system – Special purpose lamps – Adaptive Lighting system -

Instrument clusters - Wiper and washer systems - Electric horns.		
UNIT IV	**AUTOMOTIVE ELECTRONICS AND SENSORS AND ACTUATOR**	**9**
Automotive Electronics - Overview and demands - Basic principles of semiconductor technology - Electronic Components - semiconductor components - Microcontrollers - Sensor - Signal Processing - Data Processing in the vehicle - Glossary for automotive microelectronics. Automotive Sensors – Basics – Sensors : Position, Speed, Acceleration / Vibrational, Force / Torque, Flow meters, Gas / Concentration, Temperature - Measured Quantities, Measuring Principles and automotive applications. Automotive Actuators - Electromechanical actuators – Fluid mechanical actuators.		
UNIT V	**VEHICLE NETWORKING**	**9**
Data transfer between automotive electronics systems - Basic principles of networking - Network topology - Network organization - OSI reference model - Control mechanisms - Communication protocols in embedded systems - Vehicle Communication Protocols – Cross-system functions - Requirements for bus systems- Classification of bus systems- Applications in the vehicle - Coupling of networks - Examples of networked Vehicles - Bus system- CAN, LIN, Flexray – MOST etc.		
		TOTAL: 45 PERIODS
COURSE OUTCOMES:		
After completion of the course, the students will be able to:		

CO1:	Illustrate the construction of automotive batteries and its charging system.
CO2:	Identify the mechanism of starter motor, and describe the working of starter motor and alternator in the vehicle.
CO3:	Summarize the lighting and auxiliary system in automobile.
CO4:	Outline the basic principle of semiconductor and its application in automobile.

CO5:	Select sensors and actuators based on the requirement of automotive system.
CO6:	Explain the various vehicle communication protocols in automobile.
TEXT BOOKS:	
1	Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive, 5th Edition, 2007.
2	S.V. Dishore, "Automotive Electrical and Electronics", Lakshmi Publications Chennai, 2019.
REFERENCES:	
1	James D Halderman, "Automotive Electrical and Electronics", Prentice Hall, USA 2013.
2	Tom Denton, "Automotive Electrical and Electronics Systems," Third Edition, SAE International, 2004.
3	William Ribbens, "Understanding Automotive Electronics - An Engineering Perspective", 7th Edition, Elsevier Butterworth-Heinemann Publishers, 2012.
4	Barry Holembeak, "Automotive Electrical and Electronics", Delmar Publishers Clifton Park, USA, 2010.

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

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

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

COURSE OBJECTIVES:

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

UNIT I	STRESS, STRAIN AND DEFORMATION OF SOLIDS	9

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

UNIT II	TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAMS	9

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

UNIT III	DEFLECTION OF BEAMS	9

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

UNIT IV	TORSION, SPRINGS AND COLUMNS	9

Theory of Torsion - Stresses and deformations in solid and

hollow circular shafts – Stepped shafts – Power transmitted by a shaft. Helical springs – Differences between closely coiled and open coiled helical springs – Closely coiled helical springs – Calculation of shear stress, deflection and stiffness. Columns – Euler's theory – Calculation of crippling load for different end conditions for a long column.		
UNIT V	**THIN CYLINDERS, SPHERES AND THICK CYLINDERS**	**9**
Stresses in thin and thick cylindrical shell, deformation in thin and thick cylinders – spherical shells subjected to internal pressure –Deformation in spherical shells.		
		TOTAL: 45 PERIODS

LIST OF EXPERIMENTS:

1. Tension test on mild steel rod
2. Double shear test on mild steel rod
3. Torsion test on mild steel rod
4. Izod Impact test on metal specimen
5. Charpy Impact test on metal specimen
6. Rockwell Hardness test on metals
7. Brinell Hardness test on metals
8. Compression test on helical spring.
9. Heat Treatment Processes- Annealing, Normalizing, Quenching and Tempering
10. Jominy End Quench Test

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

CO1:	Calculate the different stresses developed in the solids when subjected to different loading conditions.
CO2:	Analyse the shear force and bending moment diagrams of the beams under the various loading conditions.
CO3:	Examine the bending stress and shear stress distribution of various sections of the beam.

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

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

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

23AU421	AUTOMOTIVE ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- To understand the principles, components, and functions of vehicle lighting systems, including headlights, taillights, turn signals, and interior lighting, and their significance for safety and visibility.
- To provide students with a comprehensive understanding and practical skills in utilizing electronic instrumentation and microcontroller programming techniques for automotive applications.
- To develop proficiency in designing, implementing, and troubleshooting electronic systems essential for automotive diagnostics and control.

LIST OF EXPERIMENTS:

Electrical System

1. Study of Vehicle lighting system.
2. Study of an Ignition system.
3. Study of Layout of an Automotive Electrical System.
4. Study of Voltage regulator, solenoids, Horn and wiper mechanism.
5. Testing of Battery – Hydrometer, Individual Cell voltage test.
6. Testing of Starter Motor – Load test
7. Testing of Alternator – Load test.

Electronic System

1. Visualization of Engine Sensor Signals and fault Diagnosis using OBD Kit.
2. Interface of Seven segment display.
3. Interfacing of ADC for a sensor and Interfacing of DAC actuator
4. Interface circuit like amplifier, filter, Multiplexer and De Multiplexer

5. Basic microprocessor programming like arithmetic and Logic operation, code conversion, look up table etc.
6. Programming in microcontroller
7. Study of Virtual Instrumentation and Communication Protocols (CAN, LIN MOST)

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1:	Explain the working principle of Electrical circuits in automobile
CO2:	Outline the working principle of Ignition system.
CO3:	Demonstrate the working principle of Battery, and starter motor
CO4:	Summarize the working principle of auxiliary systems used in automobiles.
CO5:	Explain the use of sensors in an automobile.
CO6:	Develop programming knowledge on Microprocessor.

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

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

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

COURSE OBJECTIVES:

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

UNIT I		4

Numbers, LCM, HCF, Averages, Ratio & Proportion, Mixtures & Allegation.

UNIT II		4

Percentages, Time and work, Pipes and Cistern, coding and decoding.

UNIT III		4

Time Speed Distance, Train, Boats and Streams, Analogy.

UNIT IV		4

Data Interpretation (BAR,PIE,LINE), Seating arrangement.

UNIT V		4

Simple Interest and Compound Interest, Profit loss and Discount, Partnership.

TOTAL: 20 PERIODS

COURSE OUTCOMES:

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

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

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

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

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

23AU422	MINI PROJECT -1	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

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

COURSE DESCRIPTION:

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

PROJECT OUTLINE:

Week 1	Course Orientation and Topic Selection
Week 2	Problem Definition and Objective Setting
Week 3	Literature Review and Research
Week 4	First Review and Feedback

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

EVALUATION:

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

- The evaluation will focus on how well the project is structured, including clarity and logical flow in both oral presentations and written texts.
- The relevance and innovation of the project will be assessed, particularly its potential to contribute to sustainability, innovation, and SDG-aligned goals.
- The accuracy of English usage, including grammar, clarity, and coherence, will be reviewed in both oral and written communication to ensure effective delivery of technical content.

COURSE OUTCOMES:

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

CO1:	Apply basic engineering principles to solve simple problems.
CO2:	Choose relevant sources to understand the current knowledge and identify areas to improve.
CO3:	Utilise basic tools and techniques to test simple solutions.
CO4:	Interpret the impact of engineering solutions on society and the environment.
CO5:	Combine in teams to plan and complete projects within given constraints.
CO6:	Develop comprehensive technical reports and deliver structured presentations to effectively convey project outcomes.

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

Recommended by Board of Studies	**01-04-2024**		
Approved	**2nd ACM**	**Date**	**25-05-2024**

SEMESTER -V

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

COURSE OBJECTIVES:

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

UNIT I	INTRODUCTION TO RESEARCH FORMULATION	6

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

UNIT II	LITERATURE REVIEW	6

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

UNIT III	DATA ANALYSIS	6

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

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

Structure and components of scientific reports - Types of report – Technical reports and thesis – Significance – Different steps in the preparation – Layout, structure and Language of typical reports – Illustrations and tables - Bibliography, types of referencing, citations- index and footnotes, how to write report-

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

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Analyze the literature to identify the research gap in the given area of research.
CO2:	Identify and formulate the research Problem
CO3:	Analyze and synthesize the data using research methods and knowledge to provide scientific interpretation and conclusion.
CO4:	Prepare research reports and proposals by properly synthesizing, arranging the research documents to provide comprehensive technical and scientific report
CO5:	Conduct patent database search in various countries for the research problem identified.
CO6:	Apply ethical principles in research and reporting to promote healthy scientific practice
TEXT BOOKS:	
1	Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An Introduction to Research Methodology, RBSA Publishers.
2	Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.

3	Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications. 2 volumes.
4	Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
5	Wadehra, B.L. 2000. Law relating to patents, Trade Marks, Copy right designs and Geographical indications. Universal Law Publishing
REFERENCES:	
1	Anthony, M., Graziano, A.M. and Raulin, M.L., 2009. Research Methods: A Process of Inquiry, Allyn and Bacon.
2	Carlos, C.M., 2000. Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options. Zed Books, New York.
3	Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.
4	Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.
5	Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
6	Leedy, P.D. and Ormrod, J.E., 2004 Practical Research: Planning and Design, Prentice Hall.
7	Satarkar, S.V., 2000. Intellectual property rights and copy right. ESS Publications.

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

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

23AU501	AUTOMOTIVE CHASSIS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the basics of various vehicle frames and learn about different types of front axles.
- To explore steering systems and their functions and study suspension systems of and their components.
- To gain knowledge about braking systems used in automobiles

UNIT I	INTRODUCTION	9

Types of chassis lay out with reference to power plant locations and drives, vehicle frames, various types of frames, passenger car frames, x member type frame, box section type frame, load acting on frames, constructional details, materials, sub frame, testing of vehicle frames, checking of frame alignment

UNIT II	FRONT AXLE AND STEERING SYSTEM	9

Types of front axles, construction details, materials, front wheel geometry: castor, camber, king pin inclination, toe-in and toe-out, condition for true rolling motion of wheels during steering, steering geometry, Ackermann and Davis steering system, constructional details of steering linkages, different types of steering gear boxes, slip angle, over–steer and under steer, turning radius, wheel wobble, power assisted steering, steering ratio – power steering – centre point steering.

UNIT III	AXLES AND TYRES	9

Construction and Design of Drive Axles, Types of Loads acting on drive axles, Full – Floating, Three–Quarter Floating and Semi–Floating Axles, Axle Housings and Types – Lift axle, Dead axle, Types and Constructional Details of Different Types of Wheels and Rims, Different Types of Tyres and their constructional details.

UNIT IV	SUSPENSION SYSTEM	9

Need of suspension system, type of suspension, suspension springs, constructional details and characteristics of leaf spring,

variable rate leaf suspension, coil and torsion bar springs, anti-roll bar, front wheel & rear wheel independent suspension, rubber suspension, pneumatics suspensions, shock absorbers, torque reaction, air suspension system electronically controlled, hydro-gas suspension.		
UNIT V	**BRAKING SYSTEM**	**9**
Theory of Automobile Braking, Stopping Distance Time and Braking Efficiency, Effect of Weight Transfer during Braking, Theory of Drum Brakes, Loading and Trailing Shoes, Braking Torque, Constructional Details of Drum Brake and its Activators, Disc Brake Theory, Types and Construction, Hydraulic Braking System, Mechanical Braking System, Pneumatic Braking System, Power–Assisted Braking System, Anti–Lock Braking System, Constructional Details.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Classify the chassis lay out with reference to power plant locations and drives.
CO2:	Explain the steering geometry and derive the condition for true rolling motion of an automobile.
CO3:	Choose the type of rear axle for a various vehicle and know about the various types of wheels and tyres.
CO4:	Select appropriate suspension system based on the vehicle requirement.
CO5:	Summarize the braking system based on the constructional details.
CO6:	Compare the stopping distance, time, braking efficiency of the vehicle and weight transfer during braking.
TEXT BOOKS:	
1	Kirpal Singh, Automobile Engineering, Standard Publisher, New Delhi, 14th Edition, 2019.
2	K.K. Ramalingam, "Automobile Engineering", Sci-tech publication (India), 2011.

REFERENCES:	
1	P Heinz Hazler, Modern Vehicle Technology, Butterworth, London, 2005
2	Robert Bosch, “Bosch Automotive Handbook”, SAE International; 10th edition, 2018.
3	Newton Steeds and Garret, Motor Vehicles, 13th Edition, Butterworth, London, 2005.
4	N.K. Giri, Automotive Mechanics, Kanna Publishers, 2007.

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

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

23AU511	INTRODUCTION TO FINITE ELEMENT ANALYSIS	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To impart basic knowledge in finite element method.
- To provide knowledge in 1D, 2D elements.
- To practice approaching heat conduction problems using finite element method.

UNIT I	INTRODUCTION	9

Relevance and scope of finite element methods - Strain Vs displacement relations - Stresses and equilibrium - Natural and essential boundary conditions - Rayleigh-Ritz - Galerkin method - FEA procedure - Discretization of domain - Element shapes, types, size, location and numbers.

UNIT II	ONE-DIMENSIONAL (1D) PROBLEM	9

Coordinate systems - Global, local and natural. Finite element formulation - Shape function, Stiffness matrix, Load vector and assembly of global equation - 1D bar element and two nodded truss element problems. Introduction to beam elements.

UNIT III	TWO-DIMENSIONAL (2D) PROBLEM	9

Finite Element Formulation - Shape function for linear triangular element, Constant Strain Triangular (CST) element. Strain Vs displacement matrix of CST element, Plane stress, plane strain and axisymmetric conditions - Problems. Introduction to space frame and planar frame elements.

UNIT IV	HEAT TRANSFER APPLICATIONS	9

Formulation of shape function, Stiffness matrix, Load vector, Assembly of global equation - 1D and 2D elements with heat conduction, Heat convection and internal heat generation conditions - Problems. Introduction to 3D axisymmetric problems.

UNIT V	HIGHER ORDER ELEMENTS AND ISOPARAMETRIC ELEMENT FORMULATION	9
Selection of order of polynomial-linear, simplex, complex and multiplex elements, mesh refinement methods and convergence requirements. Iso, Sub and Super parametric element, shape functions for a 2-D four nodded and eight nodded Isoparametric rectangular element using natural coordinate system - problems. Gaussian quadrature method-problems.		
TOTAL: 45 PERIODS		
LIST OF EXPERIMENTS:		
1. Structural analysis of beam elements subjected to point loads with UDL and UVL to observe deformation, shear force, bending moment and von misses stress distribution 2. Structural analysis of solid element with drilled holes (Steel plate and L bracket) subjected to point loads to observe deformation and von misses stress distribution 3. Mode frequency analysis of beams (Cantilever, simply supported, fixed ends) to observe deformation and von misses stress distribution. 4. Thermal analysis of composite cylinder subjected to conduction and convection to determine the heat transfer, thermal flux and thermal gradient 5. Static structural analysis of piston and connecting rod to determine deformation and stress 6. Thermal analysis of automobile components to determine steady state temperature distribution		
TOTAL: 30 PERIODS		
COURSE OUTCOMES:		
After completion of the course, the students will be able to:		
CO1:	Apply the Galerkin and Rayleigh Ritz's approach in finite element methods.	
CO2:	Develop finite element equation using shape functions and stiffness matrix for 1D problems.	
CO3:	Develop finite element equation using shape functions and stiffness matrix for 2D problems.	

CO4:	Develop shape function, stiffness matrix, load vector for 1D and 2D elements with heat conduction, convection problems.
CO5:	Build the characteristics equation of Iso-parametric elements.
CO6:	Construct shape function for 2-D four and eight nodded problems.
TEXT BOOKS:	
1	Reddy. J.N., “An Introduction to the Finite Element Method”, 3rd Edition, Tata McGraw-Hill, 2005.
2	Seshu, P, “Text Book of Finite Element Analysis”, Prentice-Hall of India Pvt. Ltd., New Delhi, 2007.
REFERENCES:	
1	Bhatti Asghar M, "Fundamental Finite Element Analysis and Applications", John Wiley & Sons, 2005 (Indian Reprint 2013).
2	Chandrupatla & Belagundu, "Introduction to Finite Elements in Engineering", 3rd Edition, Prentice Hall College Div, 1990
3	Rao, S.S., "The Finite Element Method in Engineering", 3rd Edition, Butterworth Heinemann, 2004
4	Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, "Concepts and Applications of Finite Element Analysis", 4th Edition, Wiley Student Edition, 2002.

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

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

23AU521	AUTOMOTIVE COMPONENTS LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- To experience the skill of dismantling and assembling of engines and to optimize the combustion process in SI and CI engines
- To understand the requirements of fuel systems in automobile vehicle.
- To understand the mounting of components, the basic working principle of components with the engine for accurate operations.

LIST OF EXPERIMENTS:

1. Dismantling and assembling of Multi-cylinder Petrol Engine
2. Dismantling and assembling of Multi-cylinder Diesel Engine
3. Dismantling and assembling of Transfer case.
4. Study of chassis layouts and Measurement of light Vehicle Frame.
5. Exercise on dismantling and assembling of front, rear axles, and determination of differential gear ratio.
6. Exercise on brake adjustment and brake bleeding of braking system.
7. Dismantling, Measurement and Assembling of Single plate, Diaphragm Clutch.
8. Exercise on dismantling and determining the gear ratio of synchromesh gear box.
9. Measurement of steering ratio, steering angle, and turning radius of steering system.
10. Dismantling and assembling of suspension system.

TOTAL: 60 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Develop skills in dismantling, assembling and inspection of engine components.
CO2:	Identify & differentiate components of SI & CI engines.
CO3:	Explain the working of braking, steering, suspension systems.
CO4:	Outline the working of transmission system.
CO5:	Develop skills in dismantling and assembling of chassis components.
CO6:	Solve minor repairs and trouble shoots the breakdowns in the automotive components.

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

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

23AU522	MINI PROJECT -2	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- Introduce students to fundamental project-based learning experiences within their domain.
- Develop problem-solving and critical thinking abilities through hands-on application of core concepts.
- Foster teamwork, communication, and project management skills through structured collaboration.
- Encourage students to explore innovative and sustainable solutions relevant to their field of study.
- Guide students in technical documentation and presentation of project outcomes.

COURSE DESCRIPTION:

Building on the foundational knowledge from Mini Project 1, this course emphasizes a more detailed and structured approach to project execution. Students will work on a more complex problem, incorporating advanced techniques and a systematic methodology. The focus will be on innovation, problem-solving, and sustainability. Teams will develop a working prototype, test their design, and refine their solutions based on data-driven analysis. The course prepares students for final-year projects and professional engineering challenges.

PROJECT OUTLINE:

Week 1	Orientation, problem identification, and scope definition
Week 2	In-depth literature review and identification of research gaps
Week 3	Conceptual design and methodology finalization
Week 4	First Review
Week 5	Initial prototype development and testing
Week 6	Data collection, performance analysis
Week 7	Design iteration and refinement based on feedback

Week 8	Second Review
Week 9	Advanced testing, troubleshooting, and second review
Week 10	Final prototype development, validation, and documentation
Week 11	Report Writing
Week 12	Third Review Presentation and Submission of Thesis

EVALUATION:

- The progress of the mini project will be evaluated through three reviews, conducted by a committee appointed by the Head of the Department. A final project report must be submitted at the end of the semester. Evaluation will be based on oral presentation and the written report, assessed by internal examiners designated by the Head of the Department.

- The evaluation based on innovation, feasibility, execution, and documentation
- The relevance and innovation of the project will be assessed, particularly its potential to contribute to sustainability and innovation.
- The accuracy of English usage, including grammar, clarity, and coherence, will be reviewed in both oral and written communication to ensure effective delivery of technical content.

COURSE OUTCOMES:

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

CO1:	Apply advanced engineering principles to analyze and solve complex problems.
CO2:	Identify and utilize relevant sources to enhance technical understanding and innovation.
CO3:	Utilize advanced tools and methodologies to develop and test engineering solutions.

CO4:	Analyze the societal and environmental impact of engineering solutions through detailed analysis.
CO5:	Combine effectively in multidisciplinary teams to manage and execute projects.
CO6:	Develop and present comprehensive technical reports with structured documentation and impactful presentations.

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

Recommended by Board of Studies	**01-04-2024**		
Approved	**2nd ACM**	**Date**	**25-05-2024**

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

COURSE OBJECTIVES:

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

UNIT I		4

Probability, Permutation & Combination, Algebra, Problems on ages

UNIT II		4

Mensuration, Logarithms, inequalities and modulus, Syllogism

UNIT III		4

Directions, logical sequence words, number series, Analytical Reasoning

UNIT IV		4

Blood relation, Clock and Calendar, Picture puzzles

UNIT V		4

Data sufficiency, cube and cuboids, odd man out

TOTAL: 20 PERIODS

COURSE OUTCOMES:

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

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

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

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

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

SEMESTER –VI

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

COURSE OBJECTIVES:

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

UNIT I	INTRODUCTION TO ENVIRONMENT IMPACT ASSESSMENT	9

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

UNIT II	MOVEMENT OF POLLUTANTS IN ENVIRONMENT	9

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

UNIT III	ECOLOGICAL RESTORATION	9

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

treatment: sources and management (composting, vermiculture and methane production, landfill. hazardous waste treatment).		
UNIT IV	**ECOLOGICALLY SAFE PRODUCTS AND PROCESSES**	**9**
Biofertilizers, microbial insecticides and pesticides, bio-control of plant pathogen, Integrated pest management; development of stress tolerant plants, biofuel; mining and metal biotechnology: microbial transformation		
UNIT V	**CLIMATE CHANGE MODELS**	**9**
Constructing a climate model – climate system modeling – climate simulation and drift – Evaluation of climate model simulation – regional (RCM) – global (GCM) – Global average response to warming –climate change observed to date		
		TOTAL: 60 PERIODS

LIST OF EXPERIMENTS

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

COURSE OUTCOMES:

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

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

CO6:	Apply the climate model simulation to monitor climate change
TEXT BOOKS:	
1	David .E Neelin "Climate Change and Modelling", Cambridge University Press, California 2012.
2	Evans, G.G. & Furlong, J. 2010. Environmental Biotechnology: Theory and Application (2nd edition). Wiley-Blackwell Publications.
3	Pani, B. 2007. Textbook of Environmental Chemistry. IK international Publishing House
4	N.S. Raman , A.R. Gajbhiye & S.R. Khandeshwar, Environmental Impact Assessment, 2014,IK International Pvt Ltd.
REFERENCES:	
1	Carson (1907-1964). Environment Conservation-book
2	Encyclopaedia of Environmental Issues by Craig W. Allin &Probe.
3	Encyclopaedia of Environmental studies by William Ashworth.
4	Climate Change and Climate Modeling- Kindle Edition.
5	Environmentally- Friendly Product development - Eberhand Abile ,Reiner Anderl,2005

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

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

23AU611	AUTOMOTIVE ENGINE AND CHASSIS COMPONENTS DESIGN	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To understand the design concept and principle involved in various engine components.
- To apply the design procedures involved in various engine components like cylinder, piston, connecting rod, crankshaft, flywheel, axle, suspension and steering systems.
- To demonstrate the concepts of stress analysis, theories of failure and material science in the design of automotive components

UNIT I	INTRODUCTION	9

Engineering materials - Introduction endurance limit, notch sensitivity. Tolerances, types of tolerances and fits, design considerations for interference fits, surface finish, surface roughness, Rankine's formula - Tetmajer's formula - Johnson formula- design of pushrods.

UNIT II	DESIGN OF CYLINDER, PISTON AND CONNECTING ROD	9

Choice of material for cylinder and piston, design of cylinder, piston, and piston pin, piston rings, piston failures, lubrication of piston assembly. Material for connecting rod, determining minimum length of connecting rod, small end design, shank design, design of big end cap bolts.

