B.Tech. – III Year I Semester

S.No.	Category	Title	L	T	P	Credits
1	Professional Core	Theory of Machines	3	0	0	3
2	Professional Core	Automobile Components and Chassis Design	3	0	0	3
3	Professional Core	Manufacturing Technology	3	0	0	3
4	Professional Elective - I	1. Facility Layout & Design 2. Automobile ECU Design and system Integration 3. Computer Vision & Image Processing 4. Alternative Fuels 5. Fuels and Lubricants 6. MOOC's/NPTEL	3	0	0	3
5	Open Elective-I	OR Entrepreneurship Development & Venture Creation 1. Basic Automobile Engineering 2. Automotive Electrical and Electronics 3. IC Engine Technology	3	0	0	3
6	Professional Core	Manufacturing Technology Lab	0	0	3	1.5
7	Professional Core	Material Testing Lab (MOS & MMS Lab)	0	0	3	1.5
8	Skill Enhancement course	Automobile Sketching & Drawing	0	1	2	2
9	Engineering Science	**Tinkering Lab**	0	0	2	1
10	Evaluation of Community Service Internship		-	-	-	2
	Total		**15**	**1**	**10**	**23**
MC	Minor Course (Student may select from the same specialized minors pool)		3	0	3	4.5
MC	Minor Course through SWAYAM / NPTEL (Minimum 12 Week, 3 credit course)		3	0	0	3
HC	Honors Course (Student may select from the same Honors pool)		3	0	0	3
HC	Honors Course (Student may select from the same Honors Pool)		3	0	0	3

B.Tech. III Year II Semester

S.No.	Category	Title	L	T	P	C
1	Professional Core	Vehicle Dynamics	3	0	0	3
2	Professional Core	Vehicle Body Engineering	3	0	0	3
3	Professional Core	Hybrid and Electric Vehicle Technology	3	0	0	3
4	Professional Elective-II	1. Metal Forming & Press Working 2. Battery Technology 3. Machine Learning 4. Condition Monitoring 5. Engine Management Systems 6. MOOC's/NPTEL	3	0	0	3
5	Professional Elective - III	1. CFD for Automobile Applications 2. Modeling and Simulation in Manufacturing 3. Lean Manufacturing 4. Automobile HVAC 5. Sensors and Actuators 6. MOOC's/NPTEL	3	0	0	3
6	Open Elective – II	1. Two & Three Wheelers 2. Hybrid and EV Technology 3. Alternative fuels for IC Engines	3	0	0	3
7	Professional Core	Vehicle Evaluation Lab	0	0	3	1.5
8	Professional Core	Vehicle Maintenance Lab	0	0	3	1.5
9	Skill Enhancement course	Automobile ECU, Sensors and Actuators Integration Lab	0	1	2	2
10	Audit Course	Technical Paper Writing & IPR	2	0	0	-
	Total		**20**	**1**	**08**	**23**
	Mandatory Industry Internship of 08 weeks duration during summer vacation					
MC	Student may select from the same minors pool		3	0	3	4.5
MC	Minor Course (Student may select from the same specialized minors pool)		3	0	0	3
HC	Student may select from the same honors pool		3	0	0	3
HC	Honors Course (Student may select from the honors pool)		3	0	0	3

MINOR SPECIALIZATION

For the Honors/Minor Specialization student needs to complete 18 credits in addition to 160 credits.

S.NO.	Title	L	T	P	Credits
	Minors in Automobile Engineering				
1	Basic Automobile Engineering	3	-	-	3
2	IC Engines	3	-	-	3
3	Vehicle Body Engineering	3	-	-	3
4	Automobile Electrical & Electronics Engineering	3	-	-	3
5	Electrical Vehicles and Hybrid Technology	3	-	-	3
6	Automobile Pollution and its effects	3	-	-	3
	Total				18

S.NO.	Title	L	T	P	Credits
	Honors in Automotive Design Engineering				
1	Noise Vibrations and Harshness	3	-	-	3
2	Automobile Safety	3	-	-	3
3	Special Purpose Vehicles	3	-	-	3
4	Automobile Certification and Homologation	3	-	-	3
5	Vehicle Infotronics	3	-	-	3
6	Materials and Automotive Manufacturing Techniques	3	-	-	3
	Total				18

III Year I Semester	THEORY OF MACHINES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To study about the kinematic links, different types of pairs, mechanisms and principles involved in assessing the displacement, velocity and acceleration at any point in a link of a mechanism.
2. To understand the kinematic aspects of friction involved in machineries such as belts, clutches and brakes
3. To understand the basic concepts of toothed gearing and kinematics of gear trains.
4. To understand the motion resulting from a specified set of linkages and cam mechanisms for specified output motions.
5. To understand the undesirable effects of unbalancing resulting from prescribed motions in mechanism.

UNIT – I:
Mechanisms: Machine Structure – Kinematic link, pair and chain – Grublers criteria – Constrained motion – Degrees of freedom – Slider crank and crank rocker mechanisms – Inversions – Applications – Kinematic analysis of simple mechanisms – Determination of velocity and acceleration

UNIT – II:
Friction: Friction in screw and nut – Pivot and collar – Thrust bearing – Plate and disc clutches – Belt (flat and V) and rope drives. Ratio of tensions – Effect of centrifugal and initial tension – Condition for maximum power transmission – Open and crossed belt drive.

UNIT – III:
GEARS: Gear profile and geometry – Nomenclature of spur and helical gears – Gear trains: Simple, compound gear trains and epicyclic gear trains – Determination of speed and torque.

UNIT – IV:
CAMS: 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
BALANCING: Static and dynamic balancing – Single and several masses in 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.

UNIT – V:

VIBRATION: 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.

Text Books:
1. Rattan.S.S, "Theory of Machines", Tata McGraw–Hill Publishing Co., New Delhi, 2004.
2. Ballaney.P.L, "Theory of Machines", Khanna Publishers, New Delhi, 2002.

