RAJALAKSHMI ENGINEERING COLLEGE
(An Autonomous Institution Affiliated to Anna University Chennai)
Choice Based Credit System
DEPARTMENT OF AUTOMOBILE ENGINEERING
CURRICULUM AND SYLLABUS REGULATIONS – 2023
B.E. AUTOMOBILE ENGINEERING

VISION:

To be a department of excellence in the domain of Automotive Engineering and develop competent engineers imbibed with entrepreneurial and innovative skills with a concern for the society.

MISSION:

- To provide accessible quality education well grounding the students in the fundamental principles of Automotive Engineering and humane values.
- To provide a conducive environment for the students to get transformed themselves into professionals who can design, develop and effectuate automotive systems for industry and societal needs.
- To explore, develop and create innovations in Automotive Engineering thereby furthering research activities resulting in products satisfying industrial and social needs.

PROGRAMME EDUCATIONAL OBJECTIVES (PEO'S)

1. To provide students with sound foundation in the mathematical, scientific and engineering fundamentals necessary to formulate, analyze and solve engineering problems and to prepare them for higher studies and for successful careers in automobile industry.

2. To impart students with knowledge, innovation and skills towards research, design and development of Automotive Systems and allied integrated systems of global standards for betterment of society. To impart knowledge in usage of alternate fuels and emission control in IC engines.

3. To instill the values, skills, leadership, team spirit and professional ethics for comprehensive and wholesome personality and to promote entrepreneurial interest among students so that they can compete globally in the field and to create a fervor for use of Engineering in addressing societal concerns.

PROGRAM OUTCOMES (PO)

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

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

3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSO's)

PSO1. Will be able to design and develop power plant and chassis systems in a view to meet the dynamic needs of the society by harnessing the potential of electronic systems and modern software tools.

PSO2. Will be able to explore possibilities of viable alternate fuels and to develop emission control technologies and safety systems

PSO3. Will be able to work in an industry as a team member as well as an individual with professional qualities and evolve oneself for lifelong learning.

Rajalakshmi Engineering College

Department of Automobile Engineering

R2023 CURRICULUM

Sl. No.	SEM	Course Code	Course Name	Category	Total Hrs	L	T	P	C
Automobile Engineering
1	I	HS 23111	**Technical Communication I**	HS	2	2	0	0	2
2	I	MA23112	**Algebra and Calculus**	BS	4	3	1	0	4
3	I	GE23111	**Engineering Graphics**	ES	6	2	0	4	4
4	I	AT23111	**Production Technology - I**	PC	3	3	0	0	3
5	I	GE23117	தமிழர்மரபு / Heritage of Tamils	HS	1	1	0	0	1
6	I	PH23131	**Physics of Materials**	BS	5	3	0	2	4
7	I	GE23121	**Engineering Practices – Civil and Mechanical**	ES	2	0	0	2	1
8	I	MC23112	**Environmental Science and Engineering**	MC	3	3	0	0	0
Total					24	17	1	8	19

Sl. No.	SEM	Course Code	Course Name	Category	Total Hrs	L	T	P	C
1	II	MA23212	**Differential Equations and Complex Variables**	BS	4	3	1	0	4
2	II	GE23211	**Engineering Mechanics**	ES	3	2	1	0	3
3	II	GE23217	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology	HS	1	1	0	0	1
4	II	CY23233	**Engineering Chemistry**	BS	5	3	0	2	4

5	II	EE23133	Basic Electrical and Electronics Engineering	ES	5	3	0	2	4
6	II	GE23231	Programming Using Python	ES	5	1	0	4	3
7	II	HS 23221	Technical Communication II	HS	2	0	0	2	1
		HS 23222	English for Professional Competence						
8	II	GE23122	Engineering Practices - Electrical and Electronics	ES	2	0	0	2	1
9	II	MC23111	Indian Constitution and Freedom Movement	MC	3	3	0	0	0
Total					30	16	2	12	21

Sl. No.	SEM	Course Code	Course Name	Category	Total Hrs	L	T	P	C
1	III	MA23331	Transforms and Statistics	BS	5	3	0	2	4
2	III	AT23331	Automotive Engines	PC	5	3	0	2	4
3	III	AT23332	Applied Thermodynamics	PC	5	2	1	2	4
4	III	AT23333	Strength of Materials for Automobile Engineers	PC	5	2	1	2	4
5	III	AT23334	Production Technology - II	PC	5	3	0	2	4
6	III	AT23321	Computer Aided Machine Drawing Laboratory	PC	4	0	0	4	2
Total					29	13	2	14	22

Sl. No.	SEM	Course Code	Course Name	Category	Total Hrs	L	T	P	C
1	IV	AT23411	Electric and Hybrid Vehicles - I	PC	3	3	0	0	3
2	IV	AT23412	Material Science and Metallurgy	ES	3	3	0	0	3
3	IV	AT23431	Automotive Drive Line and	PC	5	3	0	2	4

Sl. No.	SEM	Course Code	Course Name	Category	Total Hrs	L	T	P	C
			Chassis						
4	IV	AT23432	**Fluid Mechanics and Machinery for Automobile Engineers**	PC	5	2	1	2	4
5	IV	AT23433	**Theory of Machines**	PC	5	2	1	2	4
6	IV	CS23422	**Python Programming for Machine Learning**	ES	4	0	0	4	2
7	IV	GE23421	**Soft Skills - I**	EEC	2	0	0	2	1
Total					27	13	2	12	21

Sl. No.	SEM	Course Code	Course Name	Category	Total Hrs	L	T	P	C
1	V	AT23511	**Design of Machine Elements**	PC	3	2	1	0	3
2	V	GE23311	**Fundamentals of Management for Engineers**	HS	3	3	0	0	3
3	V		**Professional Elective – I**	PE	3	3	0	0	3
4	V		**Open Elective - I**	OE	3	3	0	0	3
5	V	AT23531	**Automotive Electrical and Electronics**	PC	5	3	0	2	4
6	V	AT23532	**Electric and Hybrid Vehicles - II**	PC	5	3	0	2	4
7	V	AT23521	**Two and Three wheelers Laboratory**	PC	2	0	0	2	1
8	V	AT23522	**Computer Aided Vehicle Design Data Characteristics Laboratory**	PC	2	0	0	2	1
9	V	GE23521	**Soft Skills - II**	EEC	2	0	0	2	1
Total					28	17	1	10	23

Sl. No.	SEM	Course Code	Course Name	Category	Total Hrs	L	T	P	C
1	VI		**Professional Elective – II**	PE	3	3	0	0	3
2	VI		**Open Elective - II**	OE	3	3	0	0	3
3	VI	AT23631	**Automotive System Design**	PC	5	2	1	2	4
4	VI	AT23632	**Vehicle Dynamics**	PC	5	2	1	2	4
5	VI	AT23633	**Automotive Fuels and Lubricants**	PC	5	3	0	2	4
6	VI	GE23621	**Problem Solving Techniques**	EEC	2	0	0	2	1
7	VI	GE23627	**Design Thinking and Innovation**	EEC	4	0	0	4	2
Total					27	13	2	12	21

Sl. No.	SEM	Course Code	Course Name	Category	Total Hrs	L	T	P	C
1	VII	AT23711	**Automotive Pollution and Control**	PC	3	3	0	0	3
2	VII	AT23712	**Intelligent Vehicle System**	PC	3	3	0	0	3
3	VII	AT23713	**Automotive Safety**	PC	3	3	0	0	3
4	VII		**Professional Elective – III**	PE	3	3	0	0	3
5	VII	AT23721	**AI and ML for Automobile Engineers**	PC	4	0	0	4	2
6	VII	AT23722	**Vehicle Maintenance Laboratory**	PC	2	0	0	2	1
7	VII	AT23723	**Computer Aided Analysis laboratory**	PC	2	0	0	2	1
8	VII	AT23724	Internship	EEC	2	0	0	2	1
Total					22	12	0	10	17

Sl. No.	SEM	Course Code	Course Name	Category	Total Hrs	L	T	P	C
1	VIII		Professional Elective – IV	PE	3	3	0	0	3
2	VIII		Professional Elective – V	PE	3	3	0	0	3
3	VIII	AT23821	Project Work	EEC	20	0	0	20	10
Total					26	6	0	20	16

Vertical subjects with Specialization

Category	Common Verticals / Professional Electives	
	Vertical 1/ Computational Engineering	**Vertical 2/ Logistics And Supply Chain Management**
Offered in	Course Code / Name	Course Code/ Name
V Sem	ME23A11 Machine Learning for Intelligent Systems	ME23B11 Reliability and Maintenance Engineering
V Sem	ME23A12 CAD and CAE	ME23B12 Warehousing Automation
VI Sem	ME23A13 Numerical heat transfer	ME23B13 Operations Management
VI Sem	ME23A14 Theory on Computation and Visualization	ME23B14 Material Handling Equipment, Repair and Maintenance
VII Sem	ME23A15 Computational Bio- Mechanics	ME23B15 Container Logistics
VII Sem	ME23A16 Advanced Statistics and Data Analytics	ME23B16 Production Planning and Control
VII Sem	ME23A17 Noise Acoustics and Vibration	ME23B17 Operations Research
VIII Sem	ME23A18 Computational Solid Mechanics	ME23B18 Supply chain and Logistics Management
VIII Sem	ME23A19 Computational Fluid Dynamics	ME23B19 Data Science

Sl. No.	SEM	VERTICAL 3/ ELECTRIC VEHICLES							
		Course Name	Course Code	Category	Total Hrs	L	T	P	C
1	V/VI	Fuel cell Technologies	AT23C11	Vertical	3	3	0	0	3
2	V/VI	Automotive Power Electronics	AT23C12	Vertical	3	3	0	0	3
3	V/VI	Sensors and Actuators	AT23C13	Vertical	3	3	0	0	3
4	VII/VIII	Smart charging of Electric and Hybrid Vehicles	AT23C14	Vertical	3	3	0	0	3
5	VII/VIII	Electric and Plug-in Hybrid Vehicle Networks_ Optimization and Control	AT23C15	Vertical	3	3	0	0	3
6	VII/VIII	Energy Systems for Electric and Hybrid Vehicles	AT23C16	Vertical	3	3	0	0	3
7	VII/VIII	Automotive Functional Safety	AT23C17	Vertical	3	3	0	0	3
8	VII/VIII	Modelling of Electric and Hybrid Vehicles	AT23C18	Vertical	3	3	0	0	3

Sl. No.	SEM	Vertical 4/ VEHICLE RESEARCH AND VALIDATION							
		Course Name	Course Code	Category	Total Hrs	L	T	P	C
1	V/VI	Advanced Automotive Materials	AT23D11	Vertical	3	3	0	0	3
2	V/VI	Noise, Vibration and Harshness	AT23D12	Vertical	3	3	0	0	3
3	V/VI	Combustion Thermodynamics and Heat Transfer	AT23D13	Vertical	3	3	0	0	3
4	VII/VIII	Automotive Instrumentation	AT23D14	Vertical	3	3	0	0	3
5	VII/VIII	Testing and Measurement Systems	AT23D15	Vertical	3	3	0	0	3
6	VII/VIII	Homologation	AT23D16	Vertical	3	3	0	0	3
7	VII/VIII	IC Engine Process Modelling	AT23D17	Vertical	3	3	0	0	3
8	VII/VIII	Vehicle Control Systems	AT23D18	Vertical	3	3	0	0	3

Sl. No.	SEM	VERTICAL 5 / SPECIAL PURPOSE VEHICLES							
		Course Name	Course Code	Category	Total Hrs	L	T	P	C
1	V/VI	Hydraulics and Pneumatics for Automobile Engineers	AT23E11	Vertical	3	3	0	0	3
2	V/VI	Agricultural Vehicles	AT23E12	Vertical	3	3	0	0	3
3	V/VI	Defence Vehicles	AT23E13	Vertical	3	3	0	0	3
4	VII/VIII	Constructions Vehicles	AT23E14	Vertical	3	3	0	0	3
5	VII/VIII	Marine Vehicles	AT23E15	Vertical	3	3	0	0	3
6	VII/VIII	Off-road Vehicle Dynamics - Analysis, Modelling and Optimization	AT23E16	Vertical	3	3	0	0	3
7	VII/VIII	Mechatronics and Intelligent Systems for Off-road Vehicles	AT23E17	Vertical	3	3	0	0	3
8	VII/VIII	Terra-mechanics and Off-Road Vehicle Engineering	AT23E18	Vertical	3	3	0	0	3

Sl. No.	SEM	VERTICAL 6/ PRODUCT AND PROCESS DEVELOPMENT							
			Course Code	Category	Total Hrs	L	T	P	C
1	V/VI	Automotive Product Design	AT23F11	Vertical	3	3	0	0	3
2	V/VI	Ergonomics in Automotive Design	AT23F12	Vertical	3	3	0	0	3
3	V/VI	Additive Manufacturing	AT23F13	Vertical	3	3	0	0	3
4	VII/VIII	Finite Element Analysis	ME23613	Vertical	3	3	0	0	3
5	VII/VIII	New Product Development Process	AT23F15	Vertical	3	3	0	0	3
6	VII/VIII	Automotive Product Life Cycle Management	AT23F16	Vertical	3	3	0	0	3
7	VII/VIII	Production of Automotive Components	AT23F17	Vertical	3	3	0	0	3
8	VII/VIII	Geometric Dimensioning and Tolerancing	ME23D13	Vertical	3	3	0	0	3
9	VII/VIII	Instrumentation and Metrology	AT23F19	Vertical	3	3	0	0	3

Sl. No.	SEM	VERTICAL 7/DIVERSIFIED COURSES GROUP 1	Course Code	Category	Total Hrs	L	T	P	C
1	V/VI	Engine and Vehicle Management Systems	AT23G11	Vertical	3	3	0	0	3
2	V/VI	Two and Three Wheelers	AT23G12	Vertical	3	3	0	0	3
3	V/VI	Control Engineering	AE23412	Vertical	3	3	0	0	3
4	VII/VIII	Transport Management	AT23G14	Vertical	3	3	0	0	3
5	VII/VIII	Entrepreneurship Development	ME23G16	Vertical	3	3	0	0	3
6	VII/VIII	Operations Research	ME23B17	Vertical	3	3	0	0	3
7	VII/VIII	Vehicle Body Engineering	AT23G17	Vertical	3	3	0	0	3
8	VII/VIII	Total Productive Maintenance	AT23G18	Vertical	3	3	0	0	3
9	VII/VIII	Vehicle maintenance	AT23G19	Vertical	3	3	0	0	3

Sl. No.	SEM	VERTICAL 8/DIVERSIFIED COURSES GROUP 2	Course Code	Category	Total Hrs	L	T	P	C
1	V/VI	Numerical Methods	AT23H11	Vertical	3	3	0	0	3
2	V/VI	Automotive Transmission	AT23H12	Vertical	3	3	0	0	3
3	V/VI	Road Vehicle Aerodynamics	AT23H13	Vertical	3	3	0	0	3
4	VII/VIII	Lean Six Sigma	AT23H14	Vertical	3	3	0	0	3
5	VII/VIII	Renewable Sources of Energy	ME23F13	Vertical	3	3	0	0	3
6	VII/VIII	Automotive Air-Conditioning	AT23H16	Vertical	3	3	0	0	3
7	VII/VIII	Solar Energy Technology	AT23H17	Vertical	3	3	0	0	3
8	VII/VIII	Total Quality Management	ME23712	Vertical	3	3	0	0	3
9	VII/VIII	Industrial Safety	ME23G12	Vertical	3	3	0	0	3

Open Elective Course Offered by Automobile Department

Sl. No.	SEM	Course Code	Course Name	Category	Total Hrs	L	T	P	C
1	OE	OAT2311	Automotive Systems	OE	3	3	0	0	3
2	OE	OAT2312	Elements of Electric and Hybrid Vehicles	OE	3	3	0	0	3

	SEM I	SEM II	SEM III	SEM IV	SEM V	SEM VI	SEM VII	SEM VIII	Credits	%
HS	3	2			3				8	5.0
BS	8	8	4						20	12.5
ES	5	11		5					21	13.1
PC	3		18	15	13	12	13		74	46.3
PE					3	3	3	6	15	9.4
OE					3	3			6	3.8
EEC				1	1	3	1	10	16	10.0
Credit	19	21	22	21	23	21	17	16	160	100.0

I semester

Course Code	Course Name (Theory course)	Category	L	T	P	C
HS 23111	Technical Communication I	HS	2	0	0	2
	Common to all branches of B.E/B. Tech programmes – First Semester					

Objectives:
To facilitate students develop their comprehension skills
To enable students to improve their receptive skills
To equip learners with better vocabulary and enhance their writing skills
To aid students speak effectively in all kinds of communicative contexts.
To improve the learners' basic proficiency in workplace communication

UNIT-I	DEVELOPING COMPREHENSION SKILLS	6
Listening: Introduction to Informational listening – Listening to Podcasts, News		
Reading: Intentional Reading - Short Narratives and Passages.		
Speaking: Introducing Oneself, Narrating a Story / Incident.		
Writing: Sequential Writing – connecting ideas using transitional words (Jumbled Sentences), Process Description		
Grammar: Verbs – Main & Auxiliary: Simple Tenses – Form, Function and Meaning.		
Vocabulary: Word formation – Prefix, Suffix, Compound Words.		
UNIT-II	**LISTENING AND EXTENDED READING**	6
Listening: Deep Listening – Listening to Talk Shows and Debates		
Reading: In-depth Reading - Scanning Passages		
Speaking: Describing Current Issues, Happenings, etc..,		
Writing: Note Making, Note Taking – Paragraph Writing		
Grammar: Continuous Tenses, Prepositions, Articles		
Vocabulary: One Word Substitutes, Phrasal Verbs.		
UNIT-III	**FORMAL WRITING AND VERBAL ABILITY**	6

Listening: Listening to Lectures and Taking Notes

Reading: Interpretation of Tables, Charts and Graphs

Speaking: SWOT Analysis on Oneself

Writing: Formal Letter Writing and Email Writing

Grammar: Perfect Tenses, Phrases and Clauses, Discourse Markers

Vocabulary : Verbal Analogy / Cloze Exercise

UNIT-IV	ENHANCING SPEAKING ABILITY	6

Listening: Listening to eminent voices of one's interest (Martin Luther King, APJ Abdul Kalam, etc..)

Reading: Timed Reading, Filling KWL Chart.

Speaking: Just a Minute, Impromptu

Writing: Check-list, Instructions.

Grammar: 'Wh' Questions / 'Yes' or 'No' Questions, Imperatives

Vocabulary: Synonyms, Antonyms, Different forms of the same words.

UNIT-V	LANGUAGE FOR WORKPLACE	6

Listening: Extensive Listening (Audio books, rendering of poems, etc.)

Reading: Extensive reading (Jigsaw Reading, Short Stories, Novels)

Speaking: Short Presentations on Technical Topics

Writing: Recommendations, Essay Writing

Grammar: Impersonal Passive, Reported Speech, Concord

Vocabulary : Informal Vocabulary and Formal Substitutes

Total Contact Hours: 30

Course Outcomes:
On completion of the course students will be able to
apply their comprehension skills and interpret different contents effortlessly
read and comprehend various texts and audio visual contents
infer data from graphs and charts and communicate it efficiently in varied contexts
participate effectively in diverse speaking situations
to present, discuss and coordinate with their peers in workplace using their language skills

SUGGESTED ACTIVITIES

- Ice breaker
- Just A Minute
- Ship wreck
- Hot seat
- Vocabulary building
- Chinese whispers
- Case study

SUGGESTED EVALUATION METHODS

- Assignment topics
- Quizzes
- Class Presentation/Discussion
- Continuous Assessment Tests

Text Book(s):

1. Effective Technical Communication by M. Ashraf Rizvi (Author) 2nd Edition Paperback 2017
2. Sylvan Barnet and Hugo Bedau, 'Critical Thinking Reading and Writing', Bedford/st. Martin's: Fifth Edition (June 28, 2004)
3. Meenakshi Upadhyay, Arun Sharma – Verbal Ability and Reading Comprehension.
4. Teaching Speaking: A Holistic Approach, Book by Anne Burns and Christine ChuenMeng Goh, Cambridge University Press

Reference Books(s) / Web links:

1. Basic Vocabulary in Use: 60 Units of Vocabulary Practice in North American English With Answers 2nd Edition by Michael McCarthy (Author), Felicity O'Dell (Author), John D. Bunting (Contributor)
2. Reading Development and Difficulties By Kate Cain
3. The 7 Habits of Highly Effective People by Stephen Covey, Simon and Schuster, UK
4. Everybody Writes: Your Go-To Guide to Creating Ridiculously Good Content Hardcover by Ann Handley (Author)

Course Code	Course Title	Category	L	T	P	C
MA23112	**ALGEBRA AND CALCULUS**	BS	3	1	0	4

Common to I sem. B.E. - AERO, AUTO, MECH, MCT, R&A, CIVIL and B.Tech. - BT, FT & CHEM

Objectives:
● To introduce the matrix techniques and to illustrate the nature of the matrix.
● To address data and synthesis of the information to provide valid conclusions.
● To explain techniques of calculus which are applied in the solutions of engineering problems.
● To analyse special types of integrals by analytical methods and numerical techniques.
● To practice the techniques of Integration in finding area and volumes.

UNIT-I	**MATRICES**	12

Matrices - Eigenvalues and eigenvectors - Diagonalization of matrices using orthogonal transformation - Cayley-Hamilton Theorem(without proof) -Quadratic forms- Reduction to canonical form using orthogonal transformation-Numerical computation of Eigen value using Power method

UNIT-II	**FUNCTIONS OF SEVERAL VARIABLES**	12

Partial differentiation–Total derivative–Change of variables–Jacobians–Partial differentiation of implicit functions–Taylor's series for functions of two variables–Maxima and minima of functions of two variables–Lagrange's method of undetermined multipliers.

UNIT-III	**INTEGRAL CALCULUS**	12

Integral Calculus: Definite Integrals as a limit of sums - Applications of integration to area, volume - Improper integrals: Beta and Gamma integrals - Numerical computation of integrals: Trapezoidal rule - Gaussian Two point quadrature

UNIT-IV	**MULTIPLE INTEGRALS**	12

Double integrals – Change of order of integration – Area enclosed by plane curves–Triple integrals–Volume of solids–Numerical computation of double integrals: Trapezoidal rule.

UNIT-V	**REGRESSION**	12

Scatter diagram - Karl Pearson coefficient of correlation for raw data –Spearman rank correlation coefficient - Lines of regression - Regression equation X on Y and Y on X- Curve fitting by Principle of least squares - Fitting a straight line $y = ax+b$ and a parabola $y = ax^2 + bx + c$.

Total Contact Hours:60

Course Outcomes:
On completion of the course students will be able to
● Demonstrate the matrix techniques in solving the related problems in engineering and technology.
● Analyse and interpret data, and synthesize information to provide valid conclusions.
● Interpret the problems in Engineering and Technology using the principles of mathematical calculus.
● Apply the analytical methods and numerical techniques to solve the related engineering problems.
● Evaluate multiple integrals to conduct investigations of complex problems.

SUGGESTED ACTIVITIES
● Problem solving sessions
● Activity Based Learning
● Implementation of small module

SUGGESTED EVALUATION METHODS
● Problem solving in Tutorial sessions
● Assignment problems
● Quizzes and class test

● Discussion in classroom

Text Book(s):

1.	Grewal B.S., " Higher Engineering Mathematics ", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2.	Gupta S.C. and Kapoor V.K."Fundamentals of Mathematical Statistics", Sultan and Sons 10th Edition,2000.
3.	T Veerarajan, Engineering Mathematics –I , Mc Graw Hill Education, 2018.

Reference Books(s) / Web links:

1.	Ramana. B.V., " Higher Engineering Mathematics ", McGraw Hill Education Pvt. Ltd, New Delhi, 2018.
2.	T Veerarajan ,Fundamentals of Mathematical Statistics , yesdee publications, 2017.
3.	Erwin Kreyszig ," Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2016.

Course Code	Course Name	Category	L	T	P	C
GE23111	**ENGINEERING GRAPHICS**	ES	2	0	4	4

OBJECTIVES:
- To understand the importance of the drawing in engineering applications
- To develop graphic skills for communication of concepts, ideas and design of engineeringproducts
- To expose them to existing national standards related to technical drawings.
- To improve their visualization skills so that they can apply this skill in developing newproducts.
- To improve their technical communication skill in the form of communicative drawings

CONCEPTS AND CONVENTIONS (Not for Examination)   **1**
Importance of graphics in engineering applications–Use of drafting instruments– BIS conventions and specifications–Size, layout and folding of drawing sheets– Lettering and dimensioning. Basic Geometrical constructions.

UNIT-I PLANE CURVES AND PROJECTION OF POINTS   **5+12**
Curves used in engineering practices: Conics–Construction of ellipse, parabola and hyperbola by eccentricity method – Cycloidal Curves–Construction of cycloid, epicycloid and hypocycloid – Construction of involutes of square and circle–Drawing of tangents and normal to the above curves.
Principles of Projection and Projection of points.

UNIT-II PROJECTION OF LINES AND PLANE SURFACES   **6+12**
Projection of straight lines (First angle projection) inclined to both the principal planes – Determination of true lengths and true inclinations by rotating line method
Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

UNIT-III PROJECTION OF SOLIDS AND PROJECTION OF SECTIONED SOLIDS
    6+12

Projection of simple solids like prisms, pyramids, cylinder and cone when the axis is inclined to oneof the principal planes by rotating object method.
Sectioning of solids in simple vertical position when the cutting plane is inclined to HP and perpendicular to VP – obtaining true shape of the section.
Practicing three-dimensional modeling of simple objects by CAD software (Not for examination)

UNIT-IV DEVELOPMENT OF SURFACE AND ISOMETRIC PROJECTIONS   **6+12**
Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders andcones.
Principles of isometric projection–isometric scale–Isometric projections of simple solids andtruncated solids - Prisms, pyramids, cylinders and cones
Model making of isometric projection of combination of solids as assignment (Not for End semester)

UNIT-V FREE HAND SKETCHING AND PERSPECTIVE PROJECTIONS   **6+12**
Free Hand sketching: Freehand sketching of multiple views from pictorial views of objects - Freehandsketching of pictorial views of object from multiple views
Perspective projection of simple solids-Prisms, pyramids, cylinder and cone by visual ray method.