UNIT III	DESIGN OF CRANKSHAFT AND FLYWHEEL	9

Balancing of I.C. engines, significance of firing order. Material for crankshaft, design of crankshaft under bending and twisting, balancing weight calculations, development of short and long crank arms. Determination of the mass of a flywheel for a given co - efficient of speed fluctuation. Engine flywheel - stresses on the rim of the flywheels. Design of hubs and arms of the

flywheel, turning moment diagram.		
UNIT IV	**DESIGN OF VEHICLE FRAME, SUSPENSION AND STEERING SYSTEMS**	**9**
Study of loads-moments and stresses on frame members. Design of frame for passenger and commercial vehicle - Design of leaf Springs-Coil springs and torsion bar springs. Determination of optimum dimensions and proportions for steering linkages, ensuring minimum error in steering.		
UNIT V	**DESIGN OF FRONT AXLE, REAR AXLE AND DRIVE LINE**	**9**
Analysis of loads-moments and stresses at different sections of front axle. Determination of bearing loads at Kingpin bearings. Wheel spindle bearings. Design of front axle beam. Design of propeller shaft. Design details of final drive gearing. Design details of full floating, semi-floating and three quarter floating rear shafts and rear axle housings and design aspects of final drive.		
		TOTAL: 45 PERIODS

LIST OF EXPERIMENTS:

1. Design and drawing of piston, piston pin and piston rings
2. Design of connecting rod and assembly
3. Design of crank shaft.
4. Design and drawing of flywheel.
5. Design of cam and camshaft
6. Design of vehicle frame and chassis
7. Design of steering system
8. Design of suspension system
9. Design of front axle
10. Design of rear axle and drive line system.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

CO1:	Utilize the various design concepts in automobile components.
CO2:	Apply the design procedure concepts in cylinder, piston

	and connecting rod.
CO3:	Select the design parameters for the crankshaft and flywheel.
CO4:	Apply the design procedure concepts in frame, suspension and steering.
CO5:	Apply the design procedure for the design of vehicle front and rear axles.
CO6:	Utilize the design procedure for the design of drive line system.
TEXT BOOKS:	
1	Khurmi. R.S. & Gupta. J.K., "A text book of Machine Design", Eurasia Edition, New Publishing House (Pvt) Ltd, 2001.
2	Giri, N.K., "Automobile Mechanics", Khanna publishers, New Delhi, 2007.
REFERENCES:	
1	Jain.R.K, "Machine Design", Khanna Publishers, New Delhi, 2005.
2	Dean Averns, "Automobile Chassis Design", Illife Book Co., 2001.
3	J.H.Smith, An Introduction to Modern Vehicle Design, Oxford: Butterworth-Heinmann, 2001.
4	R.L.Norton, Machine Design: An Integrated Approach, New Jersey Prentice Hall, 2009.

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

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

23AU612	TWO AND THREE WHEELERS	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To understand the power transmission & frames of different two wheelers and technical specification.
- To make the students understand the construction of steering, suspension & brake system of two and three wheelers.
- To make the students understand the construction of cooling, lubrication & wheels, tyres of two and three wheelers and power transmission of electric two and three wheelers.

UNIT I	INTRODUCTION OF TWO WHEELER	9

Classifications of two wheelers – Power transmission layout of two wheelers - Mopeds- Scooters and Motorcycles - Technical Specifications. Types of two wheeler frames - Kick starter system - Self-Start system - Gear shifting mechanism - CVT- Final Drive. Two wheeler dynamics-Linear and angular motions -Handling characteristics-Road holding -Vehicle stability - Aerodynamics - Squat and dive.

UNIT II	INTRODUCTION OF THREE-WHEELER	9

Three wheeler vehicles - Auto Rickshaws- Pickup Van- Delivery Van- Body construction- Technical specifications- Engines- CNG- Diesel - Frame and body - Loads acting - Drive train – Layout – Differential.

UNIT III	STEERING, SUSPENSION AND BRAKE	9

Steering System – Handlebar- Front end Geometry - Steering Gearbox - Suspension - Front and Rear Forks - Springs for Suspension - Telescopic Suspension - Mono Suspension - Hydraulic Shock Absorber-Gas Filled Shock Absorber. Design Consideration for Brake - Drum Brakes - Disc Brakes – Control System – ABS and its types.

UNIT IV	**COOLING AND LUBRICATION SYSTEMS-WHEELS AND TYRES**	**9**
Types of Cooling System - Air Cooling System - Liquid Cooling System - Challenges in Cooling System - Lubrication System - Properties of Lubricating Oil – Additives for Lubricant – Grading - Petrol Lubrication - Splash Lubrication – Pressurized and Semi pressurized lubrication - Constructional details of wheels and tyres of two and three wheelers.		
UNIT V	**ELECTRIC TWO AND THREE WHEELERS**	**9**
Power Transmission Layout of Electric Two Wheelers – Motor - Hub Motors - Controller- Alternator- Battery systems- BMS - Performance of electric two wheelers- Electric three Wheelers- Layout- Performance.		
		TOTAL: 45 PERIODS

LIST OF EXPERIMENTS :

1. Demonstration on removal and fitting of given tyre.
2. Demonstration on the components of electric bike
3. Demonstration on compression and rebounce force of shock absorber
4. Dismantling and assembling of two wheeler gear box and finding gear ratios.
5. Dismantling and assembling of three wheeler box and finding gear ratios
6. Dismantling and assembling of three wheeler steering system
7. Two wheeler chain test
8. Brake and clutch adjustment in two and three wheeler as per specification
9. Performance test of a two wheeler using chassis dynamometer
10. Performance test on coil spring

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

CO1:	Explain about the two wheeler types, frames and transmission system.
CO2:	Summarize the three-wheeler types, frames, and

	transmission system.
CO3:	Compare about steering and suspension system of two and three wheeler.
CO4:	Select the appropriate brake system for two and three wheeler.
CO5:	Summarize about cooling systems, lubrication systems, wheels and tyres.
CO6:	Choose the power transmission for electric two and three wheelers.
TEXT BOOKS:	
1	P E Irving - 'Motorcycle Engineering' Veloce Enterprises-Inc. – 2017.
2	Dhruv U. Panchal - 'Two and Three Wheeler Technology' PHI Learning- 2015.
REFERENCES:	
1	K. Newton - W. Steeds and T. K. Garrett- 'Motor Vehicle' Butterworth Heinemann- 13th Edition- 2000.
2	Dr. Kirpal Singh - 'Automobile Engineering' Vol. I and II- Standard Random variables - Publishers- New Delhi- 2011
3	V. Ganesan- 'Internal Combustion Engines' Tata McGraw Hill Book Co- Eighth Reprint- 2010
4	Tom Denton- 'Automotive Electrical and Electronic Systems' Routledge Taylor and Francis Group- 5th Edition- 2017.

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

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

23AU621	PROJECT WORK PHASE-1	L	T	P	C
		0	0	4	2

COURSE DESCRIPTION:

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

COURSE OBJECTIVES:

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

PROJECT OUTLINE:

Week 1	Orientation and course overview. Formation of project teams and approval of topics by HoD.
Week 2	Initial meeting with supervisors. Define problem statement and objectives
Week 3	Literature review: Research methodologies and topic-specific studies.
Week 4	Zeroth Review.
Week 5	Refinement of literature review and identification of research gaps.

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

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

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

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

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

23AU622	TECHNICAL TRAINING	L	T	P	C
		0	0	2	1

PREAMBLE:

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

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

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

CO1:	Identify specific domain from the enrolled branch and to get training preferable in computer-oriented platform.
CO2:	Survey and apprehend the learning modules in the training program and to become expert in the specific domain.
CO3:	Apply theoretical learning in the practical environment and enhance the skillset of learner.
CO4:	Estimate the learning using available data.
CO5:	Defend a presentation about the learning done in the specified skillset.

CO6:	Construct a technical report about the training.

GUIDELINES:

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

EVALUATION PATTERN:

Training Coordinator:

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

Presentation of Application:

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

Report about Application:

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

Training duration – 30 Hours

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

23AU623	TECHNICAL SEMINAR – 1	L	T	P	C
		0	0	2	1

PREAMBLE:

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

COURSE OBJECTIVES:

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

GUIDELINES:

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

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

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

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

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

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

SEMESTER – VII

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

COURSE OBJECTIVES:

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

UNIT I	**INTRODUCTION TO INTELLIGENT VEHICLE SYSTEMS**	**9**

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

UNIT II	**AUTOMOTIVE IOT INTEGRATION**	**9**

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

UNIT III	**TRAFFIC SURROUNDING SYSTEM**	**9**

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

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

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

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

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

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

23AU702	COMPREHENSION	L	T	P	C
		2	0	0	2

PURPOSE:

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

COURSE OUTCOMES:

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

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

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

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

23AU711	VEHICLE MAINTENANCE	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To understand the various methods of maintaining vehicles and their subsystems and familiarize with transmission driveline maintenance.
- To acquire knowledge on the chassis maintenance and learn the working principles of battery and electrical maintenance.
- To understand the Air conditioning maintenance

UNIT I	MAINTENANCE OF WORKSHOP AND PRACTICES	9

Maintenance – Need, importance, primary and secondary functions, policies - classification of maintenance work - vehicle insurance - basic problem diagnosis. 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.

UNIT II	ENGINE AND SUBSYSTEM MAINTENANCE	9

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.

UNIT III	TRANSMISSION & DRIVELINE MAINTENANCE	9

Clutch- general checks, adjustment and service- Dismantling, identifying, checking and reassembling transmission, transaxle- road testing- Removing and replacing propeller shaft, servicing of cross and yoke joint and constant velocity joints- Rear axle service points- removing axle shaft and bearings- servicing

differential assemblies- fault diagnosis.		
UNIT IV	**CHASSIS MAINTENANCE**	**9**
Inspection, Maintenance and Service of brakes, bleeding of brakes. Inspection, Maintenance and Service of Mc person strut, coil spring, leaf spring, shock absorbers. 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, power steering system		
UNIT V	**MAINTENANCE OF AUXILIARY SYSTEMS**	**9**
Maintenance of batteries, starting system, charging system and body electrical -Fault diagnosis using Scan tools. Maintenance of air conditioning parts like compressor, condenser, expansion valve, evaporator - Replacement of hoses- Leak detection- AC Charging- Fault diagnosis Vehicle body repair like panel beating, tinkering, soldering, polishing, painting.		
TOTAL: 45 PERIODS		
LIST OF EXPERIMENTS:		
1. Tightening and adjustment of wheel bearing. 2. Adjustment of pedal play in clutch, brake, hand brake lever and steering wheel orientation. 3. Wheel alignment in four-wheelers. 4. Minor and major tune-up of gasoline and diesel engines. 5. Calibration of Fuel injection pump. 6. Fault diagnosis and service of Electrical systems like battery, starting system, charging system, lighting system. 7. Removal and fitting of tyre. 8. Engine fault diagnosis using a scan tool. 9. Fault diagnosis of brake system - Air bleeding from hydraulic brakes. 10. Performance test on two-wheeler chassis dynamometer. 11. Servicing of Coolant and Lubrication System.		
TOTAL: 30 PERIODS		

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Explain about the classification of maintenance, vehicle problem diagnosis and service procedures and layout of the automotive service station.
CO2:	Analyze the engine problems, diagnose the fault, and engine subsystem maintenance.
CO3:	Identify the fault in clutches and differential assemblies
CO4:	Identify the fault and service in the brake, suspension and steering system
CO5:	Explain the fault diagnosis and maintenance of batteries, the starting system, and the charging system
CO6:	Illustrate the fault diagnosis and maintenance of the air-conditioning system and vehicle body.
TEXT BOOKS:	
1	Ed.May, "Automotive Mechanics" Volume One and Two, McGraw-Hill Publications, 2003
2	W.C. Haresign, "Modern Vehicle Maintenance," Routledge, 2010
REFERENCES:	
1	Bosch Automotive Handbook, Sixth Edition, 2004.
2	Ramalingam. K.K., "Internal combustion engine", Scitech publications, Chennai, 2003.
3	A.W. Judge, "Vehicle Maintenance: Mechanics and Practices," McGraw-Hill Publications, 2005.
4	James D. Halderman, "Automotive Technology: Principles, Diagnosis, and Service," Prentice Hall, 2012.

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

23AU712	VEHICLE DYNAMICS	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To understand the fundamentals of vibration and acquire knowledge on the tyre under various mode of operations.
- To familiarize with the mathematical model of vehicle system and acquire knowledge on the vehicle during manoeuvring.
- To evaluate the tractive force and braking force for different vehicles.

UNIT I	CONCEPT OF VIBRATION	9

Formation, Definitions, Modelling and Simulation, Global and Vehicle Coordinate System, Free, Forced, Undamped and Damped Vibration, Response Analysis of Single DOF, Two DOF, Magnification factor, Transmissibility, Vibration absorber, Vibration measuring instruments.

UNIT II	TYRES	9

Tyre forces and moments, Tyre structure, Longitudinal and Lateral force at various slip angles, rolling resistance, Tractive and cornering property of tyre. Performance of tyre on wet surface. Ride property of tyres. Magic formulae tyre model, Estimation of tyre road friction. Test on Various road surfaces. Tyre vibration.

UNIT III	VERTICAL DYNAMICS	9

Human response to vibration, Sources of Vibration. Design and analysis of Passive, Semi-active and Active suspension using Quarter car, half car and full car model. Influence of suspension stiffness, suspension damping, and tyre stiffness. Control law for LQR, H-Infinite, Skyhook damping. Air suspension system and their properties.

UNIT IV	LONGITUDINAL DYNAMICS AND CONTROL	9

Aerodynamic forces and moments. Equation of motion. Tyre forces, rolling resistance, Load distribution for three wheeler and

four wheeler. Calculation of Maximum acceleration, Reaction forces for Different drives. Braking and Driving torque. Prediction of Vehicle performance. ABS, stability control, Traction control.		
UNIT V	**LATERAL DYNAMICS**	**9**
Steady state handling characteristics. Steady state response to steering input. Testing of handling characteristics. Transient response characteristics, Direction control of vehicles. Stability of vehicle on banked road, during turn. Effect of suspension on cornering.		
		TOTAL: 45 PERIODS
LIST OF EXPERIMENTS:		
1. Response analysis of Single degree of freedom system. 2. Modelling of Tyre using magic formula 3. Response analysis of quarter car model 4. Maximum acceleration for different vehicle drives. 5. Steady state handling characteristics		
		TOTAL: 30 PERIODS
COURSE OUTCOMES:		
After completion of the course, the students will be able to:		

CO1:	Evaluate the natural frequencies for free, forced and damped vibration
CO2:	Analyze the response of single DOF and two DOF system.
CO3:	Illustrate the forces and moments acting on the tyre for different roads.
CO4:	Examine the performance of suspension systems using mathematical model
CO5:	Explain the effect of vehicle longitudinal dynamics.
CO6:	Analyze the cornering stability of the vehicle using lateral dynamics.
TEXT BOOKS:	
1	Rajesh Rajamani, "Vehicle Dynamics and Control", 1st edition, Springer, 2005

2	Singiresu S. Rao, "Mechanical Vibrations", 5th Edition, Prentice Hall, 2010.
REFERENCES:	
1	Dean Karnopp, "Vehicle Stability", 1st edition, Marcel Dekker, 2004.
2	Hans B Pacejka, "Tyre and Vehicle Dynamics", 2nd edition, SAE International 2005
3	Jan Zuijdijk, 'Vehicle dynamics and damping", Author House, 2009.
4	Michael Blundell & Damian Harty, "The Multibody Systems Approach to Vehicle Dynamics", Elsevier Limited, 2004.

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

Recommended by Board of Studies	**07-11-2024**		
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23AU721	PROJECT WORK PHASE-2	L	T	P	C
		0	0	6	3

COURSE DESCRIPTION:

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

COURSE OBJECTIVES:

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

PROJECT OUTLINE:

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

Week 4	Second Review.
Week 5	Validation of test problem or refinement of prototype/simulation
Week 6	Optimisation of the test setup or solution trials, Data curation / uncertainty analysis
Week 7	Final testing of setup or simulation outcomes, Validation of Data.
Week 8	Third Review
Week 9	Demonstration of the solution with high level of data accuracy and precision.
Week 10	Compilation of Phase 2 results, report writing, and presentation preparation.
Week 11	Preparing or publishing of research article/ Filing or Grant of Patent
Week 12	Final Viva Voce Presentations.
Individual meetings will be set up on a need's basis in conjunction with developing work	

EVALUATION:

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

COURSE OUTCOMES:

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

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

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

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

23AU722	TECHNICAL SEMINAR – 2	L	T	P	C
		0	0	2	1

PREAMBLE:

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

COURSE OBJECTIVES:

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

GUIDELINES:

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

- Choosing a seminar topic: The topic for a UG seminar should be current and broad based rather than very specific research work, beyond the syllabus. Every member of the project team could choose or be assigned Seminar topics that covers various aspects linked to the Project area.
- A topic/paper relevant to the discipline shall be selected by the student during the semester break.
- Topic/Paper shall be finalized in the first week of the semester and shall be submitted to the IAC. The IAC shall approve the selected topic/paper by the second week of the semester.
- Accurate references from genuine peer reviewed published material to be given in the report and to be verified.

EVALUATION PATTERN

Seminar Coordinator:

40 marks (Background Knowledge – 10 (The coordinator shall give deserving marks for a candidate based on the candidate's background knowledge about the topic selected), Relevance of the paper/topic selected – 10).

(Seminar Diary – 10 (Each student shall maintain a seminar diary and the coordinator shall monitor the progress of the seminar work on a weekly basis and shall approve the entries in the seminar diary during the weekly meeting with the student), Attendance – 10).

Presentation:

40 marks to be awarded by the IAC (Clarity of presentation – 10, Interactions – 10 (to be based on the candidate's ability to answer questions during the interactive session of her/his presentation), Overall participation – 10 (to be given based on her/his involvement during interactive sessions of presentations by other students), Quality of the slides – 10).

Report:

20 marks to be awarded by the IAC (check for technical content, overall quality, templates followed, adequacy of references etc.).

COURSE OUTCOMES:

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

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

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

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

SEMESTER -VIII

23AU821	CAPSTONE PROJECT	L	T	P	C
		0	0	20	10

COURSE DESCRIPTION:

Prerequisites:

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

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

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

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

COURSE OBJECTIVES:

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

During this course, students will

- Investigate and evaluate prominent literature connected to your CP.
- Present a clearly articulated investigative framework, while situating projects within established academic practices and/ or ideas.
- Develop and create practical resources (either

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

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Take part in challenging practical problems and find solutions by formulating proper methodology.
CO2:	Plan research methodology to tackle a specific problem.
CO3:	Construct extensive study on particular research projects.
CO4:	Develop experimental and computational studies on innovative research projects.
CO5:	Estimate incremental study on existing research projects.
CO6:	Take part in real life engineering challenges and propose appropriate solutions.

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

VERTICAL -1 - ELECTRIC VEHICLE

23AU031	**ELECTRIC VEHICLE, DRIVE AND STORAGE SYSTEM**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To explain the fundamentals of electric vehicles drive systems and energy storage components and to differentiate between battery electric vehicles and hybrid electric vehicles.
- To describe about the components of an electric drive system- electric motor, power electronics and transmission.
- To explain about the different types of energy storage systems used in EV and about the challenges and opportunities associated with EV charging infrastructure development.

UNIT I	**ELECTRIC VEHICLES**	**9**

Need of electric vehicles, Comparative study of diesel, Petrol and pure Electric Vehicles, Advantages and Limitations of electric vehicles, Layout of an electric vehicles, System components, Performance of electric Vehicles. Traction motor characteristics. Tractive effort.

UNIT II	**HYBRID VEHICLES**	**9**

Hybrid electric drive trains - Types of hybrid drive - Train topologies, Concepts, architecture, Power flow control, Fuel efficiency analysis, Regenerative braking in HEVs - Energy consumption during braking, Control strategies, Plug - In hybrid, Merits and demerits

UNIT III	**ELECTRIC DRIVE TRAINS**	**9**

Basic concept of electric traction, Electronic control system, Configuration of electric vehicles, Introduction to various electric drive-train topologies, Power flow control in electric drive-train topologies, Requirements of motor for electric vehicles, DC Motor drives, Induction Motor drives, Magnet Motor drives.

UNIT IV	ENERGY STORAGE	9
Requirements of energy sources in electric vehicles, Battery based energy storage and its analysis, Fuel cell based energy storage and its analysis, Supercapacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices.		
UNIT V	**CHARGING SYSTEM**	**9**
Conductive - Basic charger circuits, Microprocessor based charger circuit. Inductive - Principle of inductive charging, charging Infrastructure: Domestic Charging Infrastructure, Public Charging Infrastructure, Normal Charging Station, Occasional Charging Station, Fast Charging Station, Battery Swapping Station, Move and - Charge zone.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Apply the knowledge of operations of the subsystems and components used in electric vehicles.
CO2:	Compare electric and hybrid vehicles.
CO3:	Explain the operations of different types of drive train topology used in different types of electric vehicles.
CO4:	Choose an appropriate energy storage device based on the application in Electric vehicles.
CO5:	Choose the suitable charging methods for electric vehicles based on the requirements.
CO6:	Explain the various charging station.
TEXT BOOKS:	
1	C.C. Chan and K.T. Chau, Modern Electric Vehicle Technology, Oxford University Press, 2001
2	James Larminie and John Lowry, "Electric Vehicle Technology Explained" John Wiley & Sons, 2003.
REFERENCES:	
1	Ron HodKinson, "light Weight Electric/ Hybrid Vehicle

	Design", Butterworth Heinemann Publication, 2005
2	Lino Guzzella, "Vehicle Propulsion System" Springer Publications, 2005.
3	Iqbal Husain, "Electric and Hybrid Vehicles-Design Fundamentals", CRC Press, 2003
4	Mehrdad Ehsani, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles", CRC Press, 2005.

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

<table>
<tr><td rowspan="2">23AU032</td><td rowspan="2" colspan="2">BATTERIES AND MANAGEMENT SYSTEM</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="7">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="7">To explain about different types of batteries and to find the performance parameters of battery pack and cycle life.
To calculate the battery health and its significance in battery management.
To introduce model-based approaches and to identify the components of a battery management system.</td></tr>
<tr><td>UNIT I</td><td colspan="5">ADVANCED BATTERIES</td><td>9</td></tr>
<tr><td colspan="7">Li-ion Batteries-different formats, chemistry, safe operating area, efficiency, aging. Characteristics-SOC, DOD, SOH. Balancing-Passive Balancing Vs Active Balancing. Other Batteries-NCM and NCA Batteries. NCR18650B specifications.</td></tr>
<tr><td>UNIT II</td><td colspan="5">BATTERY PACK</td><td>9</td></tr>
<tr><td colspan="7">Battery Pack - Design, Sizing, Calculations, Flow chart, real and simulation Model. Peak power – Definition, Testing methods - Relationships with Power, Temperature and ohmic Internal Resistance. Cloud based and Local Smart charging.</td></tr>
<tr><td>UNIT III</td><td colspan="5">BATTERY MODELLING</td><td>9</td></tr>
<tr><td colspan="7">Battery Modelling Methods-Equivalent Circuit Models, Electrochemical Model, Neural Network Model. ECM Comparisons- Rint model, Thevenin model, PNGV model. State space Models- Introduction. Battery Modelling software/simulation frameworks.</td></tr>
<tr><td>UNIT IV</td><td colspan="5">BATTERY STATE ESTIMATION</td><td>9</td></tr>
<tr><td colspan="7">SOC Estimation- Definition, importance, single cell Vs series batteries SOC. Estimation Methods- Load voltage, Electromotive force, AC impedance, Ah counting, Neural networks, Neuro-fuzzy forecast method, Kalman filter. Estimation Algorithms.</td></tr>
<tr><td>UNIT V</td><td colspan="5">BMS ARCHITECTURE AND REAL TIME COMPONENTS</td><td>9</td></tr>
<tr><td colspan="7">Battery Management System- need, operation, classification.</td></tr>
</table>

BMS ASIC-bq76PL536A-Q1 Battery Monitor IC- CC2662R-Q1 Wireless BMS MCU. Communication Modules- CAN Open-Flex Ray- CANedge1 package. ARBIN Battery Tester. BMS Development with Modeling software and Model-Based Design.	
TOTAL: 45 PERIODS	
COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Apply the working knowledge of different Li-ion Batteries.
CO2:	Develop a Battery Pack and make related calculations.
CO3:	Apply various battery modelling techniques to assess battery performance.
CO4:	Select suitable battery based on the estimation of battery state.
CO5:	Develop range calculations based on different types of modelling approaches.
CO6:	Model different BMS architectures for real-world usage.
TEXT BOOKS:	
1	Ali Emadi et al., Vehicular Electric Power Systems, Marcel Dekker, Inc, 2004.
2	James Larminie and John Lowry, "Electric Vehicle Technology Explained" John Wiley & Sons, 2003.
REFERENCES:	
1	Iqbal Husain, "Electric and Hybrid Vehicles-Design Fundamentals", CRC Press, 2003.
2	Mehrdad Ehsani, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles", CRC Press, 2005.
3	Xiaojun Tan, Andrea Vezzini, Yuqian Fan, Neeta Khare, You Xu, Liangliang Wei Battery Management System and its Applications, China Machine Press, 2022.
4	Valer Pop, Henk Jan Bergveld, Dmitry Danilov, Paul P. L. Regtien and Peter H. L. Notten Battery Management Systems, Springer, 2008.