Reference Books:
1. Rao,J.S and Dukkipati, R.V, "Mechanism and Machine Theory", Second Edition, Wiley Eastern Ltd., 1992.
2. Malhotra, D.R and Gupta, H.C., "The Theory of Machines", Satya Prakasam, Tech. India Publications, 1989.
3. Gosh, A. and Mallick, A.K., "Theory of Machines and Mechanisms", Affiliated East West Press, 1989.
4. Shigley, J.E. and Uicker, J.J., "Theory of Machines and Mechanisms", McGraw-Hill, 1980.
5.Burton Paul, "Kinematics and Dynamic of Planer Machinery", Prentice Hall, 1979.

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

CO's	Statements	Bloom's Level
CO1	Demonstrate the fundamentals of mechanisms and their applications and able to analyse the kinematic properties of mechanism such as displacement, velocity and acceleration	L3
CO2	Analyse the effect of friction in machines such as belt drives, clutches and brakes	L4
CO3	Understand the basic nomenclature of gears and analyze gear kinematics	L2
CO4	Perform the kinematic analysis of cam and demonstrate the balancing of any kinematic system.	L3

III Year I Semester	**AUTOMOBILE COMPONENTS AND CHASSIS DESIGN**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:
1. To make students familiar with the constructional details of chassis and components.
2. To understand about various steering systems, steering linkages and steering gear boxes.
3. To understand the principle of suspension system.
4. To learn the gear box design .
5. To learn the principles of CVT

UNIT – I: Chassis Design
Center of Gravity and handling properties –Body weight & Body center of gravity – Mass Moment of Inertia. Vehicle Frame: Study of Loads –Moments and Stresses on Frame Members. Design of Frames for Passenger and Commercial Vehicle.

UNIT – II: Steering Design
Rack & Pinion: Advantages & Disadvantages, Configurations, Steering gear, manual with side tie rod takeoff, Steering gear, manual with centre tie rod take-off Recirculating Ball type: Advantages & Disadvantages, Steering Gear, Power Steering Systems: Hydraulic, Electro-Hydraulic and Electrical systems and Steering Kinematics: Maximum displacement of Rack, Calculation of inner and outer wheel angles, Length of Tie rod.

UNIT – III: Suspension System
Wheel travel requirement, Sprung & un-sprung mass distribution, Calculation of Tyre rolling radius, checking of camber change & Toe Change, front view swing arm length, side view swing arm length, Calculation of Jacking force & its effects on suspension, Camber change rate, Wheel base and wheel track change, Anti Dive and Anti- squat considerations

UNIT – IV: Gear Box Design
In-line shaft arrangement, Internal gear arrangement, Face-dog selectors, Bearing arrangement, Crown wheel and pinion layout, Differential location and type, Transverse-shaft arrangement, Selector system, Selector interlock system, Lubrication method and Gearbox casing.

UNIT – V: Continuous Variable Transmission (CVT)
Tuning of CVT: Speed & Power- Shift speed, engagement speed, power curves; Drive ratio & efficiency; Driven (secondary) clutch; Driving (primary) clutch; Pressure Spring; Fly weight System, Belt, and Gearing.

Text Books:

1. Automotive Chassis by Jonsen Reimpell, Butterworth Heinemann Pub, 2001.
2. Automotive Chassis Volume 1 by Giancarlo Genta & Lorenzo Morello, Springer, 2009.
3. Clutch Tuning Hand Book by Olav Aaeen, for serious racers and one who wants more performance from their variable ratio belt transmission.

Reference Books:

1. Automotive Chassis Volume 2 by Giancarlo Genta & Lorenzo Morello, Springer, 2009.
2. Manual Gear Box Design by Alec Stokes, SAE International, Butterworth Heinemann Pub, 1992.

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

CO's	Statements	Bloom's Level
CO1	Design the frames for the passenger and Commercial vehicles	L3
CO2	Design various vehicle components.	L3
CO3	Understand the different steering systems design	L2
CO4	Summarize the need for suspension systems and its types	L3

III Year I Semester	**MANUFACTURING TECHNOLOGY**	L	T	P	C
		3	0	0	3

Course Objectives:

1. To study the concepts and basic mechanics of metal cutting and the factors affecting machinability.
2. To learn working of basic and advanced turning machines.
3. To teach the basics of machine tools with reciprocating and rotating motions and abrasive finishing processes.
4. To study the basic concepts of CNC of machine tools and constructional features of CNC.
5. To learn the basics of CNC programming concepts to develop the part programme for Machine centre and turning centre.

UNIT – I:

MECHANICS OF METAL CUTTING: Mechanics of chip formation, forces in machining, Types of chip, cutting tools – single point cutting tool nomenclature, orthogonal and oblique metal cutting, thermal aspects, cutting tool materials, tool wear, tool life, surface finish, cutting fluids and Machinability.

UNIT – II:

TURNING MACHINES: Centre lathe, constructional features, specification, operations – taper turning methods, thread cutting methods, special attachments, surface roughness in turning, machining time and power estimation. Special lathes - Capstan and turret lathes- tool layout – automatic lathes: semi-automatic – single spindle: Swiss type, automatic screw type – multi spindle

UNIT – III:

RECIPROCATING MACHINE TOOLS: Reciprocating machine tools: shaper, planer, slotter: Types and operations- Hole making: Drilling, reaming, boring, tapping, type of milling operations-attachments- types of milling cutters– machining time calculation - Gear cutting, gear hobbing and gear shaping – gear finishing methods Abrasive processes: grinding wheel – specifications and selection, types of grinding process – cylindrical grinding, surface grinding, centreless grinding, internal grinding - micro finishing methods

UNIT – IV:

CNC MACHINES: Computer Numerical Control (CNC) machine tools, constructional details, special features – Drives, Recirculating ball screws, tool changers; CNC Control systems – Open/closed, point-to-point/continuous - Turning and machining centres – Work holding methods in Turning and machining centres, Coolant systems, Safety features**.**

UNIT – V:

PROGRAMMING OF CNC MACHINE TOOLS: Coordinates, axis and motion, Absolute vs Incremental, Interpolators, Polar coordinates, Program planning, G and M codes, Manual part programming for CNC machining centers and Turning centers – Fixed cycles, Loops and subroutines, Setting up a CNC machine for machining.

Text Books:
1. Kalpakjian. S, "Manufacturing Engineering and Technology", Pearson Education India,7th Edition, 2018.
2. Michael Fitzpatrick, Machining and CNC Technology, McGraw-Hill Education; 4th edition, 2018.