          Total Contact Hours: (L=30; P=60) 90 Periods

COURSE OUTCOMES:

After learning the course, the students should be able
  ● To construct different plane curves and to comprehend the theory of projection
  ● To draw the basic views related to projection of lines and planes
  ● To draw the projection of simple solids and to draw the projection of
    development of surfacesof Sectioned solids in simple vertical position
  ● To draw the orthographic projection from pictorial objects and Isometric
    projections ofsimple solids
  ● To visualize Perspective view of simple solids

CO PO PSO MAPPING

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

1: Slight (Low)   2: Moderate (Medium)   3: Substantial (High)

TEXT BOOK (S):
  1. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing
     House, 50thEdition, 2010.
  2. Natarajan K.V., "A text book of Engineering Graphics", Dhanalakshmi
     Publishers, Chennai,2017.

REFERENCE BOOKS(S) / WEB LINKS:
  1. Varghese P I., "Engineering Graphics", McGraw Hill Education (I) Pvt.Ltd., 2013.
  2. V.B Sikka "Civil Engineering Drawing", S.K Kataria & Sons, New Delhi.
  3. Venugopal K. and PrabhuRaja V., "Engineering Graphics", New Age
     International(P)Limited, 2008.
  4. Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas
     Stores,Bangalore, 2017.
  5. Basant Agarwal and Agarwal C.M., "Engineering Drawing", McGraw Hill
     PublishingCompany Limited, New Delhi, 2018.

Course Code	Course Name	Category	L	T	P	C
AT23111	**Production Technology – I**	PC	3	0	0	3

OBJECTIVES:

1. To learn about various metal casting process principle and procedure involved
2. To rephrase the process principle and application of powder metallurgy and polymer processing
3. To learn about the process principle of various types of welding and its applications.
4. To understand the process principles of metal forming techniques.
5. To understand various sheet metal operations and processing techniques.

UNIT I	METAL CASTING PROCESSES	9

Sand Casting : Sand Mould – Type of patterns - Pattern Materials – Pattern allowances – Moulding sand Properties and testing – Cores –Types and applications – Moulding machines– Types and applications; Melting furnaces : Blast and Cupola Furnaces; Principle of special casting processes : Shell - investment – Ceramic mould – Pressure die casting - Centrifugal Casting - Defects in Sand casting. Design of patterns, moulds and cores; riser and gating design.

UNIT II	POWDER METALLURGY AND POLYMER PROCESSING	9

Historical and modern developments in Powder Metallurgy. Advantages, limitations and applications of Powder Metallurgy. Basic Steps for Powder Metallurgy. Powder Compaction Methods, Powder Forming Methods and Sintering.

Types of plastics- Working principles and typical applications of - Injection Moulding- Compression moulding- Extrusion- Thermoforming- Transfer moulding-Rotational Moulding and Film blow moulding.

UNIT III	JOINING PROCESSES	9

Operating principle, basic equipment, merits and applications of: Fusion welding processes: Gas welding - Types – Flame characteristics; 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 – Electron beam welding –Laser Beam welding, Friction welding and Friction Stir Welding; Weld defects: types, causes and cure. Principles of brazing, soldering.

UNIT IV	METAL FORMING PROCESSES	9

Hot working and cold working of metals – Forging processes – Open, impression and closed die forging – forging operations. Rolling of metals– Types of Rolling – Flat strip rolling – shape rolling operations – Defects in rolled parts. Principle of rod and wire drawing – Tube drawing – Principles of Extrusion – Types – Hot and Cold extrusion. Load estimation for bulk (forging,

rolling, extrusion and drawing).	
UNIT V **SHEET METAL PROCESSES**	**9**
Sheet metal characteristics – shearing, bending and drawing operations – Stretch forming operations – Formability of sheet metal – Test methods –special forming processes-Working principle and applications – Hydro forming – Rubber pad forming – Metal spinning– Introduction of Explosive forming, magnetic pulse forming, peen forming, Super plastic forming – Micro forming.	
	TOTAL : **45 PERIODS**

COURSE OUTCOMES:
1. The students will be able to comprehend various metal casting process principle and procedure
2. The students will be able to demonstrate the working principle and application of powder metallurgy and polymer processing.
3. The students will be to explain principle of various types of welding and its applications
4. The students will be able to illustrate the working principles of metal forming techniques.
5. The students will be able to demonstrate various sheet metal operations and processing techniques.

TEXT BOOKS:
1   P N Rao, "Manufacturing Technology: Vol. I",4th Edition, McGraw hill Education, 2013.
2   2013S SK HajraChoudhury and A K HajraChoudhury, Nirjhar Roy, "Elements of WorkshopTechnology Volume I: Manufacturing Processes' ', Media Publishers and Promoters Pvt. Ltd.,2008.

REFERENCE BOOKS:
1.   Mikell P Groover, "Fundamentals of Modern Manufacturing Materials processes and systems"Fourth Edition, Wiley Publication.
2.   Roy. A. Lindberg, "Processes and Materials of Manufacture", PHI / Pearson education, 2006
3.   J. T. Black, Ronald A. Kohser, "DeGarmo's Materials and Processes in Manufacturing" Twelfth Edition, John Wiley & Sons, 2017.
4.   Steven R. Schmid and SeropeKalpakjian, "Manufacturing Engineering and Technology" Seventh Edition, Pearson Education, 2014.

GE23117   தமிழர் மரபு   **L T P C**

                                                            1 0 0 1

அலகு I   மொழி மற்றும் இலக்கியம்:   **3**

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

அலகு II மரபு - பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை - சிற்பக் கலை:   **3**

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

அலகு III   நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்:   **3**

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

அலகு IV   தமிழர்களின் திணைக் கோட்பாடுகள்:   **3**

தமிழகத்தின் தாவரங்களும், விலங்குகளும் - தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் - தமிழர்கள் போற்றிய அறக்கோட்பாடு - சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் - சங்ககால நகரங்களும் துறை முகங்களும் - சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி - கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.

அலகு V   இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு:   **3**

இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு - இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் - சுயமரியாதை இயக்கம் - இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு - கல்வெட்டுகள், கையெழுத்துப்படிகள் - தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.

                                                TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

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

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

3. கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)

4. பொருநை - ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)

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

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

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

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

9. Keeladi – 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

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

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

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

Course Code	Course Name	Category	L	T	P	C
PH23131	**PHYSICS OF MATERIALS** **Common to I sem. B.E. - Aero, Auto, Civil, Mech, MCT and R&A**	BS	3	0	2	4

Objectives:

- To enhance the fundamental knowledge of elasticity and its applications relevant to engineering streams.

- To become proficient in crystal growth and crystal systems.

- To introduce the essential of phase transformation in materials.

- To impart knowledge on the structure, properties, treatment, testing and applications of metals and alloys.

- To familiarize students with thermal properties and applications.

UNIT-I	**PROPERTIES OF MATTER**	9

Elasticity–Hooke's law-stress–strain-modulus of elasticity-stress-strain diagram-Poisson's ratio-rigidity modulus-twisting couple on a cylinder-moment of inertia - torsional pendulum method. Bending of beams -bending moment-cantilever depression-theory and experiment - Young's modulus determination–uniform and non-uniform bending-I-shape girders. Viscosity-flow of motion-Reynolds number.

UNIT-II	**THERMAL PHYSICS**	9

Transfer of heat energy – thermal expansion of solids and liquids – expansion joints - bimetallic strips - thermal conduction, convection and radiation –rectilinear heat flow – thermal conductivity - Forbe's and Lee's disc method: theory and experiment - conduction through compound media (series and parallel) – thermal insulation – applications: heat exchangers, refrigerators, ovens and solar water heaters.

UNIT-III	**PHASE DIAGRAMS**	9

Solid solutions - Hume-Rothery's rules –Gibb's phase rule – unary phase diagram- binary phase diagrams - isomorphous systems - tie-line and lever rule - eutectic, eutectoid, peritectic, peritectoid, monotectic and syntectic systems - formation of microstructures-homogeneous and non-homogenous cooling – nucleation (Qualitative)– iron-carbon phase diagram - eutectoid steel – hypo-eutectoid and hyper-eutectoid steel – diffusion - Fick's laws – T-T-T diagrams.

UNIT-IV	**CRYSTAL PHYSICS**	9

Basis – lattices – unit cell-crystal systems – Bravais lattices –number of atoms, atomic radius, co-ordination number and packing fraction - SC, BCC, FCC, HCP lattices and diamond structure - polymorphism and allotropy-graphite structure - Miller indices – determination of d-space-crystal growth techniques-solution growth –melt growth-Bridgmann and Czochralski - crystal defects.

UNIT-V	**ADVANCED MATERIALS & TESTING**	9

Metallic glasses – preparation, properties and applications - Composites – types and properties - Shape memory alloys – properties and applications - Nano-materials – top down and bottom up approaches –sol-gel method-pulsed laser deposition-ball milling- properties-applications - Tensile strength – Hardness – Fatigue - Impact strength – Creep - Fracture – types of fracture.

			Contact Hours	:	45

	List of Experiments
1	Determination of Young's modulus of given material by non-uniform bending method.
2	Determination of moment of inertia of a disc and rigidity modulus of a given wire using Torsional pendulum.
3	Determination of Young's modulus of given beam by cantilever method.
4	Determination of viscosity of the given liquid using Poiseuille's method.
5	Determination of Thermal conductivity of a bad conductor – Lee's Disc method.
6	Determination of Velocity of ultrasound and compressibility of given liquid – Ultrasonic interferometer.
7	Determination of the wavelength of Laser and particle size of given powder.
8	Determination of the Hysteresis loss of ferromagnetic material by B-H curve experiment.
9	Find the thickness of a given thin wire – Air wedge method.
10	Study the characteristics of solar cell parameters.

	Contact Hours	:	30
	Total Contact Hours	:	**75**

Course Outcomes:

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

- apply the elastic nature of materials and determine the elastic moduli of different materials.
- apply the basic knowledge of crystal structure in solids.
- analyse and measure the properties of alloys.
- analyse various material testing methods and use them in suitable applications.
- understand the concepts of heat transfer in various applications.

Suggested Activities
- Problem solving sessions

Suggested Evaluation Methods
- Quizzes
- Class Presentation / Discussion

Text Book(s):

1	Bhattacharya, D.K. &Poonam, T. *"Engineering Physics"*.Oxford University Press, 2018.
2	Gaur, R.K. & Gupta, S.L. *"Engineering Physics"*.DhanpatRai Publishers, 2018.
3	Raghavan, V. *"Physical Metallurgy: Principles and Practice"*. PHI Learning, 2019.

Reference Books(s) / Web links:

1	Balasubramaniam, R. *"Callister's Materials Science and Engineering"*.Wiley India Pvt. Ltd., 2017

2	Resnick, R., Halliday, D., & Walker, J. *"Principles of Physics"*, Wiley India Pvt., 2018.
3	Raghavan, V. *"Materials Science and Engineering: A First course"*. PHI Learning, 2019.
4	https://nptel.ac.in/courses/113104068
5	https://archive.nptel.ac.in/courses/115/105/115105099/

List of Equipment Available

(Common to B.E. Aero, Auto, Civil, Mechanical, Mechatronics Engineering and R&A)

S. No	Name of the equipment	Quantity Required	Quantity Available	Deficiency
1	Young's modulus by Non - Uniform bending method Travelling Microscopes, Meter scale etc.,	6	13	-
2	Rigidity Modulus - Torsional Pendulum Setup	6	19	-
3	Velocity of sound and compressibility of liquid – Ultrasonic Interferometer	6	14	-
4	Wavelength of Laser and Characteristics -Laser source And grating plate	6	15	-
5	B-H curve Setup and CRO	6	7	-
6	Thermal conductivity of bad conductor- Lee's Disc setup	6	16	-
7	LCR circuit kit	6	7	-
8	Thickness of a thin wire-Air wedge method – Travelling microscope	6	13	-
9	Solar cell parameters setup	6	8	-
10	Poiseuille's method set up	6	10	-

CO - PO – PSO matrices of course

1: Slight (Low)

2: Moderate (Medium)

3: Substantial (High) If there is no correlation, put "- "

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	2	-	-	-	-	-	-	-	-	-	1	1	1
CO 2	3	2	1	-	-	-	-	-	-	-	-	-	-	1	-
CO 3	3	3	2	-	-	-	-	-	-	-	-	1	1	1	-
CO 4	3	2	2	-	-	-	-	-	-	-	-	1	1	1	1
CO 5	3	3	2	-	-	-	-	-	-	-	-	1	1	-	-
Average	3	2.6	1.8	-	-	-	-	-	-	-	-	1	1	1	1

Course Code	Course Name(Laboratory Course)	Category	L	T	P	C
GE23121	**ENGINEERING PRACTICES – Civil and Mechanical**	ES	0	0	2	1

Objectives:

To provide exposure to the students with hands on experience on various basic engineering practices in Civil and Mechanical Engineering.

List of Experiments
CIVIL ENGINEERING PRACTICE

1.	Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, and elbows in household fittings.
2.	Preparation of basic plumbing line sketches for wash basins, water heaters, etc.
3.	Hands-on-exercise: Basic pipe connections – Pipe connections with different joining components.

Carpentry Works:

4.	Study of joints in roofs, doors, windows and furniture.
5.	Hands-on-exercise: Woodwork, joints by sawing, planning and chiselling.

MECHANICAL ENGINEERING PRACTICE

6.	Preparation of butt joints, lap joints and T- joints by Shielded metal arc welding.
7	Gas welding practice.

Basic Machining:

8	Simple Turning and Taper turning
9	Drilling Practice

Sheet Metal Work:

10	Forming & Bending:
11	Model making – Trays and funnels
12	Different type of joints.

Machine Assembly Practice:

13	Study of centrifugal pump
14	Study of air conditioner

Total Contact Hours	**:**	**30**

Course Outcomes:	
●	Able to perform plumbing activities for residential and industrial buildings considering safety aspects while gaining clear understanding on pipeline location and functions of joints like valves, taps, couplings, unions, reducers, elbows, etc.
●	Able to perform wood working carpentry activities like sawing, planning, cutting, etc. while having clear understanding of the joints in roofs, doors, windows and furniture.
●	Able to produce joints like L joint, T joint, Lap joint, Butt joint, etc. through arc welding process while acquiring in depth knowledge in the principle of operation of welding and other accessories
●	Able to perform operations like Turning, Step turning, Taper turning, etc. in lathe and Drilling operation in drilling machine
●	Able to perform sheet metal operations like Forming, Bending, etc. and fabricating models like Trays, funnels, etc.

POS/PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	1	1	1	-	-	2	1	-	2	-	-	2	-	2	1
CO 2	1	1	1	-	-	2	1	-	2	-	-	2	-	2	1
CO 3	1	1	1	-	-	2	1	-	2	-	-	2	-	2	1
CO 4	1	1	1	-	-	2	1	-	2	-	-	2	-	2	1
CO 5	1	1	1	-	-	2	1	-	2	-	-	2	-	2	1

1: Slight (Low)   2: Moderate (Medium)   3: Substantial (High)

Course Code	Course Name(Theory course)	Category	L	T	P	C
MC23112	**ENVIRONMENTAL SCIENCE AND ENGINEERING** **Common to all branches of B.E./B.Tech. courses (Except B.Tech-CSBS)**	MC	3	0	0	0

Objectives:
To develop the understanding of environmental and associated issues
To develop an attitude of concern for the environment
To promote enthusiasm in participating environmental protection initiatives
To nurture skills to solve environmental degradation issues

UNIT-I   Air and Noise pollution

9

Definition –sources of air pollution –chemical and photochemical reactions in the atmosphere - formation of smog, PAN, acid rain, ozone depletion, particulate pollutants-Air quality standards-Air quality indices - control of particulate air pollutants-gravitational settling chambers, cyclone separators, wet collectors, fabric filters (Bag-house filter), electrostatic precipitators (ESP)-catalytic converters. Noise pollution –sources - health effects - standards- measurement and control methods.

UNIT-II   Water pollution and its management

9

Definition-causes-effects of water pollution-point and nonpoint sources of wastewater-marine pollution - thermal pollution - Control of water pollution by physical, chemical and biological methods – wastewater treatment-primary, secondary and tertiary treatment-sources and characteristics of industrial effluents- zero liquid discharge.

UNIT-III   Solid waste and Hazardous waste management

9

Solid waste – types- municipal solid waste management: sources, characteristics, collection, and transportation- sanitary landfill, recycling, composting, incineration, energy recovery options from waste - Hazardous waste – types, characteristics, and health impact - hazardous waste management: neutralization, oxidation reduction, precipitation, solidification, stabilization, incineration and final disposal. E-waste-definition-sources-effects on human health and environment- E-waste management- steps involved - Role of E-waste management within the initiatives of the Govt. of India- Swachh Bharat Mission.

UNIT-IV   **Sustainable Development**

9

Sustainable development- concept-dimensions-sustainable development goals - value education-gender equality – food security - poverty – hunger - famine - Twelve principles of green chemistry - Green technology - definition, importance - Cleaner development mechanism - carbon credits, carbon trading, carbon sequestration, eco labeling-International conventions and protocols-Disaster management.

UNIT-V   **Environmental Management and Legislation**

9

Environmental Management systems - ISO 14000 series- Environmental audit-Environmental Impact Assessment- life cycle assessment- h uman health risk assessment - Environmental Laws and Policy- Objectives - Polluter pays principle, Precautionary principle - The Environment (Protection) Act 1986 - Role of Information technologyin environment and human health.

Total Contact Hours   :   45

Course Outcomes:	
On completion of the course, the students will be able to	
CO1	associate air and noise quality standards with environment and human health.
CO2	illustrate the significance of water and devise control measures for water pollution.
CO3	analyze solid wastes and hazardous wastes.
CO4	outline the goals of sustainable development in an integrated perspective.
CO5	comprehend the significance of environmental laws.

Text Books:	
1	Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2016
2	Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6th Edition, New Age International Publishers ,2018.
3	Johri R., E-waste: implications, regulations, and management in India and current global best practices, TERI Press, New Delhi

	Reference Books
1	R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media. 38. Edition 2010.
2	Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001.
3	Fowler B, Electronic Waste – 1 st Edition (Toxicology and Public Health Issues), 2017Elsevier

Note: Enter correlation levels 1, 2 or 3 as defined below:

1: Slight (Low)   2: Moderate (Medium)   3: Substantial (High)

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PSO2	PSO3
MC23112.1	1	2	3	1	-	2	2	2	1	1	1	2			
MC23112.2	1	2	3	1	-	2	2	2	1	1	1	2			
MC23112.3	-	-	3	1	-	2	3	2	1	-	1	2			
MC23112.4	-	1	2	1	1	3	3	2	1	1	1	2			
MC23112.5	-	1	2	-	-	2	2	2	1	2	2	2			
AVG.	0.4	1.2	2.6	0.8	0.2	2.2	2.4	2	1	1	1.2	2			

	Web links:
1	https://onlinecourses.nptel.ac.in/noc19_ge22/
2	NPTEL
3	https://news.mit.edu/2013/ewaste-mit

Suggested activities
1. Case studies presentation

Method of evaluation
1. Classroom presentations on case studies (or) Site visits, instead of CAT-I (or)CAT-II or CAT III

II Semester

Course Code	Course Title	Category	L	T	P	C
MA23212	**DIFFERENTIAL EQUATIONS AND COMPLEX VARIABLES**	BS	3	1	0	4
Common to II Sem. B.E. –AERO, AUTO, BME, CIVIL, EEE, ECE, MECH, MCT, R&A **and B. Tech. - BT, FT & CHEM**						

Objectives:
● To provide students with an introduction to the theory of ordinary differential equations through applications, methods of solution, and numerical approximations.
● To introduce students to how to solve linear Partial Differential with different methods.
● To enable the students to study the Laplace Transforms, properties of Laplace Transform, inverse Laplace Transform and some applications to solve the differential equations and integral equations.
● To explain the concept of a vector integration in a plane and in space.
● To describe basic properties of complex variables and to have the ability to compute complex integrals.

UNIT-I	ORDINARY DIFFERENTIAL EQUATIONS	12
Second and higher order Linear differential equations with constant coefficients - Method of variation of parameters – Legendre's linear equations – Numerical solution of ODE - Single Step methods: Taylor's series method, Euler's method.		
UNIT-II	PARTIAL DIFFERENTIAL EQUATIONS	12
Formation of partial differential equations - Classification of PDE – Solutions of standard types of first order partial differential equations - Lagrange's linear equation –Linear homogeneous partial differential equations of second and higher order with constant coefficients.		
UNIT-III	LAPLACE TRANSFORM	12
Laplace transform –Basic properties – Transforms of derivatives and integrals of functions - Transforms of unit step function and impulse functions, periodic functions. Inverse Laplace transform – Problems using Convolution theorem – Solution of linear ODE of second order with constant coefficients using Laplace transformation techniques		
UNIT-IV	VECTOR CALCULUS	12
Gradient, divergence and curl – Directional derivative – Irrotational and Solenoidal vector fields – Vector integration – Green's theorem in a plane, Gauss divergence theorem and Stokes' theorem (excluding proofs) – Simple applications involving cubes and rectangular parallelopipeds.		
UNIT-V	COMPLEX VARIABLES	12
Analytic functions — Construction of analytic function - Bilinear transformation –Singularities – Cauchy's integral theorem (without proof) - Residues – Residue theorem (without proof) - Simple problems - Contour integral over $|z|=1$.		

Course Outcomes:
On completion of the course students will be able to
● Apply the methods as a potent tool in the solution of a variety of problems in the natural sciences and technology.
● Develop specific methodologies, techniques and resources in Partial differential equations to conduct research and produce innovative results in the area of specialisation.
● Use Laplace transform and inverse transform techniques to solve the complex problems in engineering and technology.
● Apply the concepts in multivariable analysis, including space curves; directional derivative; gradient;

	multiple integrals; line and surface integrals; vector fields; divergence, curl ; the theorems of Green and Stokes, and the divergence theorem in different fields of engineering.
●	Demonstrate the concept of Analytic functions, conformal mapping and complex integration in solving Engineering problems.
	Total Contact Hours: 60

SUGGESTED ACTIVITIES
- Problem solving sessions
- Activity Based Learning

SUGGESTED EVALUATION METHODS
- Problem solving in Tutorial sessions
- Assignment problems
- Quizzes and class test
- Discussion in classroom

Text Book(s):	
4.	Grewal B.S., " Higher Engineering Mathematics ", Khanna Publishers, New Delhi, 43rd Edition, 2014.
5.	Veerarajan. T, Engineering Mathematics –II, Mc Graw Hill Education, 2018.
6.	Erwin Kreyszig," Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2016.
7.	Glyn James, "Advanced Modern Engineering Mathematics", Pearson Education, 4th Edition, New Delhi, 2011.
8.	Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", Narosa Publications, 5 th Edition, New Delhi, 2017.

Reference Books(s) / Web links:	
1.	Ramana. B.V., "Higher Engineering Mathematics ", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
2.	T Veerarajan, Transforms and Partial Differential Equations, Third Edition, 2018.
3.	Bali, N.P. and Manish Goyal, A Text Book of Engineering Mathematics, Lakshmi Publications Pvt. Ltd., New Delhi, 4th Edition 2006.
4.	Peter V.O'Neil, "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, 7th Edition, New Delhi, 2012.

Course Code	Course Name	Category	L	T	P	C
GE23211	**Engineering Mechanics** **(Common to Mech, Aero, Auto, Civil and MCT)**	**ES**	**2**	**1**	**0**	**3**

Objectives: The students can be able to
●   To understand the basics of mechanics and apply the concept of equilibrium of system of forces.
●   To understand the concept of equilibrium and to solve problems of rigid bodies.
●   To learn about the centroid and centre of gravity of objects and moment of inertia
●   To learn the basic concepts of friction.
●   To learn the concepts in kinematics and kinetics of rigid bodies in plane motion.

UNIT-I	STATICS OF PARTICLES	9

Introduction – Units and Dimensions – Laws of Mechanics – Lami's theorem, Parallelogram and triangular Law of forces – Resolution of forces – Vector operations of forces - Coplanar Forces – rectangular components – Equilibrium of a particle – Forces in space – Equilibrium of a particle in space
– Equivalent systems of forces – Principle of transmissibility.

UNIT-II	EQUILIBRIUM OF RIGID BODIES	9

Free body diagram – Types of supports –Action and reaction forces –stable equilibrium – Moments andCouples – Moment of a force about a point and about an axis – Vectorial representation of moments and couples – Scalar components of a moment – Varignon's theorem – Single equivalent force - Equilibrium of Rigid bodies in two dimensions – Equilibrium of Rigid bodies in and three dimensions (class room lecture only) – (Descriptive treatment only)

UNIT-III	PROPERTIES OF SURFACES AND SOLIDS	12

Centroids - First moment of area – Second moment of area 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	DYNAMICS OF PARTICLES	7

Displacements, Velocity and acceleration, their relationship – Relative motion – Curvilinear motion - Newton's laws of motion – Work Energy Equation– Impulse and Momentum – Impact of elastic bodies.

UNIT-V	FRICTION AND RIGID BODY DYNAMICS	8

Friction force – Laws of sliding friction - Characteristics of dry friction – equilibrium analysis of simple systems with sliding friction –wedge friction, Ladder friction, Rolling resistance -Translation and Rotationof Rigid Bodies – Velocity and acceleration – General Plane motion of simple rigid bodies such as cylinder, disc/wheel and sphere.