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

<table>
<tr><td rowspan="2">23AU033</td><td rowspan="2">NEW GENERATION AND HYBRID VEHICLES</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="6">To familiarize with the challenges associated with hybrid vehicle technology and explore advancements in new generation vehicle technologies.
To explain the components and operation of hybrid vehicle drivetrains and to understand the fuel cells and solar for EV.
To explore the advancements in battery technology, vehicle-to-grid integration, autonomous driving features, and connectivity.</td></tr>
<tr><td>UNIT I</td><td colspan="4">INTRODUCTION</td><td>9</td></tr>
<tr><td colspan="6">Introduction on New generation vehicles - Electric and hybrid vehicles, Flexible Fuel Vehicles (FFV), Solar Powered Vehicles, Magnetic track vehicles. Principle and comparison.</td></tr>
<tr><td>UNIT II</td><td colspan="4">ELECTRIC VEHICLES</td><td>9</td></tr>
<tr><td colspan="6">Electric Vehicle – Need - Types – Cost and Emission. Electric Vehicle Technology – Layouts, Cables, Components, Controls. Batteries – Overview and its types. Battery plug - In and life. Ultra - Capacitor, Charging – Methods and Standards. Alternate charging sources – Wireless & Solar.</td></tr>
<tr><td>UNIT III</td><td colspan="4">HYBRID ELECTRIC VEHICLES</td><td>9</td></tr>
<tr><td colspan="6">Hybrid Electric vehicles – Classification – Micro, Mild, Full, Plug-in, EV. Layout and Architecture – Series, Parallel and Series - Parallel Hybrid, Propulsion systems and components.</td></tr>
<tr><td>UNIT IV</td><td colspan="4">FUEL CELLS AND SOLAR FOR ELECTRIC VEHICLES</td><td>9</td></tr>
<tr><td colspan="6">Fuel cell – Introduction, Technologies & Fuel cell types – Aspects of alkaline, SOFC, DMFC, and PEM fuel cells, Obstacles. Operation principles, Solar panels, Battery Selection Options.</td></tr>
<tr><td>UNIT V</td><td colspan="4">VEHICLE AUTOMATED TRACKS</td><td>9</td></tr>
<tr><td colspan="6">National highway network with automated roads and vehicles - Satellite control of vehicle operation for safe and fast travel, GPS. Advanced Safety systems in Automobiles.</td></tr>
</table>

	TOTAL: 45 PERIODS
COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Explain the classification of new generation hybrid vehicles.
CO2:	Model the operation and architecture of electric vehicles
CO3:	Compare different type of hybrid vehicle.
CO4:	Choose suitable solar panels for applications in hybrid electric vehicles.
CO5:	Identify fuel cell for applications in hybrid electric vehicles.
CO6:	Apply the knowledge of vehicle automated tracks
TEXT BOOKS:	
1	Amir Khajepour, Saber Fallah and Avesta Goodarzi, Electric and hybrid vehicles technologies, modeling and control: A Mechatronic approach, Wiley 2014.
2	Tom Denton, Electric and Hybrid Vehicles, Second Edition, Routledge, 2020.
REFERENCES:	
1	Robert Bosch, "Bosch Automotive Handbook", SAE International; 10th edition, 2018.
2	Gopal K. Dubey, Fundamentals of Electrical Drives, Narosa Publishing House, 2010.
3	Mehrdad Ehsani, Yimin Gao, Stefano Longo, and Kambiz M. Ebrahimi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, Third Edition, CRC Press, 2018.
4	Advance hybrid vehicle power transmission, SAE Technical papers.

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

23AU034	AUTOMOTIVE POWER ELECTRONICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To explain the significance of power electronics in automotive engineering.
- To Identify and explain the function of power electronic components used in automotive systems.
- To familiarize with semiconductor devices commonly used in automotive power electronics.

UNIT I	AUTOMOTIVE POWER SEMICONDUCTOR DEVICES	9

Power Electronic Circuits - Types, design of equipments, RMS waveforms, Peripheral effects. Power Transistors – Types, operation. Diodes - Types, operation and characteristics. BJT and MOSFETs - Steady state, Switching characteristics. Power MOSFETs and IGBTs - Importance, Operations. SPICEMODELS - Diode, BJT and MOSFETs Simulation concepts

UNIT II	AUTOMOTIVE POWER ELECTRONIC CONVERTERS	9

DC-DC Converters - Principle, Operation and characteristics. Step-Down (Buck) Converter – Step-Up (Boost) Converter – Buck–Boost Converter. Input Filter & Convertors - Design considerations. SPICE MODEL - Buck Converter simulation concept.

UNIT III	RECTIFIERS AND INVERTERS	9

Diode Rectifiers – Single -Phase, Three-Phase, Poly-Phase Diode Rectifiers - Rectifier circuit design. Voltage Source Inverters – Single-Phase, Three-Phase Voltage Source Inverters. Current Source Inverters - Inverter circuit design. SPICE MODEL - Rectifiers and Invertors simulation concepts.

UNIT IV	AC AND DC DRIVES	9

DC Drives - Performance equations, single - Phase and three phase half - Wave, full, Dual converter and semiconductor drives. AC Drives – Three-Phase Induction Motor, Various

controls, DSP based Vector Control. MATLAB/SIMULINK Modeling Capabilities. Field - Oriented Control Modeling of Induction Motor Drives.		
UNIT V	**RECENT TRENDS AND CASE STUDIES IN POWER ELECTRONICS**	**9**
Wide bandgap (WBG) semiconductors - Silicon power Transistors - Design overview - Gallium Nitride Transistors - SiC Vs GaN in power switching applications - HEV/EV On board chargers - Wibotic autonomous wireless charging systems - Boeing 787 Electrical Power System - Case studies. Simulation Packages overview.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1:	Choose Power Semiconductor Devices for specific applications.
CO2:	Identify the operation and characteristics of the DC-DC Converters.
CO3:	Analyze the operation of Rectifiers and Inverters.
CO4:	Explain the operation of AC and DC Drives.
CO5:	Explain the operations of wireless charging systems.
CO6:	Analyze and compare wide bandgap (WBG) semiconductors and silicon power transistors.

TEXT BOOKS:

1	Rashid M.H., "Power Electronics Circuits- Devices and Applications", Pearson Education, Fourth Edition, 2014.
2	Haitham Abu-Rub, Mariusz Malinowski and Kamal Al-Haddad "Power Electronics for Renewable Energy Systems, Transportation and Industrial Applications", John Wiley and sons, 2014.

REFERENCES:

1	Ali Emadi, "Handbook of automotive power electronics and motor drives ", CRC Press, 2005.

2	Rashid M.H., "SPICE for Power Electronics and Electric Power", CRC Press, Third Edition, New Delhi, 2012.
3	Bimal K. Bose," New Power Electronics and Variable Frequency Drives"- IEEE Press, 1997.
4	Bhimbhra P.S., "Power Electronics", Khanna Publishers, 2002.

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

23AU035	FUEL CELL TECHNOLOGIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To describe the basic operating principles of fuel cells and to Identify and the key components of a fuel cell system.
- To familiarize with hydrogen storage technologies and to explore fuel cell stack design -stack architecture, cell arrangement.
- To discuss standards, protocols, and testing procedures for assessing fuel cell reliability and safety.

UNIT I	FUEL CELL PERFORMANCE	9

Basic structure, critical functions of components – Fuel cell stacking - Fuel cell systems types – Advantages and disadvantages – Applications and status - Cell efficiency – Factors affecting - The efficiency of Electrochemical Energy conversion.

UNIT II	ALKALINE (AFC) AND SOLID OXIDE FUEL CELLS	9

Principle of operation – Modules - Fuel cell stacks - General performance characteristics - Ammonia as AFC - Electrodes: materials and manufacturing - Stacks and systems - Factors affecting the performance of AFC - Cell components Anode and Cathode materials - Configurations and performance – Cell components - Mechanisms of Electrode reactions

UNIT III	DIRECT METHANOL AND PROTON EXCHANGE MEMBRANE FUEL CELLS	9

Catalyst and Non catalyst aspects - Methanol cross over - Catalyst aspects and scale up - Engineering aspects - Scientific aspects and challenges - Milestones in technology development - Challenges to high temperature operations.

UNIT IV	FUEL PROCESSING AND HYDROGEN STORAGE	9

Processing hydrogen from alcohols - Producing hydrogen from

hydrocarbons - Hydrogen from other sources - Gas clean up - Hydrogen storage - Methods of Hydrogen storage - Hydrogen as Engine fuel.		
UNIT V	**FUEL CELL SYSTEMS**	**9**
Introduction to fuel cell power conditioning systems- Various options- Fuel cell systems fuelled by Natural gas (PEFC, PAFC, MCFC systems)- Coal fuelled fuel cell system-Combined fuel cell and Gas turbine system- Hybrid fuel cell systems- Electric vehicles.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Explain the various factors affecting the performance of fuel cells.
CO2:	Analyze the performance of alkaline and solid oxide fuel cells.
CO3:	Utilize the direct methanol and proton exchange membrane fuel cells.
CO4:	Apply the knowledge of hydrogen storage.
CO5:	Evaluate the fuel cell power conditioning systems.
CO6:	Assess environmental impact of Fuel cells.
TEXT BOOKS:	
1	Viswanathan.B and Aulice Scibion, "Fuel Cells: Principles and applications", CRC Press, 2008.
2	Ryan O'Hayre, Suk-Won Cha, Whitney Colella, Fritz B. Prinz, "Fuel Cell Fundamentals", John Wiley & Sons, 2016.
REFERENCES:	
1	Bent Sorensen, "Hydrogen and Fuel Cells Emerging technologies and applications", Elsevier Publishers, Second Edition, 2011.
2	Noriko Hikosaka Behling, "Fuel cells", Elsevier Publishers, 1st Edition, 2012.

3	Hoogers G. (Ed), “Fuel Cell Handbook”, John Wiley & Sons Ltd. 7th Edition, 2004.
4	Nigel Sammes, “Fuel Cell Technology: Reaching Towards Commercialization”, Springer, 6th Edition, 2006.

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

23AU036	SENSORS AND ACTUATORS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To differentiate between sensors and actuators and to familiarize with different types of sensors used in automotive applications.
- To explore the role of actuators in automation, robotics and manufacturing.
- To explore emerging trends and innovations in sensor and actuator technologies

UNIT I	INTRODUCTION TO MEASUREMENTS AND SENSORS	10

Sensors: Functions - Classifications - Main technical requirement and trends Units and standards - Calibration methods - Classification of errors - Error analysis - Limiting error - Probable error Propagation of error - Principle of transduction - Classification. Static characteristics – Mathematical model of transducers - Zero, First and Second order transducers.

UNIT II	VARIABLE RESISTANCE AND INDUTANCE SENSORS	8

Principle of operation - Construction details - Characteristics and applications of resistive potentiometer - Strain gauges - Resistive thermometers – Thermistors – Piezo-resistive sensors - Inductive potentiometer - Variable reluctance transducers - LVDT

UNIT III	VARIABLE AND OTHER SPECIAL SENSORS	9

Variable air gap type, Variable area type and variable permittivity type - Capacitor microphone Piezoelectric, Magneto strictive, Hall Effect, semiconductor sensor - Digital transducers - Humidity Sensor. Rain sensor, climatic condition sensor, solar, light sensor.

UNIT IV	AUTOMOTIVE ACTUATORS	9

Electromechanical actuators - Electrical machines - Direct - Current machines - Three -Phase machines - Single-phase

alternating current Machines - Duty-type ratings for electrical machines. Working principles, Construction and location of actuators, Solenoid, Relay, Stepper motor.		
UNIT V	**AUTOMATIC TEMPERATURE CONTROL ACTUATORS**	**9**
Different types of actuators used in automatic temperature control - Fixed and variable displacement temperature control - Semi Automatic - Controller design for Fixed and variable displacement type air - Conditioning system.		
		TOTAL: 45 PERIODS
COURSE OUTCOMES:		
After completion of the course, the students will be able to:		
CO1:	Explain common types of sensor and actuators used in vehicles.	
CO2:	Develop mathematical model for zero, first and second order transducers.	
CO3:	Develop new ideas in designing the variable resistance and inductance sensors.	
CO4:	Explain the operation of the variable and other special sensors.	
CO5:	Summarize the working principles, advantages, and limitations of each type of actuator.	
CO6:	Develop temperature control actuators for vehicles.	
TEXT BOOKS:		
1	Doebelin's Measurement Systems: 7th Edition (SIE), Ernest O. Doebelin DhaneshN.Manik McGraw Hill Publishers, 2019.	
2	Patranabis.D, "Sensors and Transducers", 2nd Edition, Prentice Hall India Ltd, 2003	
REFERENCES:		
1	James D Halderman, "Automotive Electrical and Electronics", Prentice Hall, USA, 2013.	

2	Tom Denton, "Automotive Electrical and Electronics Systems," Third Edition, SAE International, 2004.
3	Robert Brandy, "Automotive Electronics and Computer System", Prentice Hall, 2001.
4	William Ribbens, "Understanding Automotive Electronics -An Engineering Perspective," 7th Edition, Elsevier Butterworth-Heinemann Publishers, 2012.

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

23AU037	AUTOMOTIVE EMBEDDED SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To explore semiconductor devices and their applications in electronic circuits.
- To familiarize with digital electronics concepts.
- To familiarize with the architecture and components of microprocessors to explore the applications of microprocessors automotive electronics.

UNIT I	BASIC OF ELECTRONIC ENGINE CONTROL SYSTEMS	9

Overview of Automotive systems, fuel economy, air-fuel ratio, emission limits and vehicle performance; Automotive microcontrollers- Electronic control Unit- Hardware & software selection and requirements for Automotive applications – open source ECU- RTOS - Concept for Engine management-Standards; Introduction to AUTOSAR and Introduction to Society SAE- Functional safety ISO 26262- Simulation and modeling of automotive system components.

UNIT II	SENSORS AND ACTUATORS FOR AUTOMOTIVES	9

Review of sensors- sensors interface to the ECU, conventional sensors and actuators, Modern sensor and actuators - LIDAR sensor- smart sensors- MEMS/NEMS sensors and actuators for automotive applications.

UNIT III	VEHICLE MANAGEMENT SYSTEMS	9

Electronic Engine Control-engine mapping, air/fuel ratio spark timing control strategy, fuel control, electronic ignition-Adaptive cruise control - speed control-anti-locking braking system-electronic suspension - electronic steering , Automatic wiper control- body control system ; Vehicle system schematic for interfacing with EMS, ECU. Energy Management system for electric vehicles- Battery management system , power management system-electrically assisted power steering system

Adaptive lighting system- Safety and Collision Avoidance.		
UNIT IV	**ONBOARD DIAGONSTICS AND TELEMATICS**	**9**
On board diagnosis of vehicles -System diagnostic standards and regulation requirements Vehicle communication protocols Bluetooth, CAN, LIN, FLEXRAY, MOST, KWP2000 and recent trends in vehicle communications- Navigation- Connected Cars technology – Tracking- Security for data communication- dashboard display and Virtual Instrumentation, multimedia electronics- Role of IOT in Automotive systems.		
UNIT V	**ELECTRIC VEHICLES**	**9**
Electric vehicles –Components- Plug in Electrical vehicle- Charging station – Aggregators- Fuel cells/Solar powered vehicles- Autonomous vehicles.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Apply the electronic concept in automotive engine.
CO2:	Categorize the types of sensors and actuators in automobiles.
CO3:	Demonstrate the various vehicle management systems.
CO4:	Analyze the various diagnostic tools used in vehicle system.
CO5:	Summarize the connected car technology and tracking system.
CO6:	Select the appropriate electric vehicles.
TEXT BOOKS:	
1	Milman and Halkias, “Integrated Electronics”, Tata McGraw-Hill publishers, 1995.
2	Ramesh Goankar, “Microprocessor Architecture”, Programming and Applications with 8085, Wiley Eastern, 1998.

REFERENCES:	
1	Malvino and Leach, "Digital Principles and Applications", Tata McGraw-Hill, 1996
2	Mehta V.K, "Principles of Electronics", S. Chand and Company Ltd., 1994
3	DouglesV.Hall, "Microprocessor and Interfacing", Programming and Hardware, Tata McGraw- Hill, 1999.
4	Salivahanan S, Suresh Kumar N, Vallavaraj A, "Electronic Devices and Circuits" First Edition, Tata McGraw-Hill, 1999.

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

23AU038	AUTOMOTIVE ELECTRICAL SYSTEMS AND DRIVES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To explain the basic principles of electricity, circuits and electrical components relevant to automotive applications.
- To explain the operation of charging, starting and ignition system.
- To familiarize with power electronics used in modern vehicles and to explore emerging trends and technologies in automotive electrical systems.

UNIT I	ELECTRICAL WIRING AND COMPONENTS	9

Introduction – Electrical wiring, Terminals and switching devices output devices relays - Relay logic diagram contractors - OLR DOL starter - MCB fuses timer counter - Vehicle interior and exterior lighting systems - Horn circuit - Wiper circuit – Power window circuit and central locking circuit.

UNIT II	CHARGING AND STARTING SYSTEM	9

Requirements of charging system, Charging systems principles, Alternators and charging circuits, Starting system circuits, Starter motor types, Characteristics - Drive mechanisms, Capacity requirements, Servicing and trouble shooting.

UNIT III	IGNITION SYSTEM	9

Magneto coil ignition system - Battery coil ignition system – Electronic – Programmed - Distributor less ignition systems - Spark advance and retard mechanisms – Types of spark plugs.

UNIT IV	POWER ELECTRONIC DEVICES	9

Concept of power electronics - Power electronic systems - Power semi - Conductor devices principle of operation steady state and switching characteristics of power diodes - Power BJT - Power MOSFET – SCR - DIAC - TRIAC

UNIT V	ELECTRIC MOTOR DRIVES	9

Introductions DC TO DC converters - Boost converter and buck converter – AC Induction motor and control - BLDC motor and

control - Plug in battery charger design, stepper motor and control - Servo Motor and control - Permanent magnet synchronous motor	
	TOTAL: 45 PERIODS
COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Explain the vehicle wiring harness, working of field devices and circuit diagrams for various sub systems.
CO2:	Illustrate the circuit diagram for starting and charging system with characteristics of starter motor and alternator.
CO3:	Explain the various ignition systems with spark advance and retard mechanisms.
CO4:	Summarize various power electronic devices with characteristics and functions.
CO5:	Relate the operations of the different types of Traction motors.
CO6:	Classify AC convertor & DC convertor.
TEXT BOOKS:	
1	Tom Denton, Automobile electrical and electronic systems" 5th edition, United Kingdom, 2017.
2	Rashid .M.H, Power electronics: circuit devices and applications" 4th edition, Pearson education. New Delhi, 2017.
REFERENCES:	
1	Wei Liu, Introduction to hybrid vehicle system modelling and control, 1st Edition, Wiley, New Delhi, 2015.
2	Robert Bosch, "Bosch Automotive electric and automotive electronics, 5th Edition, Springer, 2013.
3	John G. Hayes and G. Abas Goodarzi, Electric Powertrain: Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles, Wiley Publication, 1999.

4	K. T. Chau, Electric Vehicle Machines and Drives: Design, Analysis and Application, Wiley-IEEE Press, 2015.

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

VERTICAL -2 - COMPUTATIONAL DESIGN

23AU039	COMPUTER AIDED DESIGN AND MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn fundamental design principles and techniques, geometric dimensioning and tolerance.
- To familiarize with computer aided design and manufacturing (CAD/CAM) techniques, CAD/CAM integration, CNC programming.
- To develop problem-solving skills related to design and manufacturing challenges.

UNIT I	COMPUTER AIDED DESIGN (CAD)	9

Overview of 2D drawings, Work area customization, Constraints and parameters, sketching tools, Geometrical modifications, Converting 2D drawings to 3D models, Modeling features and tools, Dimensioning and annotations, Materials and appearances, File import/export.

UNIT II	COMPUTER AIDED MANUFACTURING (CAM)	9

Overview of machining processes, Work setup, cutting tool selection, Calculation of feeds and speeds, Material removal rate, CAM cycles, Cutting planes selection, Toolpath setup, Post-processing of G-Codes.

UNIT III	CAD AND CAM INTEGRATION	9

Introduction - Networking - Techniques, components, Interface cards, Network standards, Graphics standards - Graphical kernel system, Data exchange format - IGES and STEP. Process planning, Computer Aided Process Planning (CAPP), Product life cycle management (PLM), Enterprise resource planning (ERP).

UNIT IV	FUNDAMENTAL OF CNC AND PART PROGRAMMING	9

Introduction to NC systems and CNC - Machine axis and Co-ordinate system - CNC machine tools - Principle of operation

CNC - Construction features including structure - Drives and CNC controllers - 2D and 3D machining on CNC - Introduction of Part Programming types - Detailed Manual part programming on Lathe & Milling machines using G codes and M codes - Cutting Cycles, Loops, Sub program and Macros.		
UNIT V	**ADDITIVE MANUFACTURING**	**9**
Rapid Prototyping: Introduction, Classification of RP Processes, Advantages & disadvantages. RP Applications in Design, Concept Models, Form & fit checking, Functional testing, CAD data verification, Rapid Tooling, and bio fabrication. Working Principle, Application, Advantages & disadvantages of Stereolithography Apparatus (SLA) Selective Laser Sintering (SLS), 3D Printing, Fused Deposition Modeling (FDM).		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Build part drawings and 3D models using CAD techniques.
CO2:	Construct the CAM Toolpath for specific given operations
CO3:	Apply the knowledge of the process between conceptualization of a product to its reality.
CO4:	Develop collaboration between product design and manufacturing.
CO5:	Apply NC & CNC programming concepts to develop part programme for Lathe & Milling Machines
CO6:	Apply the knowledge of various cost-effective alternatives for manufacturing products.
TEXT BOOKS:	
1	Mikell. P. Groover "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall of India, 2008.

2	Radhakrishnan P, Subramanyan S. and Raju V., “CAD/CAM/CIM”, 2nd Edition, New Age International (P) Ltd, New Delhi, 2000.
REFERENCES:	
1	Chris McMahon and Jimmie Browne “CAD/CAM Principles", "Practice and Manufacturing management “ Second Edition, Pearson Education, 1999.
2	Donald Hearn and M. Pauline Baker “Computer Graphics”’. Prentice Hall, Inc, 1992.
3	Foley, Wan Dam, Feiner and Hughes - "Computer graphics principles & practice" Pearson Education, 2003
4	William M Neumann and Robert F. Sproul “Principles of Computer Graphics”, McGraw Hill Book Co. Singapore, 1989.

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

23AU040	INTEGRATED COMPUTATIONAL MATERIALS ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To explore methods for materials selection and design based on performance requirements, constraints, and optimization criteria.
- To learn about optimization techniques and design of experiments (DOE) methods
- To analyze current challenges and future directions in the development of new computational methods

UNIT I	BASICS OF COMPUTATIONAL MATERIALS SCIENCE	9

Atomistic theory of matter, Statistical mechanics of materials (equilibrium and non -Equilibrium systems and ensembles) Coarse graining methods, Continuum models of materials and microstructures.

UNIT II	MULTISCALE SIMULATION METHODS	9

Molecular Dynamics, Equilibrium and kinetic Monte Carlo simulation, Mesoscopic methods such as Dislocation Dynamics and the Phase Field method and continuum -Level modeling of materials behavior in Finite Element simulations.

UNIT III	NUMERICAL METHODS FOR ATOMISTIC MODELING I	9

General theory of atomistic simulations - MD integration algorithms for different thermodynamic ensembles (NVE,NVT,NPT), Energy minimization algorithms and structure optimization, Introduction to Density Functional Theory, Determination of defect properties, Atomic interaction potentials, including EAM, BOP and Tight Binding Methods.