Reference Books:
1.Roy. A. Lindberg, Processes and materials of manufacture, PHI / Pearson education, 2006.
2. Geofrey Boothroyd, "Fundamentals of Metal Machining and Machine Tools", McGraw Hill, 1984.
3. Rao. P.N "Manufacturing Technology," Metal Cutting and Machine Tools, Tata McGraw-Hill, New Delhi, 2009.
4. A. B. Chattopadhyay, Machining and Machine Tools, Wiley, 2nd edition, 2017.
5. Peter Smid, CNC Programming Handbook, Industrial Press Inc.;Third edition, 2007.

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

CO's	Statements	Bloom's Level
CO1	Apply the mechanism of metal removal process and to identify the factors involved in improving machinability.	L3
CO2	Describe the constructional and operational features of centre lathe and other special purpose lathes.	L2
CO3	Describe the constructional and operational features of reciprocating machine tools.	L2
CO4	Apply the constructional features and working principles of CNC machine tools.	L3
CO5	Demonstrate the CNC machine tools Program through planning, writing codes and setting up CNC machine tools to manufacture a given component.	L2

		L	T	P	C
III Year I Semester	**FACILITY LAYOUT & DESIGN**	3	0	0	3

COURSE OBJECTIVES:

The aim of this course is to make students understand the importance of facility layout design and its impact on productivity. Students can get acquainted with different types of computerized layout improvement approaches. The course is also aimed at imparting knowledge of plant layout and material handling aspects to students

UNIT – I

Introduction: Facilities design function- Scope, Objectives, need for layout study, types of layout problem, Types of flow pattern, Types of plant layout, Nature, Significance and Scope of Facilities Layout Planning, Facility design procedure

Plant location: Plant location analysis-factors, costs, Facility location: Single facility location problem, Multiple facility location problem, Gravity facility location problem, Euclidean distance location problem

UNIT II

Activity relationship analysis: Activity relationship diagram, worksheet, dimensionless block diagram, Flow analysis, Computer generated REL chart

Layout design: Design cycle - SLP procedure manpower, machinery requirements – Computer algorithms - ALDEP, CORELAP, CRAFT.

UNIT III

Quantitative methods: Group technology-Production Flow analysis (PFA), ROC (Rank Order clustering), Quantitative analysis in cellular manufacturing.

Manual Assembly Lines: Assembly workstations, Analysis of Single model assembly lines, Line balancing problems, Line balancing algorithm: i) Largest candidate rule ii) Kilbridge and wester method iii) Ranked positional weight method iv) COMSOAL, Mixed model assembly lines, Line of balance

UNIT IV

Auxiliary Services Requirement Space: Receiving and shipping, Storage, Warehousing, Maintenance and Tool room, Utilities and Lighting.

Employee Services-Space requirements: Parking lot, Employee entrances, Locker rooms, Toilets and Restrooms, Lunch room, Recreation, Drinking fountains, Aisles, Medical facilities

UNIT V

Materials handling: Cost justification, Goals of material Handling, Principles of material handling, MH problem solving procedure, Unit load concept, and material handling system design.
Material Handling Equipment: Receiving and shipping, Stores, Fabrication, Assembly, Shop floor, Warehousing, Packaging. Computer integrated material handling system

Reference Books:
1. Plant layout & Material Handling, G. K. Agrawal, Jain Publishers, New Delhi.
2. Automation, Production Systems and Computer Integrated Manufacturing, 2nd edition, Mikell P. Groover, Prentice Hall of India, New Delhi, 2003.
3. Plant Layout & Material Handing, 3rd edition, J.M Apple, John Wiley & Sons, 1972, New York.
4. Production and Operations Management, 3rd edition, R. Panneerselvam, PHI Learning Private Ltd., New Delhi, 2012.
5. Facilities planning, J. A. Tompkins and J. A. White, John Wiley, 1984.
6. Facilities Layout and Location: An analytical approach, Richard Francis L. and John A. White, Prentice Hall Inc., 1984.
7. Plant Layout and Design, Moore, J. M. Macmillan Company, New York, 1970.
8. Manufacturing Facilities Design, 2nd edition, Fred F. Meyers, Matthew P. Stephens, Prentice Hall, New Jersey.
9. Practical Plant layout, Richard Muther, McGraw Hill Book Company, New York
10. Facilities Planning and Materials Handling, Vijay Sheth, Marcle Decker, New York.

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

CO's	Statements	Bloom's Level
CO1	Understand the concept of Facility planning and layout design	L2
CO2	Know the concept of Facility location problem in different areas.	L2
CO3	Understand the concept of Activity Relationship Diagram	L2
CO4	Understand different line balancing algorithms and their use.	L3
CO5	Understand how to generate computerized layout solutions for plant layout design problem.	L3

III Year I Semester	AUTOMOBILE ECU DESIGN AND SYSTEM INTEGRATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

This course aims to equip students with the knowledge and skills to design, develop, and integrate Electronic Control Units (ECUs) in automotive systems, focusing on understanding ECU architecture, software, hardware, and communication protocols, along with vehicle integration and testing.

UNIT I:
ECU DESIGN CONCEPT

The concepts of ECU design for automotive applications- Need for ECUs- advances in ECUs for automotive- design complexities of ECUs-V-Model for Automotive ECU 's Architecture of an advanced microcontroller used in the design of automobile ECUs -analog and digital Interfaces-Controllers for ECUs: Understanding different ECUs in an automobile-challenges and design requirements of ECU design - selection of sensors and interfaces for ECU design.