	Total Contact Hours	:	45

	Course Outcomes: Upon completion of this course, the students will be able to:
CO1	Analyze the forces in the system and to understand vectorial and scalar representation of forces and moments
CO2	Study about the rigid body in equilibrium and to analyze the problems in engineering systems using the concept of static equilibrium
CO3	Determine the properties of surfaces and solids by means of finding centroid , centre of gravity and moment of inertia.
CO4	Solve problems involving kinematics and kinetics of rigid bodies in plane motion.
CO5	Solve problems involving frictional phenomena in machines by understanding the concept of friction and the effects by the laws of friction

Text Books:	
1	Beer, F.P and Johnston Jr. E.R, Cornwell and Sanghi ., "Vector Mechanics for Engineers (In SI Units): Statics and Dynamics", 12th Edition, McGraw-Hill Publishing company, New Delhi (2018).
2	Rajasekaran S and Sankarasubramanian G., "Engineering Mechanics Statics and Dynamics", 3rd Edition, Vikas Publishing House Pvt. Ltd., 2005.

Reference Books(s) / Web links:	
1	Meriam J.L. and Kraige L.G., "Engineering Mechanics- Statics - Volume 1, Dynamics- Volume 2", 7th Edition, Wiley India, 2018.
2	Hibbeller, R.C and Ashok Gupta, "Engineering Mechanics: Statics and Dynamics", 14th Edition, Pearson Education 2017.
3	Irving H. Shames and Krishna Mohana Rao. G., "Engineering Mechanics – Statics and Dynamics" 4th Edition, Pearson Education 2006.
4	Bhavikatti S S, Engineering Mechanics, New Age International Publishers, 2016
5	Vela Murali, "Engineering Mechanics", Oxford University Press 2010
6	Palanichamy M S, Nagan S, Elango P, Engineering Mechanics: Dynamics, Tata McGraw-Hill Publishing Company Limited, 2004

CO & PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	1	2	-	-	1	-	2	1	3	2	3	-	3
CO 2	3	3	1	2	-	-	1	-	2	1	3	2	3	-	3
CO 3	3	3	1	2	-	-	1	-	1	1	3	2	3	-	3
CO 4	3	3	1	2	-	-	1	-	3	1	3	2	3	-	3
CO 5	3	3	1	2	-	-	1	-	3	1	3	2	3	-	3

1: Slight (Low)   2: Moderate (Medium)   3: Substantial (High)

GE23217   **தமிழரும் தொழில்நுட்பமும்**   **L T P C**

                                                                1 0 0 1

அலகு I   நெசவு மற்றும் பானைத் தொழில்நுட்பம்:   3

சங்க காலத்தில் நெசவுத் தொழில் - பானைத் தொழில்நுட்பம் - கருப்பு சிவப்பு பாண்டங்கள் - பண்டங்களில் கீறல் குறியீடுகள்.

அலகு II   வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்:   3

சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப்பொருட்களில் வடிவமைப்பு - சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் - சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் - மாமல்லபுரச் சிற்பங்களும், கோவில்களும் - சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் - நாயக்கர் காலக் கோயில்கள் - மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் - செட்டிநாடு வீடுகள் - பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ - சாரோசெனிக் கட்டிடக் கலை.

அலகு III   உற்பத்தித் தொழில் நுட்பம்:   3

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

அலகு IV   வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்:   3

அணை, ஏரி, குளங்கள், மதகு - சோழர்காலக் குமுழித் தூம்பின் முக்கியத்துவம் - கால்நடை பராமரிப்பு - கல்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் - வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் - கடல்சார் அறிவு - மீன்வளம் - முத்து மற்றும் முத்துக்குளித்தல் - பெருங்கடல் குறித்த பண்டைய அறிவு - அறிவுசார் சமூகம்.

அலகு V   அறிவியல் தமிழ் மற்றும் கணித்தமிழ் :   3

அறிவியல் தமிழின் வளர்ச்சி - கணித்தமிழ் வளர்ச்சி - தமிழ் நூல்களை மின்பதிப்பு செய்தல் - தமிழ் மென்பொருட்கள் உருவாக்கம் - தமிழ் இணையக் கல்விக்கழகம் - தமிழ் மின் நூலகம் - இணையத்தில் தமிழ் அகராதிகள் - சொற்குவைத் திட்டம்.

                                                      TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

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

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

3. கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)

4. பொருநை - ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)

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

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

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

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

9. Keeladi – 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

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

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

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

<div align="center">

ENGINEERING CHEMISTRY

</div>

Course Code	Course Name(Theory Laboratory embedded course)	Category	L	T	P	C
CY23233	**ENGINEERING CHEMISTRY**	BS	3	0	2	4
Common to	**B.E. – AERONAUTICAL, AUTOMOBILE, MECHANICAL and CIVIL ENGG.**					

Objectives:

- To understand the types of corrosion and its prevention

- To develop an understanding of the basic concepts of phase rule and its applications
- To provide a brief outline of polymers and composites in mechanical sciences

- To interpret the different types of batteries and fuel cells

- To provide an insight on nanomaterials and lubricants

UNIT-I   CORROSION SCIENCE AND CONTROL   9

Corrosion: Introduction- chemical and electrochemical theory of corrosion- types of corrosion- galvanic, differential aeration (waterline and pitting) and stress corrosion (caustic embrittlement)- corrosion penetration rate (CPR).
Corrosion control: Cathodic protection- Metallic coatings- Electroplating- electroplating of chromium (hard and decorative)- Electroless plating-electroless plating of nickel- Chemical conversion coatings-Organic coatings-paints-constituents-functions - special paints.

UNIT-II   PHASE RULE AND THERMAL ANALYSIS   9

Phase rule - Introduction, definition of terms - phase, components and degree of freedom - phase diagram- one component system -water system - reduced phase rule - thermal analysis and cooling curves - two component systems - lead-silver system. Alloys - significance of alloying - heat treatment of steel.
Thermal analysis - Thermogravimetric analysis- Differential thermal analysis- Differential scanning calorimetry- instrumentation (block diagram) and applications.

UNIT-III   POLYMERS AND COMPOSITES   9

Plastics - Types-preparation, properties and uses of Teflon, polycarbonate and PMMA
Rubbers - Types-vulcanization-synthetic rubber-Buna N rubber, Butyl rubber.
Composite Materials - Introduction-Types– MMC, CMC and PMC-Fiber-Reinforced composites-preparation, properties, and applications.

UNIT-IV   FUELS AND ENERGY STORAGE DEVICES   9

Fuels - Introduction, calorific value- numerical problems GCV and NCV-Green fuels-Introduction, synthesis and applications of power alcohol and biodiesel-High energy fuels-Production of hydrogen by electrolysis of water and its advantages.
Energy devices - Electrode potential-electrochemical series - construction, working and applications of lead acid battery, Lithium-ion battery-Fuel Cell-Hydrogen-Oxygen (H_2-O_2) fuel cell, proton exchange membrane and solid oxide fuel cells.

UNIT-V   NANOMATERIALS AND LUBRICANTS   9

Nanomaterials - Introduction, size-dependent properties - Synthesis of Nanomaterials-sol-gel, precipitation, hydrothermal and solvothermal methods - Carbon based nano materials - Introduction to CNT, Graphene and Fullerenes- synthesis, properties and applications of CNT.
Lubricants: Classification- properties of lubricants- mechanism of lubrication- additives to lubricants- solid lubricants (graphite and MoS_2).

                                                          Total Contact Hours:45

Description of the Experiments   **Total Contact**
                                                          Hours:30

1. Estimation of the acid by pH metry

2. Determination of corrosion rate on mild steel by weight loss method

3. Estimation of mixture of acids by conductometry

4. Estimation of extent of corrosion of Iron pieces by potentiometry

5. Determination of flash and fire points of lubricating oil

6. Determination of cloud and pour points of lubricating oil

7. Determination of molecular weight of a polymer by viscometry method

8. Synthesis of nanomaterials by simple precipitation method

9. Determination of phase change temperature of a solid

10. Determination of strength of an acid in Pb acid battery

11. Synthesis of biodiesel

12. Determination of acid value of biofuel

Course Outcomes: At the end of the course the student will be able to:

CO1: explain and the fundamental concepts of corrosion, its control and surface modification methods such as electroplating and electroless plating
CO2: apply the concept of phase rule in alloying and predict its thermal properties

CO3: identify the different types of plastics and composite materials of industrial importance
CO4: categorize the types of fuels and the energy storage devices

CO5: synthesize nanomaterials for modern engineering and technology

SUGGESTED ACTIVITIES

- Electroplating of desired metal on substrate.
- Synthesis of boidiesel

SUGGESTED EVALUATION METHODS

- Continuous assessment tests

- Assignments

- Model lab examination

- End semester examination

Text Book(s):

1. P. C. Jain and Monika Jain, "Engineering Chemistry", 17th Edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2018.

2. O.G.Palanna, "Engineering Chemistry", McGraw Hill Education (India) Pvt, Ltd, New Delhi, 2nd Edition, 2017.

3. Shikha Agarwal "Engineering Chemistry-Fundamentals and applications", Cambridge University Press, New Delhi, 2019

Reference Books(s)

- Polymer Science, V R Gowariker, N V Viswanathan, Jayadev, Sreedhar, Newage Int. Publishers,4th Edition, 2021

- A Text Book Engineering Chemistry, Sunita Rattan, S.K. Kataria & Sons, 1st 2018

- A Text Book of Engg. Chemistry, Shashi Chawla, Dhanpat Rai & Co. (P) Ltd.2011

- PradeepT, "A Text Book of Nanoscience and Nanotechnology", Tata McGraw Hill, New Delhi, 2012

- Laboratory Manual Engg. Chemistry, Anupma Rajput, Dhanpat Rai & Co

Weblinks

- **http://libgen.rs/**
- https://nptel.ac.in/courses/104/103/104103019/
- https://ndl.iitkgp.ac.in/
- https://www.youtube.com/watch?v=j5Hml6KN4TI
- https://www.youtube.com/watch?v=1xWBPZnEJk8

Lab equipment required:

S. No	Name of the Equipment	Quantity Required	Remarks
1.	Conductivity meter	10	
2.	Potentiometer	10	
3	pH meter	10	
4	Magnetic stirrer with hot plate	1	
5	Flash and Fire point apparatus	2	
6	Cloud and pour point apparatus	2	

CO - PO – PSO matrices of course

1: Slight (Low)

2: Moderate (Medium)

3: Substantial (High) If there is no correlation, put "-"

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO. 1	2	2	1	-	-	1	1	-	-	-	-	1			
CO.2	3	1	1	-	-	-	-	-	-	-	-	1			
CO.3	2	2	2	-	-	-	-	-	-	-	-	1			
CO.4	2	1	1	-	-	-	-	-	-	-	-	1			
CO.5	3	2	2	-	-	-	-	-	-	-	-	1			
AVG.	2.4	1.6	1.4	-	-	1`	1	-	-	-	-	1			

SUGGESTED EVALUATION METHODS

- Experiment based viva
- Quizzes

Web links for virtual lab (if any)

https://drive.google.com/drive/folders/1k8g7fGRJ0Dl8FPbjQYg4l5jS1U9qIXnJ

Course Code	Course Name(Lab oriented Theory Courses)	Category	L	T	P	C

EE23133	BASIC ELECTRICAL AND ELECTRONICS ENGINEERING	ES	3	0	2	4

Objectives:

- To provide knowledge on the analysis of DC circuits.
- To provide knowledge on the analysis of AC circuits
- To expose the principles of electrical machines and electronic devices.
- To teach the concepts of different types of electrical measuring instruments and transducers.
- To experimentally analyze the electrical circuits and machines, electronic devices and transducers.

UNIT-I	DC CIRCUITS	9

Electrical circuit elements (R, L and C), Voltage and current sources, Kirchhoff 's laws, Analysis of simple circuits with DC excitation, Superposition, Thevenin and Norton Theorems.

UNIT-II	AC CIRCUITS	9

Representation of sinusoidal waveforms, Power and Power factor, Analysis of single-phase AC circuits consisting of R, L, C, RL, RC, RLC combinations, Series resonance, Three phase balanced circuits

UNIT-III	ELECTRICAL MACHINES	9

Construction, Principles of operation of DC machines, Single phase Transformers, Synchronous machines, Single phase induction motors. (Qualitative Treatment Only).

UNIT-IV	ELECTRONIC DEVICES & CIRCUITS	9

Review of PN Junction diode – Forward and Reverse Bias – Bipolar Junction Transistor – Common Emitter characteristics – MOSFET - Introduction to operational Amplifier –Inverting and Non-Inverting Amplifier.

UNIT-V	MEASUREMENTS & INSTRUMENTATION	9

Introduction to transducers - Classification of Transducers: Resistive, Inductive, Capacitive, Piezoelectric, - Classification of instruments - PMMC and MI Ammeters and Voltmeters – Digital Storage Oscilloscope.

	Contact Hours	:	45

List of Experiments	
1	Verification of Kirchhoff's Laws.
2	Load test on DC Shunt Motor (Virtual Lab)
3	Load test on Single phase Transformer (Virtual Lab)
4	Load test on Single phase Induction motor (Virtual Lab)
5	Characteristics of P-N junction Diode.
6	Characteristics of CE based NPN Transistor.
7	Characteristics of MOSFET
8	Characteristics of LVDT, RTD and Thermistor.

	Contact Hours	:	30
	Total Contact Hours	:	75

Course Outcomes:

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

- analyse DC circuits and apply circuit theorems.
- calculate the power and power factor in AC circuits
- understand the principles of electrical machines.
- comprehend the principles of different types of electronic devices, electrical measuring instruments and transducers.
- experimentally analyze the electric circuits and machines, electronic devices, and transducers.

Suggested Activities

- Problem solving sessions

Suggested Evaluation Methods

- Quizzes
- Class Presentation / Discussion

Text Book(s):

1	J.B.Gupta, "Fundamentals of Electrical Engineering and Electronics" S.K.Kataria & Sons Publications, 2010.
2	Joseph A. Edminister, Mahmood, Nahri, "Electric Circuits" – Shaum Series and Systems", Schaum"s Outlines, Tata McGrawHill, Indian. 5th Edison , 2017
3	Thereja .B.L., "Fundamentals of Electrical Engineering and Electronics", S. Chand & Co. Ltd., 2008

Reference Books(s) / Web links:

1	Del Toro, "Electrical Engineering Fundamentals", Pearson Education, New Delhi, 2015
2	John Bird, "Electrical Circuit Theory and Technology", Elsevier, First Indian Edition, 2007
3	Allan S Moris, "Measurement and Instrumentation Principles", Elseveir, Third Edition, 2006
4	Rajendra Prasad, "Fundamentals of Electrical Engineering", Prentice Hall of India, Third Edition, 2014
5	A.E.Fitzgerald, David E Higginbotham and Arvin Grabel, "Basic Electrical Engineering", McGraw Hill Education(India) Private Limited, 2009

6	D P Kothari and I.J Nagarath, "Basic Electrical and Electronics Engineering", McGraw Hill Education(India) Private Limited, Third Reprint ,2016
7	https://nptel.ac.in/courses/108108076

Lab Equipment Required:

Sl. No.	Name of the Equipment	Quantity Required (For a batch of 30 students)
1.	**Verification of ohms and Kirchhoff's Laws** 1. DC Regulated Power supply (0 - 30 V variable) 2. Bread Board 3. Resistors 4. Multimeter 5. Connecting wires	1 1 As per Circuit diagram1 As Required
2.	**Load test on DC Shunt Motor.** 1. Ammeter MC (0-20A) 2. Voltmeter MC (0-300)V 3. Tachometer 4. Field Rheostat 500 Ω, 1.5 A 5. Connecting wires	1 1 1 1 As Required
3.	**Load Test on Induction Motor** 1. Ammeter MI (0-20A) 2. Voltmeter MI (0-300)V 3. Wattmeter – 300V, 30 A 4. Tachometer – Digital 5. Connecting Wires 6. Single phase Induction motor	1 1 1 1 As Required1
4.	**Load test on Single phase Transformer** 1. Ammeter (0-30) A, (0-5) A 2. Voltmeter (0-150)V, (0-300)V 3. Wattmeter – 300V, 5A, UPF 4. Autotransformer 5. Single phase Transformer 6. Connecting Wires	**1** **1** **1** **1** **1** As Required
5.	**Characteristics of PN and Zener Diodes** 1. PN Diode (IN4007), Zener diode (6.8V, 1A) 2. Resistor 1 KΩ, 100Ω 3. Bread Board 4. DC Regulated Power supply (0 - 30 V variable) 5. Multimeter 6. Connecting wires	1 1 1 1 1 As Required
6.	**Characteristics of BJT** 1. Transistor (BC107) 2. Resistors- 1kΩ, 470KΩ, 1MΩ 3. Bread Board 4. DC Regulated Power supply (0 - 30 V variable) 5. Multimeter 6. Connecting wires	1 1 1 1 1 As Required

7	**Characteristics of MOSFET** 1. MOSFET (IRF510) 2. Resistors- 100kΩ, 1kΩ 3. Bread Board 4. DC Regulated Power supply (0 - 30 V variable) 5. Multimeter 6. Connecting wires	1 1 1 1 1 As Required
7.	**Measurement of displacement of LVDT, RTD and Thermistor** 1. LVDT Kit 2. RTD 3. Thermistor 4. Multimeter	1 1 1 1 1

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	3	3		3	1	1	2	1	1	1			
CO 2	3	3	3	3		3	1	1	2	1	1	1			
CO 3	3	3	3	3		3	1	1	2	1	1	1			
CO 4	3	3	3	3		3	1	1	2	1	1	1			
CO 5	3	3	3	3		3	1	1	2	1	1	1			
Average	**3**	**3**	**3**	**3**		**3**	**1**	**1**	**2**	**1**	**1**	**1**			

Course Code	SubjectName(LaboratoryCourse)	Category	L	T	P	C
GE23231	**PROGRAMMING USING PYTHON** Common to all branches of B. E. / B.Tech program (Except–CSE, CSBS, CSD, IT, AI/ML, CYBER SECURITY, AI/DS)	ES	1	0	4	3

Course Objectives:

- To understand computers, programming languages and their generations and essential skills for a logical thinking for problem solving.
- To write, test, and debug simple Python programs with conditionals, and loops and functions
- To develop Python programs with defining functions and calling them
- To understand and write python programs with compound data-lists, tuples, dictionaries
- To search, sort, read and write data from /to files in Python.

List of Experiments
1. Study of algorithms, flowcharts and pseudocodes.
2. Introduction to Python Programming and Python IDLE/Anaconda distribution.
3. Experiments based on Variables, Data types and Operators in Python.
4. Coding Standards and Formatting Output.
5. Algorithmic Approach: Selection control structures.
6. Algorithmic Approach: Iteration control structures.
7. Experiments based on Strings and its operations.
8. Experiments based on Lists and its operations.
9. Experiments based on Tuples and its operations.
10. Experiments based on Sets and its operations.
11. Experiments based on Dictionary and its operations.
12. Functions: Built-in functions.
13. Functions: User-defined functions.
14. Functions: Recursive functions.
15. Searching techniques: Linear and Binary.
16. Sorting techniques: Bubble and Merge Sort.
17. Experiments based on files and its operations.

	Contact Hours	:	75

Course Outcomes:

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

- Understand the working principle of a computer and identify the purpose of a computer programming language and ability to identify an appropriate approach to solve the problem.
- Write, test, and debug simple Python programs with conditionals and loops.
- Develop Python programs step - wise by defining functions and calling them.
- Use Python lists, tuples, dictionaries for representing compound data.
- Apply searching, sorting on data and efficiently handle data using flat files.

TextBooks:

1. Allen B. Downey, Think Python:How to Think Like a Computer Scientist, Second edition,UpdatedforPython3, Shroff/ O'Reilly Publishers, 2016 (http://greenteapress.com/wp/think-python/)

2. Guido Van Rossum and Fred L. Drake Jr, An Introduction to Python-Revised and updated for Python3.2, Network Theory Ltd., 2011.

ReferenceBooks:

1. JohnVGuttag, Introduction to Computation and Programming Using Python, Revised and expanded Edition, MIT Press,2013.

2. Robert Sedgewick, Kevin Wayne, Robert Dondero, Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt.Ltd., 2016.

3. Timothy A.Budd, Exploring Python, Mc-Graw Hill Education(India)PrivateLtd.,2015.

4. Kenneth A. Lambert, Fundamentals of Python: First Programs, CengageLearning,2012.

5. Charles Dierbach, Introduction to Computer Science using Python: A Computational Problem Solving Focus, Wiley India Edition,2013.

6. Paul Gries, Jennifer Campbell and Jason Montojo, Practical Programming: An Introduction to Computer Science using Python3, Second edition, Pragmatic Programmers, LLC, 2013.

CO -PO–PSO matrices of course

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
GE19211.1	2	2	2	2	1	-	-	-	1	1	1	1	3	3	-
GE19211.2	2	1	1	1	1	-	-	-	-	-	1	1	3	2	-
GE19211.3	1	1	2	1	2	-	-	-	-	-	1	1	2	3	2
GE19211.4	2	2	3	2	2	-	-	-	-	-	2	1	2	2	2
GE19211.5	2	2	3	2	3	-	-	-	-	-	2	1	2	2	2
Average	1.8	1.6	2.2	1.6	1.8	0.0	0.0	0.0	0.2	0.2	1.4	1	2.4	2.4	2

1:Slight(Low)   **2:Moderate(Medium)**   **3:Substantial(High)**

Course Code	Course Name(Theory course)	Category	L	T	P	C
HS 23221	Technical Communication II	HS	0	0	2	1
	Common to all branches of B.E/B. Tech programmes –Second Semester					

Objectives:
• To facilitate students to improve their vocabulary for a better communication
• To enable learners to understand and reproduce language
• To aid students to write technical reports in a convincing manner
• To expose students to different sentence structures
• To equip learners to present their ideas in an efficient manner

UNIT-I	VOCABULARY FOR BETTER COMMUNICATION	6

Listening: Telephonic Conversations and TV News
Reading: Newspapers and Magazines
Speaking: Conversational Practice: Speaking in a given situation, Asking permission and requesting etc..,
Writing: Job Application Letter and Resume
Grammar: Reference words: pronouns and determiners
Vocabulary: Guessing meanings of words in different contexts.

UNIT-II	FUNCTIONAL LANGUAGE ASPECTS	6

Listening: Motivational listening – listening to real life challenges
Reading: Articles and Technical reports
Speaking: Using Polite Expressions, Indirect Questions
Writing: Paraphrasing a Text, Poem
Grammar: Purpose Statements, Cause and Effect Expressions
Vocabulary: Neologisms.

UNIT-III	TECHNICAL REPORTWRITING	6

Listening: Empathetic Listening – Giving Solutions to Problems
Reading: Inferential Reading
Speaking: Dialogues – Interviewing Celebrities / Leaders / Sportspersons, etc..,
Writing: Report Writing
Grammar: Functional Usage of Expressions – used to, gone / been, etc..,
Vocabulary: Words Often Confused

UNIT-IV	STRUCTURAL GRAMMAR	6

Listening: Comprehension (IELTS practice tests)
Reading: Intensive Reading for specific information
Speaking: Pick and Talk
Writing: Proposals
Grammar: Sentence Structures – Simple, Compound, Complex Sentences
Vocabulary: Replacing dull words with vivid ones

UNIT-V	PRESENTATION SKILLS	6

Listening: Discriminative listening – sarcasm, irony, pun, etc..,
Reading: Practice of chunking – breaking up reading materials
Speaking: Mini presentation on some topic
Writing: Minutes of the meeting
Grammar: Correction of Errors
Vocabulary: Advanced vocabulary – fixing appropriate words in the given context.

	Total Contact Hours: 30

Course Outcomes:
On completion of the course students will be able to
• communicate effectively using appropriate vocabulary
• use the acquired language skills to comprehend various types of language contents
• evaluate different texts and write effective technical content
• use appropriate sentence structures to convey their thoughts in varied contexts
• present their concepts and ideas in an effective manner

SUGGESTED ACTIVITIES

- Story Lines
- One truth and two lies
- Hang Man
- Pictionary
- Word Scramble
- Case study

SUGGESTED EVALUATION METHODS
- Assignment topics
- Quizzes
- Class Presentation/Discussion
- Continuous Assessment Tests

Text Book(s):
5. Raymond Murphy, "Intermediate English Grammar," Second Edition , Cambridge University Press, 2018
6. Meenakshi Raman & Sangeeta Sharma, "Technical Communication" Third Edition, Oxford University Press, 2015
7. Teaching Speaking: A Holistic Approach, Book by Anne Burns and Christine ChuenMeng Goh, Cambridge University Press

Reference Books(s) / Web links:
1. Michael McCarthy (Author), Felicity O'Dell (Author), John D. Bunting (Contributor), "Basic Vocabulary in Use: 60 Units of Vocabulary Practice in North American English With Answers" 2nd Edition
2. Dale Carnegie, "The Art of Public Speaking," Insight Press
3. Jack C. Richards & Theodore S. Rodgers, " Approaches and Methods in Language Teaching, Second Edition, Cambridge University Press

Course	Course Name	Category	L	T	P	C

Code						
HS 23222	English for Professional Competence Common to all branches of B.E/B. Tech programmes – Second Semester	HS	0	0	2	1

Objectives:

- To facilitate the learners in acquiring listening and reading competence

- To enable the learners to communicate effectively through written and oral medium

- To assist the learners in preparing for competitive examinations

- To train the students in acquiring corporate skills

- To inculcate professional standards among the students and make them realize their responsibility in addressing the challenges

UNIT-I	RECEPTIVE SKILLS	6

Listening – Comprehensive Listening – Watching the news – Listening to a peer giving presentation, etc. – Critical Listening – Watching a televised debate, Listening to poems – **Reading** – Extensive Reading – Short stories and One-act Plays – Intensive Reading – Articles or Editorials in Magazines, Blog posts on topics like science and technology, arts, etc.