UNIT IV	NUMERICAL METHODS FOR ATOMISTIC MODELING II	9

Monte Carlo and kinetic Monte Carlo methods, Modeling thermally activated events: Transition state theory, Nudged

<table>
<tr><td colspan="3">elastic band calculations, Hyperdynamic Generalized Continuum Models of Microstructure: Cosserat continua, Micromorphic continua, Nonlocal and gradient-dependent models.</td></tr>
<tr><td>UNIT V</td><td>DISLOCATION THEORY AND SIMULATION</td><td>9</td></tr>
<tr><td colspan="3">Foundations of dislocation theory (stress and strain fields, dislocation energetics and interactions), Dislocation-based modeling of plastic deformation processes, Discrete and continuous simulation approaches.</td></tr>
<tr><td colspan="3" align="right">TOTAL: 45 PERIODS</td></tr>
<tr><td colspan="3">COURSE OUTCOMES:</td></tr>
<tr><td colspan="3">After completion of the course, the students will be able to:</td></tr>
<tr><td>CO1:</td><td colspan="2">Summarize different types of models of materials based on statistical mechanics.</td></tr>
<tr><td>CO2:</td><td colspan="2">Identify the simulation techniques for solving a particular problem in material science.</td></tr>
<tr><td>CO3:</td><td colspan="2">Develop basic atomistic and microstructure level simulations.</td></tr>
<tr><td>CO4:</td><td colspan="2">Apply numerical methods for thermally activated events.</td></tr>
<tr><td>CO5:</td><td colspan="2">Apply numerical methods for generalized continuum models, gradient-dependent models.</td></tr>
<tr><td>CO6:</td><td colspan="2">Model the role of dislocations and other material defects.</td></tr>
<tr><td colspan="3">TEXT BOOKS:</td></tr>
<tr><td>1</td><td colspan="2">Lee, J., Computational Materials Science: An Introduction, 2nd Edition, CRC Press 2016.</td></tr>
<tr><td>2</td><td colspan="2">Sholl, D. S., and Steckel, J. A., Density Functional Theory: A Practical Introduction, 1st Edition, Wiley, 2009.</td></tr>
<tr><td colspan="3">REFERENCES:</td></tr>
<tr><td>1</td><td colspan="2">Richard Lesar, “Introduction to Computational Materials Science: Fundamentals to Applications”, Cambridge University Press, 2013.</td></tr>
</table>

2	June Gunn Lee, “Computational Materials Science: An Introduction”, CRC press, 2011
3	Dove, M.T., Introduction to Lattice Dynamics, 1st Edition, Cambridge University Press, 1993.
4	Maciej Pietrzyk, Lukasz Madej, Lukasz Rauch, Danuta Szeliga, “Computational Materials Engineering: Achieving High Accuracy and Efficiency in Metals Processing Simulations” Butterworth-Heinemann Publisher, 2015.

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

23AU041	VEHICLE DESIGN AND DATA CHARACTERISTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To collect important technical specifications of an automobile from Technical notes, research publications.
- To calculate and tabulate various vehicle performance parameters.
- To draw vehicle performance curves using design parameters.

UNIT I	INTRODUCTION	9

Assumptions to be made in designing a vehicle, Range of values for Gross Vehicle Weight, Frontal Area, maximum speed, maximum acceleration, gradability in different gears, Basics of Automobile Design.

UNIT II	RESISTANCE TO VEHICLE MOTION	9

Calculation, Tabulation and Plotting of Curves for Air and Rolling Resistances at various vehicle speeds, Calculation and Plotting of Driving force, Power requirement for different loads and acceleration, Maximum Power calculation.

UNIT III	PERFORMANCE CURVES - I	9

Calculation, Tabulation and Plotting of Torque and Mechanical Efficiency for different vehicle speeds, Interpolation of Pressure – Volume diagram, Calculation of frictional Mean Effective Pressure, Calculation of Engine Cubic Capacity, Bore and Stroke Length.

UNIT IV	PERFORMANCE CURVES - II	9

Connecting rod length to Crank Radius Ratio, Plotting of Piston Velocity and Acceleration against Crank Angle, Plotting Gas force, Inertia force and Resultant force against Crank Angle, Turning Moment and Side Thrust against Crank Angle.

UNIT V	GEAR RATIOS	9

Determination of Gear Ratios, Acceleration and Gradability, Typical Problems on Vehicle performance.

	TOTAL: 45 PERIODS
COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Choose the parameters required to design Engine.
CO2:	Explain the different resistances of the vehicle and tractive Effort.
CO3:	Compare Engine performance parameters
CO4:	List various design parameters of the Vehicle
CO5:	Model various gear ratios related to Vehicle Performance.
CO6:	Develop the performance curves of the Engine and vehicle
TEXT BOOKS:	
1	Giri. N. K., "Automotive Mechanics", Khanna Publishers, New Delhi, 2005.
2	P.M. Heldt, "High Speed Combustion Engines", Oxford and I.B.H. Publishing Co., Kolkata, 2002.
REFERENCES:	
1	Gupta. R.B., "Automobile Engineering", Sathya Prakashan, 8th Edition, 2013.
2	V. Ganesan "Internal Combustion Engines" Tata McGraw Hill Publishers, 2003.
3	Internal combustion engine Fundamentals by John B. Heywood, Second Edition, McGraw-Hill Education, 2018.
4	Julian Happian-smith, "Introduction to Modern Vehicle Design" SAE, 2002.

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

23AU042	COMPUTATIONAL AND VISUALIZATION THEORY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To explore the fundamental principles of computation, including algorithms, data structures, complexity analysis, and computational models
- To familiarize with software tools and libraries for interactive data visualization and exploration
- To apply computational and visualization theory in various scientific and engineering domains

UNIT I	AUTOMATA THEORY	9

Defining Automaton, Finite Automaton, Transitions and Its properties, Acceptability by Finite Automaton, Nondeterministic Finite State Machines, DFA and NDFA equivalence, Mealy and Moore Machines, Minimizing Automata.

UNIT II	REGULAR GRAMMAR & CONTEXT FREE LANGUAGES AND PUSHDOWN AUTOMATA	9

Regular Grammar, Regular Expressions, Finite automata and Regular Expressions, Pumping Lemma and its Applications, Closure Properties, Regular Sets and Regular Grammar Context Free Languages: Context-free Languages, Derivation Tree, Ambiguity of Grammar, CFG simplification, Normal Forms, Pumping Lemma for CFG Pushdown Automata: Definitions, Acceptance by PDA, PDA and CFG

UNIT III	TURING MACHINES & UNDECIDABILITY	9

Turing Machine Definition, Representations, Acceptability by Turing Machines, Designing and Description of Turing Machines, Turing Machine Construction, Variants of Turing Machine, Undecidability: The Church-Turing thesis, Universal Turing Machine, Halting Problem, Introduction to Unsolvable Problems

UNIT IV	**FOUNDATIONS FOR DATA VISUALIZATION**	**9**
Introduction to Visualization – Visualization stages – Experimental Semiotics based on Perception – Gibson 's Affordance theory – A Model of Perceptual Processing – Costs and Benefits of Visualization – Types of Data.		
UNIT V	**MULTIDIMENSIONAL VISUALIZATION**	**9**
1D, 2D, 3D – Multiple Dimensions – Trees – Web Works – Data Mapping: Data Visualization– Workspaces.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Distinguish between different types of automata and apply minimization techniques to optimize automata
CO2:	Analyze and construct regular grammars and context-free grammars
CO3:	Explain Turing Machines and Pushdown Automata
CO4:	Apply visualization techniques by understanding the stages of visualization
CO5:	Interpret 1D, 2D, and 3D visualizations
CO6:	Utilize various techniques for effective representation of multidimensional data.
TEXT BOOKS:	
1	Hopcroft E. J., Ullman D. J. and Motwani R., Introduction to Automata Theory, Languages and Computation, Pearson Education (2007) 3rd edition.
2	Kavi Mahesh, "Theory of Computation", Wiley India, 2011.
REFERENCES:	
1	Martin C. J., "Introduction to Languages and the Theory of Computation", McGraw-Hill Higher Education (2011) 4th edition.

2	Colin Ware "Information Visualization Perception for Design", 3rd edition, Morgan Kaufman 2012. Introduction to Languages and the Theory of Computation, John E Martin, McGraw-Hill Education
3	Chaomei Chan, "Information Visualization", beyond the horizon, 2nd edition, Springer Verlag, 2004.
4	Pauline Wills, "Visualisation: A Beginner's Guide", Hodder and Stoughlon, 1999.

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

23AU043	COMPUTER INTEGRATED MANUFACTURING IN AUTOMOTIVE SECTOR	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To explore techniques and technologies for quality control and inspection in automotive manufacturing
- To demonstrate the concept of FMS, agile production of automotive components and products.
- To infer the PLM concepts and tools used to manage the entire lifecycle of automotive products

UNIT I	INTRODUCTION	10

Manufacturing and its types – CIM - Definition and need: Hardware and software. Concurrent Engineering: Definition, Sequential Engineering Versus Concurrent Engineering, Benefits of Concurrent Engineering, Characteristics of concurrent Engineering, Collaborative Product Development. Basic Elements of an automated system – Levels of Automation – Lean Production and Just–In-Time Production.

UNIT II	PRODUCTION PLANNING & CONTROL AND COMPUTERISED PROCESS PLANNING	10

Process planning – Aggregate Production Planning and Master Production Schedule – Material Requirement Planning (MRP) – Simple Problems – Capacity Planning – Shop Floor Control – Inventory Control – EOQ, WIP costs & Inventory Holding Costs - Simple Problems.

UNIT III	CELLULAR MANUFACTURING	9

Group Technology (GT), Part Families – Parts Classification and coding – Simple Problems in OPITZ Part Coding system – Production flow Analysis – Cellular Manufacturing – Composite part concept – Machine cell design and layout – Quantitative analysis in Cellular Manufacturing – Rank Order Clustering Method - Arranging Machines in a GT cell – Hollier Method.

UNIT IV	**FLEXIBLE MANUFACTURING SYSTEM (FMS) AND AUTOMATED GUIDED VEHICLE SYSTEM (AGVS)**	**8**
Types of Flexibility - FMS – FMS Components – FMS Application & Benefits – FMS Planning and Control – Quantitative analysis in FMS – Simple Problems. Automated Guided Vehicle System (AGVS) – AGVS Application – Vehicle Guidance technology – Vehicle Management & Safety		
UNIT V	**INDUSTRIAL ROBOTICS**	**8**
Robot Anatomy and Related Attributes – Classification - Control systems – End Effectors – Sensors – Applications – Basics of Robot Part Programming – Robot Accuracy and Repeatability – Simple Problems.		
		TOTAL: 45 PERIODS
COURSE OUTCOMES:		
After completion of the course, the students will be able to:		

CO1:	Compare Traditional Manufacturing environment to Computer Integrated Manufacturing environment.
CO2:	Explain the basic elements of an automated system
CO3:	Apply computers for process planning
CO4:	Summarize cellular manufacturing
CO5:	Apply the knowledge of the operations of Automatic guidance system
CO6:	Utilize Robot part programming
TEXT BOOKS:	
1	Mikell .P. Groover "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall of India, 2009.
2	Kant Vajpayee S, "Principles of Computer Integrated Manufacturing", Prentice Hall India, 2003.

REFERENCES:	
1	Henry Webber "Computer Integrated Manufacturing", NY research press, USA, 2020.
2	Gideon Halevi and Roland Weill, "Principles of Process Planning – A Logical Approach" Chapman & Hall, London, 1995.
3	P Rao, N Tewari and T.K. Kundra, "Computer Aided Manufacturing", Tata McGraw Hill Publishing Company, 2000.
4	James A.Rehg, "Computer Integrated Manufacturing", Pearson 3rd edition, 2004.

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

23AU044	CFD AND HEAT TRANSFER	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To Enhance problem-solving skills by applying CFD and heat transfer principles
- Gain insight into different heat transfer mechanisms such as conduction, convection, and radiation
- To solve complex problems in the field of fluid flow and heat transfer by using high speed computers.

UNIT I	GOVERNING EQUATIONS AND BOUNDARY CONDITIONS	9

Basics of computational fluid dynamics – Continuity, Momentum and Energy equations – Chemical species transport equations – Initial conditions and boundary conditions – Time - Averaged equations for Turbulent Flow – Mathematical behavior of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations.

UNIT II	FINITE DIFFERENCE AND FINITE VOLUME METHODS FOR DIFFUSION	9

Derivation of finite difference equations – Simple Methods – General Methods for first and second order accuracy – Finite volume formulation for steady state One, Two and Three – Dimensional diffusion problems – Parabolic equations – Explicit and Implicit schemes - Stability conditions – Example problems on elliptic and parabolic equations – Use of Finite Difference and Finite Volume methods.

UNIT III	FINITE VOLUME METHOD FOR CONVECTION DIFFUSION	9

Steady one - Dimensional - Convection and diffusion – Central, Upwind differencing schemes - Properties of discretization schemes – Conservativeness, Boundedness, Transportiveness, Hybrid, Power - Law, QUICK Schemes.

UNIT IV	FUNDAMENTALS OF HEAT TRANSFER	9

Conduction in parallel, Radial and composite wall – Basics of

Convective heat transfer – Fundamentals of Radiative heat transfer – Flow through heat exchangers.		
UNIT V	**PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS**	**9**
Nusselt's theory of condensation - Regimes of Pool boiling and Flow boiling. Correlations in boiling and condensation. Heat Exchanger Types - Overall Heat Transfer Coefficient – Fouling Factors - Analysis – LMTD method - NTU method.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Explain the governing equations and boundary conditions for Fluid dynamics
CO2:	Analyze Finite difference and Finite volume method for Diffusion
CO3:	Solve Convective diffusion by Finite volume method
CO4:	Apply the concepts of heat transfer in three modes to real problems
CO5:	Apply the concepts of phase change heat transfer
CO6:	Examine the performance of heat exchangers
TEXT BOOKS:	
1	Ghoshdastidar, P.S., "Computer Simulation of flow and heat transfer", Tata McGraw Hill Publishing Company Ltd., 2017.
2	Versteeg, H.K. and Malalasekera, W., "An Introduction to Computational Fluid Dynamics: The finite volume Method", Pearson Education Ltd. Second Edition, 2007.
REFERENCES:	
1	Anil W. Date "Introduction to Computational Fluid Dynamics" Cambridge University Press, 2005.
2	Ghoshdastidar P.S., "Heat Transfer", Oxford University Press, 2005

3	Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 2014.
4	Patankar, S.V. "Numerical Heat Transfer and Fluid Flow", Hemisphere Publishing Corporation, 2004.

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

<table>
<tr><td rowspan="2">23AU045</td><td rowspan="2">MECHNAICS OF MACHINES</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="6">• To analyze the geometry and motion of mechanisms-involved with displacement, velocity and acceleration.
• To evaluate the forces and torques acting on machine components to understand their motion.
• To explore cams and gears, vibration and balancing, effect of friction in power transmission.</td></tr>
<tr><td>UNIT I</td><td colspan="4">MECHANISMS</td><td>9</td></tr>
<tr><td colspan="6">Definition – Machine and Structure – Kinematic link, pair and chain – Classification of Kinematic pairs – Constraint and motion – Degrees of freedom - Slider crank – Single and double – Crank rocker mechanisms – Inversions, applications – Introduction to Kinematic analysis and synthesis of simple mechanisms – Determination of velocity and acceleration of simple mechanisms.</td></tr>
<tr><td>UNIT II</td><td colspan="4">FRICTION</td><td>9</td></tr>
<tr><td colspan="6">Types of friction – Friction in screw and nut – Screw jack – Pivot, collar and thrust bearings – Plate and cone clutch – Belt and rope drives – Creep in belts – Open and crossed belt drives – Ratio of tensions – Effect of centrifugal and initial tensions – Condition for maximum power transmission.</td></tr>
<tr><td>UNIT III</td><td colspan="4">GEARS AND CAMS</td><td>9</td></tr>
<tr><td colspan="6">Gear – Types and profile – Nomenclature of spur and helical gears – Laws of gearing – Interference – Requirement of minimum number of teeth in gears – Gear trains – Simple, compound and reverted gear trains – Epicyclic gear trains – Cams different types of followers – Cam – Types of cams and followers – Cam design for different follower motions.</td></tr>
<tr><td>UNIT IV</td><td colspan="4">VIBRATION</td><td>9</td></tr>
<tr><td colspan="6">Free, forced and damped vibrations of single degree of freedom systems – Force transmitted to supports – Vibration Isolation – Vibration absorption – Torsional vibration of shafts – Single and</td></tr>
</table>

multi- Rotor systems – Geared shafts – Critical speed of shafts.		
UNIT V	**BALANCING**	**9**
Static and dynamic balancing – Single and several masses in different planes – Primary and secondary balancing of reciprocating masses – Balancing of single and multi -Cylinder engines – Governors and Gyroscopic effects.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1:	Apply the concepts of kinematics and dynamics of machinery in design and analysis of engineering problems.
CO2:	Apply the frictional concept in automotive systems.
CO3:	Analyze cam and their motion
CO4:	Choose the gears and gear trains for their applications.
CO5:	Examine the concept of free, forced and damped vibrations.
CO6:	Identify the required balancing mass needed in rotary and reciprocating masses.

TEXT BOOKS:

1	Bansal R.K., "Theory of Machines", Laxmi Publications Pvt Ltd., New Delhi, 20th edition 2009.
2	Rattan S.S., "Theory of machines", Tata McGraw Hill publishing Co., New Delhi, 2nd edition 2011.

REFERENCES:

1	Gosh A and Mallick A.K., "Theory of Machines and Mechanisms", Affiliated East West press, 2009.
2	Malhotra D.R. and Gupta H.C, "The Theory of machines", Satya Prakasam, Tech. India Publications, 2008.
3	Rao J.S. and Dukkipati R.V., "Mechanism and Machine Theory", Second Edition, Wiley Eastern Limited, 2006.
4	Shigley J.E. and Uicker J.J., "Theory of Machines and Mechanisms", McGraw Hill, 2006.

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

<table>
<tr><td rowspan="2">23AU046</td><td rowspan="2" colspan="2">MACHINE DESIGN</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="7">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="7">To understand the design methodology for machine elements.
To analyze the forces acting on a machine element and apply the suitable design methodology.
To understand the various standards and methods of standardization.</td></tr>
<tr><td>UNIT I</td><td colspan="5">STEADY STRESSES AND VARIABLE STRESSES IN MACHIN MEMBERS</td><td>9</td></tr>
<tr><td colspan="7">Introduction to the design process - Factors influencing machine design, materials selection direct - Fits and tolerances – Direct, Bending and torsional stress equations – Impact and shock loading – Calculation of principle stresses for various load combinations, eccentric loading – Curved beams – crane hook and ‘C’ frame- Factor of safety - Theories of failure – Design based on strength and stiffness – Stress concentration</td></tr>
<tr><td>UNIT II</td><td colspan="5">SHAFTS AND COUPLINGS</td><td>9</td></tr>
<tr><td colspan="7">Variable load and cyclic loads - Fatigue strength - S-N curve - Continued cyclic stress - Stress concentration factor - Soderberg and Good man equations. Design of solid and hollow shafts based on strength, Rigidity and critical speed – Keys, keyways and splines – Types of couplings - Design of couplings based on given speed and load conditions.</td></tr>
<tr><td>UNIT III</td><td colspan="5">TEMPORARY AND PERMANENT JOINTS</td><td>9</td></tr>
<tr><td colspan="7">Threaded fasteners - Bolted joints including eccentric loading, Knuckle joints, Cotter joints – Welded joints, Riveted joints for structures - Theory of bonded joints.</td></tr>
<tr><td>UNIT IV</td><td colspan="5">ENERGY STORING ELEMENTS AND ENGINE COMPONENTS</td><td>9</td></tr>
<tr><td colspan="7">Various types of springs, Optimization of helical springs - Rubber springs – Flywheels considering stresses in rims and</td></tr>
</table>

arms for engines and punching machines - Connecting Rods and crank shafts.		
UNIT V	**BEARINGS**	**9**
Sliding contact and rolling contact bearings - Hydrodynamic journal bearings, Sommerfeld Number, Raimondi and Boyd graphs - Selection of Rolling Contact bearings.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Model the machine members to withstand a steady load using failure theories.
CO2:	Develop shaft that are able to withstand the Fatigue failure by using Soderberg, Goodman and Gerbers equations.
CO3:	Identify and Design coupling using given load conditions.
CO4:	Select different types of joining technique (metric bolts, rivets and welded joints) for integrating the machine elements in assembly under static and variable loading conditions.
CO5:	Examine the nomenclature of springs for different applications (Railway buffer spring, Automobile suspension, engine valve and safety valve) to prevent unwanted shock and vibrations.
CO6:	Select the suitable bearing based on the application
TEXT BOOKS:	
1	Bhandari V, “Design of Machine Elements”, 4th Edition, Tata McGraw-Hill Book Co, 2016.
2	R.S.Khurmi, “A text book of Machine Design”, S Chand, New Delhi.
REFERENCES:	
1	Alfred Hall, Halowenko, A and Laughlin, H., “Machine Design”, Tata McGraw-Hill Book Co., 2010.

2	Ansel Ugural, “Mechanical Design – An Integral Approach", 1st Edition, Tata McGraw-Hill Book Co, 2003.
3	P.C. Gope, “Machine Design – Fundamental and Application”, PHI learning private Ltd, New Delhi, 2012.
4	R.B. Patel, “Design of Machine Elements”, MacMillan Publishers India P Ltd., Tech-Max Educational resources, 2011.

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

VERTICAL -3 - VEHICLE RESEARCH AND VALIDATION

23AU047	ADVANCED AUTOMOTIVE MATERIALS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To provide students with a comprehensive understanding of engineering materials, their properties, and the basis of material selection in various applications.
- To understand the concepts of materials selection for various components in internal combustion engines and automotive structures.
- To identify the technologies utilized in sensors and electronic devices for automotive applications.

UNIT I	ENGINEERING MATERIALS AND THEIR PROPERTIES	9

Classes of engineering materials - The evolution of engineering materials, Definition of materials properties, Displaying material properties using materials selection charts, Forces for change in materials selection and design, Materials and the environment - Selection of materials for automotive applications.

UNIT II	BASIS OF MATERIAL SELECTION	9

Selection strategy, Attribute limits and Material indices, Structural index Selection procedure: Design process - Types of design, design requirements, Function, Material attributes, Shape and Manufacturing processes. Systematic process selection, Energy consumption for production, Material costs, Availability, Recyclability, Environmental consideration.

UNIT III	MATERIALS FOR ENGINES AND TRANSMISSION SYSTEMS	9

Materials selection for IC engines: Piston, Piston rings, Cylinder, Engine block, Connecting rod, Crank shaft, Fly wheels, Gear box, Gears, Clutches.

UNIT IV	MATERIALS FOR AUTOMOTIVE STRUCTURES	9

Materials selection for bearings, Leaf springs, Chassis & frames, Bumper, Shock absorbers, Wind screens, Panels, Brake shoes, Disc, wheels, Differentials, Damping and antifriction fluids, Tires and tubes.		
UNIT V	**ELECTRONIC MATERIALS FOR AUTOMOTIVE**	**9**
Materials for sensors and electronic devices meant for Engine Speed and Crank Position, Throttle position sensor, Manifold Absolute Pressure, Temperature Sensor, Oxygen Sensor, Piezoelectric Sensor, Ultrasonic Sensor and Dew Sensor, Sensor Materials and Technologies, Merits and Demerits.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Compare different class of materials and their applications.
CO2:	Identify the Selection criteria for various components and importance.
CO3:	Develop the various costs of materials for IC engines parts.
CO4:	Summarize various materials used for automotive structures.
CO5:	Select suitable electronic material for Automobile applications.
CO6:	Analyze different materials used for sensors in a vehicle.
TEXT BOOKS:	
1	Gladius Lewis, "Selection of Engineering Materials", Prentice Hall Inc. New Jersey USA, 1995.
2	Hiroshi Yamagata," The Science and Technology of Materials in Automotive Engines", Woodhead Publishing, 2005
REFERENCES:	
1	ASM Handbook. "Materials Selection and Design", Vol.