UNIT II:
MATHEMATICAL MODELING AND VALIDATION

Top level blocks diagram development for ECUs- design of software modules and hardware modules for ECU design- mathematical modeling of automotive Applications-Designing-modelling and porting of software models on ECUs-development of test setup for ECU testing- System level testing: Experimental setup for ECU validation-system level optimization for cost- reliability check and endurance check of ECUs- signal integrity check and EMI/EMC analysis- integration of ECUs into automotive

UNIT III:
MODEL BASED SYSTEM DESIGN

Introduction to Model based system design -hardware in-the-loop simulation- continuous and discrete simulation basics-modeling basics. Connection between Hardware and Simulation-Coupling concepts-simulator coupling and co-simulation, synchronization of co-simulations, basic coupling principles- Event Discrete Simulation-Real Time Workshop-Introduction to basic Simulink blocks, xPC target, Real Time Workshop-State flow and Real Time Embedded coder

UNIT IV:
MODEL BUILDING WITH SIMULINK

Model Building with Simulink: Controller programming using model based system design for an automotive application using Simulink-Plant Modelling- Plant modelling using Simulink for the automotive application-PID controller design, analog output, targeting a processor for plant Hardware Implementation-Design of ECU for automotive applications,

interfacing of sensors and Actuators-System modelling and validation using test setup-Interfacing of software models with hardware design.

UNIT V:
HARDWARE IN LOOP SIMULATION
System programming and development of experimental setup for hardware in loop simulation. Hardware in-the-Loop-Testing of plant separately, testing of controller separately and testing of plant and controller in the loop-System Verification and Validation-Comparing the HIL test results with real world result Hardware in-the-Loop testing- Experimental setup for HIL-HIL testing using dSPACE micro autobox, introduction to carmaker, building scenarios and vehicle analysis using carmaker- interfacing dSPACE with carmaker and case studies on micro autobox.

TEXT BOOKS:
1. Frank Vahid and Tony Givargis, Embedded System Design, 2012
2. John Wiley & Sons Ronald K. Jurgen, A Unified Hardware/Software Introduction, Automotive Electronics Handbook, McGraw-Hill, 2013
3 Hall, Douglas V, Microprocessors and Interfacing: Programming and Hardware, 2nd edition, Tata McGraw Hill, 2014

REFERENCES:
1.David E. Simon, An Embedded Software Primer, Pearson Education, 2015
2. Ferguson, Colin R, Kirkpatrick, Allan T., Internal Combustion Engine - 2014

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

CO's	Statements	Bloom's Level
CO1	Familiarize on concepts of ECU design for automotive applications.	L2
CO2	Gain knowledge on software modules and hardware modules for ECU design	L3
CO3	Acquire the knowledge to solve complex problems in Model based system design & hardware in-the-loop simulation	L3

III Year I Semester	COMPUTER VISION & IMAGE PROCESSING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:
This course will provide students with more techniques in the digital image
processing for image enhancement, restoration of noisy images, Segmentation and various machine learning techniques. Emphasis is given more on implementation of various algorithms so that students will able to develop their own algorithm. The techniques covered in the syllabus have wide applicability in any field which needs to handle the image data.

UNIT I
Digital Image Fundamentals:
Light and Electromagnetic spectrum, Components of Image processing system Image formation and digitization concepts, Neighbours of pixel adjacency connectivity, regions and boundaries, Distance measures, Applications.

UNIT II
Image Enhancements:
In spatial domain: Basic gray level transformations, Histogram processing, Using arithmetic/Logic operations, smoothing spatial filters, Sharpening spatial filters. In Frequency domain: Introduction to the Fourier transform and frequency domain concepts, smoothing frequency-domain filters, Sharpening frequency domain filters

UNIT III
Image Restoration:
Various noise models, image restoration using spatial domain filtering, image restoration using frequency domain filtering, Estimating the degradation function Inverse filtering.

UNIT IV
Colour Image Processing
Color fundamentals, Color models, Color transformation – Algorithms **Image Segmentation:** Detection of discontinuities, Edge linking and boundary detection, thresholding**.**

UNIT V
Computer Vision:
Feature descriptors: HOG SIFT SURF, Object detection and tracking, Object recognition, Motion detection, Principal Component analysis, Intelligent video surveillance
Applications: Face detection, Vehicle detection, pedestrian detection, Suspicious activity detection and recognition, Crowd detection, Medical imaging for disease detection

Reference Books:
1.Digital Image Processing, Rafel C. Gonzalez and Richard E. Woods, Publisher: Pearson Education
2.Digital Image Processing, Bhabatosh Chanda and Dwijesh Majumder, Publisher: 3.PHI Computer Vision - A modern approach, D. Forsyth and J. Ponce, Publisher: Prentice Hall
4.Feature Extraction & Image Processing for Computer Vision, Mark Nixon and Alberto S. Aquado, Third Edition, Academic Press, 2012
5.John V Guttag. "Introduction to Computation and Programming Using Python", Prentice Hall of India

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

CO's	Statements	Bloom's Level
CO1	Understand the basic image enhancement techniques in spatial and frequency domains.	L2
CO2	Understand the various kind of noise present in the image and how to restore the noisy image	L3
CO3	Understand various segmentation methods and to apply this concept for image handling in various fields	L2
CO4	To develop applications using computer vision techniques	L4

III Year I Semester	ALTERNATIVE FUELS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

To impart the necessity of finding alternative energy sources for automobiles and to understand merits and demerits, performance characteristics of various sources of fuels and their comparison.

UNIT – I

CONVENTIONAL FUELS FOR I.C. ENGINES: Petroleum based conventional fuels for SI and CI engine, Demand and Availability of crude oil – vehicle population increase – national and international standards for conventional and alternative fuels. Desirable characteristics of SI Engine fuels – Petrol – Properties, Specification, chemical structure, 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

ALCOHOLS AS FUELS: Availability of different alternative fuels for engines. Alcohols – Properties, Production methods and usage in engines. Blending, dual fuel operation, surface ignition, spark ignition and oxygenated additives. Performance, combustion and emission characteristics in engines. Advantages and disadvantages of alcohol fuels

UNIT – III

VEGETABLE OILS AND BIODIESEL AS FUELS: Properties of Vegetable oils and biodiesel- Methods of using vegetable oils – Blending, preheating, and emulsification – Preparation of biodiesel from non-edible, edible oil and Algae - Performance, combustion and emission Characteristics in diesel engines. Advantages and disadvantages of Vegetable oils and biodiesel

UNIT – IV

HYDROGEN AS FUEL: Hydrogen – Properties, Production methods, storage and safety aspects. Methods of using hydrogen in engines. Performance, combustion and emission Characteristics in engines. Advantages and disadvantages of Hydrogen fuel.