UNIT-II	PRODUCTIVE SKILLS	6

Speaking – Demonstrative Speaking – Process description through visual aids – Persuasive Speaking – Convincing the listener with the speaker's view – **Writing** – Descriptive Writing - Describing a place, person, process – Subjective Writing – Autobiography, Writing based on personal opinions and interpretations

UNIT-III	ENGLISH FOR COMPETITIVE EXAMS	6

An introduction to International English Language Testing System (IELTS) – Test of English as a Foreign Language (TOEFL) – Graduate Record Examination (GRE) – Civil Service, Indian Economic Service Examination, Indian Statistical Service Examination, Combined Defence Services Examination, Staff Selection- (Language Related) – Aptitude tests.

UNIT-IV	CORPORATE SKILLS	6

Critical Thinking and Problem Solving – Case Study, Brainstorming, Q & A Discussion –

Team work and Collaboration – Activities like Office Debates, Perfect Square, Blind Retriever, etc. – **Professionalism and Strong Work Ethics** – Integrity, Resilience, Accountability, Adaptability, Growth Mind set

UNIT-V	PROJECT WORK	6

Case Study based on the challenges faced by the employers and the employees – Devise Plan, Provide Solution

	Total Contact Hours		30

Course Outcomes:

On completion of the course, students will be able to

- interpret and respond appropriately in the listening and reading contexts.
- express themselves effectively in spoken and written communication
- apply their acquired language skills in writing the competitive examinations
- exhibit their professional skills in their work place
- identify the challenges in the work place and suggest strategies solutions

SUGGESTED ACTIVITIES

- Online Quizzes on Vocabulary
- Online Quizzes on grammar
- Communication Gap Exercises
- Presentations
- Word Building Games
- Case study

SUGGESTED EVALUATION METHODS

- Assignment topics
- Quizzes
- Class Presentation/Discussion
- Continuous Assessment Tests

Reference Books	
1	How to Read Better & Faster, Norman Lewis, Goyal Publishers
2	Teaching Speaking: A Holistic Approach, Book by Anne Burns and Christine Chuen Meng Goh, Cambridge University Press

3	The Official Cambridge Guide To IELTS by Pauline Cullen, Cambridge University Press
4	The 7 Habits of Highly Effective People by Stephen Covey, Simon and Schuster, UK

Reference Books(s) / Web links:

1. Board of Editors. Sure Outcomes. A Communication Skills Course for Undergraduate Engineers and Technologists. Orient Black Swan Limited, Hyderabad, 2013.

2. Hartley, Mary. "The Power of Listening," JaicoPublishing House; First Edition (2015).

3. Chambers, Harry. "Effective Communication Skills for Scientific and Technical Professionals," Persues Publishing, Cambridge, Massachusetts, 2000.

Course Code	Course Name	Category	L	T	P	C
GE23122	**ENGINEERING PRACTICES - ELECTRICAL AND**	**ES**	**0**	**0**	**2**	**1**

	ELECTRONICS				

Objectives:

•	To provide hands-on experience on various basic engineering practices in Electrical Engineering.
•	To provide hands-on experience on various basic engineering practices in Electronics Engineering.

List of Experiments

A. ELECTRICAL ENGINEERING PRACTICE

1	Residential house wiring using switches, fuses, indicators, lamp and energy meter.
2	Fluorescent lamp wiring.
3	Stair case wiring.
4	Measurement of electrical quantities – voltage, current, power & power factor in RL circuit.
5	Measurement of earth resistance using Megger.
6	Study of Ceiling Fan and Iron Box

B. ELECTRONICS ENGINEERING PRACTICE

1	Study of electronic components and equipment – Resistor, colour coding, measurement of AC signal parameters (peak-peak, rms period, frequency) using CRO/DSO.
2	(a) Measurement of electrical quantities using Multimeter (b) Testing of electronic components.
3	Study of logic gates : AND, OR, EXOR and NOT.
4	Generation of Clock Signals.
5	Soldering practice – Components Devices and Circuits – Using general purpose PCB.
6	Measurement of ripple factor of Half-wave and Full-wave Rectifiers.

	Total Contact Hours	**:**	**30**

Course Outcomes:

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

•	fabricate the basic electrical circuits
•	implement the house wiring circuits
•	fabricate the electronic circuits
•	verify the truth table of logic gates
•	design the Half-wave and Full-wave Rectifiers using diodes and passive components

SUGGESTED EVALUATION METHODS

- ● Experiment based Viva

REFERENCE

1	Bawa H.S., "Workshop Practice", Tata McGraw – Hill Publishing Company Limited, 2007.

2	Jeyachandran K., Natarajan S. & Balasubramanian S., "A Primer on Engineering Practices Laboratory", Anuradha Publications, 2007.
3	Jeyapoovan T., Saravanapandian M. &Pranitha S., "Engineering Practices Lab Manual",Vikas Publishing House Pvt.Ltd, 2006.
4	Rajendra Prasad A. &Sarma P.M.M.S., "Workshop Practice", SreeSai Publication, 2002.

Lab Equipment Required:

S.	Name of the Equipment	Quantity Required
1	Residential house wiring using switches, fuse, indicator, lamp and energy	3 Nos
2	Fluorescent lamp wiring.	3 Nos
3	Stair case wiring	3 Nos
4	Measurement of electrical quantities – voltage, current, power & power	2 Nos
5	Study purpose items: Iron box, Ceiling fan.	2 each
6	Megger (250V/500V)	2 Nos.
7	Soldering guns	10 Nos.
8	Assorted electronic components for making circuits	50 Nos.
9	Small PCBs	10 Nos.
10	Multimeters	10 Nos.
11	Digital trainer kit	5 Nos.
12	CRO	8 Nos.
13	Transformer	8 Nos.
14	Function Generator	8 Nos.

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	3	2	-	-	2	-	3	2	-	3			
CO 2	3	3	2	2	-	-	2	-	3	2	-	3			
CO 3	3	3	3	2	-	-	2	-	3	2	-	3			
CO 4	3	3	3	2	-	-		-	3	2	-	3			
CO 5	3	3	3	2	-	-		-	3	2	-	3			
Average	3	3	2.67	2	-	-	2	-	3	2	-	3			

Course Code	Course Name(Theory course)	Category	L	T	P	C
MC23111	Indian Constitution and Freedom Movement	MC	3	0	0	0
	Common to all branches of B.E/B. Tech Programmes – First / Second/third Semester					

Objectives:
- To apprehend the sacrifices made by the freedom fighters.
- To inculcate the values enshrined in the Indian constitution.
- To instil a sense of responsibility as the citizens of India.
- To familiarise about the functions of the various levels of Government.
- To be informed about Constitutional and Non- Constitutional bodies.

UNIT-I	INDIAN FREEDOM MOVEMENT	9

British Colonialism in India-Colonial administration till 1857- Revolt of 1857- Early Resistance to British Rule-Rise of Nationalism in India-**Indian Freedom Struggle under Mahatma Gandhi-**Non- Cooperation Movement-Civil Disobedience Movement- Quit India Movement-British Official response to National movement- Independence of India Act 1947-Freedom and Partition.

UNIT-II	CONSTITUTION OF INDIA	9

Historical Background – Indian Constitution: Constitution' meaning of the term, Sources and constitutional history, Constituent Assembly of India – Philosophical foundations of the Indian Constitution – Preamble – Fundamental Rights – Directive Principles of State Policy – Fundamental Duties – Citizenship – Constitutional Remedies for citizens.

UNIT-III	STRUCTURE AND FUNCTIONS OF CENTRAL GOVERNMENT	9

Union Government – Structure of the Union Government and Functions – President – Vice President – Prime Minister – Cabinet – Parliament – Supreme Court of India – Judicial Review.

UNIT-IV	STRUCTURE AND FUNCTION OF STATE GOVERNMENT AND LOCAL BODY	9

State Government – Structure and Functions – Governor – Chief Minister – Cabinet – State Legislature – Judicial System in States – High Courts and other Subordinate Courts- Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation, Pachayati Raj: Introduction, Elected officials and their roles, Village level: Role of Elected and Appointed officials.

UNIT-V	CONSTITUTIONAL FUNCTIONS AND BODIES	9

Indian Federal System – Centre – State Relations – President's Rule – Constitutional Functionaries – Assessment of working of the Parliamentary System in India- CAG, Election Commission, UPSC, GST Council and other Constitutional bodies-. NITI Aayog, Lokpal, National Development Council and other Non –Constitutional bodies.

Total Contact Hours: 45

Course Outcomes: Upon completion of the course, students will be able to:
- appreciate the sacrifices made by freedom fighters during freedom movement.
- be responsible citizens and abide by the rules of the Indian constitution.
- be aware of the functions of the Indian government.
- be knowledgeable about the functions of the state Government and the Local bodies.
- apply the knowledge on constitutional functions and role of constitutional bodies and non-constitutional bodies.

SUGGESTED ACTIVITIES

- Famous speeches from around the world relating to independence
- Case study
- Quiz on Portfolio and Cabinet
- Discussions on International Associations like the UN, BRICS, QUAD
- Presentation on issues around the world

SUGGESTED EVALUATION METHODS

- Assignment topics
- Quizzes
- Class Presentation/Discussion

- Continuous assessments (CAT)

Text Book(s):

8. M. Laxmikanth , "Indian Polity:, McGraw-Hill, New Delhi.
9. Durga Das Basu, "Introduction to the Constitution of India ", Lexis Nexis, New Delhi. 21sted 2013.
10. P K Agarwal and K N Chaturvedi ,PrabhatPrakashan, New Delhi, 1sted , 2017.

Reference Books(s) / Web links:

1. Sharma, Brij Kishore, "Introduction to the Constitution of India:, Prentice Hall of India, New Delhi.
2. U.R.Gahai, "Indian Political System ", New Academic Publishing House, Jalaendhar
3. Bipan Chandra, India's Struggle for Independence, Penguin Books, 2016.
4. Maciver and Page, "Society: An Introduction Analysis ", Mac Milan India Ltd., New Delhi.2nded, 2014.
5. Bipan Chandra,   History of Modern India, Orient Black Swan, 2009.

III Semester

Subject Code	Course Name(Lab oriented Theory Courses)	Category	L	T	P	C
AT23331	**AUTOMOTIVE ENGINES**	PC	3	0	2	4

OBJECTIVES:

1. To understand the basic principles, construction and working of IC engines

2. To understand the concept & working of various fuels systems employed in IC engines

3. To understand the combustion and combustion chamber types in IC engines.

4. To understand the concept of turbocharging, supercharging, and engine testing

5. To understand the requirements and types of cooling and lubrication systems in IC engines

UNIT I	**CONSTRUCTION AND OPERATION**	9

Classification of IC engines, Constructional details of spark ignition (SI) and compression ignition (CI) engines. Working principles. Two stroke SI and CI engines – construction and working. Comparison of SI and CI engines and four stroke and two stroke engines. Firing order. Cam shaft and Valve train actuation mechanisms, Variable valve timing (VVT). Air Standard Otto, diesel, dual and Brayton cycles.

UNIT II	**FUEL SYSTEMS**	9

Air fuel ratio requirements of SI engines, Air fuel ratio and emissions, Working of a simple carburettor, Throttle body injection, MPFI and GDI system. Diesel fuel injection systems-Jerk pumps, distributor pumps, pintle and multi-hole nozzles, Unit injector and common rail injection systems. Injection pumps calibration. Need for a governor for diesel engines. Description of a simple diesel engine governor.

UNIT III	**COMBUSTION AND COMBUSTION CHAMBERS**	9

Introduction to combustion in SI and diesel engines and stages of combustion. Dependence of ignition timing on load and speed. Knock in SI and CI engines. Combustion chambers for SI and CI engines. Direct and indirect injection combustion chambers for CI engines. Importance of Swirl, squish and turbulence. Factors controlling combustion chamber design.

UNIT IV	**SUPERCHARGING, TURBOCHARGING AND ENGINE TESTING**	9

Supercharging and Turbocharging, Different methods of turbocharging, Inter-cooling, Turbocharger controls including, waster gate, variable geometry, variable nozzle types. Measurement of Brake Power, Frictional Power and Cylinder pressure. Indicated thermal, brake thermal and volumetric efficiencies. Engine performance maps, Engine testing standards.

UNIT V	**COOLING AND LUBRICATION SYSTEMS**	9

Need for cooling, types of cooling systems- air and liquid cooling systems. Thermosyphon and forced circulation and pressurized cooling systems. Radiator construction and Types. Properties of coolants. Requirements of lubrication systems. Types-mist, pressure feed, dry and wet sump systems. Properties of lubricants. Growth of Electric Vehicles - Comparison of Automotive Engines and Electric Vehicles – Challenges in implementation of electric vehicles.			
	TOTAL :	**45**	**PERIODS**

	AUTOMOTIVE ENGINES LAB
	LIST OF EXPERIMENTS
1.	Dismantling and Assembling of Multi-cylinder Petrol Engine
2.	Dismantling and Assembling of Multi-cylinder Diesel Engine
3.	Valve timing and port timing diagram
4.	Study of Petrol engine fuel system
5.	Study of Diesel engine fuel system
6.	Determination of p-θ and p-V diagrams for IC engine with piezo-electric pick up, charge amplifier, angle encoder and PC
7.	Performance and emission test on multi cylinder CI engine
8.	Performance and emission test on multi cylinder SI engine.
9.	Heat balance test on multi-cylinder SI engine
10.	Heat balance test on multi-cylinder CI engine
11.	Study of cooling system used in automotive engines
12.	Study of lubrication system used in automotive engines
	Total : 30 Periods

COURSE OUTCOMES:

On completion of the course the students will be able to

1. Explain basic construction, working of IC engines, operating cycles, perform dismantling and assembly of engines, draw valve and port timing diagrams.
2. Identify and demonstrate various fuel systems employed in automobiles.
3. Explain the stages of combustion, types of chambers and various parameters affecting combustion, conduct experiments using combustion analyser to find combustion characteristics.
4. Explain turbocharging, supercharging, engine testing, and test a variety of engines to draw their performance and emission characteristics.
5. Students will be able to explain the requirements of cooling and lubrication and different types of cooling and lubrication systems employed in IC engines

TEXT BOOKS:

1	Ganesan V., "Internal Combustion Engines", Tata McGraw Hill, 4th edition, 2012.
2	R.P. Sharma and M.L. Mathur"Internal Combustion Engines"DhanpatRai Publications, 2013

REFERENCE BOOKS:

1	B. P. Pundir, "IC Engines: Combustion and Emissions" Narosa Publication, 2017
2	Ramalingam K.K., "Internal Combustion Engines", Sci-Tech Publications, 3rd edition, 2016.
3	Devaradjane. Dr. G., Dr. M. Kumaresan, "Automobile Engineering", AMK Publishers, 2013
4	Heinz Heisler, "Advanced Engine Technology", Butterworth Heinemann Publications, 1995
5	John B. Heywood, "Fundamentals of Internal Combustion Engines", McGraw Hill, 1988
6	Gupta. H.N. "Fundamentals of Internal Combustion Engines", reprint, PHI Learning Pvt. Ltd. 2006

Course Code	Course Name(Lab oriented Theory Courses)	Category	L	T	P	C
AT23332	**APPLIED THERMODYNAMICS**	ES	2	1	2	4
(Use of Standard and approved Steam Table, Mollier Chart, Compressibility Chart Refrigeration Tables, Psychrometric Chart and HMT Data Book are permitted)						

OBJECTIVES:

1. To illustrate the thermodynamic laws and their applications
2. To make the students understand the second law of thermodynamics and availability.
3. To make the student understand the basics of ideal and real gases and properties of steam and steam power cycles.
4. To explain the various refrigeration systems and air compressors used in practice.
5. To make the students to understand the basics of heat transfer

UNIT I	FIRST LAW OF THERMODYNAMICS	9

Role of Thermodynamics in Engineering and Science - Applications of Thermodynamics, Macroscopic and microscopic aspects – thermodynamic system and surrounding – forms of energy– properties of a system – state - equilibrium– Quasi static process – Zeroth law of Thermodynamics – Heat – Work –First law of Thermodynamics - PMM I –Application of First law to non flow system– Thermodynamic analysis of control volume– Steady flow energy equation– Applications.

UNIT II	SECOND LAW OF THERMODYNAMICS	9

Limitations of first law – cyclic heat engine - heat pump – refrigerator - second law of thermodynamics – equivalence of Kelvin-Planck and Clausius statements - PMM II - Reversibility and irreversibility – causes of Irreversibility - Carnot cycle - reversed Carnot cycle - Carnot theorem – absolute thermodynamic temperature scale – Clausius theorem - Clausius inequality - concept of entropy – principle of increase of entropy - Applications of Second Law.

UNIT III	IDEAL & REAL GASES AND STEAM POWER CYCLE	9

Properties of ideal and real gases - equation of state for ideal and real gases - Vander Waal's equation of states, compressibility factor and compressibility chart, Gas Mixtures

Pure substance, Facts about Pure Substances - Vapor - liquid - solid Phase - thermodynamic properties of steam - Use of Steam Table and Mollier Chart - Determination of dryness fraction - Standard Rankine cycle and Reheat cycle.

UNIT IV	REFRIGERATION AND AIR COMPRESSORS	8

Psychrometry – Property calculations of air vapour mixtures by using chart and expressions – basic psychrometric processes - Refrigeration- properties of refrigerants - vapour compression refrigeration cycle – p-H Charts – Working principle of vapour absorption system – comparison between vapour compression and absorption systems - Air conditioning systems

Air Compressors : Classification and working principle Reciprocating and rotary air compressors. **(Descriptive treatment only)**

UNIT V	HEAT TRANSFER	10

Heat transfer through conduction - Fourier's law of conduction - Problems on one dimensional heat conduction through plain walls, composite walls and cylinder walls

Heat transfer through convection – Natural and Forced Convection, Problems on pin fin and Heat Exchangers.

Introduction to Heat transfer through radiation, Stefan Boltzman Law, black body and grey body. **(Descriptive treatment only),** Applications of Heat Transfer in Automotive Systems.

	TOTAL :	45	PERIODS

APPLIED THERMODYNAMICS LAB	
LIST OF EXPERIMENTS	
1.	Study on Steam Power Plant
2.	Performance test on a reciprocating air compressor
3.	Performance test in Air Conditioning System
4.	Performance test on refrigeration system
5.	Determination of Thermal conductivity of composite wall.
6.	Effectiveness of Parallel /counter flow heat exchanger.
7.	Heat transfer from pin-fin apparatus (natural & forced convection modes)
8.	Determination of emissivity of a grey surface.
	Total : 30 Periods

COURSE OUTCOMES:

On completion of the course students will be able to **:**

1. Explain the basic concepts in thermodynamics and solve problems in first law of thermodynamics
2. Apply the second law of thermodynamics and availability to calculate the efficiency of Heat engine and COP of Heat pump
3. Calculate properties of real gas, ideal gases, gas mixture, explain the basic operation of a steam power plant, calculate efficiency, steam rate and heat rate of the steam power cycles.
4. Calculate psychrometric properties, Explain VCR system, VAR system, conduct performance test on AC, refrigeration system, explain working of various air compressors and examine performance test on reciprocating air compressor.
5. Explain basic laws pertaining to heat transfer, calculate heat transfer through various modes, calculate heat transfer coefficient, design basic heat exchanger, conduct experiment to find thermal conductivity of a composite wall, and find out emissivity of a grey surface.

TEXT BOOKS:

1	Nag. P. K., 'Basic and Applied Thermodynamics', Tata McGraw-Hill Education Pvt. Ltd., 2010.
2	S. Domkundwar, C.P. Kothandaraman and A.V. Domkundwar., "A Course in Thermal Engineering", DhanpatRai and Co, 2004.

REFERENCE BOOKS:

1	Ramalingam K.K. 'Thermodynamics', Sci-Tech Publications, 2006.
2	P.Chattopadhyay, "Engineering Thermodynamics", Oxford University Press, 2010.
3	Rathakrishnan E, "Fundamentals of Engineering Thermodynamics", PHI Learning P. Ltd. New Delhi, 2009.
4	Holman. J.P., "Thermodynamics", 3rd Ed. Tata McGraw-Hill Education Pvt. Ltd., 2007.
5	Arora C.P, 'Thermodynamics', Tata McGraw-Hill Education Pvt. Ltd., 2004.
6	Merala C, Pother, Craig W, Somerton, 'Thermodynamics for Engineers', Schaum Outline Series, Tata McGraw-Hill Education Pvt. Ltd., New Delhi, 2004.
7	Rajput R.K., "Thermal Engineering", Laxmi Publications (P) Limited, New Delhi, 2010

Course Code	Course Name	Category	L	T	P	C

AT23333	**Strength of Materials for Automobile Engineering**	PC	2	1	2	4

OBJECTIVES:

1. To understand the fundamental concepts of stress, strain and elastic constants of solids under external loading
2. To acquire knowledge about the transverse and bending loads acting on structural components.
3. To learn the deformation of shafts subjected to torsion and various methods for calculating deflection of beams
4. To study the various stresses acting on thin, thick cylinders and spheres due to internal pressure of fluid.
5. To conduct tensile, impact and hardness tests on materials, compression test on spring, wood and brick.

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 – Volumetric strains –Stresses on inclined planes – principal stresses and principal planes – Mohr's circle of stress, failure theories.

UNIT II	**TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM**	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 – Flitched beams – Shear stress distribution.

UNIT III	**TORSION**	9

Torsion formulation stresses and deformation in circular and hollows shafts – Stepped shafts– Deflection in shafts fixed at the both ends – Stresses in helical springs – Deflection of helical springs, carriage springs.

UNIT IV	**DEFLECTION OF BEAMS**	9

Double Integration method – Macaulay's method for computation of slopes and deflections in beams - Conjugate beam and strain energy.

Columns – end conditions – equivalent length of a column – Euler equation – slenderness ratio – Rankine formula for columns.

UNIT V	**THIN CYLINDERS, SPHERES AND THICK CYLINDERS**	9

Stresses in thin cylindrical shell due to internal pressure circumferential and longitudinal stresses and deformation in thin and thick cylinders – spherical shells subjected to internal pressure –Deformation in spherical shells – Lame's theorem- compound cylinder.			
	TOTAL :	**45**	**PERIODS**

List of Experiments
1. Tension test on a mild steel rod
2. Torsion test on mild steel rod
3. Impact test on metal specimen (IZOD AND CHARPY)
4. Hardness test on metals – Brinell and Rockwell Hardness Number
5. Deflection test on beams
6. Compression test on helical springs
7. Hardness and impact strength of hardened, hardened and tempered steel.
8. Effect of Tempering and quenching – Comparison of Improvement Mechanical properties and Microscopic Examination of   (i) Unhardened specimen   (ii) Quenched Specimen and   (iii) Quenched and tempered specimen.
9. Double Shear test on Mild Steel rod
10. Compression test on Wood & Brick
Total : 30 Periods

COURSE OUTCOMES:

1. The students will be able to explain tension, compression and shear stresses and construct the Mohr's circle for the given stress condition. The students will be able to conduct tensile, compression, hardness and impact tests.

2. The students will be able to draw the shear force diagram and bending moment diagram for beams subjected to different loading conditions. The students will be able to perform torsion and double shear tests.

3. The students will be able to calculate the deformation of shafts subjected to torsional loads. The students will be able to demonstrate a compression test on wood.

4. The students will be able to calculate the deflection of beams using Macaulay's method and their strain energy. The students will be able to examine a deflection test on beams.

5. The students will be able to determine the stresses acting on thin cylinders, thick cylinders

and spheres.

TEXT BOOKS:
1.	Bansal, R.K ,"Strength of Materials", Laxmi Publications (P) Ltd, Sixth Edition-2017
2.	Jindal U.C., "Strength of Materials by Pearson", Publisher: Education Pearson; Second edition (2017).

REFERENCE BOOKS:
1.	Egor. P.Popov "Engineering Mechanics of Solids" Publisher: Phi Learning, 2nd Edition-2009
2.	Subramanian R., "Strength of Materials", Oxford University Press, Oxford Higher Education Series, 2016
3.	Hibbeler, R.C., "Mechanics of Materials", Pearson Education, Low Price Edition, 2018
4.	Ferdinand P. Been, Russell Johnson, J.r. and John J. Dewole "Mechanics of Materials", Tata McGraw Hill Publishing co. Ltd., New Delhi, 2016.
5.	Suraj Prakash harsha, "Strength of materials" Department of mechanical and industrial engineering, IITR.https://nptel.ac.in/courses/112107147/

Course Code	Course Name	Category	L	T	P	C

AT23334	**PRODUCTION TECHNOLOGY – II**	PC	3	0	2	4

OBJECTIVES:

1. To demonstrate the working principle and operation capabilities of a turning machine
2. To demonstrate the gear manufacturing process and working of unconventional machining process
3. To learn about computer aided manufacturing and understand operation of CNC machine
4. To learn about principle working and operation of various additive manufacturing process
5. To learn about the industry 4.0 and to explain various advanced manufacturing process

UNIT I	TURNING MACHINING	9

General principles (with schematic diagrams only) of working and commonly performed operations in the following machines: Lathe, Shaper, Planer, Horizontal milling machine, Universal drilling machine, Broaching machines, Cylindrical grinding machine, Capstan and Turret lathe.

UNIT II	MANUFACTURING OF GEARS AND UNCONVENTIONAL MACHINING PROCESSES	12

Gear cutting - forming and generation principle and construction of gear milling, hobbing and gear shaping processes - finishing of gears. Thread Rolling.