	20- ASM Metals Park Ohio. USA, 1997.
2	Cantor, “Automotive Engineering: Lightweight, Functional, and Novel Materials”, Taylor & Francis Group, London, 2006.
3	James A. Jacobs, Thomas F. Kilduff., “Engineering Materials Technology: Structure, Processing, Properties & Selection”, Prentice Hall, USA, 1996.
4	M F Ashby, “Materials Selection in Mechanical Design”, third edition, Butterworth- Heineman, New York, 2005.

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

23AU048	AUTOMOTIVE FUNCTIONAL SAFETY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To provide students with a comprehensive understanding of system and functional safety principles, and cybersecurity in the context of automotive technology and road networks.
- To understand functional safety assessment methods and functional safety design principles in the context of automotive systems.
- To understand the functional safety verification methods in automotive systems.

UNIT I	INTRODUCTION	9

Definition of System and Functional safety, Lifecycle of safe product, Safety terminologies, System engineering – From Faults to Hazards, Reliability.

UNIT II	AUTOMOTIVE FUNCTIONAL SAFETY STANDARD	9

Cyber security in Road Network, V2V connectivity, SAE J3016 – Levels of automation, ADAS system block diagrams, Overview of Safety standards ISO26262, IEC 61508, ISO 13849, ISO TS5083, ISO PAS 21448, and ISO SAE DIS 21434.

UNIT III	FUNCTIONAL SAFETY ASSESSMENT METHODS	9

System decomposition, Safety analysis methods, Safety function, Automotive Safety Integrity Levels (ASIL), Item definition, Impact Analysis, HARA, Functional Safety Concept, Diagnostic techniques, Technical Safety Concept.

UNIT IV	FUNCTIONAL SAFETY DESIGN	9

Safety function, Safety pitfalls, Residual faults, Fault prevention design, Fault tolerant design, Modelling methods in Technical Safety concept, Safety plan, Safe SW development, Role of product safety engineer.

UNIT V	FUNCTIONAL SAFETY VERIFICATION	9

HW & SW integration checks, Safety - Related systems design assessments, Verification of functional safety, Test results integration in safety case, Introduction to Automotive SPICE – SW maturity model, introduction to SW stacks (AUTOSAR, RTOS, etc.).	
TOTAL: 45 PERIODS	
COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Explain the automotive functional safety product lifecycle.
CO2:	Choose the safety standards according to application in automotive industry.
CO3:	Choose a functional item on a vehicle level, construct hazard assessment and risk analysis, and select an ASIL level for the item.
CO4:	Analyze and select appropriate work products while understanding the lifecycle.
CO5:	List the requirements of functional safety at the system, hardware, and software design phases.
CO6:	Solve Functional problems in automobile design, development, and in-use phases.
TEXT BOOKS:	
1	Hans- Leo Ross, "Functional Safety for Road Vehicles: New Challenges and Solutions for E-mobility and Automated Driving" Springer International Publishing; 1st edition, 2016.
2	Joseph D. Miller, 'Automotive System Safety: Critical Considerations for Engineering and Effective Management', Wiley, 2020.
REFERENCES:	
1	Markus Maurer, Hermann Winner, "Automotive Systems Engineering - I & II", Springer, 2013.
2	Bülent Sari, "Fail-operational Safety Architecture for

	ADAS/AD Systems and a Model-driven Approach for Dependent Failure Analysis", Springer, 2020.
3	Peter Johannes Bergmiller, "Towards Functional Safety in Drive-by-Wire Vehicles", Springer, 2015.
4	Robert Bosch GmbH - "Safety, Comfort and Convenience Systems"- Wiley; 3rd edition, 2007.

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

23AU049	COMBUSTION TERMODYNAMICS AND HEAT TRANSFER	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To study and understand the applications of thermodynamics in combustion and concepts of combustion kinetics and impart the knowledge about the different types of flames during combustion.
- To apply the heat transfer concepts for the measurement of temperature in piston.
- To study about the different types of instruments for the analysis of combustion in IC engines.

UNIT I	THERMODYNAMICS OF COMBUSTION	9

Combustion process in IC Engines-Premixed – Diffusion, First and Second Law of Thermodynamics applied to combustion – Combustion Stoichiometry - Chemical equilibrium - Spray formation.

UNIT II	CHEMICAL KINETICS OF COMBUSTION	9

Combustion kinetics, Rate of reaction, equation of Arrhenius, Activation energy, Chemical thermodynamic model for Normal Combustion.

UNIT III	FLAMES	9

Laminar – Premixed - Diffusion flames – Flame speed correlations – Quenching - Flammability. Ignition flame stabilization - Turbulent premixed, diffusion flames – Damkohler number.

UNIT IV	HEAT TRANSFER IN IC ENGINES	9

Engine heat transfer - Heat Balance. Measurement of instantaneous heat transfer rate. Heat transfer modelling. Heat transfer coefficients- Radiative heat transfer. Temperature measurement in piston.

UNIT V	INSTRUMENTATION	9

Pressure sensors - Piezoelectric pickup - Crank angle encoder -

Thermocouples. Hot wire anemometer - Laser Doppler anemometry and velocimetry for flow and combustion analysis in IC engines. Measurement of cylinder peak pressure and HRR calculation.	
TOTAL: 45 PERIODS	
COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Summarize the concepts of combustion in thermodynamics.
CO2:	Identify the kinetics behind the chemical reaction of combustion of fuels.
CO3:	Distinguish the flame types inside a combustion chamber.
CO4:	Apply the principle of different modes of heat transfer in IC engines.
CO5:	Explain the various measuring sensors related to combustion analysis
CO6:	Analyze the in-cylinder pressure and HRR.
TEXT BOOKS:	
1	John. B. Heywood, “Internal Combustion Engines", Tata McGraw Hill Co., Newyork, 1988.
2	Achintya Mukhopathyay and Swarnendu Sen, “Fundamentals of Combustion Engineering John. B. Heywood,” Internal Combustion Engines”, CRC Press., New York, 2019.
REFERENCES:	
1	Ashley Campbel, “Thermodynamic analysis of combustion engine”, John book company, New York, 1979.
2	Ganesan. V. “Computer Simulation of Spark Ignition Engine Process”, Wiley eastern India ltd, 1996.
3	Irvin Glasman, “Combustion” Academic Press, London, 1987, ISBN 0-12-285851-4

4	J.I. Ramos, "Modeling of Internal Combustion Engine", McGraw hill book company New York 1990.

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

23AU050	ALTERNATIVE FUELS AND ENERGY SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To provide students with a comprehensive understanding of alternative liquid fuels, and their applications in automotive engines.
- To provide students with a comprehensive understanding of alternative gaseous fuels, and their applications in automotive engines.
- To provide students with a comprehensive understanding of electric vehicles (EVs) and hybrid vehicles (HVs).

UNIT I	ALCOHOL FUELS	9

Introduction to alternative fuels - Need for alternative fuels - Availability of different alternative fuels for SI and CI engines. Alcohols as fuels. Production methods of alcohols. Properties of alcohols as fuels. Methods of using alcohols in CI and SI engines. Performance combustion and emission characteristics in CI and SI engines. DME – DEE - as fuels.

UNIT II	VEGETABLE OILS	9

Various vegetable oils and their important properties. Different methods of using vegetable oils engines – Blending, preheating Trans-esterification - Emulsification - Performance – Combustion - Emission Characteristics in diesel engines.

UNIT III	HYDROGEN AND LPG	9

Production methods of hydrogen- Properties of hydrogen - Problems associated with hydrogen as fuel - Solutions. Different methods of using hydrogen in SI and CI engines – Performance - Combustion - Emission Characteristics in SI and CI engines. Hydrogen storage – Safety aspects of hydrogen and its limitations. LPG - Properties of LPG – Limitations of LPG as a fuel - Performance-combustion – Emission Characteristics in SI and CI engines.

UNIT IV	BIOGAS AND NATURAL GAS	9

Production methods of Biogas and Natural gas - Properties.

Scrubbing of CO_2 and H_2S from Biogas. Modification required to use in SI and CI Engines – Performance -combustion – Emission characteristics of Biogas and Natural gas in SI and CI engines		
UNIT V	**ELECTRIC AND HYBRID VEHICLES**	**9**
Layout of Electric vehicle and Hybrid vehicles – Advantages and drawbacks of electric and hybrid vehicles. System components and drives - Electronic control system – Different configurations of Hybrid vehicles. Power split device. High energy and power density batteries.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Develop knowledge in all the possible ways of using alcohols as a fuel in IC engines.
CO2:	Summarize on biodiesel and their properties to use as fuel in CI and SI engines.
CO3:	Identify the uses of hydrogen and LPG as fuel in IC engines as an alternative for fossil fuels.
CO4:	Explain the usefulness of natural gas and biogas towards IC engines.
CO5:	Develop the adequate knowledge on electric vehicle.
CO6:	Show the adequate knowledge on hybrid vehicle.
TEXT BOOKS:	
1	Ayhan Demirbas, 'Biodiesel A Realistic Fuel Alternative for Diesel Engines', Springer- Verlag London Limited 2008.
2	Devaradjane. Dr. G., Kumaresan. Dr. M., "Automobile Engineering", AMK Publishers, 2013.
REFERENCES:	
1	Gerhard Knothe, Jon Van Gerpen, Jargon Krahl, The Biodiesel Handbook, AOCS Press Champaign, Illinois 2005.

2	Richard L Bechtold P .E. Alternative Fuels Guide book, Society of Automotive Engineers, 1997.
3	Science direct journals (Biomass & Bio energy, Fuel, Energy, Energy conversion Management, Hydrogen Energy, etc.) on biofuels.
4	Transactions of SAE on Biofuels (Alcohols, vegetable oils, CNG, LPG, Hydrogen, Biogas etc.).

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

23AU051	AUTOMOTIVE INSTRUMENTATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To provide students with a comprehensive understanding of mechanical measurement techniques and vibration and body testing methods in automotive engineering.
- To understand the concepts of crash and brake testing methods in automotive engineering.
- To provide students with a comprehensive understanding of experimental techniques used in engine and vehicle testing in automotive engineering.

UNIT I	MECHANICAL MEASUREMENT	9

Introduction to measurements – Construction, Principle, Working of Instruments for measuring force, Torque, Pressure, Temperature, Fluid flow, Velocity, Rotational speed.

UNIT II	VIBRATION AND BODY TEST	9

Vibration measurement instrument – accelerometer and signal conditioning. Dynamic simulation sled testing, methodology, vehicle acceleration measurement and documentation. Dolly roll over test, dolly role over fixture, photographic / video coverage. Vehicle roof strength test –Door system crush test – wind tunnel tests.

UNIT III	CRASH AND BRAKE TEST	9

Crash tests – Standards – Road hazard impact test for wheel and tyre assemblies, test procedures, Failure and performance criteria. Bumpers - Types of tests, pendulum test, Fixed collision barrier test, Procedure, Performance criteria. Air and hydraulic brake test, Air brake actuator, Valves test, Performance requirements.

UNIT IV	ENGINE EXPERIMENTAL TECHNIQ	9

I.S Code for Engine testing – Instruments for performance, Emission and combustion testing of engine, Instrumentation for measuring noise, Vibration in cylinder.

UNIT V	**VEHICLE EXPERIMENTAL TECHNIQUES**	**9**
Laboratory tests - Test tracks - Endurance Tests - Dynamic cornering fatigue, Dynamic radial fatigue tests – Procedure, Bending moment and radial load calculations.		
		TOTAL: 45 PERIODS
COURSE OUTCOMES:		
After completion of the course, the students will be able to:		
CO1:	Show the knowledge of engine measurement for various parameters.	
CO2:	Develop a measurement strategy for vibration test.	
CO3:	Explain standards of crash test and identify the failures.	
CO4:	Identify the different codes used for engine testing	
CO5:	Analyze the engine characteristics using different instruments	
CO6:	Explain about endurance test and fatigue test of vehicle.	
TEXT BOOKS:		
1	Crouse W H and Anglin D L., “Automotive Mechanics”’ Tata McGraw Hill Publishing Company, 2004.	
2	Jain R K “Mechanical and Industrial Measurements”, Khanna Publishers, Delhi, 1999.	
REFERENCES:		
1	Beckwith TG and Buck N L, “Mechanical Measurements”, Addition Wesley Publishing Company Limited, 1995.	
2	J.G .Giles, Vehicle Operation & Testing. Volume 7 of automotive technology series, Iliffe, 1969.	
3	Stockel M W, “Auto Mechanics Fundamentals”, Good Heart-Wilcox Co., Inc., 2000.	
4	Richard D. Atkins, “An Introduction to Engine Testing and Development”, SAE International, 2009.	

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

23AU052	TESTING AND MEASUREMENT SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To provide students with a comprehensive understanding of measurement systems and transducers commonly used in automotive applications.
- To understand the various measurements commonly used in automotive engineering.
- To provide students with a comprehensive understanding of experimental techniques used in engine and vehicle testing in automotive engineering.

UNIT I	BASIC OF MEASUREMENT SYSTEMS	9

Introduction to Measurement systems-static and dynamic measurement – Closed and open loop system - Requirements and characteristics – Analysis of experimental detail. Error analysis - Calibration of instruments.

UNIT II	TRANSDUCERS, MODIFIERS AND TERMINATING DEVICE	9

Transducers for Automotive Applications – Amplifiers - Filters – Data Acquisition - Indicators, Printers and displays – Signal analyzer.

UNIT III	ENGINE MEASUREMENT SYTEMS	9

Engine torque – Wheel force – Exhaust temperature - Aerodynamic measurements – G-force measurement – Fuel flow measurements - Vibration measurement - Acoustic measurement.

UNIT IV	ENGINE EXPERIMENTAL TECHNIQUES	9

I.S Code for Engine testing - Study of engine dynamometers – Instrumentation for testing of engine - Measurement of noise – Vibration - In cylinder gas flow – Flame temperature - Dynamic Cylinder pressure measurements.

UNIT V	VEHICLE EXPERIMENTAL TECHNIQUES	9

Laboratory tests – Study of chassis dynamometer – Test tracks – Endurance Tests – Crash tests – Vehicle performance test – Brake tests.

	TOTAL: 45 PERIODS
COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Show their knowledge about different measurement method and devices used in industries.
CO2:	Utilize equipment for the measurement of pressure, force, temperature and flow.
CO3:	Develop new ideas in designing measuring instruments for automotive application.
CO4:	Identify various IS codes used for engine testing
CO5:	Examine the parameters of the engine including noise and vibration.
CO6:	Interpret measurement data, to estimate measurement uncertainties.
TEXT BOOKS:	
1	Crouse W H and Anglin D L., "Automotive Mechanics" Tata McGraw Hill Publishing Company, 2004.
2	Rangan, Sharma and Mani, Instrumentation Devices and systems, Tata McGraw Hill Publishing Co., Ltd., 1990.
REFERENCES:	
1	A.W. Judge, Engineering Precision Measurement, Chapman and Hall Ltd, Essex Street W.C., 1951.
2	Beckwith TG and Buck N L, "Mechanical Measurements", Oxford and IBH Publishing House, New Delhi, 1995.
3	D.Patambis, Principle of Industrial Instrumentation, Tata McGraw Hill Publishing Co, New Delhi, 1990.
4	Richard D. Atkins, "An Introduction to Engine Testing and Development", SAE International, 2009.

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

23AU053	VEHICLE BODY ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To provide students with a comprehensive understanding of car body, bus body and commercial vehicle details in automotive design and manufacturing.
- To understand the concepts of vehicle aerodynamics in automotive engineering.
- To provide students with a comprehensive understanding of body materials, trim, mechanisms, and body repair techniques in automotive engineering.

UNIT I	CAR BODY DETAILS	9

Types of Car body - Saloon, convertibles, Limousine, Racing and Sports car – Car body terminology – Visibility - Regulations, Improvement in visibility and tests for visibility. Driver seat design - Car Body Construction - Various panels in car bodies. Safety: Safety design, safety equipment for cars.

UNIT II	BUS BODY DETAILS	9

Types of bus body: based on capacity, Distance travelled and based on construction – Bus body lay out, Floor height, Engine location, and Entrance and exit location. Types of metal sections used – Regulations – Constructional details: Conventional and integral.

UNIT III	COMMERCIAL VEHICLE DETAILS	9

Types of commercial vehicle bodies - Light commercial vehicle body. Construction details of Flat platform body, Tipper body and Tanker body – Dimensions of driver's seat in relation to controls – Driver's cab design.

UNIT IV	VEHICLE AERODYNAMICS	9

Objectives, Vehicle drag and types. Effects of forces and moments. Side wind effects on forces and moments. Various body optimization techniques for minimum drag. Wind tunnels – Principle of operation, Types. Wind tunnel testing such as:

Flow visualization techniques, Airflow management test – Measurement of various forces and moments by using wind tunnel balance.		
UNIT V	**BODY MATERIALS, TRIM, MECHANISMS AND BODY REPAIR**	**9**
Types and properties of materials used in body construction and insulation - Steel sheet, timber, plastics and GRP, Insulation materials. Body trim items - Body mechanisms. Hand tools power tools for body repair. Vehicle corrosion - Anticorrosion methods -Modern painting process procedure.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Explain the different aspects of car body based on construction details.
CO2:	Summarize the various types of bus body.
CO3:	Identify the commercial vehicle body based on construction details.
CO4:	Explain the role of various aerodynamic forces and moments in vehicle body design.
CO5:	Identify the properties of various materials used in vehicle body construction.
CO6:	Select hand tools for body repairs and maintenance.
TEXT BOOKS:	
1	Dieler Anselm., The passenger car body, SAE International, 2000.
2	James E Duffy, Body Repair Technology for 4-Wheelers, Cengage Learning, 2009.
REFERENCES:	
1	Braithwaite, J.B., Vehicle Body building and drawing, Heinemann Educational Books Ltd., London, 1997.
2	Giles, G.J., Body construction and design, Illiffe Books Butterworth & Co., 1991.

3	John Fenton, Vehicle Body layout and analysis, Mechanical Engineering Publication Ltd., London,1992.
4	Powloski, J., Vehicle Body Engineering, Business Books Ltd., 1998.

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

23AU054	IC ENGINE PROCESS MODELLING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the principles and fundamentals of simulation, including the advantages of computer simulation over traditional experimental methods in analyzing internal combustion engine performance.
- To provide students with a comprehensive understanding of stoichiometry and adiabatic flame temperature in the I.C engine combustion processes.
- To gain insights into SI engine simulation techniques that include the modeling of gas exchange processes and CI engine simulation

UNIT I INTRODUCTION TO SIMULATION 9

Introduction to Simulation, Advantages of computer simulation, Classification of engine models. Intake and exhaust flow models – Steady and Unsteady flow - Gas Dynamic Models. Thermodynamic based in cylinder models. Step by step approach in SI engine simulation.

UNIT II STOICHIOMETRY AND ADIABATIC FLAME TEMPERATURE 9

Reactive processes, Heat of reaction, measurement of URP, Measurement of HRP. Introduction - Combustion equation for hydrocarbon fuels. Calculation of minimum air, excess air and stoichiometric air required for combustion. Introduction, Complete combustion in C-H-N-O systems, Constant volume adiabatic combustion, constant pressure adiabatic combustion, calculation of adiabatic flame temperature.

UNIT III SI ENGINE SIMULATION 9

Introduction to SI Engine simulation with air as working medium. Fuel air cycle analysis - Temperature drop due to fuel vaporization, Full throttle operation, Work output and efficiency calculation, Part - Throttle operation, Engine performance at part throttle, supercharged operation. SI Engines simulation with

progressive combustion.		
UNIT IV	**SI ENGINE SIMULATION WITH GAS EXCHANGE PROCESS**	**9**
Introduction to gas exchange process, Heat transfer process, friction calculations, Compression of simulated values, Validation of the computer code, Engine performance simulation, Pressure crank angle diagram, Brake power, Brake thermal efficiency, Effect of speed on performance.		
UNIT V	**CI ENGINE SIMULATION**	**9**
Zero, one and multi-zone models for diesel engine combustion. Wiebe's Model, Whitehouse model and Watson model for diesel combustion. Heat release rate and heat transfer models. Equilibrium calculations. Parametric studies on simulated engine performance.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Explain about simulation of IC engine components.
CO2:	Apply the principle of the stoichiometric ratio and adiabatic flame temperature.
CO3:	Develop a simulation model for SI engine.
CO4:	Summarize the concept of gas exchange process in SI engine.
CO5:	Develop a simulation model for CI engine.
CO6:	Examine parametric studies of CI engine simulation.
TEXT BOOKS:	
1	Ganesan.V. "Computer Simulation of spark ignition engine process", Universities Press (I) Ltd, Hyderbad, 1996.
2	Lino Guzzella and Christpher H.Onder, "Introduction to Modeling and Control of Internal Combustion Engine Systems", Springer, 2010.

REFERENCES:	
1	Ashley Campbel, "Thermodynamic analysis of combustion engines", John Wiley & Sons, New York, 1986.
2	Benson.R.S., Whitehouse.N.D., "Internal Combustion Engines", Pergamon Press, oxford, 1979
3	John. B. Heywood, 'Internal Combustion Engines'", Tata McGraw Hill Co., Newyork, 1988.
4	Ramoss.A.L., "Modelling of Internal Combustion Engines Processes", McGraw Hill Publishing Co., 1992.

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

VERTICAL -4 - SPECIAL PURPOSE VEHICLES

23AU055	AGRICULTURAL VEHICLES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the various types of agricultural vehicles and their functions
- To familiarize with safety practices and regulatory compliance related to agricultural vehicle operation
- To develop problem-solving and decision-making skills relevant to agricultural vehicle operation and management.

UNIT I	TRACTORS	9

Tractors - Classification - Types of tractors with their application, Power take off shaft – Purpose – Application - Types, hydraulic system in tractors – Necessity, Depth & draft control –Types. Final drives - Farming equipment's – Types - Disc plough, Mouldboard plough, Harrow plough, Rotary plough, Thresher, Sprayer. Farm Equipment for Marginal, Small & amp; Medium land holding farmers – Power Tiller & amp; Attachments, Power reaper, Power sprayer, Irrigation Pump set, Electric Farm Equipment (viz Brush Cutter, Battery operated sprayer, Multi-purpose Power Tiller) Mini Robots.

UNIT II	FARM MACHINERY DESIGN	9

Research and development procedure; Basic design principles of farm machines, Implements and tools. Design of various components for performance, Strength and wear. Selection of materials of construction. Design of power transmission of elements, Bearings, Controls and safety devices. Seed drill, planter, harvesting and threshing machine and its components.

UNIT III	TRACTOR DESIGN PRINCIPLES	9

Trends in tractor design. Principles of similitude in engine design. Design of principle engine parts. Design of main, big and small end bearings. Design of cooling and lubrication systems. Design of tractor clutches, Brakes, Transmission, chassis,

Steering, and hydraulics system. Design of seat and controls from ergonomic consideration. Introduction to computer aided design.		
UNIT IV	**FARM MACHINERY DYNAMICS, NOISE AND VIBRATION**	**9**
Tractor chassis mechanics, Hydraulic control of tractors, Determination of C.G and moment of inertia, Dynamic stability and tractive ability of tractor, Tire selection. Noise and vibration effects, Design of operators' seat and suspension and controls, Strain gauges and instruments for the measurement of tractor engine power, Torque, Fuel consumption, Draft and drawbar power.		
UNIT V	**PRECISION FARMING MACHINERY TECHNIQUES**	**9**
Concept and introduction of precision farming – Importance, Definition, Principles and concepts – Role of GIS and GPS - Mobile mapping system and its application in precision farming – Geo referencing and photometric correction – Sensors for information gathering – UAV – Geo statistics – Robotics in horticulture		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Explain the fundamentals of Agricultural Vehicles.
CO2:	List the tools and techniques used in Agricultural vehicles.
CO3:	Explain the design of the farm machinery
CO4:	Identify the implementation and challenges in precision farming machinery techniques.
CO5:	Develop continuous improvement methods for farming.
CO6:	Identify the methods of improving productivity, efficiency and making farming more sustainable.