UNIT – V

BIOGAS, CNG AND LPG AS FUELS: Biogas, Compressed Natural gas (CNG) and LPG – Properties and production methods. CO2 and H2S scrubbing in Biogas, Modifications required for use in Engines- Performance, combustion and emission Characteristics in engines. Advantages and disadvantages of Gaseous fuels. ~~Working of~~ LPG and CNG kits used in automotive engines.

Reference Books:
1. Arumugam S. Ramadhas, "Alternative Fuels for Transportation" CRC Press, 2011.
2. Ayhan Demirbas and M. Fatih Demirbas, "Algae Energy-Algae as a New Source of Biodiesel", Springer-Verlag London Limited 2010.
3. Ayhan Demirbas, 'Biodiesel A Realistic Fuel Alternative for Diesel Engines', Springer-Verlag London Limited 2008.
4. David M. Mousdale, "Introduction to Biofuels", CRC Press, 2015.
5. Ganesan.V., "Internal Combustion Engineering", Tata McGraw-Hill Publishing Co., New Delhi, 2003.
6. Gerhard Knothe, Jon Van Gerpen, Jargon Krahl, The Biodiesel Handbook, AOCS Press Champaign, Illinois 2005.
7. M. K. Gajendra Babu and K. A. Subramanian, "Alternative Transportation Fuels-Utilisation in Combustion Engines", CRC Press, 2013.
8. M.L. Mathur, R.P.Sharma "A course in internal combustion engines", Dhanpatrai publication, 2003.
9. Richard L Bechtold P.E.,Alternative Fuels Guide book, Society of Automotive Engineers, 1997 ISBN 0-76-80-0052-1.

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

CO's	Statements	Bloom's Level
CO1	Possess a comprehensive understanding of available alternative fuels for IC engines. They will possess complete knowledge on producing different biofuels, modifying them and using them in IC engines.	L2
CO2	Acquire the skills in developing new technologies for alternative fuels efficiently in IC engines.	L3
CO3	Demonstrate the importance of using alternative fuels for sustainable energy supply and for emission control in IC engines.	L3

III Year I Semester	**FUELS AND LUBRICANTS**	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES: The objective of this course is to prepare the students to understand the role, properties and testing of various fuels and lubricants in the design and operation of IC engines

UNIT-I: REFINERY OF FUELS AND LUBRICANTS
Introduction to Structure of petroleum, refining Process-Distillation, cracking processes, Catalytic reforming, alkylation, isomerisation and polymerization, finishing process-blending, products of refining process. Manufacture of lubricating oil base stocks, manufacture of finished automotive lubricants.

UNIT-II: THEORY OF LUBRICATION
Engine friction: introduction, total engine friction, effect of engine variables on friction, hydrodynamic lubrication, elastic hydrodynamic lubrication, boundary lubrication, bearing lubrication, functions of the lubrication system, introduction to design of a lubricating system

UNIT-III: LUBRICANTS
Specific requirements for automotive lubricants, oxidation deterioration and degradation of lubricants, additives and additive mechanism, synthetic lubricants, classification of lubricating oils, properties of lubricating oils, tests on lubricants. Grease, classification, properties, test used in grease- lubricants for gearbox, brake, differential and steering systems

UNIT-IV: PROPERTIES AND TESTING OF FUELS
Properties and testing of fuels- density, calorific value, cetane and octane number, flash point, fire point, distillation, vapour pressure, spontaneous ignition temperature, viscosity, cloud and pour point, flammability, ignitability, diesel index, API gravity, aniline point, carbon residue, copper strip corrosion. Test on used lubricants. Biofuel- properties and testing.

UNIT-V: TESTING INSTRUMENTS
Working principles and types – viscometers, calorimeters, flash and fire point apparatus, cloud and pour point apparatus, distillation apparatus, carbon residue apparatus, CFR engine, vapour pressure testing, copper strip, Aniline point apparatus -Ash content testing equipment - specifications of fuels. ASTM and SAE standards - FTIR- GCMS analysers.

Text Books:

1.Ganesan.V., "Internal Combustion Engines", Tata McGraw-Hill Publishing Co., New Delhi, 2017.

2. George E. Totten, Editor, Fuels and Lubricants Handbook: Technology, Properties, Performance, and Testing, ASTM International.

Reference Books:

1. Paul Richards "Automotive fuels reference book" SAE International, Third edition 2014.

2. Roger Frederick Haycock, John Hillier, Arthur J. Caines "Automotive lubricants Reference book", SAE International, Second edition 2004.

3. Wilfrid Francis– Fuels and Fuel Technology, Vol. I & II

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

CO's	Statements	Bloom's Level
CO1	Analyse the behaviour of fuels and lubricants	L3
CO2	Select suitable fuel and lubricant testing equipment	L3
CO3	Evaluate the properties of fuels and lubricants	L2
CO4	Understand the properties of fuels and lubricants and its testing equipment	L2
CO5	Identify the fuels and lubricants for automotive applications	L3

III Year I Semester	BASIC AUTOMOBILE ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE: aims to provide students with foundational knowledge of vehicle systems, components, and operations, enabling them to identify, explain, and analyze vehicle performance and troubleshoot issues.

UNIT-I:

Introduction: Layout of automobile chassis and body components. types of Automobile engines. – power unit –engine lubrication – engine servicing.

Fuel System: S. I. Engine: Fuel supply systems, Mechanical and electrical fuel pump – filters – carburettor – types – air filters – petrol injection. Introduction to MPFI and GDI Systems.

C.I. Engines: Requirements of diesel injection systems, types of injection systems, DI Systems. fuel pump, nozzle, injection timing. Introduction to CRDI and Turbocharger Systems.

UNIT – II:

Cooling System: Cooling Requirements, Air Cooling, Liquid Cooling, Thermo, water and Forced Circulation System – Radiators – Types – Cooling Fan - water pump, thermostat, evaporative cooling – pressure sealed cooling – antifreeze solutions.

Ignition System: Function, battery ignition system, storage battery, auto transformer, Magneto coil ignition system, electronic ignition system using contact breaker, electronic ignition using contact triggers – spark advance and retard mechanism.

Electrical System: Charging circuit, generator, current – voltage regulator – starting system, bendix drive mechanism solenoid switch, lighting systems, Horn, wiper, fuel gauge – oil pressure gauge, engine temperature indicator.