General principles and applications of the following processes: Abrasive jet machining, Ultrasonic machining, Electric discharge machining, Electro chemical machining, Electro chemical grinding, Plasma arc machining, Chemical machining, Electron beam machining and Laser beam machining.

UNIT III	COMPUTER AIDED MANUFACTURING	8

Introduction to NC systems and CNC - Machine axis and Co-ordinate system - CNC machine tools- Principle of operation CNC- Introduction of Part Programming, types - Detailed Manual part programming on Turning centres and Vertical Milling centres using G codes and M codes- Cutting Cycles, Loops, Sub program.

UNIT IV	ADDITIVE MANUFACTURING SYSTEMS	8

Three dimensional Printing (3DP): Principle, basic process, Physics of 3DP, types of printing, Stereolithography Apparatus (SLA), Solid Ground Curing (SGC), Fused deposition Moulding (FDM), Laminated Object Manufacturing (LOM), **Wire Arc Additive Manufacturing (WAAM)**: Working Principles, details of processes, products, materials, advantages, limitations and applications.

UNIT V	ADVANCED MANUFACTURING PROCESSES	8

Group Technology (GT), Part Families – Parts Classification and coding – Cellular Manufacturing – Types of Flexibility – Flexible Manufacturing System (FMS) – FMS Components – FMS Application and Benefits. Robot Anatomy – Classification of Robots – Robot Control systems – Sensors in Robotics – Industrial Robot – Application - Introduction to INDUSTRY 4.0, Lean manufacturing and Digital Twins.

	TOTAL :	45	PERIODS

LIST OF EXPERIMENTS	
Cylindrical Surface processes	
Lathe	Taper Turning
Lathe	External thread cutting
Drilling Machine	Drilling, Tapping & Reaming
Milling Processes	
Milling Machine	Surface Milling
Gear Manufacturing Processes	
Milling Machine	Spur gear
Gear hobber	Gear Hobbing
Shaping Process	
Shaping Machine	Keyway cutting
Surface Finishing Processes	
Grinding Machine	Surface Grinding
Grinding Machine	Cylindrical Grinding
Tool Manufacturing Processes	
Tool and Cutter Grinder	Machining of single point cutting tool
Additive Manufacturing System	CAD model Drawing, Slicing, 3D printing in FDM machines
Demonstration	

Practice on CNC Machines – Part programming			
Demonstration of Mould preparation in sand casting process.			
Demonstration of TIG welding process.			
Demonstration of Reverse Engineering through 3D scanning.			
	TOTAL :	**30**	**PERIODS**

COURSE OUTCOMES:

1. The students will be able to demonstrate the working principle and operation capabilities of a lathe, shaper, milling, drilling, broaching and grinding machine
2. The students will be able to explain the gear manufacturing process and working of unconventional machining process
3. The students will be able to comprehend about computer aided manufacturing and their codes for machining operation for part programming.
4. The students will be able to rephrase about the principle working, operation limitation and application of various additive manufacturing process
5. The students will be able to describe the industry 4.0 and the potential use of robotics in advanced manufacturing process.

	TEXT BOOKS:
1.	Mikell P Groover, "Fundamentals of Modern Manufacturing: Materials, Processes, and Systems", Sixth edition, John Wiley & sons, Inc, 2015.
2.	Rao. P.N "Manufacturing Technology - Metal Cutting and Machine Tools", Third edition, Tata McGraw-Hill, New Delhi, 2013.

	REFERENCE BOOKS:
1.	Joshi, P.H. "Jigs and Fixtures", Third Edition, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 2010.
2.	HMT, "Production Technology", First edition, Tata McGraw Hill, New Delhi, 1980.
3.	Winston A. Knight, Geoffrey Boothroyd, "Fundamentals of Metal Machining and Machine Tools", Third edition, CRC Press, 2005.
4.	Roy. A. Lindberg, "Process and Materials of Manufacture", Fourth Edition, PHI/Pearson Education 2006.

Course Code	Course Name(Laboratory Course)	Category	L	T	P	C
AT23321	**Computer Aided Machine Drawing Laboratory**	**PC**	**0**	**0**	**4**	**2**

Objectives:
To learn about the BIS specifications and symbols for welding joints, riveted joints, keys and fasteners.
To learn the concepts of fits and tolerances and to know about geometric dimensioning and tolerance
To enable the students to interpret the production drawings and understand part drawings and assembly drawings.
To learn the commands and steps involved in creating two dimensional sketches of mechanical components
To learn the steps involved to draw and assembly drawing using part drawing of mechanical components.

	List of Experiments
1.	Introduction to AutoCAD and Study of fits, limits and tolerances
2.	Explain the meaning of the geometrical tolerances for the machine tool components.
3.	Draw two dimensional assembly & sectional view of Sleeve and cotter joint using part diagram.
4.	Draw two dimensional assembly & sectional views of flange coupling using part diagram.
5.	Draw two dimensional assembly & sectional views of Universal joint using part diagram.
6.	Draw two dimensional assembly &sectional views of screw jack using pat diagram.
7	Draw two dimensional assembly & sectional views of Piston using part diagram.
8	Draw two dimensional assembly & sectional views of connecting rod using part diagram.
9	Draw two dimensional assembly & sectional views of knuckle joints using part diagram.
10	Draw two dimensional assembly & sectional views of Plummer Block using part diagram
	Total Contact Periods : 45

Course Outcomes:
1. Students will be able to explain BIS specifications and symbols for welding joints, riveted joints, keys and fasteners.   2. Students will be to describe the fits, tolerances and geometric dimensioning.

3. Students will be able to construct the production drawings, part drawings and assembly drawings.
4. Students will be able to draw two-dimensional sketches for mechanical components.
5. Students will be able to generate assembly drawings for mechanical components using a CAD package.

IV Semester

Course Code	Course Name	Category	L	T	P	C
AT23411	**Electric and Hybrid Vehicles - I**	PC	3	0	0	3

Objectives:
● To give the students the idea of global energy scenario, pollution levels and green mobility technology solutions
● To make the students understand the suitability and control of direct current machines for EV and HEV application.
● To make the students understand the characteristics of alternating current motors, their performance and control.
● To make the students realise the potential of advanced electric motors for traction application.
● To make the students realise the importance of various design parameters and their effect on the performance of the vehicle.

UNIT-I	**Introduction**	**9**

Global energy scenario - Electric and hybrid vehicle – need, advantages, challenges – Hybrid vehicle – advantages, disadvantages, architecture and energy flow– series, parallel, series-parallel, micro, mild, full and plugin hybrid. Hybrid and Electric vehicle layouts - Drive train for hybrid and electric vehicles-Hybrid vehicle operating modes. Electronic control system for EV & EHV. Power flow control**.** Comparison of Electric and Hybrid Drivetrains with conventional system, Emissions from Hybrid Electric Vehicles.

UNIT-II	**BLDC Motor**	**9**

Introduction – types of motors – trends. DC Series motor – structure and principle of operation. Moor control – speed control and regenerative braking. BLDC motor - Types of BLDC Motor - Torque Equation, Speed-Torque Characteristics, Microprocessor and DSP based control of BLDC motor. Sensorless control of DC motor. EV Motor sizing. Thermal management in BLDC motors. Losses in DC motors

UNIT-III	AC Motors	9

Three phase induction motor – basics, Inverter Based Induction Motor Drive, Modifying Torque-speed characteristics of 3 phase induction motor – Variable voltage, variable frequency control, field oriented control, direct torque control. Braking of the Induction Motor – Regenerative braking and dynamic braking. Losses in AC motors

UNIT-IV	PMSM and SRM machines	9

PMSM –structure – Principle of operation, Torque equation. Speed- torque Characteristics, Speed Control – vector control of PMSM, sensorless control, Microprocessor and DSP based control. Introduction - Constructional features of Switched Reluctance Motor – Principle of operation –Torque equation and characteristics – Losses - Drive circuits of SRM, Control of SRM- Speed torque Characteristics.

UNIT-V	Vehicle Mechanics	9

Vehicle forces – tractive effort and vehicle speed, estimation of power, range, and energy consumption, rolling resistance power, downgrade force and regeneration. Sizing of power train components in a hybrid drive. **Braking and energy recuperation - series and parallel RBS, Drive cycle implications - Electric vehicle and regenerative electric vehicle cycles for PHEVs, Average speed and impact on fuel economy** Maximum speed of the vehicle. Gradeability. Vehicle acceleration. Vehicle fuel economy estimation in a hybrid drive.

	Total Contact Hours	:	45

Course Outcomes:

1. The students will be aware of global pollution, emission standards and modern drive train technology options available for automobiles.
2. The students will able to suggest a suitable direct current motor for EV and HEV application.
3. The students will be able to comprehend the use of AC motors for traction application
4. The students will be able to describe the suitability of advanced motors for powertrain application.
5. The students will be able to compute the various vehicular resistances and performance parameters for the vehicle.

Text Books:

1	Tom denton. " Electric and Hybrid Vehicles" Routledge Publications, 2016

2	Austin Hughes and Bill Drury. " Electric Motors and Drives – Fundamentals, Types and Applications, Newnes-Elsevier, 2013.
3	Vinodhkumar, Ranjan Kumar Behera, Dheeraj Joshi " Power Electronics, Drives and Advanced Applications", CR press, 2020.

Reference Books	
1	Gianfranco Pistoia. "Electric And Hybrid Vehicles Power Sources, Models, Sustainability, Infrastructure and The Market". Elsevier, 2010.
2	Jack Erjavec. "Hybrid, Electric & Fuel-Cell Vehicles". Cenage Learning, 2013.
3	Chau. K. T. "Electric Vehicle Machines and Drives – Design, Analysis and Application", John Wiley & Sons Singapore Pte. Ltd., 2015
4	"Introduction to hybrid and electric vehicles", Department of electrical engineering, IITG.https://archive.nptel.ac.in/courses/108/103/108103009/#

Course Code	Course Name	Category	L	T	P	C
AT23412	**Material Science and Metallurgy**	ES	**3**	**0**	**0**	**3**

	Objectives
1	To impart knowledge on the phase diagram of alloys.
2	To make the students comprehend the various heat treatment methods for steels
3	To make the students understand various ferrous and non-ferrous materials
4	To make aware about various non-metallic material
5	To make the students understand various destructive testing methods for metals

UNIT-I	ALLOYS AND PHASE DIAGRAMS	9

Phase diagrams: - Limitations of pure metals and need of alloying–classification of alloys-Iron-Carbon equilibrium diagram with microstructure and properties changes in Austenite, Ledeburite, Ferrite, Cementite, special features of Martensite transformation, Bainite, Spheroidite Classification of steel and cast iron microstructure, properties and application.

UNIT-II	FRACTURE, OXIDATION, CORROSION &HEAT TREATMENT	10

Ductile fracture, Brittle fracture, Fracture toughness, methods of protection against fracture. Oxidation & Corrosion-Mechanisms and Control. Definition – Full annealing, stress relief, recrystallisation and spheroidizing – normalizing, hardening and Tempering of steel. Isothermal transformation diagrams – cooling curves superimposed on I.T. diagram CCR – Hardenability, Jominy end quench test - Austempering, martempering – case hardening, carburizing, Nitriding, nito-carburising, carbonitriding – Flame and Induction hardening – Vacuum and Plasma hardening, electron beam hardening, laser beam hardening

UNIT-III	FERROUS AND NON-FERROUS METALS	9

Effect of alloying additions on steel- α and β stabilizers– stainless and tool steels – HSLA, Maraging steels – Cast Iron - Grey, white, malleable, spheroidal – alloy cast irons, Copper and copper alloys – Brass, Bronze and Cupronickel – Aluminium and Al-Cu – precipitation strengthening treatment – Bearing alloys, Mg-alloys, Ni-based super alloys and Titanium alloys.

UNIT-IV	NON-METALLIC MATERIALS	9

Polymers – types of polymers, commodity and engineering polymers – Properties and applications of various thermosetting and thermoplastic polymers (PP, PS, PVC, PMMA, PET, PC, PA, ABS, PI, PAI, PPO, PPS, PEEK, PTFE, Polymers – Urea and Phenol formaldehydes)-Engineering Ceramics – Properties and applications of Al2O3, SiC, Si3N4, PSZ and SIALON – Composites-Classifications- Metal Matrix and FRP - Applications of Composites.

UNIT-V	ADVANCED MATERIALS	8

Shape memory alloys, Pseudoelastic effect - Ni-based super alloys, Titanium alloys and NiTi alloys and applications. Carbon Fiber, Carbon nanotubes – types, properties-applications (Fundamentals only). Quasicrystal, Nano crystalline materials. Introduction to Ferrofluids, Self-healing materials, Piezoelectric materials and magnetorheological fluid, Superconducting materials

Total Contact Hours	:	45

Course Outcomes:

On completion of the course students will be able to

The students will be able to construct a phase diagram for alloys

The student will be able to select the most appropriate heat treat process for required metal characteristics.

The student will be able to suggest ferrous and nonferrous materials for a given application.

The student will able to explain the various non-metallic materials and their specific engineering applications

The student will be familiar about the properties and application of various advanced materials

Text Books:

1	Avner S.H., "Introduction to Physical Metallurgy", McGraw Hill Education; 2 edition 2017.

2	R. Balasubramaniam, Williams D Callister, "Material Science and Engineering", Wiley India Pvt Ltd, 2nd edition, 2014

	Reference Books / Web links:
1	R.Srinivasan,Engineering Materials and Metallurgy, McGraw Hill Education,edition, 2ndEdition 2009
2	V. Raghavan, Materials Science and Engineering: A First Course,6thEdition, PHI Publications
3	Williams D Callister, ―Material Science and Engineering‖, Revised Indian edition, Wiley India Pvt Ltd, 2007
4	Kenneth G. Budinski and Michael K. Budinski, *Engineering Materials: Properties and Selection*, Pearson, 9th Edition, 2010
5	Vivek Pancholi, "Material science and engineering" Department of metallurgical and materials engineering. IITR, https://nptel.ac.in/courses/113107078

Course Code	Course Name	Category	L	T	P	C
AT23431	**AUTOMOTIVE DRIVE LINE AND CHASSIS**	PC	3	0	2	4

OBJECTIVES:

1. To impart knowledge on types of chassis layout and constructional details of drive lines

2. To learn about the steering geometry and components of the steering system of a vehicle.

3. To make the students understand the loads acting on rear axles, types of tyres and wheels of an automobile.

4. To impart the knowledge about various suspension systems utilized for automobiles.

5. To impart knowledge on various braking system in automobile.

UNIT I	LAYOUT , FRAME AND DRIVE LINE	9

Basic construction of vehicles, Types of Chassis layout, with reference to Power Plant location and drive, various types of frames, frame materials, Electric vehicle frame model, forces acting on a vehicle, Clutch and types, Gear Box and types, Fluid coupling, Torque converter and its characteristics, Hotchkiss drive, torque tube drive, Propeller Shaft, Universal Joints, Constant Velocity Universal Joints, Final drive and its types. Principle and Constructional details of differential unit, Non–Slip differential, Differential locks.

UNIT II	FRONT AXLE AND STEERING SYSTEM	9

 Types of Front Axles and Stub Axles, Front Wheel Geometry. Condition for True Rolling Motion. Ackerman's and Davis's Steering Mechanisms, Steering Linkages, Different Types of Steering Gear boxes, Slip Angle, effects of Over–Steer and Under–Steer, Reversible and Irreversible Steering, Power Steering, Electrical power steering, Electronic power steering, radius rods and stabilizers.

UNIT III	REAR AXLES, WHEELS, RIMS AND TYRES	9

Construction of rear axles, Types of Loads acting on rear axles, Full –Floating, Three–Quarter Floating and Semi–Floating Axles, Twist beam rear axle, Multi axle vehicles and its types. Wheels and Rims, Types of Tyres and their constructional details, Specification of tyres and wheels.

UNIT IV	SUSPENSION SYSTEM	9

Requirement of Suspension System, Types of Suspension Springs, Constructional details and characteristics of Single Leaf, Multi–Leaf spring, Coil and Torsion bar Springs, Rubber, Pneumatic and Hydro – elastic Suspension Spring Systems, Independent and dependent Suspension System, Shock Absorber and its types, Electronic Suspension System, anti-roll bar, wheel alignment.

UNIT V	BRAKE SYSTEMS	9

Need for Brake systems, Stopping Distance, Time and Braking Efficiency, Effect of Weight Transfer during Braking, Classification of brakes, Braking Torque, drum brake and disc Brake Theory, Types and Construction of Hydraulic Braking System, Mechanical Braking System, Pneumatic Braking System, Power–Assisted Braking System, Servo Brakes, Retarders – antilock braking systems(ABS), Electromagnetic brake system, Electronic brake system(EBS), Electric braking system and types.

	TOTAL:	45	PERIODS

AUTOMOTIVE DRIVE LINE AND CHASSIS LABORATORY:
LIST OF EXPERIMENTS:
1.   Study, measurement of light and heavy commercial Vehicle Frame
2.   Measurement of wheel alignment parameters.
3.   Study, dismantling and assembling of steering gear boxes and calculation of gear ratios
4.   Study, dismantling and assembling of clutches
5.   Study, dismantling and assembling of Light and Heavy gear box
6.   Study, dismantling and assembling of differential system
7.   Study, dismantling and assembling of front axle
8. Study, dismantling and assembling of rear axle

9.	Study, dismantling and assembling of suspension systems
	10. Study of braking system, mapping pedal displacement with pressure.
	11. Study of vehicle tyres and its specifications.
	12. Study of different types of wheels and features
	Total : 30 Periods

COURSE OUTCOMES:

1. The students will be able to explain types of chassis layout, frames and derive lines in the vehicle. The students will be able to identify the components and function of vehicle frame, clutch, gearboxes and differential.

2. The students will be able to illustrate the steering geometry, condition for true rolling motion and types of vehicle steering systems. The students will be able to identify the components, function of the steering gear boxes, front axle, and measure the wheel alignment parameters.

3. The students will be able to describe various types of rear axles, wheels and tires. The students will be able to identify the components and function of the rear axles, different types of wheels and tires with features.

4. The students will be able to comprehend the various suspension springs for vehicles. The students will be able to demonstrate the function and components of the various suspension systems.

5. The students will be able to realize the importance of braking systems in a vehicle and possess knowledge about ABS, EBS. The students will be able to explain function and components of the braking system and mapping pedal displacement with pressure.

TEXT BOOKS:

1. T.K. Garrett, K. Newton and W. Steeds, "The Motor Vehicle", Butterworth-Heinemann Publication, 13th Edition, 2000

2. Kirpal Singh, "Automobile Engineering Vol.1", Standard Publisher Distributors, 14th Edition, 2017.

REFERENCE BOOKS

1. Giri. N.K., "Automobile Mechanics" Khanna Publishers, New Delhi, 1998.

2. S.K.Gupta, "A Textbook of Automobile Engineering", S CHAND Publication, Copyright edition, 2013.

3. Heinz Heisler, "Advanced Vehicle Technology", Butterworth Heinemann Publications 2nd Edition, 2002.

4. S Srinivasan, "Automotive mechanics", McGraw-Hill Education, 2nd edition, 2003.

5. P.M. Heldt, *Automotive Chassis*, Chilton Book Company, 2nd Edition, 1992.

Course Code	Course Name	Category	L	T	P	C
AT23432	**FLUID MECHANICS & MACHINERY FOR AUTOMOBILE ENGINEERS**	**PC**	**2**	**1**	**2**	**4**

Objectives:	
1	The properties of fluids and concept of control volume are studied.
2	The applications of the conservation laws to flow through pipes are studied.
3	To understand the importance of dimensional analysis
4	To understand the importance of various types of flow in pumps
5	To understand the importance of various types of flow in turbines.

UNIT-I	**FLUID PROPERTIES AND FLOW CHARACTERISTICS**	10

Units and dimensions- Properties of fluids- mass density, specific weight, specific volume, specific gravity, viscosity, compressibility, vapour pressure, surface tension and capillarity, hydrostatics. Flow characteristics – concept of control volume - application of continuity equation, energy equation and momentum equation –Venturi-orifice meter. Construction and working principle, coefficient of discharge, derivation for discharge

UNIT-II	**FLOW THROUGH CIRCULAR CONDUITS**	9

Hydraulic and energy gradient - Laminar flow through circular conduits and circular annuli - Boundary layer concepts - types of boundary layer thickness - Darcy Weisbach equation - friction factor - Moody diagram - commercial pipes - minor losses for pipe fittings and valves- Flow through pipes in series and parallel –Flow over a flat plate–Bluff body, concept of Drag

and Lift, Air foil and spoiler.

UNIT-III	DIMENSIONAL ANALYSIS	8

Need for dimensional analysis - methods of dimensional analysis - Similitude - types of similitude - Dimensionless parameters- application of dimensionless parameters - Model analysis - Similarity between Model and Prototype Vehicle.

UNIT-IV	PUMPS	9

Impact of jets – Euler's equation - Theory of roto-dynamic machines - various efficiencies - velocity components at entry and exit of the rotor- velocity triangles - Centrifugal pumps - working principle and its trouble shooting- work done by the impeller - performance curves - Reciprocating pump -working principle - Diaphragm pump - Rotary pumps - classification and working principle. Fuel pumps – selection of type and working principle.

UNIT-V	TURBINES	9

Classification of turbines - heads and efficiencies - velocity triangles. Axial, radial and mixed flow turbines - Pelton wheel, Francis turbine and Kaplan turbines - working principles - work done by water on the runner - draft tube. Specific speed - unit quantities - performance curves for turbines - governing of turbines.

	Total Contact Hours	:	45

	List of Experiments
1	Determination of the Coefficient of discharge of given Orifice meter.
2	Determination of the Coefficient of discharge of given Venturi meter.
3	Conducting experiments and drawing the characteristic curves of centrifugal pump.
4	Conducting experiments and drawing the characteristic curves of Reciprocating

	pump.
5	Conducting experiments and drawing the characteristic curves of Gear pump.
6	Determination of friction factor of given set of pipes.
7	Determination of minor losses for given set of pipes.
8	Conducting experiments and drawing the characteristic curves of Pelton wheel.
9	Conducting experiments and drawing the characteristic curves of Kaplan turbine.
10	Drag estimation of basic models in wind tunnel.
	Contact Periods : **30**

Course Outcomes:

1. The students will be able to calculate the properties and explain the characteristics of a fluid. The students will be able to perform tests on orifice and venturi meter.

2. The students will be able to calculate the various losses and friction factor during flow of liquid.

3. The students will be able to apply the mathematical knowledge for dimensional analysis.

4. The students will be able to compute the performance parameters of hydraulic pumps and identify suitable pumps for a given practical application.

5. The students will be able to compute the performance parameters of hydraulic turbine and identify suitable turbine for a given practical application.

	Text Books:
1	Bansal, R.K., "Fluid Mechanics and Hydraulics Machines", 5th edition, Laxmi Publications Pvt. Ltd, New Delhi, 2008.
2	Modi P.N. and Seth, S.M. "Hydraulics and Fluid Mechanics", Standard Book House, New Delhi, 2004.

	Reference Books / Web links:
1	Fox W.R. and McDonald A.T., "Introduction to Fluid Mechanics", John-Wiley and Sons, Singapore, 1995.
2	Jain A. K. "Fluid Mechanics", Khanna Publishers, 2010.
3	Roberson J.A and Crowe C.T., "Engineering Fluid Mechanics", Jaico Books Mumbai, 2000.
4	Streeter, V.L., and Wylie, E.B., "Fluid Mechanics", McGraw Hill, 2000.
5	White, F.M., "Fluid Mechanics", Tata McGraw Hill, 5th Edition, New Delhi, 2003.

Course Code	Course Name	Category	L	T	P	C
AT23433	THEORY OF MACHINES	PC	2	1	2	4

OBJECTIVES:

To understand the principles in the formation of mechanisms and their kinematics.

To understand the fundamental concepts behind gears and experimentally determine the various speeds in a gearbox.

To understand the concepts in cam and gyroscopes and generate the cam profile practically.

To understand the principle in balancing of rotating masses in machines and validate the concept experimentally.

To understand the importance of vibration in machines and practically determine the natural frequency of a given mechanical system.

UNIT I	MECHANISMS	09

Machine Structure – Kinematic link, pair and chain – Grubler's criteria – Constrained motion – Degrees of freedom – Slider crank and crank rocker mechanisms – Inversions – Applications – Kinematic analysis of simple mechanisms – Determination of velocity and acceleration by relative velocity Method. Velocity and acceleration of piston, angular velocity and angular acceleration of connecting rod of reciprocating engine.

UNIT II	GEARING AND POWERDRIVES	09

Gears: profile and geometry – Nomenclature of spur and helical gears –Velocity of sliding, Length of path of contact and arc of contact, Contact ratio, Interference, Calculation of minimum number of teeth.

Gear trains: Simple, compound gear trains and epicyclic gear trains – Determination of speed and torque.

Belt drive: Types of belts, Selection of belt drive, length of open and crossed belt drive Velocity ratio, slip and creep of belt drives, Power transmitted by a belt, Condition for transmission of maximum power. Comparison between Belt and chain drive.

UNIT III	CAMS AND CLUTCHES	09

Cams – Types of cams – Design of profiles – Knife edged, flat faced and roller ended followers with and without offsets for various types of follower motions.

CLUTCH : Different types of clutches, principle & Construction of Single and multiple plate clutches, Centrifugal clutches, Hydraulic and cone clutches.

UNIT IV	BALANCING AND GYROSCOPIC MOTION	09

Static and dynamic balancing – Several masses rotating in same and different planes – Balancing of reciprocating masses- primary balancing and concepts of secondary balancing – Single and multi cylinder engines (Inline).

Balancing of radial V engine - direct and reverse crank method (descriptive treatment only).