TEXT BOOKS:	
1	Srivastava, A.K., Goering, C.E., Rohrbach, R.P. and Buckmaster, D.R. “Engineering Principles of Agricultural Machines”, 2nd Edition. USA. 2013.
2	Kepner, R.A., Bainer, R. and Berger, E.L. Principles of Farm Machinery. John Wiley and Sons, New York. 1978.
REFERENCES:	
1	Singh, T.P, “Farm Machinery”, PHI Learning Pvt. Ltd., Delhi, 2017.
2	MacMillan, R.H. Mechanics of Tractor Implement Performance. University of Melbourne, 2002.
3	Bernacki, H., Haman, J. and Kanafojski, Cz. “Agricultural Machines: Theory and Construction”. U.S. Dept. of Commerce, National Technical Information Service, Springfield, Virginia, 1972.
4	Liljedahl, J.B., Turnquist, P.K., Smith, D.W. and Hoki, M., “Tractors and their Power Units”, 4th Edition. CBS Publishers & Distributors, New Delhi, 2004

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

23AU056	DEFENCE VEHICLES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn about defence vehicle systems, including their design, construction, and operation.
- To understand the latest technological innovations in defence vehicle design, such as improvements in armor protection, weapon systems integration
- To familiarize on safety protocols and best practices to prevent accidents

UNIT I	COMBAT VEHICLE ENGINEERING	9

Engineering principles to the design of combat systems with emphasis on detection, Tracking and identification systems, Vehicle Configuration, Man Machine Interface, Sensor technologies (radars, ESM, active and passive sonar, infrared, electro-optical, and magnetic/electric/gravity field sensors).

UNIT II	AEROSPACE PROPULSION	9

Classification & mode of operation of various propulsion systems, basis thermodynamics & fluid Dynamics. Rocket motor design & analysis, Gas Turbine Engine design, GT engine efficiency, GT engine heat transfer & cooling. Jet engine control (compressor performance, axial turbine performance, Fuel systems & pumps, airframe fuel systems, hydro mechanical fuel metering, Electronics engine control).

UNIT III	NAVAL TECHNOLOGY	9

Introduction of naval combat systems, Integration of naval combat systems, Detection, Engagement and control elements interact with each other and on how to combine them into an efficient and survivable combat system, System-oriented approach to integrating the principles of Naval Architecture and Marine Engineering in the design of ship subsystems.

UNIT IV	COMMUNICATION SYSTEMS AND SENSORS	9

Introduction to RADAR, Radar parameters/definitions, radar

equations, Radar cross section (RCS) & Theory of detection, Clutter. Atmospheric propagation, Surveillance and Tracking Radar, Free space optical communication, Fiber optics communication, Wireless/cellular communications.		
UNIT V	**HIGH ENERGY MATERIALS TECHNOLOGY**	**9**
Understanding of high energy materials from theoretical and practical standpoints, to formulate the bases for evaluating competitive and alternative high energy material systems, High energy materials physics and chemistry. Molecular energetic of the high energy materials.		
TOTAL: 45 PERIODS		
COURSE OUTCOMES:		
After completion of the course, the students will be able to:		
CO1:	Explain the fundamentals of combat vehicle engineering.	
CO2:	Identify the tools and techniques used in naval technology.	
CO3:	Summarize the communication systems and sensors.	
CO4:	Analyze high energy materials technology.	
CO5:	Apply the principles of basis thermodynamics & fluid dynamic in defence vehicle	
CO6:	Explain high energy material technology	
TEXT BOOKS:		
1	Measurement, Instrumentation and sensor Handbook", by John G Webster. Publisher: CRC Press, Florida.	
2	Engineering Principles of Combat Modeling and Distributed Simulation", by Andreas Tolk. Publisher: Wiley Publication.	
REFERENCES:		
1	"Rocket Propulsion Elements", by George Paul Sutton and Oscar Biblarz. Publisher: John Wiley & Sons, 2017.	
2	"Modern Engineering for Design of Liquid-Propellant Rocket Engines: Progress in Astronautics and Aeronautics	

	Series" by Dieter K. Huzel, David H. Huang, 1992.
3	"Introduction to Naval Architecture", by Tupper, E. C Fourth. Publisher Butterworth-Heinemann. Formerly Muckle's Naval Architecture for Marine Engineers, 2005.
4	"The Maritime Engineering Reference Book: A Guide to Ship Design, Construction and Operation". Publisher: Butterworth-Heinemann, 2008.

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

23AU057	CONSTRUCTION VEHICLES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn about current industry trends, emerging technologies, and future directions in construction vehicle design and operation.
- To familiarize with safety practices and regulatory compliance related to construction vehicle operation.
- To understand the operational principles associated with construction vehicles, including maneuvering, and utilization of different attachments and accessories.

UNIT I	INTRODUCTION AND EQUIPMENT COST	9

Selection of equipment for earth work - Earth moving operations - Types of earthwork equipment- Tractors, Motor graders, Scrapers, Front end waders, Earth movers.

UNIT II	DOZERS AND SCRAPERS	9

Dozers types- Crawler bulldozer, Wheel bulldozer, Mini bulldozer, Straight blades (S-blade), Universal blade (U-blade), S-U (semi-u) blade, Angle blade. Scrapers types – Single - Engine wheeled, Dual-engine wheeled, Elevating and pull-type scrapers.

UNIT III	EARTH MOVING CONSTRUCTIONAL MACHINES-TRUCKS AND HAULING EQUIPMENT	9

Dumpers - Safety features, safe warning system for dumper, Design aspects on dumper body, Articulated dumpers, Loaders - Single bucket, Multi bucket and rotary types - bulldozers, Kinematics for loader and bulldozers with operational linkages, Motor graders, Power shawl, Bush cutters, Stumpers.

UNIT IV	VEHICLE SYSTEMS & ADVANCE FEATURES	9

Brake system and actuation – Disc caliper brakes. Body hoist and bucket operational hydraulics. Hydro - pneumatic suspension

cylinders. Power steering system. Articulated steering assembly - Power and capacity of earth moving machines.		
UNIT V	**OFF-THE-ROAD TIRES AND TRACKS**	**9**
Types of off-the-road tires, Transport for earthmoving machines, Work for slow moving earthmoving machines and load and carry for transporting - digging. Off-highway tires have six categories of service compactor, Earthmover, Grader, Loader, log-skidder and mining and logging.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1:	Explain the various earth moving operations
CO2:	Identify the types of dozers.
CO3:	Explain the construction, working and applications of various earth moving operations.
CO4:	Analyze the types and use of off road tires.
CO5:	Distinguish the concept of hydraulics and pneumatics.
CO6:	Summarize various earth moving constructional machines, trucks and hauling operations.

TEXT BOOKS:

1	Abrosimov.K. Bran berg.A and Katayer.K. & quot; Road making machinery & quot; MIR Publishers, Moscow, 1971.
2	Satyanarayana. B., Construction planning and equipment standard publishers and distributors, New Delhi, 1985.

REFERENCES:

1	Bart H Vanderveen; Tanks and Transport Vehicles Frederic Warne and Co Ltd. London.
2	S. Ageikin, “Off the Road Wheeled and Combined Traction Devices: Theory and Calculation”, Ash gate Publishing Co. Ltd. 1988.
3	Schulz Erich; Diesel equipment I, McGraw Hill Company, London, 1982.

4	Robert L Peurifoy, "Construction, planning, equipment and methods" Tata McGraw Hill Publishing company Ltd. 2002.

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

<table>
<tr><td colspan="2">23AU058</td><td rowspan="2">MARINE VEHICLES</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td colspan="2"></td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="7">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="7">• To learn about Marine vehicle systems, including their design, construction, and operation.
• To understand the latest technological innovations in marine vehicle design
• To familiarize on safety protocols and best practices to prevent accidents</td></tr>
<tr><td>UNIT I</td><td colspan="5">MARINE VEHICLES</td><td>9</td></tr>
<tr><td colspan="7">Types – General – By function – Commercial marine vehicles - Passenger ship, Cargo ships, Oil and chemical tankers, Cattle carriers, Harbor crafts, Off shore platform, Container ships, Reefers and gas carriers.</td></tr>
<tr><td>UNIT II</td><td colspan="5">REMOTELY OPERABLE VEHICLE (ROV), UMS SHIPS</td><td>9</td></tr>
<tr><td colspan="7">Remotely Operable Vehicles (ROV) – The ROV business – Design theory and standards – Control and simulation – Design and stability – Components of ROV – Applications, UMS operation and controls, Submersibles types – Applications, Autonomous Underwater Vehicle (AUV) – Design and construction considerations – Components – Sensors – Navigation - Control strategies – Applications.</td></tr>
<tr><td>UNIT III</td><td colspan="5">MANNED AND UN MANNED SUBMERSIBLE</td><td>9</td></tr>
<tr><td colspan="7">Introduction – Design and operational consideration – Pressure hull exo-structure – Ballasting and trim – Maneuvering and control – Life support and habitability – Emergency devices and equipment’s – Certification and classification, Towed vehicles – Gliders – Crawler.</td></tr>
<tr><td>UNIT IV</td><td colspan="5">MOTION OF SHIPS & FLOATING SYSTEMS</td><td>9</td></tr>
<tr><td colspan="7">Ship motions – Co-ordinate systems, six- DOF, Uncoupled and coupled equation of motion; Hydrodynamic coefficients; Wave excitation – Summary of wave theory, Dispersion relation, Wave</td></tr>
</table>

pressure, Velocity, Acceleration; Encounter frequency; Motion damping effects, Magnification and tuning factors. Ship responses in regular waves. Ship controllability fundamentals - Stability and control in the horizontal and vertical planes.		
UNIT V	**MARINE POWER PLANT**	**9**
Marine Diesel Engines – Low speed and medium speed engines – Auxiliary engines –Marine Nuclear power installation - Principles of operation of Atomic Reactors – Different types of Reactors – Use of Nuclear reactors in sea going vessels Marine Turbines – Steam turbine classification based on impulse and reaction principles – Flow through blade passages, Marine gas turbines.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Identify various marine vehicles based on their function
CO2:	Explain the concept of remote and under water operated vehicles
CO3:	Distinguish manned and unmanned submarine operations.
CO4:	Analyze the motion of floating systems
CO5:	Demonstrate the requirement of marine power plant
CO6:	Build preliminary knowledge in marine vehicle design, construction and its components
TEXT BOOKS:	
1	Jonathan M. Ross, human factors for naval marine vehicle design and operation.
2	Sabiha A. Wadoo, Pushkin Kachroo, Autonomous underwater vehicles, modelling, control design and Simulation, CRC press, 2011.
REFERENCES:	
1	R. Frank Busby, Manned Submersibles, Office of the oceanographer of the navy, 1976.

2	Ferial L hawry, The ocean engineering handbook, CRC press, 2000.
3	Richard A Geyer, “Submersibles and their use in oceanography and ocean engineering”, Elsevier, 1997.
4	Robert D. Christ, Robert L. Wernli, Sr. “The ROV Manual A User Guide for Remotely Operated Vehicles”, Elsevier, second edition, 2014.

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

23AU059	SPACE VEHICLES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn about space vehicle systems, including their design, construction, and operation.
- To understand the latest technological innovations in space vehicle design
- To familiarize with the concepts of propulsion, dynamics & controls.

UNIT I	UNDERSTANDING FLIGHT LIGHTER THAN AIR & HEAVIER THAN AIR	9

Classification of flight: Lighter-than-air & Heavier-than-air. Historical evolution of Man-made object flight: Balloon & Archimedes principle, flapping wing & Bird flight, Fixed wing Gliders, Sustained flight with propulsion systems, Rotary-wing & Helicopters. Forces in action during a flight: Lift, Drag, Thrust, weight. Compare: Aerospace vs Space, Levitation Vs Controlled-Flight.

UNIT II	MATERIALS, MODELS AND MANUFACTURING TECHNIQUES	9

Functional requirements: Thermal, Structural, Chemical. Fabrication techniques: Material removal, Material Addition-Additive manufacturing/3D printing, Material forming - Forging, Rolling, Spinning, Extrusion, Material Joining - Welding, Bonding, Bolting. Material models: Elastic, Plastic, Visco - elastic, Spring - Mass - Damper models, equivalent electrical/mathematical models. Real world material examples: Metallic, Non-metallic-Elastomeric, Composite, Superalloys.

UNIT III	PROPULSION, DYNAMICS & CONTROLS	9

Principles of achieving controlled flight by various control mechanisms, with simple mathematical models History of Propulsion. Chemical Propulsion: Solid, Liquid, Cryogenic, Hybrid. Electric propulsion. Static & Dynamic Stability and Controls.

UNIT IV	**STRUCTURAL DESIGN & PERFORMANCE OPTIMIZATION**	**9**
Design approach for constraints: Geometry limits - Stiffness based. Material limits - Strength based, Strain based, Fracture-based. Other constraints: Thermal & Thermo-structural. Optimization: Mass, Aerodynamic. Stiffening approaches: Sandwich, Honey-comb, Hat-stiffened, Pressurized.		
UNIT V	**FUTURE DIRECTIONS & RESEARCH AREAS IN SPACE VEHICLES**	**9**
Reusable vehicles, Space debris reduction, Green propellants, Space robotics, Inter-planetary travel vehicles.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Explain the concept of flight design
CO2:	Apply Materials, Models and Manufacturing techniques for space applications
CO3:	Examine the Propulsion, Dynamics & Controls devices
CO4:	Compare the design and performance of Jet Propulsion systems.
CO5:	Identify research areas in Space Propulsion
CO6:	Analyze propulsion, dynamics and control
TEXT BOOKS:	
1	Anderson, J. D., "Introduction to Flight", 7th edition, McGraw-Hill, 2011.
2	B.N.Suresh, Sivan.K, Integrated Design for Space Transportation System, 1st edition, Springer Nature, 2015.
REFERENCES:	
1	Daniel P. Raymer, Aircraft Design: A Conceptual Approach, American Institute of Aeronautics and Astronautics, Inc., Washington, 1989.

2	Campbell, F. C., "Manufacturing Technology for Aerospace Structural Materials", Elsevier, 2006.
3	Turner, M. J. L., Rocket and Spacecraft Propulsion: Principles, Practice and New Developments, 3rd ed., Springer, 2009.
4	Robert C. Nelson, Flight Stability and Automatic Control (Hardcover), Tata McGraw Hill, 1989.

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

23AU060	GAS DYNAMICS AND JET PROPULSION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the basic difference between incompressible and compressible flow.
- To understand the phenomenon of shock waves and its effect on flow.
- To gain some basic knowledge about jet propulsion and Rocket Propulsion.

UNIT I	BASIC CONCEPTS AND ISENTROPIC FLOWS	9

Energy and momentum equations of compressible fluid flows – Stagnation states, Mach waves, Mach angle and Mach cone – Effect of Mach number on compressibility – Isentropic flow through variable ducts - Nozzle and Diffusers.

UNIT II	FLOW THROUGH DUCTS	9

Flows through constant area ducts with heat transfer (Rayleigh flow), Rayleigh line and Rayleigh flow equation and Friction (Fanno flow), Fanno curves and Fanno flow equation. Variation of flow properties.

UNIT III	NORMAL SHOCKS	9

Governing equations, Variation of flow parameters like static pressure, Static temperature, Density, Stagnation pressure and entropy across the normal shock, Prandtl – Meyer equation, Impossibility of shock in subsonic flows, Flow in convergent and divergent nozzle with shock.

UNIT IV	JET PROPULSION	9

Aircraft propulsion – Types of jet engines – Study of turbojet engine components – Diffuser, Compressor, Combustion chamber, Turbine and exhaust systems, Performance of turbo jet engines – Thrust, Thrust power, Propulsive and overall efficiencies, Thrust augmentation in turbo jet engine, Ram jet and pulse jet engines.

UNIT V	ROCKET PROPULSION	9
Rocket propulsion – Types of rocket engines – Propellants – Feeding Systems – Theory of rocket propulsion – Rocket engine performance, Solid and liquid propellants.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Explain the flow through nozzle and diffuser.
CO2:	Distinguish between Rayleigh flow and Fanno flow.
CO3:	Develop the adequate knowledge on governing equation and shock waves
CO4:	Summarize on different types of jet engines and infer the performance parameters.
CO5:	Model different types of propellants and feeding system in rocket engines.
CO6:	Solve the performance parameters of rocket engines
TEXT BOOKS:	
1	Anderson, J.D., "Modern Compressible flow", 3rd Edition, McGraw Hill, 2003.
2	Yahya, S.M. "Fundamentals of Compressible Flow", New Age International (P) Limited, New Delhi, 1996
REFERENCES:	
1	Sutton. G.P., "Rocket Propulsion Elements", John wiley, New York, 1986.
2	Ganesan.V., "Gas Turbines", Tata McGraw Hill Publishing Co., New Delhi, 1999.
3	Babu. V., "Fundamentals of Gas Dynamics", ANE Books India, 2008.
4	Cohen. H., G.E.C. Rogers and Saravanamutto, "Gas Turbine Theory", Longman Group Ltd., 1980.

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

23AE069	DRONE TECHNOLOGIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn and understand the fundaments of design, fabrication and programming of drone
- To impart the knowledge of an flying and operation of drone
- To know about the various applications of drone

UNIT I	INTRODUCTION TO DRONE TECHNOLOGY	9

Drone Concept - Vocabulary Terminology - History of drone - Types of current generation of drones based on their method of propulsion - Drone technology impact on the businesses - Drone business through entrepreneurship - Opportunities/applications for entrepreneurship and employability.

UNIT II	DRONE DESIGN, FABRICATION AND PROGRAMMING	9

Classifications of the UAV - Overview of the main drone parts - Technical characteristics of the parts - Function of the component parts - Assembling a drone - The energy sources - Level of autonomy- Drones configurations -The methods of programming drone - Download program - Install program on computer- Running Programs - Multi rotor stabilization - Flight modes - Wi-Fi connection.

UNIT III	DRONE FLYING AND OPERATION	9

Concept of operation for drone - Flight modes - Operate a small drone in a controlled environment - Drone controls Flight operations – management tool – Sensors - Onboard storage capacity - Removable storage devices - Linked mobile devices and applications.

UNIT IV	DRONE COMMERCIAL APPLICATIONS	9

Choosing a drone based on the application - Drones in the insurance sector - Drones in delivering mail, Parcels and other

cargo - Drones in agriculture - Drones in inspection of transmission lines and power distribution - Drones in filming and panoramic picturing.		
UNIT V	**FUTURE DRONES AND SAFETY**	**9**
The safety risks - Guidelines to fly safely - Specific aviation regulation and standardization - Drone license - Miniaturization of drones - Increasing autonomy of drones - The use of drones in swarms.		
		TOTAL: 45 PERIODS
COURSE OUTCOMES:		
After completion of the course, the students will be able to:		
CO1:	Explain about various type of drone technology, drone fabrication and programming.	
CO2:	Select the suitable operating procedures for functioning a drone	
CO3:	Select appropriate sensors and actuators for Drones	
CO4:	Model a drone mechanism for specific applications	
CO5:	Develop programs for various drones	
CO6:	Summarize drone commercial applications	
TEXT BOOKS:		
1	Daniel Tal and John Altschuld, "Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation", John Wiley & Sons, Inc. 2021.	
2	Garvit Pandya, "Basics of Unmanned Aerial Vehicles: Time to start working on Drone Technology", Notion Press, 2021.	
REFERENCES:		
1	John Baichtal, "Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs", Que Publishing, 2016	

2	Ales Zavrsnik, “Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance” Springer International Publishing; 1st ed. 2016.
3	Sachi Nandan Mohanty, J.V.R. Ravindra, “Drone Technology: Future Trends and Practical Applications”, Wiley, 2023.
4	Terry Kilby and Belinda Kilby, “Make: Getting Started with Drones “, Maker Media, Inc., 2016.

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

<table>
<tr><td>23AU061</td><td colspan="2">AUTONOMOUS AND CONNECTED VEHICLES</td><td>L
3</td><td>T
0</td><td>P
0</td><td>C
3</td></tr>
<tr><td colspan="7">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="7">

To learn current industry trends, market developments, and real-world applications of autonomous and connected vehicles
To familiarize safety standards, regulations, and ethical considerations associated with autonomous and connected vehicle technologies
To gain knowledge of system integration, testing methodologies, and validation procedures for autonomous and connected vehicle systems.

</td></tr>
<tr><td>UNIT I</td><td colspan="5">INTRODUCTION TO AUTONOMOUS VEHICLE TECHNOLOGY</td><td>9</td></tr>
<tr><td colspan="7">Introduction - SAE autonomous Level Classification – Examples - Application of Autonomous Vehicle - Advantages and Disadvantages of Autonomous Vehicles.</td></tr>
<tr><td>UNIT II</td><td colspan="5">PATH PLANNING AND DECISION MAKING</td><td>9</td></tr>
<tr><td colspan="7">Principles of decision making and path planning for autonomous vehicles - Decision making approaches – Approximation – Heuristic - Graph based - Point guidance. Verification and validation of decision making and path planning - Application examples of task allocation and path planning algorithms.</td></tr>
<tr><td>UNIT III</td><td colspan="5">SENSORS, PERCEPTION AND VISUALISATION</td><td>9</td></tr>
<tr><td colspan="7">Introduction to sensors, Perception and visualization for autonomous vehicles - Sensor integration architectures and multiple sensor fusion - AI algorithms for sensing and imaging - neural networks.</td></tr>
<tr><td>UNIT IV</td><td colspan="5">NETWORKING AND CONNECTED VEHICLES</td><td>9</td></tr>
<tr><td colspan="7">Current and future vehicle networking technologies - CAN, LIN,</td></tr>
</table>

MOST and Flex-ray. The use of modern validation and verification methods - software-in-the-loop, and hardware-in-the-loop techniques. The role of Functional Safety and ISO26262 within the overall control system. Inter-dependency between software engineering and control system - advanced test methods for the validation of safety - critical systems. Connected vehicle control (CACC), intelligent traffic signals, collaborative adaptive cruise and vehicle platooning.		
UNIT V	**HUMAN FACTORS AND ETHICAL DECISION MAKING**	**9**
Introduction to Human Factors-Human Performance: Perception and Attention -Situation Awareness and Error - Human Reliability: Driver Workload and Fatigue - and Assistive Technology - Designing ADAS Systems-Driverless Vehicles and Ethical Dilemmas: Human Factors and Decision Making Software - Application of Human Factors in Autonomous Vehicles. International and national regulatory frameworks for CAV and their safe operation.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1:	Explain the autonomous vehicle technology.
CO2:	Explain the principle of path planning and decision making.
CO3:	Select sensors based on the application.
CO4:	Develop AI algorithms for sensing and imaging.
CO5:	Examine the role of functional safety within the overall control system.
CO6:	Summarize the application of human factors in autonomous vehicle.

TEXT BOOKS:

1	Romil Rawat, A. Mary Sowjanya, Syed Imran Patel, Varshali Jaiswal, Imran Khan, Allam Balaram, Autonomous Vehicles Volume 1: Using Machine

	Intelligence,1st Edition, Wiley-Scrivener; 2022.
2	Hanky Sjafrie, "Introduction to Self-Driving Vehicle Technology", 1st Edition, CRC Press, 2019.
REFERENCES:	
1	Autonomous Driving: How the Driverless Revolution will Change the World, by Andreas Herrmann, Emerald Publishing, 2018.
2	George Dimitrakopoulos, Aggelos Tsakanikas, Elias Panagiotopoulos "Autonomous Vehicles: Technologies, Regulations, and Societal Impacts", 1st Edition, Elsevier, 2021.
3	Hod Lipson, Melba Kurman, "Driverless: Intelligent Cars and the Road Ahead", 1st Edition, MIT Press 2016.
4	Dominique paret, "Autonomous and Connected Vehicles: Network Architectures from Legacy Networks to Automotive Ethernet", Wiley Publications, 2022.