UNIT – III:

Transmission System: Clutches, principle, types, cone clutch, single plate clutch, multi plate clutch, centrifugal clutches, fluid fly wheel – gear boxes, types, sliding mesh, constant mesh, synchro mesh gear boxes, Introduction to automatic transmission systems. Propeller shaft, universal joint, differential rear axles wheels and tyres.

Suspension System: Objectives – rigid axle suspension system, torsion bar, shock absorber, Independent suspension system.

UNIT-IV:

Braking System: Mechanical brake system, Hydraulic brake system, Master cylinder, wheel cylinder Requirement of brake fluid, Pneumatic and vacuum brakes.

Steering System: Steering geometry – camber, castor, king pin rake, combined angle toe-in and toe-out,. Types of steering mechanism – Ackerman and Davis, Introduction to power steering, steering linkages.

UNIT – V:

Emissions from Automobiles: Pollution standards National and international – Pollution Control Techniques – Catalytic Convertor, SCR, Particulate filter, DOC.

Energy alternatives: Solar Photo-voltaic, hydrogen, Biomass, alcohols, LPG, CNG, Hydrogen as a fuel for IC Engines. - their merits and demerits.

TEXT BOOKS:
1. Automobile Engineering / William H Crouse.
2. Automobile Engineering (Vol 1) Kirpal Singh
3. Fundamentals of IC Engines – V. Ganesan

REFERENCE BOOKS:
1. Automotive Mechanics / Heitner.
2. Automotive Engineering / Newton Steeds & Garrett.
3. Introduction to IC Engines Mathur & Sharma

Course Outcomes: On the completion of the course the student will be able to

CO's	Statements	Bloom's Level
CO1	To understand basics of automobile engineering, conversant with drive train and transmission.	L2
CO2	conversant with suspension and brake system.	L3
CO3	Understand basics of vehicle performance.	L3
CO4	Conversant with automobile electrical systems and maintenance.	L2

III Year I Semester	AUTOMOTIVE ELECTRICAL AND ELECTRONICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To define the glossary related to vehicle electrical and electronic system.
2. To understand the need for starter batteries, starter motor and alternator in the vehicle.
3. To differentiate the conventional and modern vehicle architecture and the data transfer among the different electronic control unit using different communication protocols.
4. To list common types of sensor and actuators used in vehicles.
5. To understand networking in vehicles

UNIT-I:

Batteries and Accessories: Principle and Construction of Lead Acid Battery, Characteristics of battery, rating capacity and Efficiency of Batteries, Lighting System: Insulated and Earth Return System, Details of Head Light and Side Light, LED Lighting System, Head Light Dazzling and Preventive Methods – Horn, Wiper System and Trafficator.

UNIT-II:

Starting System: Requirements, Series Motor – Working Principle, construction and its Characteristics, Principle and Construction of Starter Motor, Starter Switches.

UNIT-III:

Charging System: Requirements– Alternators –Working Principle – power losses – characteristics curve- Alternator operation in the vehicle- Alternator circuitry.

UNIT-IV:

Engine Sensors: Speed, Throttle Position, Exhaust Oxygen, knock, Manifold Pressure, Crankshaft Position, Temperature, Air Mass Flow.

Automotive Sensors: Impact Sensor, Rain Sensor, GPS Sensor, Speed Sensor.

Actuators: Solenoids, Stepper Motors.

UNIT-V:

Fundamentals of Automotive Electronics: Engine Management System – PFI, GDI and CRDI, Electronic Dashboard Instruments, Onboard Diagnostic System, Security and Warning System.

Text Books
1. Young A.P. & Griffiths. L. "Automotive Electrical Equipment", ELBS & NewPress-1999.
2. William B.Ribbens "Understanding Automotive Electronics", 5th edition -Butter worth Heinemann Woburn,1998.

References

1. Bechtold "Understanding Automotive Electronics", SAE,1998.

2. Crouse, W.H "Automobile Electrical Equipment", McGraw-Hill Book Co.,
   Inc., New York, 3rd edition, 1986.

3. Judge A.W "Modern Electrical Equipment of Automobiles", Chapman & Hall,
   London,1992.

4. Kholi.P.L "Automotive Electrical Equipment", Tata McGraw-Hill Co., Ltd., New
   Delhi,1975.

5. Robert Bosch "Automotive Hand Book", SAE (5th Edition),2000.

Course Outcomes: On the completion of the course the student willable to

CO's	Statements	Bloom's Level
CO1	Define the glossary related to vehicle electrical and electronic system	L1
CO2	Understand the need for starter batteries, starter motor and alternator in the vehicle.	L2
CO3	Differentiate the conventional and modern vehicle architecture and the data transfer among the different electronic control unit using different communication protocols.	L2
CO4	List common types of sensor and actuators used in vehicles.	L1
CO5	Understand networking in vehicles.	L2

III Year I Semester	IC ENGINE TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:
- To impart the knowledge and providing holistic view on IC Engines and its developments
- To enable the students to calculate the performance and testing of IC engines
- To fetch with SI & CI fuelling system and combustion behaviour and its advancements to meet the stringent emission norms
- Understanding the formation and control strategies of SI and CI Engine emissions

UNIT-I
Engine Principles: Introduction, Comparison of Air Standard and Actual Cycles, Constructional Details of Four Stroke SI and CI Engines, Working Principle, Actual Indicator Diagram, Two Stroke Engine Construction and Operation, Comparison of Four Stroke and Two Stroke Engine Operation, Firing Order and Its Significance.

UNIT-II
ENGINE TESTING & PERFORMANCE
Engine Performance Testing & Numerical- methods and Performance Characteristics; Performance Maps. Lubrication and Cooling systems, Introduction to Supercharging and Turbocharging; Introduction to Engine Cooling and Lubrication

UNIT-III
SI ENGINE COMBUSTION
Carburettor Working Principle, Requirements of an Automotive Carburettor, and types, Fuel Injection Systems; Pre-mixed charge combustion, SI Engine Combustion Conceptual models, Knocking Combustion

UNIT-IV:
CI ENGINE COMBUSTION
Fuel Injection and Spray Structure: Fuel Atomization. Diesel Combustion Process Characterization: Ignition Delay, Effect of Engine and Operational Parameters on Delay, Pre-mixed Combustion and Mixing Controlled Combustion.