Gyroscopes: Gyroscopic forces and couple – Forces on bearing due to gyroscopic action – Gyroscopic effect in motor cycle, car

UNIT V	VIBRATION	09

Free, forced and damped vibrations of single degree of freedom systems – Force transmitted to supports – Vibration isolation – Vibration absorption – Torsional vibration of shaft – Single and multi rotor systems – Geared shafts – Critical speed of shaft.

		TOTAL :	45	PERIODS

	List Of Experiments
1	Study of gear terminologies and determination of velocity ratios of simple, compound, Epicyclic and differential gear trains.
2	Motorized gyroscope – Study of gyroscopic effect and couple.
3	Determination of range sensitivity and effort of Hartnell Governor.
4	Cams – Cam profile drawing, Motion curves and study of jump phenomenon

5	Determination of natural frequency and damping coefficient of spring mass system.	
6	Balancing of rotating masses	
7	Determination of natural frequency of torsional vibration in single rotor system.	
8	Determination of free transverse vibration of a cantilever and simply supported beam	
		Total : 30 Periods

COURSE OUTCOMES:
1. The students will be able to calculate the velocity and acceleration for simple mechanisms 2. The students will be able to deduce the dimensions for a spur gear and speeds of gears in a gear train, and validate the results experimentally. 3. The students will be able to generate the cam profile for the given follower motion and will be able to apply gyroscopic effect to automobiles. 4. The students will be able to balance the reciprocating and rotating masses in machines. 5. The students will be able to compute the frequency of free, forced and damped vibration in a mechanical system and validate the results practically.

TEXT BOOKS:	
1.	Thomas Bevan, "Theory of Machines", Dorling Kindersley India Pvt. Ltd. New Delhi, 2010.
2.	Rattan S S, "Theory of Machines", MCGraw Hill, 2014.
REFERENCE BOOKS:	
1.	R.S.Khurmi, "Theory of Machines" by, S. Chand Pub. 2005
2.	Ambekar A.G., "Mechanism and Machine Theory", Prentice Hall of India, New Delhi, 2007

3.	AmitabhaGhosh, Asok Kumar Mallik, "Theory of Mechanisms and Machines", Affiliated East-West Pvt. Ltd., New Delhi, 3rd edition.
4.	Ramamurthi. V., "Mechanisms of Machine",Narosa Publishing House, 2002.
5.	Robert L.Norton, "Design of Machinery", McGraw-Hill, 2004.

Course Code	Course Title	Category	L	T	P	C
CS23422	**Python Programming for Machine learning** (with effect from 2023 batch onwards)	**ES**	0	0	4	2

Objectives:
This course is aimed at enabling the students to:
● To understand the relationship of the data collected for decision making.
● To know the concept of principal components, factor analysis and cluster analysis for profiling and interpreting the data collected.
● Lay the foundation of machine learning and its practical applications and prepare students for real-time problem-solving in data science.
● Develop self-learning algorithms using training data to classify or predict the outcome of future datasets.
● Distinguish overtraining and techniques to avoid it such as cross-validation.

List of Experiments		
1.	NumPy Basics: Arrays and Vectorized Computation	
2.	Getting Started with pandas	
3.	Data Loading, Storage, and File Formats	
4.	Data Cleaning and Preparation	
5.	Data Wrangling: Join, Combine, and Reshape	
6.	Plotting and Visualization	
7.	Data Aggregation and Group Operations	
8.	Time Series	
9.	Supervised Learning	
10.	Unsupervised Learning and Pre-processing	
11.	Representing Data and Engineering Features	
12.	Model Evaluation and Improvement	
	Contact Hours :	**60**

Course Outcomes:

On completion of the course, students will be able to:
• Develop a sound understanding of current, modern computational statistical approaches and their application to a variety of datasets.
• Analyze and perform an evaluation of learning algorithms and model selection.
• Compare the strengths and weaknesses of many popular machine learning approaches.
• Appreciate the underlying mathematical relationships within and across machine learning algorithms and the paradigms of supervised and unsupervised learning.
• Design and implement various machine learning algorithms in a range of real-world applications.

Text Books:

1. Wes McKinney, Python for Data Analysis - Data wrangling with pandas, Numpy, and ipython, Second Edition, O'Reilly Media Inc., 2017.

2. Andreas C. Müller and Sarah Guido, Introduction to Machine Learning with Python - A Guide for Data Scientists, First Edition, O'Reilly Media Inc, 2016.

Reference Books:

1. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 2nd Edition, O'Reilly Media Inc, 2019.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CS23422.1	2	2	2	2	1	-	-	-	1	1	1	1	2	2	2
CS23422.2	2	1	1	1	1	-	-	-	-	-	1	1	2	2	2
CS23422.3	1	1	2	1	2	-	-	-	-	-	1	1	2	2	2
CS23422.4	2	2	3	2	2	-	-	-	-	-	2	1	2	2	2
CS23422.5	2	2	3	2	3	-	-	-	-	-	2	1	2	2	2
Average	1.8	1.6	2.2	1.6	1.8	0.0	0.0	0.0	0.2	0.2	1.4	1	2	2	2

Course Code	:	GE23421
Course Title	:	Soft Skills-I
Teaching Period	:	4th Semester
Credit Points	:	L T P C – 0 0 2 1
Course Category	:	EEC

Course Objectives:

The major course objectives are:

a. To help students break out of shyness.
b. To build confidence
c. To enhance English communication skills.
d. To encourage students' creative thinking to help them frame their own opinions,

Learning and Teaching Strategy:

The program is completely student centric where the focus is on activities led by students which include role plays, discussions, debates other games as well. These activities would be supplemented by interactive use of technology and brief trainer input.

Week	Activity Name	Description	Objective
1	Introduction	The trainer and the college facilitator talk to the students about the course and in turn the students introduce themselves.	To set expectations about the course and the students are made aware of the rules and regulations involved in this program
2	If I ruled the world	This is a quick and useful game by getting students to form a circle and provide their point of view. Each student then repeats what the other has said and comes up with	The aim of this activity is to for students to get to know each other and also develop their listening skills as well as

		their own opinion.	learning how to agree and disagree politely.
3	Picture Narrating	This activity is based on several sequential pictures. Students are asked to tell the story taking place in the sequential pictures by paying attention to the criteria provided by the teacher as a rubric. Rubrics can include the vocabulary or structures they need to use while narrating.	The aim of this activity is to make the students develop creative way of thinking.
4	Brainstorming	On a given topic, students can produce ideas in a limited time. Depending on the context, either individual or group brainstorming is effective and learners generate ideas quickly and freely. The good characteristics of brainstorming are that the students are not criticized for their ideas so students will be open to sharing new ideas.	The activity aims at making the students speak freely without the fear of being criticized. It also encourages students to come up with their own opinions.
5	Debate	Is competition necessary in regards to the learning process?	The aim of this activity is to develop the students ability to debate and think out of the box
6	Short Talks	Here the students are given topics for which they take one minute to prepare and two minutes to speak. They can write down points but can't read them out they can only use it as a reference.	The activity aims at breaking the students' shyness and encouraging them to standup in front of the class and speak. It also aims at creating awareness that they are restricted for time so they only speak points that are relevant and important.
7	Debate	Will posting students' grades on bulletin boards publicly motivate them to perform better or is it humiliating?	This activity aims at enhancing the students unbiased thought process when it comes to exams and grades as well as develop their skills to debate
8	The Art of diplomacy	The facilitator proceeds to share multiple concepts of conversation and helps the participants to identify the various methods of being diplomatic and how do deal with misinformation.	The aim of the lesson is to provide an opportunity for the participants to learn about body language and choosing the appropriate words for conversation.

9	Debate	Are humans too dependent on computers?	The aim of this activity is to test the students debating skills and thought process with a topic that affects everybody in daily life.
10	Story Completion	The teacher starts to tell a story but after 2 sentences he/she asks students to work in groups to create the rest of the story which includes the plot and the ending.	This activity aims at building their narrating skills as well as their creativity and ability to work in a team.
11	Role play debate	Students scrutinize different points of view or perspectives related to an issue. For example, a debate about the question "Should students be required to wear uniforms at school?" might yield a range of opinions. Those might include views expressed by a student (or perhaps two students – one representing each side of the issue), a parent, a school principal, a police officer, a teacher, the owner of a clothing store, and others.	The aim of this activity is to get students to speak based on other people's perspective instead of their own. The students take the role of various characters and debate accordingly.
12	I Couldn't Disagree More	This is a game where students practice rebuttal techniques where one student provides a thought or an idea and the other students starts with the phrase I couldn't disagree more and continues with his opinion	The aim of this activity is to improve general communication skills and confidence.
	Feedback	At the end of the session in the final week (12) the trainer would provide feedback to the students on best practices for future benefits	The aim is to do both give feedback to students as well as obtain feedback on the course from them.

Course Learning Outcome:

On successful completion of the course, students should be able to:

1. Be more confident
2. Speak in front of a large audience
3. Be better creative thinkers
4. Be spontaneous
5. Know the importance of communicating in English.

Course Code	Course Name	Category	L	T	P	C
AT23511	DESIGN OF MACHINE ELEMENTS	PC	2	1	0	3

PSG design Data book permitted

Objectives:	
•	To analyse the effect of different loading conditions on machine members and evaluate failure criteria to ensure safe and efficient design.
•	To Design and analyse shafts and couplings considering mechanical strength, rigidity, and dynamic performance.
•	To Select and evaluate different types of mechanical joints based on functional requirements and loading conditions.
•	To Design and optimize energy-storing elements such as springs and flywheels for improved performance in automotive applications.
•	To Evaluate the selection and performance of different types of bearings based on load conditions and lubrication principles.

UNIT I	STEADY STATE STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS	10
	Introduction to the design process - factors influencing machine design, selection of materials based on mechanical properties - Preferred numbers, fits and tolerances – Direct, Bending and torsional stress equations – 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 – Design for variable loading.	

UNIT II	SHAFTS AND COUPLINGS	8

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

UNIT III	TEMPORARY AND PERMANENT JOINTS	9

Indian Standard for fasteners - Threaded fasteners –- Bolted joints including eccentric loading, Specification of Bolts, Estimation of torque in bolt tightening- Knuckle joints, Cotter joints – Welded joints, riveted joints for structures, **Gasketed joints**.

UNIT IV	ENERGY STORING ELEMENTS	9

Various types of springs, optimization of helical springs - rubber springs - Flywheels considering stresses in rims and arms for single cylinder engines, multi cylinder engine and punching machines

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 Contact Hours	**:**	**45**

Course Outcomes:	
●	The student will able to design a machine component when it subjected to various types of loading and estimate corresponding stress induced in the machine component
●	The student will able to design a shaft, key and coupling on satisfying the given loading conditions
●	The student will able to evaluate the loading conditions and design the joints (permanent/temporary) based on requirement

●	The student will able to design the energy absorbing members(springs, flywheel) for the given constraints
●	The student will able to explain the selection of roller bearing and design of journal bearing for the given set of constrains

Text Books:	
1	Bhandari V, "Design of Machine Elements", 3rd Edition, Tata McGraw-Hill Book Co, 2016.
2	Richard G Budynas Richard Gordon Budynas, J.KeithNisbett., "Shigley's Mechanical Engineering Design", 10th edition, Tata McGraw-Hill, 2015

Reference Books / Web links:	
1.	R.S. Khurmi& J. K. Guptha, "A Textbook of Machine Design", 34th edition, S. Chand publication. 2014.
2.	Sundararajamoorthy T. V. Shanmugam N, "Machine Design", Anuradha Publications, Chennai, 2003.
3.	Robert C. Juvinall and Kurt M. Marshek, "Fundamentals of Machine Design", 6th Edition, Wiley, 2018
4.	Alfred Hall, Halowenko, A and Laughlin, H., "Machine Design", Tata McGraw-Hill BookCo.(Schaum's Outline), 2010.
5.	Bernard Hamrock, Steven Schmid,Bo Jacobson, "Fundamentals of Machine Elements", 2nd Edition, Tata McGraw-Hill Book Co., 2006.

CO, PO and PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	3	3	-	1	2	-	1	1	2	3	3	1	2
CO 2	3	3	3	3	-	1	2	-	1	1	2	3	3	1	2
CO 3	3	3	3	3	-	1	2	-	1	1	2	3	3	1	2
CO 4	3	3	3	3	-	1	2	-	1	1	2	3	3	1	2
CO 5	3	3	3	3	-	1	2	-	1	1	2	3	3	1	2
AVG	3	3	3	3	-	1	2	-	1	1	2	3	3	1	2

Course Code	Course Name	Category	L	T	P	C
AT23531	**AUTOMOTIVE ELECTRICAL AND ELECTRONICS**	**PC**	**3**	**0**	**2**	**4**

OBJECTIVES:

1. To understand the basic principle, types, testing and maintenance of batteries
2. To learn the basics of starting and ignition systems and the fundamentals of wiring, lighting and accessories used in vehicles
3. To learn the working principles of various sensors used in vehicles and actuators along with its application.
4. To conduct tests on battery, starter motor, alternator and DC shunt motor.
5. To study about of rectifiers, filters, logic gates, adder, flip-flops and ADC for Data Acquisition

UNIT I	INTRODUCTION AND TYPES OF BATTERIES	9

Electrical and electronic principles, insulator, conductor and semiconductor, voltage current and resistance, and its measurement of current, voltage and resistance, common circuit symbols for automobiles.

Principle and construction of Lead Acid Battery - Characteristics, Battery Rating, Capacity and Efficiency, Various Tests on Battery, Battery–Charging Techniques, Defects - Effect of overheating, Effect of overcharging, Dislocation of active material, sulphation, Internal short circuits, Corrosion / sulphation of terminals. Storage of lead acid battery (in dry & wet condition), Maintenance of batteries. Maintenance free battery-dry battery-Tubular battery. Sustainability – Techniques for recycling EV batteries, Environmental impact and regulatory considerations**.

UNIT II	STARTING, CHARGING AND IGNITION SYSTEMS	9

Starter motors characteristics, capacity requirements. Types of starter motor drives – mechanisms of Standard Bendix drive, Folo-thru' Bendix drive, over running clutch drive, Dyer drive, pre-engaged type. Starter switches- manual, solenoid switch cum shift, solenoid with relay. DC Generators and Alternators their characteristics. Control unit – cut out, electronic regulators. Spark plugs. Spark advance mechanisms. Different types of ignition systems, Electronic ignition systems, Kinetic Energy Recovery Systems (KERS) Role in hybrid and electric vehicles.

UNIT III	AUTOMOTIVE WIRING, LIGHTING AND ACCESSORIES	9

Wiring cables, color codes, harness, multiplexing, electromagnetic compatibility, vehicle Interior wiring circuit, vehicle exterior wiring circuit, lamps-types-gas discharge, xenon, LED, headlight – bulbs, reflectors, lenses, leveling and beam setting- Adaptive Front Lights (AFL)-Digital turn signals- Auto dimming mirror- Dashboard instruments, Horn, windscreen wipers and its controls, power windows, electric pumps –fuel pump, wiper pump. Electric power steering, vehicle tracking system.

UNIT IV	AUTOMOTIVE SENSORS	11

Sensors construction with automotive applications Temperature measurement –Thermistor, Thermocouple - Potentiometer – LVDT and rotary – Air flow measurement, Throttle position, Hot wire anemometry – air flow measurement, Inductive – Magnetic and Hall effect – speed and position detection, Piezoelectric – Knock detection, Acceleration sensor – inertia and capacitive type, Yaw rate sensor Feedback sensor – EGO sensor-construction and working - Manifold Absolute Pressure (MAP) sensor, Differential exhaust gas pressure and Air bag sensor

UNIT V	AUTOMOTIVE ACTUATORS	7

Construction and working of actuators with automotive applications: Relays, Solenoid type – Injectors, Air valve, Linear motor – Door lock actuator, DC motors – Fuel pump, Gear shift actuators. Stepper motors – Idle speed control, Cruise control.

	TOTAL :	**45**	**PERIODS**

LIST OF EXPERIMENTS	
(a) AUTOMOTIVE ELECTRICAL LABORATORY	
1	Testing of batteries and battery maintenance
2	Testing of starting motors and generators
3	Study of Automobile electrical wiring, Sensors and Actuators
4	Open circuit and load characteristics of DC shunt generator- critical resistance and critical speed.

5	Load test on DC shunt and compound motor.
6	Load test on DC series motor
7	Load test on single-phase induction motor.
8	Load test on three-phase induction motor.

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(b) AUTOMOTIVE ELECTRONICS LABORATORY

</div>

1.	Study of rectifiers, filters, logic gates, adder and flip-flops
2.	Study of SCR and IC timer
3.	Interfacing Sensors like RTD, LVDT, Load Cell etc.
4.	Interfacing ADC for Data Acquisition
5.	Interfacing DAC for Control Application
	Total : 30 Periods

COURSE OUTCOMES:

1. The students will be able to explain the principle, types of batteries and its applications. The students will be able to conduct various tests on the battery.

	2. The students will be able to describe the principle of starting system and ignition systems in a vehicle. The students will be able to perform tests on various motors used in vehicle.
	3. The students will be able to explain procedure for wiring, lighting and accessories.
	4. The students will be able to identify the sensors and explain their working principles.
	5. The students will be able to gain knowledge about the actuators employed in vehicles and perform diagnosis tests.

TEXT BOOKS:

1	Kohli. P.L, "Automotive Electrical Equipment", Tata McGraw-Hill co ltd, New Delhi, 2006.
2	Bosch Automotive Electrics and Automotive Electronics, 5th Edition, Springer Vieweg, 2014.

REFERENCE BOOKS:

1	Ronald. K, Jurgen, "Automotive Electronics Handbook", McGraw Hill, New Delhi, 1999.
2	William B Ribbens, "Understanding Automotive Electronics – An engineering perspective", 8th Edition, Butterworth-Heinemann, 2017.
3	Hillier. V.A.W., Peter Coombes & David Rogers, "Hillier's Fundamentals of Motor Vehicle Technology", Nelson Thornes., United Kingdom, 2012.
4	Judge. A.W., "Modern Electrical Equipment of Automobiles", Chapman & Hall, London, 1992
5	https://nptel.ac.in/courses/108102121/

CO, PO and PSO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	2	2	2	1	2	1	-	1	1	-	2	3	3	1
CO 2	3	2	2	2	1	2	1	-	1	1	-	2	3	3	1
CO 3	3	2	2	2	1	2	1	-	1	1	-	2	3	3	1
CO 4	3	2	2	2	1	2	1	-	1	1	-	2	3	3	1
CO 5	3	2	2	2	1	2	1	-	1	1	-	2	3	3	1
AVG	3	2	2	2	1	2	1		1	1		2	3	3	1

Course Code	Course Name	Category	L	T	P	C
AT23532	**ELECTRIC AND HYBRID VEHICLES - II**	**PC**	**3**	**0**	**2**	**4**

OBJECTIVES:

- To give the students the basics about traction batteries and their charging technologies

- To make the students understand the importance of battery management in electric and hybrid electric vehicles.

- To make the students realise the potential of Fuel cells as primary energy storage systems.

- To make the students understand the basics of power electronics used in hybrid and electric vehicles.

- To make the students be aware of various testing standards, electromagnetic interference and its suppression techniques for electric vehicles.

UNIT I	Traction batteries and its charging	9

Targets and properties of batteries for EV and HEV. Construction, working principle and properties of Li-Po battery, Li ion battery, Nickel Metal Hydride Battery, Sodium Sulphur Battery and Aluminium Air Battery. Battery charging - battery charging profile. Fast charging affect health of battery cell- charging time – charging standards – charging methods – charging modes – vehicle to grid technology – Wireless power transfer charging. Estimation of battery pack capacity – BEV battery sizing.

UNIT II	Battery management systems	9

Functions of a BMS – Block diagram, main functions, sensing requirements, Cell/module level: cell voltage, cell/module temperature, (humidity, smoke, air/fluid flow), Pack level: current, pre-charge temperature, bus voltage, pack voltage, isolation, Control Requirements, Contactor control, pre-charge circuitry, Thermal system control, State of Charge estimation; State of Health estimation, Non-contact methods. Failure modes of individual cell & pack and its prognosis. Power estimation, Energy consumption estimation. Ageing of cells. Ultra capacitors and their role.

UNIT III	Fuel cells and other energy storage devices	9

Operation principles of fuel cells – Electrode potential and current-voltage curves. Types – Proton exchange membrane fuel cells, alkaline fuel cells, phosphoric acid fuel cells, molten carbonate fuel cells, solid oxide fuel cells, direct methanol fuel cells. Fuel cell hybrid drive train. Control strategy. Fuel processor, fuel storage integrated with fuel cell system,Power design of fuel cell system - Fuel cell characteristic curves- Energy flow in FCEV. Case study – Honda FCX. Energy storage in flywheels. Hydraulic and pneumatic hybrid systems

UNIT IV	Power Electronics	9

Semiconductor power diodes, transistors, MOSFET, IGBT, Thyristor, triacs, GTOs. AC-DC converters, DC-DC converters and types – buck, boost, fly back. Isolated converters. Inverters based on MOSFET. Microcontrollers/DSP based controllers, Types of sensors for electric drive, Current sensors and signal conditioners.

UNIT V	**Electromagnetic Interference and Testing**	**9**

EMI – Noise propagation modes – cabling – components – PCB EMC – SAE Automotive EMC standards – SAE J551- SAE J 1113 – Test methodology- Need for testing EVs – Safety checklist (AIS 038). – significance of isolation resistance - measurement of isolation resistance – water tests motor power test (AIS 041) – chassis dynamometer– Energy consumption test (AIS 039) – battery testing (AIS 048) –Range test (AIS 040).

	TOTAL :	**45**	**PERIODS**

List of Experiments

1. Vehicle Power and Energy Consumption Analysis

2. Modeling and Simulation of BLDC Motor Drive for EVs

3. Performance Analysis of Induction Motor Drive for EVs

4. Battery Management System (BMS) and SOC Estimation

5. Simulation of DC-DC Converter for Electric Vehicles

6. Simulation of Electric Vehicle Drivetrain with Different Drive Cycles

7. Torque-Speed Characteristics of PMSM and SRM for EVs

8. Thermal Management System for EV Battery Packs

TOTAL: 30 PERIODS

SOFTWARE REQUIREMENTS

MATLAB SIMULINK R2024a

COURSE OUTCOMES:

1. The students will be able to describe various traction batteries, their performance and charging techniques.
2. The students will be able to estimate the battery capacity and can suggest suitable cell balancing techniques for traction batteries.
3. The students will be able to explain of various fuel cells and their suitability for electric and hybrid vehicle application.

4. The students will be able to comprehend the operation of electronic controllers used in electric and hybrid vehicles.
5. The students will be aware of various testing standards and electromagnetic interference suppression techniques for electric vehicles.

TEXT BOOKS:

1. Iqbal Hussain. "Electric and Hybrid Vehicles Design Fundamentals". CRC Press, 2013

2. MehrdadEhsani, Yimin Gao, Ali Emadi, "Modern Electric, Hybrid Electric and Fuel cell Vehicles", CRC press, 2017.

REFERENCE BOOKS:

1. Gianfranco Pistoia. "Electric And Hybrid Vehicles Power Sources, Models, Sustainability, Infrastructure and The Market". Elsevier, 2010.
2. Jack Erjavec. "Hybrid, Electric & Fuel-Cell Vehicles". Cenage Learning, 2013. John Wiley & Sons, 2015.
3. MengChu Zhou, Advances in Battery Manufacturing, Service and Management System, IEEE press series on Systems Science and Engineering, 2016.
4. Philip Weicker, " A Systems Approach to Lithium Ion Battery Management", Artech House, London, 2014.
5. NPTEL course on Introduction to Hybrid and Electric Vehicles, https://nptel.ac.in/courses/108/103/108103009/

CO, PO and PSO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	2	1	1	1	3	2	1	1	1	-	3	2	-	-
CO 2	3	2	1	1	1	3	2	1	1	1	-	3	2	-	-
CO 3	3	2	1	1	1	3	2	1	1	1	-	3	2	-	-
CO 4	3	2	1	1	1	3	2	1	1	1	-	3	2	-	-
CO 5	3	2	1	1	1	3	2	1	1	1	-	3	2	-	-
AVG	3	2	1	1	1	3	2	1	1	1	-	3	2	-	-

Course Code	Course Name(Laboratory Course)	Category	L	T	P	C
AT23521	**TWO AND THREE WHEELERS LABORATORY**	**PC**	**0**	**0**	**2**	**1**

Objectives:	
●	To impart students with fundamentals of two-wheeler testing methods
●	To impart students with fundamentals principles of two and three-wheeler clutch and braking system
●	To impart students with fundamentals principles of gear boxes used in two and three wheeled vehicles
●	To impart students with fundamentals of chassis measurement of two and three wheelers.
●	To impart students with fundamentals of steering systems used in three wheelers and two wheelers.

List of Experiments	
1.	Performance test of a two-wheeler using chassis dynamometer.
2.	Dismantling and assembling of two-wheeler /three-wheeler engine
3.	Dismantling and study of front fork and suspension assembly of two-wheeler.
4.	Two-wheeler chain test and chain adjustment.

5.	Dismantling, assembly and maintenance of Disc and Drum Brake
6.	Dismantling and assembling of two-wheeler /three-wheeler gear box and finding gear ratios
7	Dismantling and study of Swing arm rear suspension assembly of two-wheeler.
8	Study of Steering geometry of two/ three-wheeler
9	Dismantling and assembling of three-wheeler steering system.
10	Study of three-wheeler chassis frame and power transmission system.
11	Study and draw wiring layout of a two/ three-wheeler.
	Total Contact Hours	**:**	**30**

Course Outcomes:
● The students will be able to describe basic knowledge in testing of two-wheeler vehicles.
● The students will be able to identify and explain the function of clutch and brake system used in two and three-wheeler vehicles.
● The students will be able to dismantle and assemble the two and three-wheeler gearboxes and find the gear ratios used.
● The students will be able to measure the dimensions of a three-wheeler chassis.
● The students will be able to dismantle and assemble the front fork assembly used in the two and three-wheeler steering system.