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

VERTICAL -5 - PRODUCT AND PROCESS DEVELOPMENT

<table>
<tr><td rowspan="2">23AU062</td><td rowspan="2">AUTOMOTIVE PRODUCT DESIGN</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="6">• To acquire knowledge on product design and apply them in practice.
• To develop understanding of the fundamentals of new product development.
• To learn prototyping and validation.</td></tr>
<tr><td>UNIT I</td><td colspan="4">PRODUCT PLANNING AND CONCEPT PHASE</td><td>9</td></tr>
<tr><td colspan="6">Introduction – Product Plan – Scope of the Product Plan – Market Research – Business Case Preparation and approval – Project Team – Package Data – Concept Generation and Theme Selection - Studio Engineering and Tape Drawing – Form Explorations.</td></tr>
<tr><td>UNIT II</td><td colspan="4">SYSTEM LEVEL DESIGN</td><td>9</td></tr>
<tr><td colspan="6">Surface Data release – Benchmarking - System Level Scope finalization – Component design - Simulations, CAE/CFD – E-BOM Preparations – Design Verification Plan (DVP) – GD&T - Systems Sign-off – Validation Proto Data Release.</td></tr>
<tr><td>UNIT III</td><td colspan="4">PROTOTYPING AND VALIDATION</td><td>9</td></tr>
<tr><td colspan="6">DVP Sign-off – Proto Build Plan – M-BOM Preparations – Proto Parts Development Processes – Proto Build – Component level Validation – System level Validation – Vehicle level Validation – Lab Tests – CFD Reviews – Vehicle Development; Finalization of specifications with iterations.</td></tr>
<tr><td>UNIT IV</td><td colspan="4">DATA RELEASE FOR MANUFACTURING</td><td>9</td></tr>
<tr><td colspan="6">Design for Manufacturing – Design for Assembly – PPAP – CPQ/DQA – Manufacturing Process finalization – Tool cutting Data release – CRASH Simulations – Homologations and CMVR– Integration of Product and Processes – CFT sign-off for Manufacturing.</td></tr>
<tr><td>UNIT V</td><td colspan="4">PILOT PRODUCTION AND RAMP-UP</td><td>9</td></tr>
<tr><td colspan="6">Manufacturing Tooling readiness – Pilot Production –CFT</td></tr>
</table>

Sign-off for SOP – Start of Production – Production Ramp-up.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1:	Explain about Automotive Product design techniques.
CO2:	Develop a new vehicle model by simulation.
CO3:	Summarize the importance of various design phases.
CO4:	Identify the product design procedure
CO5:	Apply the principles for pilot production.
CO6:	Categorize recent advancements in product design.

TEXT BOOKS:

1	Dieter G E, "Engineering Design", McGraw – Hill, 2009.
2	T Karl, Ulrich and D Steven, and Eppinger, "Product Design and Development", McGraw Hill, 2009.

REFERENCES:

1	Ken Hurst, "Engineering Design Principles", Elsevier Science and Technology Books, 2006.
2	Young Chiang, "Fundamentals of Design of Experiments for Automotive Engineering Volume I", SAE International, 2023.
3	Vivek D. Bhise, "Automotive Product Development: A Systems Engineering Implementation", 1st Edition, CRC Press,
4	Fang Chen, Jacques Terken, "Automotive Interaction Design", Springer Singapore, 2023.

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

23AU063	ERGONOMICS IN AUTOMOTIVE DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To recognize the electronically controlled system used in driving mechanics.
- To understand the importance of ergonomics in reducing the driver fatigue.
- To explain the role of ergonomics in look and safe operation of the vehicle.

UNIT I	FUNDAMENTALS OF ERGONOMICS	9

Introduction- principles – applications - Dimension Determination, Anthropometry – Need, Data collection methodology, Different postural considerations - Recent developments in ergonomics and styling.

UNIT II	ERGONOMICS FOR SEATING	9

Seating dimensions- Interior ergonomics - Seat comfort - Suspension seats - Split frame seating - Back pain reducers - Driver & pillion seating arrangement dash board instruments - Electronic displays - Commercial vehicle cabin ergonomics - Mechanical package layout - Goods vehicle layout.

UNIT III	ERGONOMICS FOR VISIBILITY	9

Regulations - Driver's visibility - Tests for visibility - Methods of improving visibility and space - Dash board equipment's and arrangement, Mirror and cockpit design.

UNIT IV	ERGONOMICS FOR FRAMES AND BODY	9

Types of frame, Construction, loads, Design consideration, materials, Ergonomics & comfort, Positioning of operational controls, Types of three wheeler bodies, Layout, RTO regulations, Aerodynamic, Aesthetic & ergonomics considerations for body work.

UNIT V	VEHICLE ERGONOMICS	9

Passenger Compartment, Floor Pan, Vehicle interior ergonomics, Ergonomics system design Technical requirements,

Force Analysis, Seating and position – ECE Regulations, Human Factors, Navigation systems, Pedal positioning Crash tests, Forces in rollover, head on impact.	
	TOTAL: 45 PERIODS
COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Explain about various ergonomic techniques.
CO2:	Develop a comfort seat in a given vehicle model.
CO3:	Summarize the importance of ergonomics in reducing the driver fatigue.
CO4:	Explain the role of ergonomics in look and safe operation of the vehicle.
CO5:	Apply the Knowledge in mirror design and logical formation of cockpit.
CO6:	Evaluate the regulations of human factors and navigation systems.
TEXT BOOKS:	
1	Vivek D. Bhise "Ergonomics in the Automotive Design Process", CRC Press Taylor & Francis Group, 2012.
2	Gkikas, N., "Automotive Ergonomics: Driver-Vehicle Interaction". CRC Press, 2016.
REFERENCES:	
1	Jullian Happian-Smith, "An Introduction to Modern Vehicle Design" Butter worth- Heinemann Publications, 2002.
2	Johnson, W. and Mamalis A.G., "Crashworthiness of Vehicles", London, 1995.
3	Edward. A, "Lamps and Lighting, Hodder & Stoughton", London, 1993.2016.
4	Rollover Prevention, Crash Avoidance, Crashworthiness, Ergonomics and Human Factors", SAE Special Publication, 2003.

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

<table>
<tr><td rowspan="2">23AU064</td><td rowspan="2">AUTOMOTIVE CONTROL SYSTEMS</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="6">To understand the technologies relevant to intelligent vehicle systems
To appreciate the role of electronics in providing improved control to a variety of vehicle systems.
To recognize the electronically controlled system used in driving mechanics.</td></tr>
<tr><td>UNIT I</td><td colspan="4">VEHICLE CONTROL SYSTEM</td><td>9</td></tr>
<tr><td colspan="6">Overview and examples of vehicle control system - Sensors, actuators and controller modules - Vehicle communication Network - System Engineering V-diagram - Algorithm Development - Steps in vehicle control system design - Selection of controlled, Manipulated, Measured disturbance variables - Classification of the variables in various automotive systems like engines, Suspension, Braking.</td></tr>
<tr><td>UNIT II</td><td colspan="4">CONTROL SCHEMES, CRUISE AND HEADWAY CONTROL</td><td>9</td></tr>
<tr><td colspan="6">Feed - Forward control - Cascade control - Design considerations for cascade control, Time delay compensation, Inferential control - Nonlinear control - Adaptive control etc. Cruise control design - Autonomous cruise control - Anti locking brakes - Traction control system - Vehicle stability control linear and non-linear vehicle model.</td></tr>
<tr><td>UNIT III</td><td colspan="4">DRIVER MODELING AND POWERTRAIN CONTROL SYSTEMS</td><td>9</td></tr>
<tr><td colspan="6">Driving simulators - Percentage of road departure - Driver modeling - Transfer function models - Preview/ Predictive models - Longitudinal driver models Control oriented engine modelling - Air intake model - Fuel dynamics model - Air Fuel ratio dynamics - Engine Control Loops - Air Fuel Ratio control - EGR Control.</td></tr>
</table>

UNIT IV	CONTROL OF HYBRID AND FUEL CELL VEHICLES	9
Series-Parallel - Split Hybrid Configurations - Hybrid Vehicle Control Hierarchy - Control Concepts of Series Hybrids - Equivalent Consumption minimization strategy - Control concepts for split hybrid modelling of fuel cell systems - Fuel stack model - Control of fuel cell system.		
UNIT V	**INTELLIGENT TRANSPORT SYSTEM**	**9**
Cross over model principle- Homeostatic Theory- Driving simulators- percentage of road departure Advanced traffic management system- Advanced traveler information system- commercial vehicle operation- Advanced vehicle control system- Preventing collisions- Longitudinal motion control and platoons- Site specific information comparison of longitudinal control approaches- String stability- Automated steering and lateral control – Lane sensing- automated lane change and follow control.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Explain the basics of control system used in automobiles
CO2:	Identify the electronically controlled system used in driving mechanics.
CO3:	Summarize the working principle of driver modelling and power train control systems.
CO4:	Identify the control system used in hybrid and electrical vehicles.
CO5:	Illustrate the need of automated transport systems.
CO6:	Categorize the recent trends and intelligent technologies associated with modern day vehicles.

TEXT BOOKS:	
1	Galip Ulsoy, "Automotive Control System", Cambridge University Press, 2012.

2	Uwe Kiencke and Lars Nielson, “Automotive Control System”, SAE Publications, 2006.
REFERENCES:	
1	Bosch Automotive Handbook, Sixth Edition, 2004.
2	Benjamin C.Kuo and Farid Golnaraghi, “Automatic Control System”, John Wiley & Sons, Eighth edition, 2003.
3	Katsuhiko Ogata, “System Dynamics”, Prentice Hall International, Inc. Third Edition, 1998.
4	Richard C.Dorf and Robert H.Bishop, “Modern Control Systems”, Pearson Prentice Hall, 2008.

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

23ME031	ADDITIVE MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce the development of Additive Manufacturing (AM), various business opportunities and applications
- To familiarize various software tools, processes and techniques to create physical objects that satisfy product development / prototyping requirements, using AM.
- To be acquainted with vat polymerization and direct energy deposition processes

UNIT I	INTRODUCTION	9

Overview - Need - Development of Additive Manufacturing (AM) Technology: Rapid Prototyping - Rapid Tooling - Rapid Manufacturing - Additive Manufacturing. AM Process Chain- ASTM/ISO 52900 Classification - Benefits. Applications: Building Printing - Bio Printing - Food Printing - Electronics Printing. Case studies: Automobile, Aerospace, Healthcare.

UNIT II	DESIGN FOR ADDITIVE MANUFACTURING (DFAM)	9

Concepts and Objectives - AM Unique Capabilities - Part Consolidation – Topology Optimization - Generative design - Lattice Structures - Multi-Material Parts and Graded Materials - Data Processing: CAD Model Preparation - AM File formats: STL -Problems with STL - AMF Design for Part Quality Improvement: Part Orientation - Support Structure - Slicing - Tool Path Generation– Design rules for Extrusion based AM.

UNIT III	VAT POLYMERIZATION AND DIRECTED ENERGY DEPOSITION	9

Photo polymerization: Stereo lithography Apparatus (SLA) - Materials - Process – top down and bottom up approach - Advantages - Limitations - Applications. Digital Light Processing (DLP) - Process - Advantages - Applications.

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

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

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

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

23AU065	AUTOMOTIVE AERODYNAMICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the impact of aerodynamic forces and moments on performance of vehicle.
- To acquire fundamental and applied understanding of air flows, vehicle aerodynamics and control.
- To develop design skills necessary for the aerodynamic design of road vehicles.

UNIT I	INTRODUCTION	9

Importance of vehicle aerodynamics, fluid mechanics related to vehicles - external and internal flow problem, resistance to vehicle motion, performance, fuel consumption, engine cooling requirement, air flow to passenger compartment, duct for air conditioning, cooling of transverse engine and rear engine.

UNIT II	AERODYNAMIC DRAG	9

Vehicle as a bluff body - flow field around car, drag force - types of drag force. Analysis of aerodynamic drag - drag coefficient. Strategies for aerodynamic development - low drag profiles.

UNIT III	SHAPE OPTIMIZATION OF VEHICLES	9

Front end modification, front and rear wind shield angle, boat tailing, hatch back, fast back and square back. Dust flow patterns at the rear, effects of gap configuration and effect of fasteners.

UNIT IV	VEHICLE HANDLING	9

Origin of forces and moments on a vehicle, lateral stability 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.

UNIT V	WIND TUNNELS FOR AUTOMOTIVE AERODYNAMICS	9

Introduction, principle 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.	
	TOTAL: 45 PERIODS
COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Analyze the internal and external flow in the vehicle.
CO2:	Analyze the flow separation of bluff body to reduce the drag forces.
CO3:	Analyze the vehicle shape and size to make a good aerodynamic model.
CO4:	Examine the aerodynamic force and moments on vehicle body.
CO5:	Explain the wind tunnel technology test in vehicle body.
CO6:	Demonstrate wind tunnel techniques to test the aerodynamic design.
TEXT BOOKS:	
1	Wolf-Heinrich Hucho, Aerodynamics for Road Vehicles, 4th Edition, Warrendale, PA: SAE International, 2014.
2	J. Katz, Race car aerodynamics - Designing for speed, Cambridge, MA, Bentley Publishers, 2014 Pope .A, Low Speed Wind Tunnel Testing, New York, John Wiley & Sons, 2014.
REFERENCES:	
1	Yomi Obidi, Theory and Applications of Aerodynamics for Ground Vehicles, Warrendale, PA: SAE International, 2014.
2	R.H. Barnard, Road Vehicle Aerodynamic Design, 2nd edition, St Albans: Mech Aero Publishing, 2001.
3	The International Vehicle Aerodynamics Conference, 1st Edition, Woodhead Publishing, October 2014.
4	"Automotive Aerodynamics", Update SP-706, Society of Automotive Engineers Inc., 1987.

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

23AU066	NEW PRODUCT DEVELOPMENT PROCESS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To acquire knowledge on product design and apply them in practice.
- To develop understanding of the fundamentals of new product development.
- To Familiarize with creative thinking and design concepts.

UNIT I	INTRODUCTION	9

Need for developing products – The importance of engineering design – Types of design –The design process – Relevance of product lifecycle issues in design – Designing to codes and standards - Generic product development process – Various phases of product development - Planning for products – Establishing markets - Market segments - market research.

UNIT II	CUSTOMER NEEDS	9

Identifying customer needs – Voice of customer – Customer populations - Hierarchy of human need gathering methods – Affinity diagrams – Needs importance - Establishing engineering characteristics - Competitive benchmarking - Quality function deployment - House of quality - Product design specification.

UNIT III	CREATIVE THINKING	9

Creative thinking – Creativity and problem solving - Creative thinking methods - Generating design concepts - Systematic methods for designing – Functional decomposition – Physical decomposition – Functional representation – Morphological methods - TRIZ- Axiomatic design.

UNIT IV	DECISION MAKING AND PRODUCT ARCHITECTURE	9

Decision making – Decision theory – Utility theory – Decision trees – Concept evaluation methods – Pugh concept selection method- Weighted decision matrix – Analytic hierarchy process

– Introduction to embodiment design – Product architecture – Types of modular architecture – Steps in developing product architecture		
UNIT V	**DESIGN AND COST ANALYSIS**	**9**
Industrial design – Human factors design – User friendly design – Design for serviceability – Design for environment – Cost evaluation – Categories of cost – Overhead costs – Activity based costing – Methods of developing cost estimates – Manufacturing cost – Value analysis in costing.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Explain the importance of product design.
CO2:	Analyze the needs of a customer towards a product.
CO3:	Categorize the idea of creativeness on the product.
CO4:	Develop the decision-making concepts.
CO5:	Build a product based on cost frame and need of the customer.
CO6:	Explain the various costs associated with the new product development.
TEXT BOOKS:	
1	Anita Goyal, Karl T Ulrich, Steven D Eppinger, “Product Design and Development “, 4th Edition, Tata McGraw-Hill Education, 2009.
2	Kevin Otto, Kristin Wood, “Product Design”, Pearson Education, 2015.
REFERENCES:	
1	Clive L.Dym, Patrick Little, “Engineering Design: A Project-based Introduction”, 3rd Edition, John Wiley & Sons, 2009.
2	George E.Dieter, Linda Schmidt, “Engineering Design”, McGraw-Hill International Edition, 4th Edition, 2009.
3	Yousef Haik, T. M. M. Shahin, “Engineering Design

	Process", 2nd Edition Reprint, Cengage Learning, 2010.
4	Fang Chen, Jacques Terken, "Automotive Interaction Design", Springer Singapore, 2023.

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

23AU067	AUTOMOTIVE PRODUCT LIFE CYCLE MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To acquire knowledge on product life cycle and apply them in practice
- To develop understanding of the fundamentals of new product life cycle.
- To apply the design requirement for new product life cycle management.

UNIT I	MOTIVATION AND INTRODUCTION	9

E-commerce, B to B, B to C forms of business, Extended enterprise, Concepts in PDM - product life cycle, Business objects, Work flows, versions, views, product structure, change processes, Work list, information flow model in product development, engineering bill of materials.

UNIT II	COMPONENTS OF PLM SOLUTIONS	9

Object oriented approach in product development solutions, Phase gate process in product design - Disparate databases and connectivity- Cases for preparation of combined BOM and other reports. Component supplier management and sourcing.

UNIT III	PRODUCT VISUALISATION	9

CAD neutral environment and visualization of products, Standard software, Use of visualization in several stages of lifecycle, Reviews, Mark-up - case studies.

UNIT IV	ROLE OF PLM IN INDUSTRIES	9

Automotive sectors, Ten step approach to PLM- Status Review, Data Gathering, Executive Education and Awareness; Best Practice Positioning; PLM Concept Generation and Analysis; PLM Roadmap and Plan Generation Business Benefits and Business Case Development; Management Report Preparation; Executive Presentation – Benefits of PLM.

UNIT V	DETAILS OF MODULE	9

Details of modules in a PDM/PLM software, basics on customization and implementation of automotive PDM/PLM software.

	TOTAL: 45 PERIODS
COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Apply the product lifecycle management in an automotive industry.
CO2:	Classify the suitable PLM components for OEMS and Tier-I industry.
CO3:	Build new product design and styling.
CO4:	Identify several stages of lifecycle.
CO5:	Explain the role of PLM in Industries.
CO6:	Categorize the PDM/PLM module softwares.
TEXT BOOKS:	
1	Stark John, “Product Lifecycle Management Volume 1”, Springer International Publishing, 2015.
2	Vivek D. Bhise, Automotive Product Development: A Systems Engineering Implementation 1st Edition, CRC Press, 2017.
REFERENCES:	
1	Wang Lihui and Andrew YCN, “Collaborative Design and Planning for Publications Digital Manufacturing”, Springer-Verlag London Limited, 2009.
2	Stark John, “Global Product: Strategy, Product Lifecycle Management and the Billion Customer Question”, Springer Publisher, 2007
3	Grieves Michael, “Product Life Cycle Management”, Tata McGraw Hill, 2006.
4	Stark John, “Product Lifecycle Management Volume- 2”, Springer International Publishing, 2016.

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

23AU068	DYNAMICS OF GROUND VEHICLES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To develop physical and mathematical models to predict the dynamic response of vehicles.
- To apply vehicle design performance criteria and how to use the criteria to evaluate vehicle dynamic response.
- To Use dynamic analyses in the design of vehicle.

UNIT I	PERFORMANCE CHARACTERISTICS OF VEHICLE AND AERODYNAMICS	9

SAE Vehicle axis system, Forces & moments affecting vehicle, Earth Fixed coordinate system, Dynamic axle loads, Equations of motion, transmission characteristics, vehicle performance, power limited and traction limited acceleration, braking performance, Brake proportioning, braking efficiency. Mechanics of Air Flow Around a Vehicle, Pressure Distribution on a Vehicle, Aerodynamic Forces, Drag Components, Aerodynamics Aids.

UNIT II	TYRE MECHANICS	9

Tyre Construction, Size and Load Rating, Terminology and Axis System, Tractive Properties, Cornering Properties, Camber Thrust, Aligning Moment, Combined Braking and Cornering, Conicity and Ply Steer, Slip, Skid, Rolling Resistance, Elastic Band Model for longitudinal slip, Simple model for lateral slip, Combined longitudinal/lateral slip (friction ellipse), Taut string model for lateral slip, Magic Tyre Formula.

UNIT III	SUSPENSIONS	9

Suspension Kinematics, Suspension types, Solid Axles, Independent Suspensions, Anti-Squat and Anti-Pitch Suspension Geometry, Anti-Dive Suspension Geometry, Roll Center Analysis, Suspension Dynamics, Multi-body vibration, Body and Wheel hop modes, Invariant points, Controllable Suspension Elements: Active, Semi-Active. Choice of suspension spring rate, Calculation of effective spring rate, Vehicle

suspension in fore and apt directions.		
UNIT IV	**STEERING SYSTEM**	**9**
The Steering Linkages, Steering System Forces and Moments, Steering System Models, Steering Geometry, Steady Handling (2 DOF steady-state model), Understeer and Oversteer, Effect of Tyre Camber and Vehicle Roll (3 DOF steady-state model), Transient Handling and Directional Stability (2 DOF unsteady model), Effect of Vehicle Roll on Transient Handling (3 DOF unsteady model), Steady-State and Transient Handling of Articulated Vehicles.		
UNIT V	**ROLLOVER AND MOTORCYCLE DYNAMICS**	**9**
Quasi-Static Rollover of a Rigid Vehicle, Quasi-Static Rollover of a Suspended Vehicle, Transient Rollover. Kinematic structure of motorcycle, geometry of motorcycles, importance of trail, Resistance forces acting on motorcycle (tyre rolling resistance, aerodynamic resistance forces, resistant force caused by slope), Location & height of motor cycle's centre of gravity (C.G), Moments of inertia on Motorcycle. Introduction to Front & Rear suspensions of Motorcycle.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Utilize the aerodynamics concept to improve the vehicle performance.
CO2:	Select suitable tyre based on the constructional and design details.
CO3:	Select suitable suspension system based on the working.
CO4:	Explain the principle behind the steering system.
CO5:	Analyze rollover dynamics on various vehicle.
CO6:	Evaluate the center of gravity, moment of inertia on motorcycle.

TEXT BOOKS:	
1	J. Y. Wong, "Theory of Ground Vehicles", Fourth Edition, Wiley-Inter science, 2008.
2	Singiresu S. Rao, "Mechanical Vibrations," Fifth Edition, Prentice Hall, 2010.

REFERENCES:	
1	Dean Karnopp, "Vehicle Dynamics, Stability, and Control", Second Edition, CRC Press, 2013.
2	Hans B Pacejka, "Tyre and Vehicle Dynamics," Second Edition, SAE International, 2005.
3	John C. Dixon, "Tyres, Suspension, and Handling," Second Edition, Society of Automotive Engineers Inc., 1996.
4	Michael Blundell & Damian Harty, "The Multibody Systems Approach to Vehicle Dynamics", Elsevier Limited, 2004.

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

VERTICAL -6 - DIVERISIFIED COURSES GROUP

23AU069	HYDRAULICS AND PNEUMATICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To study the fluids and components used in modern industrial fluid power system.
- To develop the design, construction and operation of fluid power circuits.
- To learn the working principles and the knowledge of the troubleshooting pneumatic power system and its components.

UNIT I	HYDRAULICS PUMPS AND ACTUATORS	9

Basics of Hydraulics – Pascal's Law – Principles of flow - Friction loss – Introduction to pumps, Types of fluid - Fluid Selection criteria-Pumps Pumping theory, Classification, gear pumps, Vane pumps, Piston pumps, Pump performance, Fixed and variable displacement pumps. Hydraulic Actuators cylinders types and construction, Mechanics of Hydraulic Cylinder loading – Problems.

UNIT II	HYDRAULIC SYSTEMS CONTROL COMPONENTS	9

Direction Control, Flow control and pressure control valves – Types, Construction and Operation – Accessories: Reservoirs, Pressure Switches – Filters – Types and selection - Applications – Fluid Power ANSI Symbols - Sizing of hydraulic systems - Sealing devices, Reservoir system, Filters and strainers, Problem caused by gases in hydraulic fluids, Wear of moving parts due to solid particle contamination, Fluid Power ANSI Symbols – Problems.

UNIT III	HYDRAULIC CIRCUIT DESIGN	9

Accumulators, Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Control of single and Double acting Hydraulic cylinder Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Deceleration circuits, Sizing of hydraulic systems,

Counter Balance Electro hydraulic circuits, Servo and Proportional valves – Applications.		
UNIT IV	**PNEUMATICS AND ELECTRO PNEUMATIC SYSTEM**	**9**
Properties of air –Air preparation and distribution – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit – Classification- Single cylinder and multi cylinder circuits - Cascade method –Integration of fringe circuits, Electro Pneumatic System – Elements– Ladder diagram – Timer circuits – Problems.		
UNIT V	**TROUBLE SHOOTING AND APPLICATIONS**	**9**
Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Press and Forklift applications - Mobile hydraulics; Mechanical, hydraulic servo systems. Conditioning of hydraulic fluids Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding - Design of Pneumatic circuits for metal working, handling, Clamping counter and timer circuits – Low-cost Automation – IOT in Hydraulics and pneumatics.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Apply the knowledge of principles of hydraulic pumps
CO2:	Identify a suitable hydraulic pump based on the applications.
CO3:	Apply the knowledge of hydraulic actuators and control components.
CO4:	Build hydraulic circuits and systems
CO5:	Apply the working principles of pneumatic circuits and power systems.
CO6:	Identify various troubles shooting methods in fluid power

	systems.
TEXT BOOKS:	
1	Anthony Esposito, "Fluid Power with Applications", Prentice Hall, 2009.
2	Jadeesha. T., "Pneumatics Concepts, Design and Applications ", Universities Press, 2015.
REFERENCES:	
1	James A. Sullivan, "Fluid Power Theory and Applications", Fourth Edition, Prentice Hall, 1997.
2	Joshi.P. "Pneumatic Control", Wiley India, 2008.
3	Majumdar, S.R., "Oil Hydraulics Systems – Principles and Maintenance", Tata McGraw Hill, 2001.
4	Shanmuga sundaram.K. "Hydraulic and Pneumatic Controls". Chand & Co, 2006.