UNIT-V:
ADVANCED COMBUSTION MODES

GDI, Flexi Fuel, CAI, Introduction to Low Temperature Combustion Like: Homogeneous Charge Compression Ignition(HCCI), Fuel Stratified Charge combustion/ Reactivity Controlled Compression Ignition (RCCI) and Pre-mixed Charge Compression (PCCI) technologies.

Text Books:
1. IC Engines, M.L. Mathur & R.P. Sharma, Dhanpath Rai & Sons
2. Engine Emissions, Pollutant Formation and Advances in Control Technology, B.P.

Pundir, Narosa Publishing House

Reference Books:

1. IC Engines Fundamentals, John B. Heywood, Mc Graw Hill Publications
2. Engineering Fundamentals of I C Engines, WiliardW.Pulkrabek, Prentice Hall Publications

Course Outcomes: At the end of the course, the students should be able to

CO's	Statements	Bloom's Level
CO1	Differentiate the ideal, air standard cycles and actual thermodynamic cycles.	L2
CO2	Evaluate the Engine performance based on the experimental data	L3
CO3	Analyse the fueling system and combustion behaviour of SI engines	L3
CO4	Analyse the fueling system and combustion behaviour of CI engines	L3
CO5	Explain the formation of emissions and its control strategies of bot SI & CI Engines.	L2

III Year I Semester	**MANUFACTURING TECHNOLOGY LAB**	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES:

1.To Selecting appropriate tools, equipment's and machines to complete a given job.

2 To Performing various welding process using GMAW and fabricating gears using gear making machines.

3 To Performing various machining process such as rolling, drawing, turning, shaping, drilling, milling and analysing the defects in the cast and machined components.

Note: Need to perform atleast Six Experiments from each of the Labs

LIST OF EXPERIMENTS
(8 out of 12)
1. Fabricating simple structural shapes using Gas Metal Arc Welding machine.
2. Preparing green sand moulds with cast patterns.
3. Taper Turning and Eccentric Turning on circular parts using lathe machine.
4. Knurling, external and internal thread cutting on circular parts using lathe machine.
5. Shaping – Square and Hexagonal Heads on circular parts using shaper machine.
6. Drilling and Reaming using vertical drilling machine.
7. Milling contours on plates using vertical milling machine.
8. Cutting spur and helical gear using milling machine.
9. Generating gears using gear hobbing machine.
10. Generating gears using gear shaping machine.
11. Grinding components using cylindrical and centerless grinding machine.
12. Grinding components using surface grinding machine.

COURSE OUTCOMES: Attending the laboratory the students shall be able to:

	Statements	**Bloom's Level**
CO1	Demonstrate the safety precautions exercised in the mechanical workshop and join two metals using GMAW.	L3
CO2	make the work piece as per given shape and size using machining process such as rolling, drawing, turning, shaping, drilling and milling.	L3
CO3	make the gears using gear making machines and analyze the defects in the cast and machined components.	L4

III Year I Semester	MATERIAL TESTING LAB	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES:

To impart practical exposure on the microstructures of various materials and their hardness evaluation. Also to impart practical knowledge on the evaluation of material properties through various destructive testing procedures.

Part-A: MECHANICS OF SOLIDS:
List of Experiments:
1. Direct tension test
2. Bending teston
 a) Simple supported beam
b) Cantilever beam
3. Torsion test
4. Hardness test
a) Brinell hardness test
b) Rockwell hardness test
5. Test on springs
6. Compression test
7. Impact test
8. Punch shear test

Part-B: METALLURGY LAB:
List of Experiments:
1. Preparation and study of the Microstructure of pure metals like Iron, Cu andAl.
2. Preparation and study of the Microstructure of Mild steel, Medium carbon steels, High carbon steels.
3. Study of the Micro Structures of Cast Irons.
4. Study of the Micro Structures of Non-Ferrous alloys.
5. Study of the Micro structures of Heat treated steels.
6. Study of Hardenability of steels
7. Study of Hardness of various treated and untreated steels.

COURSE OUTCOMES: Attending the laboratory the students shall be able to:

CO's	Statements	Bloom's Level
CO1	Identify and analyse mechanical properties such as strength, hardness, toughness, and ductility of different materials.	L2
CO2	Perform standard material tests including tensile, compression, shear, impact, hardness, and fatigue testing.	L3
CO3	investigate the failure modes of materials under different	L5

	loading conditions.	
CO4	Apply test results to enhance material selection and design considerations in engineering applications.	L3

III Year I Semester	AUTOMOBILE SKETCHING & DRAWING	L	T	P	C
		0	1	2	2

COURSE OBJECTIVES:
　　1. To familiarize with the fundamental knowledge in the field of automotive drawing.
　　2. To acquaint with required analytical abilities to provide solutions to design problems**.**

Using CAD Software
UNIT – I: Draw the Layout of different vehicle architectures
1. Layout of Fuel filing cum service station
2. Layout of EV infrastructure
3. Free hand sketching of different automobiles

UNIT – II: Draw different Engine Components
Draw the dimensioned sketches of the following automobile engine components
1. 2-Stroke and 4-stroke petrol engine pistons
2. Diesel engine pistons
3. 4-cylinder and 6-cylinder engine crank shaft
4. 4-cylinder and 6-cylinder engine cam shaft

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

UNIT – IV: Draw the Assembly drawing of various Engine components
Assembly drawing of,
1. Connecting rod
2. Assembly of single cylinder engine
3. Overhead & side valve mechanism with all parts (with side cam shaft and overhead cam shaft)
4. Spark plug & fuel injector

UNIT – V:
Design of Cam and Follower: Roller follower mechanism with spring and shaft Design of valves and valve operating mechanism
Design and selection of belts- Flat - belt and V- belt with pulley construction and Roller chain

Reference Books:

1. N.D.Bhatt - Machine Drawing – Charotar publishing house pvt. ltd
2. P.I.Varghese - Machine Drawing - VIP Publishers
3. R.B.Gupta - Automobile Engineering Drawing – Satyaprakasan pub
4. Automobile body building - T.T.T.I – Chennai
5. Anil Chikkara - Automobile Engg., Vol. 3 –Satyaprakasanpub