CO, PO and PSO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	1	1	-	-	-	-	1	1	-	-	3	2	-
CO 2	3	3	1	1	-	-	-	-	1	1	-	-	3	2	-
CO 3	3	3	1	1	-	-	-	-	1	1	-	-	3	2	-
CO 4	3	2	1	1	-	-	-	-	1	1	-	-	3	2	-
CO 5	3	2	1	1	-	-	-	-	1	1	-	-	3	2	-
AVG	3	2.6	1	1	-	-	-	-	1	1	-	-	3	2	-

Course Code	Course Name(Laboratory Course)	Category	L	T	P	C
AT23522	**COMPUTER AIDED VEHICLE DESIGN DATA CHARACTERISTICS**	PC	0	0	2	1

Objectives:

- To know about the various resistance acting on a vehicle and their effects.

- To calculate and draw the characteristic curves for the power, torque, tractive effort and acceleration with respect to vehicle speed.

- To calculate and draw the characteristic curves for various efficiencies with respect to engine speed and simulate the cylinder pressure with respect to crank angle of an engine.

- To calculate instantaneous velocity and acceleration of the piston and connecting rod with respect of crank angle.

- To find various forces and turning moment diagram with respect to crank angle.

	LIST OF EXPERIMENTS
	Theory of Various Resistances, Brake power required, Relationship between engine and vehicle speed, Tractive force, Equivalent vehicle weight, acceleration, grade ability, gear ratios, problems on vehicle performance.
1	Calculation of Air, Rolling and Total Resistances of the selected vehicle & Plotting them against vehicle speed.
2	Calculation of Brake Power and Brake torque of the engine of the selected vehicle & Plotting them against engine speed.
3	Calculation of Vehicle speed of the selected vehicle at each gear & Plotting them against engine speed.
4	Calculation of Tractive force of the selected vehicle at each gear & Plotting them against vehicle speed.
5	Calculation of Acceleration of the selected vehicle at each gear & Plotting them against vehicle speed.
	Theory of Engine performance parameters, Relationship between them, Bore to Stroke ratio, crank radius to connecting rod length ratio (λ), piston instantaneous velocity & acceleration, connecting rod instantaneous velocity & acceleration, P-V diagram, Gas force, inertia force & resultant force, side thrust, turning moment and combined turning moment.
6	Calculation of Brake thermal efficiency, Mechanical Efficiency, Volumetric Efficiency and Brake specific fuel consumption of the engine of the selected vehicle & Plotting them against engine speed.
7	Calculation of Cylinder Pressure at every crank angle of the cycle of the selected engine & Plotting them against crank angle.
8	Calculation of Brake mean effective Pressure of the engine of the selected vehicle from P-V diagram plotted from pressure, volume data calculated against each crank

	angle.			
9	Calculation of gas force, inertia force and resultant force & plotting them against each crank angle.			
10	Calculation of side thrust, turning moment and combined turning moment & plotting them against each crank angle.			
11	Calculate the wheel speed for Anti-lock Braking system simulation			
		Total	**:**	**30 PERIODS**

Course Outcomes:

1.   The students will be able to calculate the various resistances acting on a vehicle.

2.   The students will be able to draw the characteristic curves for the power, torque, tractive effort and acceleration with respect to vehicle speed for any given vehicle specification.

3.   The students will be able to estimate the various efficiencies and draw the p-V diagram for vehicular engine.

4.   The students will be able to plot the velocity and acceleration profile of piston using software.

5.   The students will be able to draw the turning moment diagram of engine with respect to crank angle

CO, PO and PSO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	2	3	3	3	-	-	-	2	2	2	2	3	-	2
CO 2	3	2	3	3	3	-	-	-	2	2	2	2	3	-	2
CO 3	3	2	3	3	3	-	-	-	2	2	2	2	3	-	2
CO 4	3	2	3	3	3	-	-	-	2	2	2	2	3	-	2
CO 5	3	2	3	3	3	-	-	-	2	2	2	2	3	-	2
AVG	3	2	3	3	3	-	-	-	2	2	2	2	3	-	2

Course Code	Course Name	Category	L	T	P	C
AT23631	**AUTOMOTIVE SYSTEM DESIGN**	PC	**2**	**1**	**2**	**4**
	Engine design Data book permitted					

Objectives:

●	To understand the design considerations and procedure for cylinder, piston and connecting rod.
●	To learn the design considerations and procedure for crankshaft, valve train
●	To know about the various load acting on axles, steering system, vehicle frame and suspension system
●	To draw 3D modelling of I.C.Engine components using 3D modelling software.
●	To draw 3D modelling of propeller shaft with universal joints using 3D modelling software.

UNIT I	DESIGN OF CYLINDER, PISTON AND CONNECTING ROD	9

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

UNIT-II	DESIGN OF CRANKSHAFT	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. Front and rear-end details.

| UNIT-III | DESIGN OF VALVE MECHANISM | 9 |

Rankine's formula – Johnson formula- design of push- rods, Materials for inlet and Exhaust Valve-Design of inlet & exhaust valves, valve springs, tappets, valve train, Design of rocker arm.

| UNIT-IV | FRONT AXLE, STEERING SYSTEM AND REAR AXLES | 9 |

Analysis of loads-moments and stresses at different sections of front axle. Determination of bearing loads at Kingpin bearings. Wheel spindle bearings. Choice of Bearings. Determination of optimum dimensions and proportions for steering linkages, ensuring minimum error in steering. Design of propeller shaft, final drive gearing, full floating, semi-floating and three quarter floating rear shafts and rear axle housings and final drive.

| UNIT-V | VEHICLE FRAME AND SUSPENSION | 9 |

Functions of Vehicle Frame and its types. Study of loads-moments and stresses on frame members. Design of frame for passenger and commercial vehicle- Frame Analysis under Torsion and Bending– Design of leaf Springs-Coil springs and torsion bar springs.

Case Study: Load Analysis of a Real Vehicle Frame

| | Total Contact Hours | : | 45 |

Text Books:	
1	U.C. Jindal, "Machine Design", Pearson Education, 2013.
2	Bhandari V, "Design of Machine Elements", 3rd Edition, Tata McGraw-Hill Book Co, 2016.
Reference Books / Web links:	

1	R.S. Khurmi & J. K. Guptha, "A Textbook of Machine Design", 34th edition, S. Chand publication. 2014.
2	Giri, N.K., "Automobile Mechanics", Khanna publishers, New Delhi, 2007
3	Jain. R. K, "Machine Design", Khanna Publishers, New Delhi, 2005.
4	Heldt, P.M., Automotive Chassis, Chilton Book Co., 1992.
5	Dean Averns, Automobile Chassis Design, Illife Book Co., 2001.

LIST OF EXPERIMENTS			
1.	Introduction to 3D geometric modelling and application of GD&T.		
2.	3D modelling of piston assembly.		
3.	3D modelling of connecting rod with complete details.		
4.	3D modelling of crankshaft assembly.		
5.	3D modelling of engine flywheel.		
6.	3D modelling of engine valves.		
7.	3D modelling of inlet and exhaust manifolds.		
8.	3D modelling of propeller shaft with universal joints.		
9.	3D modelling of final drive with axle housing.		
	TOTAL :	**30**	**PERIODS**

COURSE OUTCOMES:

1.The students will be able to explain and perform the design calculations for engine cylinder, piston and connecting rod. The students will be able to draw 3D modelling of piston and connecting rod.

2.The students will be able to describe and perform the design calculations for the crankshaft. The students will be able to perform 3D modelling of crankshaft

3.The students will be able to elucidate and carry out the design calculations for valve operating components. The students will be able to create 3D models of engine valves, manifolds and propeller shaft

4.The students will be able to calculate the various loads acting on the axles and steering system. The students will be able to draw 3D modelling of the propeller shaft with universal joints.

5.The students will be able to compute the loads acting on the vehicle frame and suspension system. The students will be able to make 3D modelling the final drive with axle housing.

TEXT BOOKS:

1. K. L. Narayana - Machine drawing, New Age International,2009.
2. R. K. Dhawan - A Text book on Machine Drawing, S. Chand Publishing, 2015.

LIST OF EQUIPMENTS

(for the batch of 30 students)

Sl. No.	Equipment Name	Nos.
1	**Computer System : i3, TFT** Color Monitor, 500 GB HDD, 4 GB RAM	30
2	Printer	1
3	**Software's like** CREO, CATIA	30 licenses

CO, PO and PSO Mapping

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	1	1	1	-	1	1	-	1	2	1	1
CO2	3	2	2	2	1	1	1	-	1	1	-	1	2	1	1
CO3	3	2	2	2	1	1	1	-	1	1	-	1	2	1	1
CO4	3	2	2	2	1	1	1	-	1	1	-	1	2	1	1
CO5	3	2	2	2	1	1	1	-	1	1	-	1	2	1	1
AVG	3	2	2	2	1	1	1	-	1	1	-	1	2	1	1

1-Slight (Low), 2- Moderate (Medium), 3- Substantial (High) , "-" No correlation

Course Code	Course Name	Category	L	T	P	C
AT23632	**VEHICLE DYNAMICS**	**PC**	**2**	**1**	**2**	**4**

OBJECTIVES:

1. To study the concept of vibration and types of vibration measuring instruments.
2. To impart knowledge about the various forces acting on tires and performance of tire.
3. To study about the various vertical forces acting on a vehicle
4. To identify the various longitudinal forces acting and control on a vehicle
5. To impart knowledge on various lateral forces acting on a vehicle.

UNIT I	**CONCEPT OF VIBRATION**	9

 Definitions, Modelling and Simulation, Free, Forced, Undamped and Damped Vibration, Response Analysis of Single DOF, Two DOF, Multi DOF, Magnification factor, Transmissibility, Vibration absorber, Vibration measuring instruments, Torsional vibration, Critical speed.

UNIT II	**TIRES**	9

Tire forces and moments, Tire structure, Longitudinal and Lateral force at various slip angles, rolling resistance, **Calculation of effective forces and radius on tire**, Tractive and cornering property of tire. Performance of tire on wet surface. Ride property of tire, Tire model, **Magic formula tire model,** Estimation of tire road friction. Test on Various Road surfaces. Tire 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 tire stiffness. Air suspension system and their properties.

UNIT IV	LONGITUDINAL DYNAMICS	9

Aerodynamic forces and moments. Equation of motion. Load distribution for three wheeler and four wheeler. Calculation of Maximum acceleration, Reaction forces for Different drives. Braking and Driving torque, **Brake Force Distribution, Braking Efficiency and Braking Distance**, Prediction of Vehicle performance. Structure of longitudinal control system, ABS, stability control, Traction control, stability of vehicle on slope.

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. Roll center, Roll axis, Vehicle under side forces. Stability of vehicle on banked road and curved road.

	TOTAL:	**45**	**PERIODS**

LIST OF EXPERIMENTS:

The following exercises can be included in vehicle dynamics as a MATLAB exercise

1.	Effect of stiffness and damping ratio of Single DOF spring mass system (Free Vibration)
2.	Response analysis of Single DOF spring mass system in Forced Vibration
3.	Response analysis of multi DOF spring mass system in Free Vibration
4.	Simulation study of Quarter car model for step input (by varying Suspension stiffness and suspension damping and tyre stiffness)
5.	Simulation study of Half car model for step input (by varying Suspension stiffness

	and suspension damping and tyre stiffness)			
6.	Simulation of steady state handling characteristics of a vehicle based on steering input (varying under steer coefficient)			
7.	Simulation study of vehicle stability on a banked road (various bank angle)			
8.	Simulation study of vehicle stability on a curved road (various speeds)			
		TOTAL :	**30**	**PERIODS**

COURSE OUTCOMES:

1. The students will be able to explain the concepts involved in vehicle vibration. The students will be able to calculate the natural frequency of Single DOF, multi DOF of free and forced vibrations using MATLAB.

2. The students will be able to explain the various forces acting on tyres and their performance.

3. The students will be able to calculate the various vertical forces acting on a vehicle. The students will be able to perform the simulation of Quarter car model and Half car model for step input using MATLAB.

4. The students will be able to describe the various longitudinal forces acting on a vehicle.

5. The students will be able to calculate the various lateral forces acting on a vehicle. The students will be able to simulate the steady state handling characteristics of a vehicle based on steering input, vehicle stability on a banked road and curved road-using MATLAB.

TEXT BOOKS:

1. Rajesh Rajamani, "Vehicle Dynamics and Control", 2nd edition, Springer, 2012

2. Thomas D. Gillespie, "Fundamentals of Vehicle Dynamics", Society of Automotive Engineers Inc, 1992

REFERENCE BOOKS/WEB LINK

1. Wong. J. Y., "Theory of Ground Vehicles", 4th Edition, John Wiley & Sons, 2008

2. Dean Karnopp, "Vehicle Stability", 1st Edition, Marcel Dekker, 2004

3. Reza N. Jazar, "Vehicle Dynamics: Theory and Application", 3rd Edition, Springer, 2017

4. Mike Blundell & Damian Harty, "The Multibody Systems Approach to Vehicle Dynamics", 2nd Edition, Butterworth-Heinemann, Elsevier, 2015

5. R. Krishnakumar, "Introduction to Vehicle Dynamics" Department of Engineering design, IITM. https://nptel.ac.in/courses/107106080/

CO, PO and PSO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	3	-	-	2	-	-	-	-	-	2	3	-	2
CO 2	3	3	3	2	2	-	1	-	-	-	-	2	3	-	1
CO 3	3	3	3	3	3	-	-	-	-	-	-	2	3	-	1
CO 4	3	3	3	3	2	1	-	-	-	-	-	2	3	-	1
CO 5	3	3	3	3	3	2	-	-	-	-	-	1	3	-	1
AVG	3	3	3	2.75	2.5	1.67	1	-	-	-	-	1.8	3	-	1.2

Course Code	Course Name	Category	L	T	P	C
AT23633	**AUTOMOTIVE FUELS AND LUBRICANTS**	PC	3	0	2	4

Objectives:	
1.	To study the world energy scenario in automotive sector and the conventional fuels for IC engines, its production, characteristics and additives
2.	To impart the knowledge of alternate liquid fuels for engines with their compatibility, performance and emission characteristics
3.	To understand the alternate gaseous fuels for engines with their compatibility, performance and emission characteristics
4.	To learn about the Air-Fuel ratio based on the engine operating conditions.
5.	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	**ALTERNATIVE LIQUID FUELS**	9

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

UNIT-III	ALTERNATIVE GASEOUS FUELS	9

Need for alternative gaseous fuels – Availability, Properties, Composition, Merits, Demerits, Performance and Emission characteristics of Hydrogen, Different types of Hydrogen, green hydrogen mission, hydrogen production and storage methods, 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 Contact Hours	:	45

LIST OF EXPERIMENTS	
1.	Study of International and National standards for fuels and lubricants.

2.	Study of Octane and Cetane Number of fuels.	
3.	Distillation test of liquid fuels	
4.	Aniline Point test of diesel	
5.	Calorific value of liquid fuel.	
6.	Calorific value of gaseous fuel.	
7.	Reid vapour pressure test.	
8.	Flash and Fire points of fuel and oil.	
9.	Copper strip Corrosion Test	
10.	Cloud & Pour point Test	
11.	Temperature dependence of viscosity of lubricants by Redwood Viscometer	
12.	Viscosity Index of lubricants by Saybolt Viscometer	
13.	Viscosity measurement of lubricant and fuels by kinematic viscosity bath	
14.	Ash content and Carbon Residue Test	
15.	Drop point of grease and mechanical penetration in grease.	
	TOTAL :	**30** **PERIODS**

LIST OF EQUIPMENTS

(for the batch of 30 students)

Sl. No.	Equipment Name	Nos.
1	Distillation test Apparatus	1 No.
2	Aniline point Apparatus	1 No.
3	Bomb Calorimeter	1 No.
4	Junkers Calorimeter	1 No.
5	Reid vapor pressure test Apparatus	1 No.
6	Flash and Fire point apparatus – Open and Closed cup	1 No. each
7	Abels flash point apparatus for Petrol Fuel	1 No.
8	Copper Strip Corrosion Test Apparatus	1 No.
9	Cloud and Pour point Apparatus	1 No.
10	Redwood Viscometer	1 No.
11	Saybolt Viscometer	1 No.
12	Kinematic viscosity bath	1 No.
13	Ash Content Test Apparatus	1 No.
14	Carbon Residue Test Apparatus	1 No.

15	Drop point and penetration Apparatus for grease	1 No.

Course Outcomes:	
On completion of the course students will be able to	
1.	Explain the distillation process, additives for fuels and characteristics of fuels.
2.	Discuss the need and performance characteristics of alternative liquid fuels for both SI and CI engines.
3.	Describe the need and performance characteristics of alternative gaseous fuels for both SI and CI engines
4.	Calculate and analyse A/F ratio for the engine operating conditions and also can estimate quantitatively the exhaust gas constituents.
5.	Explain the need for lubricants, factors influencing the engine lubrication and testing of fuels.

Text Books:	
1	B.P. Pundir, "IC Engines – Combustion and Emissions", Narosa Publication, 2017
2	S.S. Thipse, "Alternative Fuels", JAICO Publishing House, 2010.

Reference Books / Web links:	
1	EranSher "Handbook of Air Pollution from Internal Combustion Engines- Pollutant

	Formation and Control", Academic Press, 2011.
2	Marco P Nuti, "Emissions from two stroke engines", SAE Publication – 1998.
3	Sarkar, S., "Fuels And Combustion", Oriented Longmann Press, 1990.
4	Sterret, Frances S., "Alternative Fuels And The Environment", Lewis Publishers, 1994
5	Caines, Arthur J; Haycock, Roger F., "Automotive Lubricants Reference Book", Published By SAE International, 1996

CO, PO and PSO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	2	2	1	-	2	2	1	-	1	-	2	2	1	-
CO 2	3	2	2	1	-	2	2	1	-	1	-	2	2	3	-
CO 3	3	2	2	1	-	2	2	1	-	1	-	2	2	3	-
CO 4	3	3	2	1	-	2	2	1	-	1	-	2	2	2	-
CO 5	3	2	2	1	-	2	2	1	-	1	-	2	2	2	-
AVG	3	2.2	2	1	-	2	2	1	-	1	-	2	2	2.2	-

Course Code	Course Name	Category	L	T	P	C
GE23627	DESIGN THINKING AND INNOVATION	EEC	0	0	4	2

Objectives:
1. **To learn the design thinking concepts and deep understanding of user needs and experiences.**
2. **To find the problem statement and to develop innovative design solutions that address identified user challenges**
3. **To master the process of prototyping and iterating on designs.**
4. **To conduct thorough market analysis and financial planning**
5. **To effectively communicate design concepts and findings.**

UNIT I INTRODUCTION TO DESIGN THINKING

The design thinking concepts - Different design thinking models - Details of Stanford Design thinking process: Empathize, Define, Ideate, Prototype, Test

Activities:

·   **Case studies of successful domain-based Design Thinking and Innovative projects**

·   **Group discussions on design thinking**

UNIT II EMPATHISE AND DEFINE:

User research methods (interviews, surveys, observation, contextual inquiry) - Personal development- Journey mapping – Brainstorming Defining the design problem statement

Activities:

·   **Conducting user interviews and surveys**

·   **Creating user personas and journey maps**

· **Identifying key user needs and pain points**

· **Analyze the user needs and brainstorming to define problem statement**

UNIT III IDEATE AND CREATE:

Brainstorming techniques (e.g., mind mapping, SCAMPER) - Ideation tools (e.g., design thinking tools, concept sketching) - Concept generation and evaluation (e.g. Brainstorming)

Activities:

· **Group brainstorming sessions to select the best idea**

· **Creating concept sketches and prototypes**

· **Evaluating ideas based on user needs and feasibility**

UNIT IV PROTOTYPE AND TEST:

Low, Medium and high-level fidelity for prototyping-Usability testing -Iterative design

Activities:

· **Building low-fidelity prototypes (e.g., paper prototypes)**

· **Conducting usability tests with users**

· **Iterating on designs based on feedback**

UNIT V MARKET ANALYSIS AND IMPLEMENTATION:

Market research and analysis - Business model development- Financial Planning-Implementation strategies

Activities:

· **Conducting market research**

· **Developing a business model canvas**

· **Creating a financial projection**

·   **Developing an implementation plan**
Total : 45 Periods

Course Outcomes: On completion of the course, the students will be able to
1.   Construct design challenges and reframe the design challenge into design opportunity.
2.   Interview the user, and know the feelings of users to foster deep user understanding and be able to uncover the deep user insights and needs.
3.   Develop ideas and prototypes by brainstorming.
4.   Organize the user walkthrough experience to test prototype
5.   Develop smart strategies and implementation plans that will deliver/achieve the idea/solution deduced from earlier phases.

Assessment:

·   **Encourage students to work on real-world design challenges based on the user needs**

·   **Group presentations**

·   **Quizzes and exams**

·   **Final Project report and evaluation and also encourage for filing patent/ copyright / presenting in conference / publishing in journal**

Text Book(s):
1. Handbook of Design Thinking by Christian Müller-Roterberg, Kindle Direct Publishing, 2018.
2. Design Thinking – A Beginner's Perspective, by E Balagurusamy, Bindu Vijakumar, MC Graw Hill, 2024

Reference Books:
1. Design Thinking for Entrepreneurs and Small Businesses: Putting the Power of Design to Work – by Beverly Rudkin Ingle, Apress; 1st ed. Edition, 2013
2. Design Thinking: Understanding How Designers Think and Work by Nigel Cross, Bloomsbury Visual Arts; 2 edition 2023
3. Design thinking Guide: https://www.rcsc.gov.bt/wp-content/uploads/2017/07/dt-guide-book-master-copy.pdf
4. NPTEL Course on Design Thinking and Innovation By Ravi Poovaiah ; https://onlinecourses.swayam2.ac.in/aic23_ge17/preview
5. IITB Design course tools and Resources https://www.dsource.in/resource

CO, PO and PSO Mapping

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PS03
CO1	3	2	3	3	3	2	2	3	3	3	3	3	3	2	2
CO2	3	2	3	3	3	2	2	3	3	3	3	3	3	2	2
CO3	3	2	3	3	3	2	2	3	3	3	3	3	3	2	2
CO4	3	2	3	3	3	2	2	3	3	3	3	3	3	2	2
CO5	3	2	3	3	3	2	2	3	3	3	3	3	3	2	2
Avg	3	2	3	3	3	2	2	3	3	3	3	3	3	2	2

1-Slight (Low), 2- Moderate (Medium), 3- Substantial (High) , "-" No correlation

AT23711	AUTOMOTIVE POLLUTION AND CONTROL	Category	L	T	P	C
		PC	3	0	0	**3**
OBJECTIVES:						

1. To learn the sources and causes of emission from automobiles and their effect on human beings and the environment.

2. To make the student to understand the sources of emission from SI engine and methods to control the same

3. To study the sources of emission from CI engine and methods to control the same

4. To analyse the sources of noise and methods to reducing the noise

5. To understand the various methods to measure emission

UNIT I	EMISSION FROM AUTOMOBILES	8

Sources of Air Pollution. Various emissions from Automobiles — Formation — Effects of pollutants on environment and human beings - global warming – Acid Rain - National and International Emission standards - Automotive vehicle waste management - Old vehicle disposal, Recycling of Metals, Non-metals, tyres and liquids.

UNIT II	EMISSION FROM SPARK IGNITION ENGINE AND ITS CONTROL	10

Emission formation in SI Engines- Carbon monoxide & Carbon di oxide - Unburned hydrocarbon, NOx and PM — Effects of design and operating variables on emission formation – controlling of pollutants - fuel modifications – cylinder deactivation - Positive Crank case ventilation system, Evaporative Emission Control, Exhaust Gas Recirculation, Secondary air injection, thermal reactor, Catalytic converters Types – substrate, Wash coat and Catalyst, Cold start emission control - Close coupled catalytic converter, Catalyst deactivation-Hydrocarbon Adsorber- Lean de-NOx Catalysts- NOx traps.

UNIT III	EMISSION FROM COMPRESSION IGNITION ENGINE AND ITS CONTROL	10

Formation of White, Blue, and Black Smokes, Soot, Particulate Matter NOx, SOx, HC, CO and Intermediate Compounds – Significance Effect of design and Operating variables on Emission formation —Fuel modification/additives, CRDI - High Injection Pressure and Injection Rate Shaping and Multiple injection, EGR- EGR Cooling, EGR Control, Fumigation, Diesel Oxidation Catalysts, Diesel de-NOx Catalysts, NOx traps, SCR, Diesel Particulate Filters - DPF material, structure and regeneration.

UNIT IV	NOISE POLLUTION FROM AUTOMOBILES	8

Sources of Noise — Engine Noise, Transmission Noise, vehicle structural Noise, aerodynamics noise, Exhaust Noise. Noise reduction in Automobiles — Encapsulation technique for noise reduction — Silencer Design - Active cabin noise suppression - Active Exhaust noise suppression

UNIT V	TEST PROCEDURES AND EMISSION MEASUREMENTS	9

Test cycles for light and medium duty vehicles – US-EPA cycle, ECE and EUDC cycle, Japanese cycle, Indian driving cycles – steady state and transient cycles - SHED Test - Chassis dynamometer – Constant Volume Sampling (CVS) Procedure for driving cycles - Emission analyzers — NDIR, FID, Chemiluminescent Analyzer (CLA), Smoke meters, Gas Chromatography, Particulate Emission Measurement - Dilution Tunnel, Sound level meters.