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

23AU070	FUNDAMENTALS OF NANO SCIENCE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn about the categories of nanomaterial's and the effects due to which the properties changes.
- To describe the processes employed for processing zero dimensional nano materials and two dimensional materials and select suitable materials according to the application.
- To explain the importance of preparation environments for nano materials and the importance of safety issues during the preparation of nano materials.

UNIT I	INTRODUCTION	9

Nano scale Science and Technology - Implications for Physics, Chemistry, Biology and Engineering - Classifications of nanostructured materials - Nano particles - Quantum dots, Nanowires – Ultra – Thin films - Multi-layered materials. Length Scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic and Thermal properties.

UNIT II	GENERAL METHODS OF PREPARATION	9

Bottom-up Synthesis -Top-down Approach: Precipitation, Mechanical Milling, Colloidal routes, Self-assembly, Vapor phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE. Aerosol processing - Solid state processing.

UNIT III	NANOMATERIALS	9

Carbon nanotubes – Old and new forms of carbon – Structure of CNT and classification – Processing – Solid carbon based production techniques – Gaseous carbon based production technique - Growth mechanisms – Applications- Boron nanotube – Synthesis – Applications.

UNIT IV	CHARACTERIZATION TECHNIQUE	9

X-ray diffraction technique, Scanning Electron Microscopy - Environmental techniques, Transmission Electron Microscopy including high - Resolution imaging, Surface Analysis

techniques - AFM, SPM, STM, SNOM, ESCA, SIMS-Nanoindentation.		
UNIT V	**APPLICATIONS**	**9**
Information storage- nanocomputer, molecular switch, super chip, nanocrystal, Nanobiotechlogy: nanoprobes in medical diagnostics and biotechnology, Nano medicines, Targetted drug delivery, Bioimaging - Micro Electro Mechanical Systems (MEMS), Nano Electro Mechanical Systems (NEMS)-Nanosensors, nano crystalline silver for bacterial inhibition, Nanoparticles for sunbarrier products - In Photostat, printing, solar cell, battery.		
		TOTAL: 45 PERIODS
COURSE OUTCOMES:		
After completion of the course, the students will be able to:		
CO1:	Explain the categories of nano materials and the effects.	
CO2:	Apply the processes employed for processing zero-dimensional nano materials.	
CO3:	Select processes that can fabricate one-dimensional nanomaterial.	
CO4:	Explain the importance of preparation environments for nano materials.	
CO5:	Demonstrate the importance of safety issues during the preparation of nano materials.	
CO6:	Identify suitable characterization technique based on its applications.	
TEXT BOOKS:		
1	Bhusan, Bharat, “Springer Handbook of Nanotechnology”, 2nd edition, 2007.	
2	Carl C. Koch, “Nanostructured Materials, Processing, Properties and Potential Applications”, noyes publications, Norwich, New York, U.S.A. 2002.	

REFERENCES:	
1	Bamberg, D., Grundman, M. and Ledentsov, N.N., “Quantum Dot Heterostructures”, Wiley, 1999.
2	Charles P. Poole Jr., Frank J. Ownes, ‘Introduction to Nanotechnology”, Wiley Interscience, 2003.
3	G. Wilde, “Nanostructured Materials’, Elsevier, 2008.
4	Mark Ratner and Daniel Ratner, “Nano Technology”, Pearson Education, New Delhi, 2003.

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

<table>
<tr><td rowspan="2">23AU071</td><td rowspan="2">ROAD VEHICLE AERODYNAMICS</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="6">
• To learn the basics of fluid mechanics on vehicle motion and to give the exposure about the shape optimization techniques.
• To relate the influence of rolling resistance and air resistance of various vehicles and two wheelers upon drag force.
• To give insight to wind tunnel and road-testing techniques practiced in industry.
</td></tr>
<tr><td>UNIT I</td><td colspan="4">SCOPE OF ROAD VEHICLE AERODYNAMICS</td><td>9</td></tr>
<tr><td colspan="6">Introduction, Properties of Incompressible Fluids, External Flow Phenomena Related to Vehicles, Aerodynamic Forces and Moments, Resistances to Vehicle Motion, Performance, Fuel Consumption and Fuel Economy.</td></tr>
<tr><td>UNIT II</td><td colspan="4">AIR RESISTANCE ON PASSENGER CARS</td><td>9</td></tr>
<tr><td colspan="6">Car as a Bluff Body, Drag and Lift, Drag Fractions and Their Local Origins - Front End, Windshield and Pillar, Roof, Rear End, Plan View and Side Panels, Underbody, Wheels and Wheel Housings, Front Spoiler, Rear Spoiler. Strategies for Body Shape Development – Objectives, Detail Optimization, Shape Optimization, Facelift.</td></tr>
<tr><td>UNIT III</td><td colspan="4">AERODYNAMIC DRAG ON COMMERCIAL VEHICLES</td><td>9</td></tr>
<tr><td colspan="6">Relation between Tractive Resistance, Drag Reduction and Fuel Consumption, Aerodynamic Drag Coefficients of Various Commercial Vehicles, Drag Minimization on Trucks and Buses. Add-on devices for drag reduction. Reduction of Vehicle Soiling.</td></tr>
<tr><td>UNIT IV</td><td colspan="4">MOTORCYCLE AERODYNAMICS</td><td>9</td></tr>
<tr><td colspan="6">Development of Motorcycle Aerodynamics, Riding Dynamics and its Relationship with Aerodynamics, Methods of</td></tr>
</table>

Measurement in Road Tests, Rider Influences - Rider and Pillion rider, Influences, Clothing and Helmets. Case Studies on racing models.		
UNIT V	**WIND TUNNELS, MEASUREMENT AND TEST TECHNIQUES**	**9**
Fundamentals of Wind Tunnel Technique, Tests with Scale Models - Details of Model Construction and Test Technique, Reynolds Number Effects, Climatic Tunnels. Measuring Equipment and Transducers – Flow visualization techniques, Measurement of Aerodynamic Forces and Moments, Pressure Measurements, Measurement of the Airflow Velocity, Temperature Measurement.		
TOTAL: 45 PERIODS		
COURSE OUTCOMES:		
After completion of the course, the students will be able to:		

CO1:	Apply the Knowledge about the different factors influencing drag.
CO2:	Relate the influence of drag on passenger cars.
CO3:	Apply the various drag reduction techniques on commercial vehicles.
CO4:	Apply the influence of rider and pillion rider on motorcycle aerodynamics.
CO5:	Identify suitable experimental testing methods in measuring drag in Vehicles.
CO6:	Apply the knowledge of the flow visualization techniques.
TEXT BOOKS:	
1	Alan Pope, Jewel B. Barlow, William H. Rae "Low speed wind tunnel testing", John Wiley & Sons, Third edition, 1999.
2	Hucho. W.H., "Aerodynamic of Road Vehicles –From Fluid Mechanics to Vehicle Engineering", Society of Automotive Engineers, U.S, Fourth edition, 1998.

REFERENCES:	
1	R.H.Barnard, “Road vehicle aerodynamic design, An Introduction”, Mechaero publications, Third edition, 2010.
2	T. Yomi Obidi, “Theory and Applications of Aerodynamics for Ground Vehicles” SAE International, 2014
3	Gino Sovran, “Aerodynamic Drag Mechanisms of Bluff Bodies and Road Vehicles”, Springer, 2012.
4	Thomas Schuez, “Aerodynamics of Road Vehicles”, SAE International, 2015.

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

23AU072	LEAN SIX SIGMA	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn the basics of Lean and Six Sigma.
- To teach the need and the process of integrating Lean and Six sigma.
- To identify and select the resources required for LSS Projects and selection of projects including Team building.

UNIT I	INTRODUCTION TO LEAN AND SIX SIGMA	9

Introduction to Lean- Definition, Purpose, Features of Lean; Top seven wastes, Need for Lean management, The philosophy of lean management, Creating a lean enterprise, Elements of Lean, Lean principles, the lean metric, Hidden time traps. Introduction to quality, Definition of six sigma, origin of six sigma, Six sigma concept and Critical success factors for six sigma.

UNIT II	INTEGRATION OF LEAN AND SIX SIGMA	9

Evolution of lean six sigma, Synergy of Lean and six sigma, Definition of lean six sigma, Principles of lean six sigma, Scope for lean six sigma, Features of lean six sigma. Laws of lean six sigma, Key elements of LSS, LSS model and the benefits of lean six sigma. Initiation - Top management commitment – Infrastructure and deployment planning, Process focus, Organizational structures, Measures – Rewards and recognition, Infrastructure tools.

UNIT III	PROJECT SELECTION AND TEAM BUILDING	9

Resource and project selection, Selection of Black belts, Training of Black belts and Champions, Identification of potential projects, Top down (Balanced score card) and Bottom up approach –Methods of selecting projects – Benefit/Effort graph, Process mapping, Value stream mapping, Predicting and improving team performance, Nine team roles and Team leadership.

UNIT IV	THE DMAIC PROCESS AND TOOLS	9
DMAIC Methodology – Various quality tools used in the Define, Measure, Analyze, Improve and Control phases; Lean Six Sigma, Design for lean six sigma, Case studies. Cause and Effect matrix, Idea – Generating and organizing tools – Brainstorming, Nominal group technique and Multi-voting; Data collection and accuracy tools - Check sheet, Gauge R&R; Understanding and eliminating variation - Run charts; Analyze tools - Scatter plots, ANOVA, Regression analysis, Time trap analysis; Improve tools – Mistake proofing.		
UNIT V	**INSTITUTIONALIZING AND DESIGN FOR LSS**	**9**
Institutionalizing lean six sigma – Improving design velocity, Creating cycle time base line, Valuing projects, Gating the projects, Reducing product line complexity, Design for lean six sigma, QFD, Theory of Inventive Problem solving (TRIZ), Robust design; Case study presentations.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Explain the importance of lean manufacturing in the mass production.
CO2:	Explain the importance of Six Sigma in the globalized competitive world.
CO3:	Demonstrate the importance of integrating Lean and Six Sigma.
CO4:	Build a Plan to undertake the LSS projects and suitable teams.
CO5:	Apply DMAIC methodology to execute LSS projects.
CO6:	Explain the process of institutionalizing the LSS effort.
TEXT BOOKS:	
1	Michael L.George, David Rownalds, Bill Kastle, “What is Lean Six Sigma”, McGraw – Hill, 2003.

2	Nilakanta srinivasan J, "The Master Book for Lean Six Sigma Green Belt Certification", Notion Press, 1st Edition, 2022.
REFERENCES:	
1	James P. Womack, Daniel T. Jones, "Lean Thinking", Free press business, 2003
2	Ronald G.Askin and Jeffrey B.Goldberg, Design and Analysis of Lean Production Systems, John Wiley & Sons. 2003.
3	Salman Taghizadegan, "Essentials of Lean Six Sigma", Elsevier, 2010.
4	Craig Joseph Setter, "Six Sigma: A Complete Training and Reference Guide" Harmony Living, 2018.

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

23AU073	RENEWABLE SOURCES OF ENERGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To have the knowledge about the importance and Economics of renewable Energy.
- To have the knowledge about the different methods of power generation using Solar, Wind energy and Bio energy.
- To have the knowledge about the importance of Tidal energy and Wave energy and the operations of hydrogen systems and fuel cell systems

UNIT I	INTRODUCTION	9

World Energy Use – Reserves of Energy Resources – Environmental Aspects of Energy Utilization – Renewable Energy Scenario in Tamilnadu, India and around the World – Potentials - Achievements / Applications – Economics of renewable energy systems.

UNIT II	SOLAR ENERGY	9

Solar Radiation – Measurements of Solar Radiation - Flat Plate and Concentrating Collectors – Solar direct Thermal Applications – Solar thermal Power Generation - Fundamentals of Solar Photo Voltaic Conversion – Solar Cells – Solar PV Power Generation – Solar PV Applications.

UNIT III	WIND ENERGY	9

Wind Data and Energy Estimation – Types of Wind Energy Systems – Performance – Site Selection – Details of Wind Turbine Generator – Safety and Environmental Aspects.

UNIT IV	BIO - ENERGY	9

Biomass direct combustion – Biomass gasifiers – Biogas plants – Digesters – Ethanol production – Bio diesel – Cogeneration - Biomass Applications

UNIT V	OTHER RENEWABLE ENERGY SOURCES	9

Tidal energy – Wave Energy – Open and Closed OTEC Cycles – Small Hydro-Geothermal Energy – Hydrogen and Storage - Fuel Cell Systems – Hybrid Systems.	
TOTAL: 45 PERIODS	
COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Explain the Indian and global energy scenario.
CO2:	Summarize the various solar energy technologies and its applications.
CO3:	Explain the various wind energy technologies.
CO4:	Interpret the various bio-energy technologies.
CO5:	Compare the different methods of ocean energy production.
CO6:	Apply knowledge of geothermal energy sources and power plant types to assess their applications and environmental impacts.
TEXT BOOKS:	
1	Fundamentals and Applications of Renewable Energy | Indian Edition, by Mehmet Kanoglu, Yunus A. Cengel, John M. Cimbala, McGraw Hill; First edition.
2	Renewable Energy Sources and Emerging Technologies, by Kothari, Prentice Hall India Learning Private Limited; 2nd edition (1 January 2011), ISBN-10 : 8120344707
REFERENCES:	
1	Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press, U.K., 2012.
2	Rai.G.D., "Non-Conventional Energy Sources", Khanna Publishers, New Delhi, 2014.
3	Sukhatme.S.P., "Solar Energy: Principles of Thermal Collection and Storage", Tata McGraw Hill Publishing Company Ltd., New Delhi, 2009.
4	Tiwari G.N., "Solar Energy – Fundamentals Design, Modelling and applications", Alpha Science Intl Ltd, 2015.

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

23AU074	VEHICLE AIR - CONDITIONING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the components of the automotive air-conditioning and their functions and the latest developments in this field.
- To diagnose the problems in the various parts of Vehicle air conditioning system.
- To gain knowledge of semi and automatic temperature control system for AC.

UNIT I	AUTOMOTIVE AIRCONDITIONING FUNDAMENTALS	10

Purposes of Heating, Ventilation and Air Conditioning- Environmental Concerns- Ozone layer depletion- Location of air conditioning components in a car – Schematic layout of a vehicle refrigeration system. Psychrometry – Basic terminology and Psychrometric mixtures- Psychrometric Chart- Related problems.

UNIT II	AUTOMOTIVE COOLING AND HEATING SYSTEM	8

Vehicle Refrigeration System and related problems- Fixed thermostatic and Orifice tube system- Variable displacement thermostatic and Orifice tube system- Vehicle air conditioning operation Types of compressor- Compressor Clutches- Compressor Clutch electrical circuit- Compressor lubrication- Condensers- Evaporators- Expansion devices- Evaporator temperature and pressure controls- receiver-drier- Accumulators- refrigerant hoses, Connections and other assemblies- Heating system.

UNIT III	CONTROL VALVES AND DELIVERY SYSTEM	10

Types of control devices - HVAC control system modes - System protection switches and valves - Pressure cutoff, Temperature cutoff, Thermal limiters - Refrigeration system diagnosis

Preventing Compressor damage - Preventing damage to other systems - Preventing Overheating Ram air ventilation - Maintaining drivability - Refrigeration system diagnosis Air delivery Components – Handling refrigerants – Discharging, Charging & Leak detection.		
UNIT IV	**TEMPERATURE CONTROL DEVICES**	**9**
Different types of sensors and actuators used in automatic temperature control - Fixed and variable displacement temperature control - Semi Automatic - Controller design for Fixed and variable displacement type air conditioning system.		
UNIT V	**SYSTEM SERVICING AND TESTIN**	**8**
Special tools for servicing vehicle air conditioning – Diagnosing components and air conditioning systems- Diagnosing cooling system- Air delivery system- Automatic temperature Control system diagnosis and service.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Explain about the parameters in vehicle air conditioning system.
CO2:	Identify and evaluate the various components of automotive air conditioning systems.
CO3:	Identify the problems in the various Parts of the vehicle air conditioning system.
CO4:	Explain about semi and automatic temperature control system for AC.
CO5:	Examine and service vehicle air-conditioning system.
CO6:	Model the vehicle air-conditioning system.
TEXT BOOKS:	
1	Warren Farnell and James D.Halderman, "Automotive Heating, Ventilation, and Air Conditioning systems", Classroom Manual, Pearson Prentice Hall, 2004.

2	Paul Weisler, "Automotive Air Conditioning", Reston Publishing Co. Inc., 1990.
REFERENCES:	
1	William H Crouse and Donald L Anglin, "Automotive Air conditioning", McGraw Hill Inc., 1990
2	Mitchell Information Services, Inc., "Mitchell Automatic Heating and Air Conditioning Systems", Prentice Hall Inc., 1989
3	McDonald, K.L., "Automotive Air Conditioning", Theodore Audel series, 1978
4	Warren Farnell and James D.Halderman, "Automotive Heating, Ventilation, and Air Conditioning systems", Shop Manual, Pearson Prentice Hall, 2004.

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

23AU075	SOLAR ENERGY TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To describe about solar radiation and various solar collectors.
- To explain the various solar thermal energy technologies and their applications.
- To discuss various Solar PV systems designs and their applications.

UNIT I	SOLAR RADIATION AND COLLECTORS	9

Solar angles – Sun path diagrams – Radiation - Measurement and estimation on horizontal and tilted surfaces - Flat plate collector thermal analysis - Testing methods - Evacuated tubular collectors - Concentrator collectors – Classification - Design and performance parameters - Tracking systems - Compound parabolic concentrators - Concentrators with point focus - Heliostats – Performance of the collectors.

UNIT II	SOLAR THERMAL TECHNOLOGIES	9

Principle of working, Types, Design and operation of Solar heating and cooling systems - Thermal Energy storage systems – Solar Desalination – Solar cooker : Domestic, Community – Solar pond – Solar drying-solar chimney - Solar thermal electricity conversion.

UNIT III	SOLAR PV FUNDAMENTALS	9

Semiconductor – Properties - Energy levels - Basic equations of semiconductor devices physics. Solar cells - P-n junction: Homo and hetero junctions - Metal-semiconductor interface - Dark and illumination characteristics - Figure of merits of solar cell - Efficiency limits - Variation of efficiency with the band - Gap and temperature - Efficiency measurements - High efficiency cells – Solar thermo-photovoltaics.

UNIT IV	SPV SYSTEM DESIGN AND APPLICATIONS	9

Solar cell array system analysis and performance prediction -

Shadow analysis: Reliability - Solar cell array design concepts - PV system design - Design process and optimization - Detailed array design - Storage autonomy - Voltage regulation - Maximum tracking - Centralized and decentralized SPV systems - Standalone - Hybrid and grid connected system - System installation - Operation and maintenances - Field experience - PV market analysis and economics of SPV systems.		
UNIT V	**SOLAR PASSIVE ARCHITECTURE**	**9**
Thermal comfort - Bioclimatic classification – Passive heating concepts: Direct heat gain - Indirect heat gain - Isolated gain and sunspaces - Passive cooling concepts: Evaporative cooling - Radiative cooling - Application of wind, Water and earth for cooling; Shading - Paints and cavity walls for cooling roof radiation traps - Energy efficient landscape design.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Explain the solar radiation and various solar collectors.
CO2:	Explain the characteristics of solar thermal technologies.
CO3:	Analyze the various solar PV cell materials and conversion techniques.
CO4:	Select the appropriate grid system based on the application.
CO5:	Categorize various Solar SPV systems designs and their applications.
CO6:	Apply solar passive building techniques for cooling and heating applications.
TEXT BOOKS:	
1	Chetan Singh Solanki, "Solar Photovoltatics – Fundamentals, Technologies and Applications", PHI Learning Private limited, 2011.
2	Twidell, J.W. & Weir, A., "Renewable Energy Resources", EFN Spon Ltd., UK, 2015.

REFERENCES:	
1	G.D. Rai, "Non-Conventional Energy Sources", Khanna Publishers, New Delhi, 2014.
2	P John A. Duffie, William A. Beckman, "Solar Engineering of Thermal Processes", John Wiley & Sons, 2013.
3	Lovegrove K., Stein W., "Concentrating Solar Power Technology", Woodhead Publishing Series in Energy, Elsevier, 1st Edition, 2012.
4	Sukhatme S P, Nayak J K, "Solar Energy – Principle of Thermal Storage and collection", Tata McGraw Hill, 2008.

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

23AU076	DIGITAL MANUFACTURING OF AUTOMOBILES	L	T	P	C
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COURSE OBJECTIVES:

- To understand the different technologies in the digital manufacturing concept.
- To Design, analysis and optimize of parts using CAD/CAM/CAE technologies.
- To understand the concept of rapid prototyping and reverse engineering.

UNIT I	CONCEPTION AND DEVELOPMENT OF PRODUCTS	9

Design processes and methods - CAD/CAM/CAE technologies and product lifecycle management (PLM). Concepts generation and embodiment. Expression of product design ideas using 2D sketches.

UNIT II	COMPUTER AIDED DESIGN AND ENGINEERING	9

3D modeling. Parametric design. Assembly modeling. Render the appearance of a product. CAD and additive manufacturing. Finite Element Analysis (FEA) to validate functional performance: General stages of the process, Solid and FEA models, Materials definition, Loading (loads, displacements constraints...), Post-processing, Results and verifications. Topology optimization.

UNIT III	OPEN-SOURCE PRINTER AND RAPID PROTOTYPING	9

Concept of open - Source 3D printer - Structural details, Control mechanism - Materials and Applications. Introduction to rapid tooling (RT) - Direct and Indirect tooling - Silicone rubber molding, Epoxy tooling, Spray Metal Coating, 3D printing direct, Electro Optical Sintering (EOS) - Working Principle, Materials and Applications.

UNIT IV	REVERSE ENGINEERING	9

General methodology: point clouds, meshes, NURBS surface

models and parametric CAD models. Digitizing methods and main technologies: Applications and selection of reverse engineering systems, Reverse Engineering.		
UNIT V	**INDUSTRIAL INTERNET OF THINGS**	**9**
Industrial Internet of Things and Cyber Manufacturing Systems, Application map for Industrial Cyber Physical Systems (CPS) – CPS - Based manufacturing and Industries 4.0 , Application of CPS in Machine tools, Digital production - Introduction to big data and machine learning and condition Monitoring, Plant Automation, Case studies.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Develop product ideas into viable products
CO2:	Apply fundamental engineering design principles and procedures.
CO3:	Analyze, design and optimization of parts using CAD/CAM/CAE technologies
CO4:	Apply the knowledge of rapid prototyping operation
CO5:	Utilize reverse engineering processes.
CO6:	Explain IIOT in Manufacturing Sectors.
TEXT BOOKS:	
1	Radhakrishnan P, Subramanyan S. and Raju V., “CAD/CAM/CIM”, 2nd Edition, New Age International (P) Ltd, New Delhi, 2000.
2	Mikell. P. Groover “Automation, Production Systems and Computer Integrated Manufacturing”, Prentice Hall of India, 2008.
REFERENCES:	
1	Chris McMahon and Jimmie Browne “CAD/CAM Principles", "Practice and Manufacturing management “ Second Edition, Pearson Education, 1999.

2	Donald Hearn and M. Pauline Baker “Computer Graphics”’. Prentice Hall, Inc., 1992.
3	Foley, Wan Dam, Feiner and Hughes, "Computer graphics principles & practice" Pearson Education, 2003.
4	Ibrahim Zeid, “Mastering CAD CAM”, Tata McGraw-Hill Publishing, 2007.

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