		TOTAL :	45 PERIODS

COURSE OUTCOMES:

1. The students will be able to explain the sources and causes of emission and effects of emission on human beings and environment.
2. The students will be able to describe the sources of emission from SI engine and methods to control the same
3. The students will be able to examine the sources of emission from CI engine and methods to control the same
4. The students will be able to explain the sources of noise and methods to reducing the noise
5. The students will be able to describe the various methods to measure emission

TEXT BOOKS:	
1	B.P. Pundir, "Engine Emissions - Pollutant Formation and Advances in Control Technology" Narosa Publishing house Pvt. Ltd, 2011
2	Paul Degobert, "Automobiles and Pollution", EditionsTechnics, 1995

REFERENCE BOOKS:	
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	Automobile Pollution Control Engineering" – K. M. Gupta, Narosa Publishing House
5	AsifFaiz, Christopher S. Weaver, Michael P Walsh, "Air Pollution from Motor Vehicles – Standards and Technologies for Controlling Emissions" The world bank, Washington DC, 1996.

CO, PO and PSO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	2	1	1	1	3	2	1	1	1	-	3	2	-	-
CO 2	3	2	1	1	1	3	2	1	1	1	-	3	2	-	-
CO 3	3	2	1	1	1	3	2	1	1	1	-	3	2	-	-
CO 4	3	2	1	1	1	3	2	1	1	1	-	3	2	-	-
CO 5	3	2	1	1	1	3	2	1	1	1	-	3	2	-	-
AVG	3	2	1	1	1	3	2	1	1	1	-	3	2	-	-

AT23712	INTELLIGENT VEHICLE SYSTEM	Category	L	T	P	C
		PC	**3**	**0**	**0**	**3**
	OBJECTIVES:					

1. To learn the importance of IVS to the modern world and working principles of various ADAS systems.
2. To learn various principles and technologies used in connected vehicle systems.
3. To understand the basic ideology of autonomous driving
4. To understand the perception, prediction and routing of autonomous driving.
5. To understand the planning and control of autonomous driving.

UNIT I	INTRODUCTION TO INTELLIGENT VEHICLE SYSTEM	9

Need for IVS, Benefits, Modern trends in automotive industry, Goals and Visions for the Future. Overview of smart mobility.

ADAS (Advanced Driver Assistance Systems) - Driver Alertness Monitoring, Navigation system. Night Vision, Head-up Display, Adaptive Cruise Control (ACC), Curve speed warning system, Lane Departure Warning, Hill hold control, Adjustable Steering, Traffic assist system, Parking assistance, Automatic Braking.

UNIT II	CONNECTED VEHICLE SYSTEM	9

Introduction to V2V Communication, Telematics Control System, Vehicle -Vehicle interaction using TCS, Mirror link, Web link, App link, Apple Icar, Android car, V2I(Vehicle to infrastructure interaction), DSRC, vehicle OBU(OBD).

UNIT III	INTRODUCTION TO AUTONOMOUS DRIVING	9

Autonomous driving technology overview,Digital Ethics in Autonomous Driving- Ethical considerations for AI decision-making in critical situations. Autonomous driving algorithm – object recognition and tracking, autonomous driving client system and cloud platform. Autonomous vehicle localization - Localization with GNSS, LIDAR and HD map – visual odometry.

UNIT IV	PERCEPTION, PREDICTION AND ROUTING IN AUTONOMOUS DRIVING	9

Perception in Autonomous Driving – data sets, detection, segmentation and tracking, Introduction to Autonomous driving modeling - Planning and control – Traffic prediction – lane level routing.

UNIT V	DECISION PLANNING AND CONTROL IN AUTONOMOUS DRIVING	9

Behavioral Decision - Motion Planning – Vehicle and Road Model, Motion planning with path and speed planning. – Feedback control.

	TOTAL :	45 PERIODS

COURSE OUTCOMES:

1. Students will be able to describe the intelligent vehicle system and explain the convenience systems in vehicles.
2. Students will be able to explain the latest technologies and foster implementation in connected vehicle systems.
3. Students will be able to illustrate the object detection and tracking in autonomous driving
4. Students will be able to explain the perception, prediction and routing of autonomous driving.
5. Students will be able to explain the planning and control 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	Shaoshan Liu; Liyun Li; Jie Tang; Shuang Wu; Jean-Luc Gaudiot, "Creating AutonomousVehicle Systems", in Creating Autonomous Vehicle Systems, Morgan &Claypool, 2017.

REFERENCE BOOKS:

1	H. Cheng, Autonomous Intelligent Vehicles: Theory, Algorithms, and Implementation, Berlin:Springer, 2011.
2	Michael E. McGrath, "Autonomous Vehicles: Opportunities, Strategies, and Disruptions",Amazon, 2018

3	Andreas Herrmann, Walter Brenner, Rupert Stadler, "Autonomous Driving: How the Driverless Revolution will Change the World" Emerald Publishing, 2018
4	R. K. Jurgen, Navigation and Intelligent Transportation Systems - Progress in Technology, Automotive Electronics Series, Warrendale, PA: SAE International, 2014.
5	A. Eskandarian (Ed.), Handbook of Intelligent Vehicles, Springer-Verlag London Ltd, 2012.

CO, PO and PSO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	2	3	3	2	2	1	1	-	1	-	1	2	-	1
CO 2	3	2	3	3	2	2	1	1	-	1	-	1	2	-	1
CO 3	3	2	3	3	2	2	1	1	-	1	-	1	2	-	1
CO 4	3	2	3	3	2	2	1	1	-	1	-	1	2	-	1
CO 5	3	2	3	3	2	2	1	1	-	1	-	1	2	-	1
Avg	3	2	3	3	2	2	1	1	-	1	-	1	2	-	1

AT23713	**AUTOMOTIVE SAFETY**	Category	L	T	P	C
		PC	3	0	0	3

OBJECTIVES:

1. To comprehend the vehicle classifications, regulations and need for certification
2. To understand the various tests performed on brakes, steering system and vehicle related tests
3. To impart knowledge about the various tests performed on passenger safety and engine emissions.
4. To learn the various tests performed on the Individual Vehicle Components.
5. To learn about the various comfort and convenience systems in automobiles

UNIT I	**INTRODUCTION**	9

Design of the body for safety, energy equation, engine location, deceleration of vehicle inside passenger compartment, deceleration on impact with stationary and movable obstacle, concept of crumble zone, safety sandwich construction, Safety Standards.

UNIT II	**SAFETY CONCEPTS**	9

Active safety: driving safety, conditional safety, perceptibility safety, operating safety, passive safety: exterior safety, interior safety, deformation behaviour of vehicle body, speed and acceleration characteristics of passenger compartment on impact.

UNIT III	**SAFETY EQUIPMENTS**	9

Seat belt regulations, automatic seat belt tightener system, seat belt pre-tensioner, Head restraints, Child Seat Belt, collapsible steering column, tiltable steering wheel, air bags, electronic system for activating air bags, bumper design for safety, Seat Position Control. Auto dimming mirrors, Daytime running lights

UNIT IV	**ACTIVE SAFETY AND COLLISION AVOIDANCE SYSTEM**	9

Collision warning system, causes of rear end collision, frontal object detection, rear vehicle object detection system, object detection system with braking system interactions. Electronic Stability Control, Active vibration Control, Accident recorder, Event data recorder, Automatic Braking. Curve Speed Warning

UNIT V	COMFORT AND CONVENIENCE SYSTEM	9

Steering and mirror adjustment, Remote keyless entry, central locking system, Garage door opening system, tyre pressure control system, rain sensor system, Cabin environment controls, Head-up Display, Digital turn signals, Intelligent Speed Adaptation, Traffic assist, Hill hold control, Lane Correction, Lane Departure Warning, Night Vision. Blind spot recognition system, safety standard, case study.

	TOTAL :45 PERIODS

COURSE OUTCOMES:

1. The student will be able to derive the crash equation based on energy principles
2. The student will be able to explain active and passive safety.
3. The student will be able to illustrate the working of seat belts, air bags and other safety systems.
4. The student will be able to describe the working of collision warning system and integration with braking system
5. The student will be able to elaborate the various comfort systems in a vehicle.

TEXT BOOKS:

1. **Huang M.,** "Vehicle Crash Mechanics", CRC Press, Boca Raton, 2002.
2. **Segal D. J.,** "Crashworthiness of Vehicles: Structures, Occupant Protection, and Biomechanics", Springer, New York, 2015.

REFERENCE BOOKS/WEBLINK:

1. **Seiffert U., Wech L.,** "Automotive Safety Handbook", SAE International, Warrendale, 2003.
2. **Rajamani R.,** "Vehicle Dynamics and Control", Springer, New York, 2012.
3. **Huang M.,** "Vehicle Crash Mechanics", CRC Press, Boca Raton, 2002.
4. **Chan C-Y.,** "Fundamentals of Crash Sensing in Automotive Airbag Systems", SAE

International, Warrendale, 2000.

5. **Watzenig D., Horn M.,** "Automated Driving: Safer and More Efficient Future Driving", Springer, Cham, 2017

CO, PO and PSO Mapping

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PS03
CO1	3	2	1	1	-	-	1	-	-	-	-	2	3	1	-
CO2	2	2	2	1	-	-	1	-	-	-	-	2	3	1	-
CO3	2	3	3	2	-	-	1	-	-	-	-	2	3	1	-
CO4	2	3	2	3	-	-	1	-	-	-	-	2	3	1	-
CO5	2	2	2	1	-	-	1	-	-	-	-	2	3	1	-
Avg	2.2	2.4	2	1.6			1					2	3	1	

1-Slight (Low), 2- Moderate (Medium), 3- Substantial (High) , "-" No correlation

Course Code	Course Name	Category	L	T	P	C

AT23721	AI and ML for Automobile Engineers	PE	0	0	4	2

OBJECTIVES:

To enable students to apply the concepts of Artificial Intelligence and Machine Learning in the field of Automobile Engineering, students must choose one of the following topics, complete a mini-project, and submit a report.

LIST OF EXPERIMENTS

1. AI in Vehicle Health Monitoring Systems.
2. AI and ML in Fuel Efficiency and Emissions Control.
3. Driver Assistance Systems.
4. Smart Traffic Management.
5. AI in Connected Vehicles
6. AI in Electric and Hybrid Vehicles
7. AI in Vehicle Dynamics and Control Systems.
8. AI in Fleet Management
9. AI in Supply Chain and Inventory Management
10. AI in Crash Prediction and Prevention
11. AI in Road Infrastructure and Maintenance
12. Human-Centered AI in Automobiles

	TOTAL	45	PERIODS

COURSE OUTCOMES:

1.The students will be able to explain tracking of objects and in estimation algorithms of integrated vehicle safety functions.

2.   The students will be able to perform program for prevent accidents in complex traffic situations involving many dynamic road users, methods of machine learning

3.   The students will be able to use of machine learning techniques in combination with model-based approaches for safety-critical applications.

TEXT BOOKS:

1.Pattern Recognition and Machine Learning, Christopher M. Bishop

REFERENCE BOOKS and web link:

1. Artificial Intelligence: A Modern Approach, Stuart J. Russell and Peter Norvig

2. https://www.it-jim.com/blog/applications-of-artificial-intelligence-in-automotive-industry/

CO PO and PSO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	3	3	3	3	-	3	-	-	-	1	3	-	1
CO 2	3	3	3	3	3	3	-	3	-	-	-	1	3	-	1
CO 3	2	2	2	3	2	3	-	3	-	-	-	1	3	-	1
CO 4	2	3	3	3	2	3	-	3	-	-	-	1	3	-	1
CO 5	1	1	2	3	2	3	-	3	-	-	-	1	3	-	1
Impact	2.2	2.4	2.6	3	2.4	3	-	3	-	-	-	1	3	-	1

AT23722	**VEHICLE MAINTENANCE LABORATORY**	**Category**	**L**	**T**	**P**	**C**
		PC	**0**	**0**	**2**	**1**

OBJECTIVES:

1. To know about the tune up of gasoline and diesel engines and also the calibration of the fuel injection pump.
2. To provide a clear view on the fault diagnosis of engine and transmission system
3. To impart knowledge about the fault diagnosis for driveline and braking system
4. To learn and visualize the fault diagnosis for suspension and steering system
5. To provide a clear view on the fault diagnosis of car electrical and air conditioning system

STUDY EXPERIMENTS:

1. Tools and instruments required for maintenance

2. Safety aspects with respect to man, machine and tools

3. General procedures for servicing and maintenance schedule

4. Wheel Alignment procedure

LIST OF EXPERIMENTS:

1.	Minor and major tune up of gasoline and diesel engines
2.	Calibration of Fuel pump
3.	Engine fault diagnosis using scan tool
4.	Fault diagnosis and service of transmission system
5.	Fault diagnosis and service of driveline system

6.	Fault diagnosis and service of braking system
7.	Fault diagnosis and service of suspension system
8.	Fault diagnosis and service of steering system
9.	Fault diagnosis and service of Electrical system like battery, starting system, charging system, lighting system etc.
10.	Fault diagnosis and service of vehicle air conditioning system
11.	Practice the following: i. Adjustment of pedal play in clutch, brake, hand brake lever and steering wheel play. ii. Air bleeding from hydraulic brakes, air bleeding of diesel fuel system. iii. Wheel bearings tightening and adjustment. iv. Adjustment of head lights beam. v. Removal and fitting of tire and tube.
12.	Fault diagnosis of Electrical vehicle

	TOTAL :	30	PERIODS

COURSE OUTCOMES:

1. The students will be able to perform a major and minor tune up of gasoline and diesel engines and will be able to calibrate the fuel pump
2. The students will be able to do fault diagnose and service the engine and transmission system using scan tool
3. The students will be able to perform fault diagnose and service the driveline and braking system
4. The students will be able to demonstrate the servicing procedure of suspension and steering system
5. The students will be able to explain servicing procedure with diagnose the electrical and

air conditioning system

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS		
S. No.	NAME OF THE EQUIPMENT	Qty.
1.	Engine Analyzer	1 No.
2.	Cylinder compression pressure gauge	1 No.
3.	Vacuum gauge	1 No.
4.	Spark plug cleaner and tester	1 No.
5.	Cam angle and rpm tester	1 No.
6.	Tachometer	1 No.
7.	Wheel alignment apparatus	1 No.
8.	Gas welding equipment	1 No.
9.	Tyre remover	1 No.

No.	Item	Quantity
10.	Bearing puller	1 No.
11.	Head light alignment gauge	1 No.
12.	Service manuals of petrol, diesel engines	1 No.: each
13.	Cylinder reboring machine	1 No.
14.	Valve grinding machine 1 No.	1 No.
15.	Valve lapping machine 1 No.	1 No.
16.	Fuel injection calibration test bench with nozzle tester	1 No.
17.	HRD tester, Clamp on meter, Hydrometer	1 No.: each

CO PO and PSO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	2	3	3	2	1	1	-	-	2	1	2	2	3	-	1
CO 2	2	3	3	2	1	1	-	-	2	1	2	2	3	-	1
CO 3	2	3	3	2	1	1	-	-	2	1	2	2	3	-	1
CO 4	2	3	3	2	1	1	-	-	2	1	2	2	3	-	1
CO 5	2	3	3	2	1	1	-	-	2	1	2	2	3	-	1
Impact	2	3	3	2	1	1	-	-	2	1	2	2	3	-	1

AT23723	**COMPUTER AIDED ANALYSIS LABORATORY**	Category	L	T	P	C
		PC	**0**	**0**	**2**	**1**

OBJECTIVES:

1. To equip students with the ability to perform stress and frequency analyses on mechanical components using computational tools.
2. To develop proficiency in analyzing thermal and structural behavior under various loading and boundary conditions.
3. To enable students to predict fatigue life and optimize mechanical components for reliability and safety.
4. To impart knowledge on modal and harmonic frequency analyses for understanding vibration characteristics.
5. To enhance the application of thermal optimization techniques to improve component performance and efficiency.

	LIST OF EXPERIMENTS
1	Stress and Mode frequency analysis of beams (Cantilever, Simply supported, Fixed ends).
2	Stress analysis of a chassis frame and predicting the behavior of longitudinal member during braking and acceleration.
3	Stress and Thermal analysis of Piston and piston pin.
4	Stress analysis of connecting rod and predicting the fatigue life.
5	Fatigue Analysis of Crankshaft by using transient and static structural analysis.
6	Stress and Fatigue analysis of suspension control arm.
7	Mode and harmonic frequency analysis of a SDOF spring mass system and predicting the conditions of critically damped, over damped and under damped

8	Bending, Torsional and Mode frequency analysis of propeller shaft.
9	Predicting the fatigue life analysis of disc brake using Steady thermal and transient thermal analysis.
10	Thermal Analysis and optimization of fins
11	Thermal analysis of Exhaust Valve
	TOTAL :30 PERIODS
	COURSE OUTCOMES:

1. The students will be able to apply computational tools to perform stress and mode frequency analysis on beams and mechanical components to evaluate structural performance.
2. The students will be able to analyze the thermal and structural behavior of mechanical systems under various loading and boundary conditions to predict operational efficiency.
3. The students will be able to perform fatigue life analysis and implement optimization techniques to improve the reliability and safety of mechanical components.
4. The students can conduct modal and harmonic frequency analyses to understand and interpret the vibration characteristics of mechanical systems.
5. The students can Utilize computational methods to perform thermal analysis and optimize the performance of mechanical components for enhanced efficiency and durability.

LIST OF EQUIPMENTS

(for the batch of 30 students)

Sl. No.	Equipment Name	Nos.
1	**Computer System : Computer System : i3, TFT** Colour Monitor, 500 GB HDD, 4 GB RAM	35
2	Printer	1

3	**Software:** Suitable analysis software (example ANSYS)	35 licenses
4	C / MATLAB	35 licenses

	TEXT BOOKS:
1	Erdogan Madenci, Ibrahim Guven, "The finite element method and applications in engineering using ANSYS" Springer Publication, First Indian Edition 2011.
2	Paleti Srinivas, Sambana Krishna Chaitanya Datti Rajesh Kumar, "Finite Element Analysis Using Ansys 11.0", Phi Learning Private Limited, 2010

CO PO and PSO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	2	3	2	2	1	3	2	3	3	2	3	3	3	2	3
CO 2	1	1	2	3	1	2	3	2	3	2	3	2	3	2	3
CO 3	1	1	1	3	2	2	2	3	2	2	2	2	3	1	3
CO 4	1	1	2	3	2	1	1	2	3	3	1	2	3	2	3
CO 5	1	2	2	3	2	1	1	2	3	3	2	2	2	1	3
Avg	1.2	1.6	1.8	2.8	1.6	1.8	1.8	2.4	2.8	2.4	2.2	2.2	2.8	1.6	3

Open Elective Course

Sl. No.	SEM	Course Code	Course Name	Category	Total Hrs	L	T	P	C
1	OE	OAT2311	**Automotive Systems**	OE	3	3	0	0	3
2	OE	OAT2312	**Elements of Electric and Hybrid Vehicles**	OE	3	3	0	0	3

Course Code	Course Name	Category	L	T	P	C
OAT2311	AUTOMOTIVE SYSTEMS	OE	3	0	0	3

Course Objective:

1. To make the students gain knowledge about the layout of an automobile and various parts of an engine.
2. To provide a clear view on the working and types of suspension systems.
3. To provide knowledge about the working and types of clutch and brake systems.
4. To discuss the construction and working principle of transmission systems.
5. To impart knowledge about steering system and final drive

UNIT-I	ENGINE MOUNTING AND FRAME	9

Vehicle Classification and Layouts Study various vehicle layouts as front engine and front wheel drive, front engine & rear wheel drive, rear engine & rear wheel drive, Four wheel drives, Chassis Frames and Body Types of Chassis frames & body

UNIT-II	SUSPENSION SYSTEM	9

Material, Unitized construction Suspension System Purpose, Types of suspension system, Front and rear suspension, Coil spring, types of rubber & Leaf spring, Torsion bars, Shock absorbers, Air and rubber suspension, Plastic suspensions, Hydro-pneumatic suspension, Independent suspension

UNIT-III	CLUTCH, BRAKING SYSTEM	9

Recent advances in Clutch and Brakes Electromagnetic and hydraulic clutches, Lining material, Release mechanism, Fluid flywheel Function, Internal expanding brakes, Brake lining material, Properties, Hydraulic braking system, Brake oil, Bleeding of brakes, Pneumatic braking system, Vacuum brakes, Exhaust brakes, Electrical brakes, Parking brake

and braking efficiency		
UNIT-IV	TRANSMISSION SYSTEM	9
Components of transmission system, Automatic transmission system Semi-automatic and automatic transmission system Requirements, types, Torque converter, Hydro-static and hydro-dynamic transmission, Continuously variable transmission, Belt and friction drive		
UNIT-V	STEERING, TYRE AND FINAL DRIVE	9
Types of Steering system and Steering gears, Steering geometry, Wheel alignment, Power steering, Types of front axle& stub axles, Propellers shaft, Types of drive as torque tube and hotch kiss drive, Final drive types, Type of drive axles & differential – double reduction gear and clutch type differential, Fully or semi floating and three quarter floating, . Tractive efforts and draw bar pull, Tyres Types of wheel rims, Tread patterns, Types of tyres, Cross ply, Radial & tubeless tyres,		
	Total Contact Hours :	45

Course Outcomes:

1.   The students will be able to demonstrate the different layouts used in automobiles and function of all the engine parts.

2.   The students will be able to describe the suspension system

3.   The students will be able to illustrate the various parts of the clutch and braking system.

4.   The students will be able to explain the working of transmission and its types.

5. The students will be able to elucidate steering and final drive

Text Books:	
1	Kirpal Singh, "Automobile Engineering Vol.1& 2", Standard Publisher Distributors, 14th Edition, 2017.
2	R.S. Khurmi& J. K. Guptha, "A Textbook of Machine Design", 34th edition, S. Chand publication. 2014.
3	R K Rajput " A Textbook of Automobile engineering" Lakshmi Publication pvt. Ltd.,
4	Automobile Engineering Vol-I & II Dr. K.M. Gupta

REFERENCE BOOKS:
1.Devaradjane. Dr. G., Kumaresan. Dr. M., "Automobile Engineering", AMK Publishers, 2013.
2.Judge.A.W., "Modern Transmission System", Chapman and Hall Ltd, 2000.
3. Giri, N.K., "Automobile Mechanics", Khanna publishers, New Delhi, 2007
4. Automotive mechanics by W. Crouse, - TMH.
5. Motor vehicle Newton and steed

Course Code	Course Name	Category	L	T	P	C
OAT2312	ELEMENTS OF ELECTRIC AND HYBRID VEHICLES	OE	3	0	0	3

OBJECTIVES:

1. To understand the need for alternative power train system

2. To provide adequate knowledge in high energy and power density batteries and fuel cells.

3. To give basic knowledge in power controls and motors used in EV and HEV applications.

4. To make the students understand the calculations involved in the basic design of electric vehicle

5. To understand the fundamentals of hybrid electric vehicle

UNIT I	NEED FOR ALTERNATIVE SYSTEM	9

Energy demands for transportation sector- Emission regulations-Need of electric vehicles hybrid vehicles – comparative study of diesel, petrol, pure electric and hybrid vehicles. Limitations of electric vehicles. Basic layout of electric and hybrid vehicles

UNIT II	ENERGY SOURCES : BATTERIES AND FUEL CELLS	9

Battery Parameters-Power requirement of electric vehicles- Different types of batteries - Lead acid- Nickel based-Sodium based-Lithium based- Metal Air based. Battery charging- Charger design- Quick charging devices- Charging profile for batteries. Battery Management System. Fuel Cell- Fuel cell characteristics- Fuel cell types-Hydrogen fuel cell- Connecting cell in series- water management in the PEM fuel cell- Thermal Management of the PEM fuel cell

UNIT III	TRACTION MOTORS AND CONTROLLERS	12

Requirements of motors for EV and HEV application. Characteristic of permanent magnet and separately exited DC motors.PMSM and SRM motors- AC single phase and 3-phase motor – inverters – DC and AC motor speed controllers. DC-DC convertors – AC-DC convertors. DC-AC convertors.

UNIT IV	VEHICLE DESIGN CONSIDERATIONS FOR ELECTRIC VEHICLES	6

Aerodynamic-Rolling resistance- Transmission efficiency- Vehicle mass- Electric vehicle chassis and Body design considerations - Gradability requirements. Heating and cooling systems- Controllers- Power steering- Tyre choice- Wing Mirror, Aerials and Luggage racks

UNIT V	HYBRID VEHICLES	9

Concept of hybridization. Types of Hybrid- Series, parallel, split – parallel, series - parallel - Advantages and Disadvantages. Power split device – Energy Management System - Design consideration - HEV driving modes. Plug-in hybrid vehicles. Case study – Toyota prius, Honda civic.

	Total : 45 PERIODS

COURSE OUTCOMES:

1. The students will be able to explain the various alternative power trains for automobiles.

2. The students will be able to suggest high energy and power density batteries for automotive application.

3. The students will be able to suggest suitable motor that can be used for a given category of EV.

4. The students will be able to calculate the different resistance experienced by the automobile and arrive at the power requirement for EV propulsion.

5. The students will be able to explain of the fundamentals of hybrid electric vehicles.	

Text Books:

1	James Larminie and John Lowry, "Electric Vehicle Technology Explained " John Wiley & Sons,2003
2	Iqbal Husain, " Electric and Hybrid Vehicles-Design Fundamentals", CRC Press,2003
3	MehrdadEhsani, " Modern Electric, Hybrid Electric and Fuel Cell Vehicles", CRC Press,2005

Reference BOOKS:

1	Ron HodKinson, "light Weight Electric/ Hybrid Vehicle Design", Butterworth Heinemann Publication,2005
2	Lino Guzzella, " Vehicle Propulsion System" Springer Publications,2005
3	"Introduction to hybrid and electric vehicles", Department of electrical engineering, IITG. https://archive.nptel.ac.in/courses/108/103/108103009/#