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

CO's	Statements	Bloom's Level
CO1	Identify the different types of frame and chassis used in Automotive.	L2
CO2	Relate different types of drive lines and drives used in Automotive.	L2
CO3	Acquire knowledge about different types of front axle and rear axles used in motor vehicles.	L2
CO4	Examine the working principle of conventional and independent suspension systems.	L4
CO5	Apply knowledge on working principles of brake and its subsystems.	L3

III Year I Semester	TINKERING LAB	L	T	P	C
		0	0	2	1

The aim of tinkering lab for engineering students is to provide a hands-on learning environment where students can explore, experiment, and innovate by building and testing prototypes. These labs are designed to demonstrate practical skills that complement theoretical knowledge. Some specific goals are:
1. Encourage Innovation and Creativity
2. Hands-on Learning
3. Skill Development
4. Foster Collaboration and Teamwork
5. Interdisciplinary Learning
6. Problem-Solving mind-set
7. Prepare for Industry and Entrepreneurship

These labs bridge the gap between academia and industry, providing students with the practical experience. Some students may also develop entrepreneurial skills, potentially leading to start-ups or innovation-driven careers. Tinkering labs aim to cultivate the next generation of engineers by giving them the tools, space, and mind-set to experiment, innovate, and solve real-world challenges.

List of experiments: (8 out of 11)
1) Make your own parallel and series circuits using breadboard for any application of your choice.
2) Demonstrate a traffic light circuit using breadboard.
3) Build and demonstrate automatic head light using LDR.
4) Simulate the Arduino LED blinking activity in Tinkercad.
5) Build and demonstrate an Arduino LED blinking activity using Arduino IDE.
6) Interfacing IR Sensor and Servo Motor with Arduino.
7) Blink LED using ESP32.
8) LDR Interfacing with ESP32.
9) Control an LED using Mobile App.
10) Design and 3D print of a simple automobile component
11) Demonstrate all the steps in design thinking to redesign a motor bike.

Students need to refer to the following links:

1) https://aim.gov.in/pdf/equipment-manual-pdf.pdf
2) https://atl.aim.gov.in/ATL-Equipment-Manual/
3) https://aim.gov.in/pdf/Level-1.pdf
4) https://aim.gov.in/pdf/Level-2.pdf
5) https://aim.gov.in/pdf/Level-3.pdf

III Year II Semester	VEHICLE DYNAMICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for

1. Provide fundamental knowledge of the vibration,
2. Impart knowledge on tyres
3. Provide basic concepts on suspension design and function, ride modes
4. Evaluate the performance, longitudinal dynamics and control in an automobile
5. Provide basic analysis on handling, cornering stability and control

UNIT – I
CONCEPT OF VIBRATION:

Modelling and Simulation, Global and Vehicle Coordinate System. Fundamentals of vibration - Definitions, Types, Free, Forced, Undamped and Damped Vibration. Vibration analysis – Formulation of Governing equation. Response Analysis of Single DOF, Two DOF, Multi DOF. Magnification factor, Transmissibility ratio, Base excitation. Vibration absorber, Vibration measuring instruments, Torsional vibration, Critical speed.

UNIT – II
TYRES:

Tyre axis system, Construction and manufacturing of tires, tyre forces and moments, tyre marking, tyre structure, hydroplaning, wheel and rim. Rolling resistance, factors affecting rolling resistance. Tire slip – Longitudinal slip and slip angle concept, Relation between tractive effort and longitudinal slip, Friction circle. Longitudinal and Lateral force at various slip angles, Tractive and cornering property of tire. Camber and camber trust. Performance of tire on wet surface. Ride property of tyres. Various test carried on a tyre. Tyre models.

UNIT – III
VERTICAL DYNAMICS:

Human response to vibration, Sources of Vibration. Suspension requirements – types. State Space Representation. MR & ER Dampers. Design and analysis of Passive, Semiactive and Active suspension using Quarter car, Bicycle Model, Half car and full car vibrating model. Influence of suspension stiffness, suspension damping, and tire stiffness. Control law. Suspension optimization techniques. Air suspension system and their properties

UNIT – IV
LONGITUDINAL DYNAMICS AND CONTROL:

Aerodynamic forces and moments. Forces acting on a vehicle – Resistance forces, Traction force supplied by power plant. Equation of motion. Load distribution for three-wheeler and four-wheeler. Calculation of maximum acceleration, tractive effort and reaction forces for different drive vehicles. Power limited acceleration and traction limited acceleration. Estimation of CG location. Longitudinal load transfer during acceleration and braking. Stability of vehicles resting on slope. Driveline dynamics. Braking and Driving torque. Prediction of Vehicle performance. ABS, stability control, Traction control.

UNIT – V
LATERAL DYNAMICS:

Steering Geometry – Steady state handling characteristics. Steady state response to steering input – Yaw velocity gain, Lateral acceleration gain, curvature response gain. Testing of handling characteristics. Transient response characteristics. Directional stability. Stability of vehicle on banked road, during turn. Effect of suspension on cornering. Roll dynamics - Roll center, Roll axis, effect of roll on vehicle dynamics. Yaw control. Stability control

Text Books:

1. Singiresu S. Rao, "Mechanical Vibrations – SI Edition," Sixth Edition, Pearson, 2018 2. J. Y. Wong, "Theory of Ground Vehicles", Fifth Edition, Wiley-Inter science, 2022
3. Rajesh Rajamani, "Vehicle Dynamics and Control," Second edition, Springer,2012
4. Reza N. Jazar, "Vehicle Dynamics: Theory and Application", Third edition, Springer, 2017

Reference Books:

1. Thomas D. Gillespie, "Fundamentals of Vehicle Dynamics", Revised Edition, Society of Automotive Engineers Inc, 2021
2. Dean Karnopp, "Vehicle Dynamics, Stability, and Control", Second Edition, CRC Press, 2013
3. Michael Blundell & Damian Harty, "The Multi body Systems Approach to Vehicle Dynamics", 2nd Edition, Butterworth - Heinemann,2014
4. Hans B Pacejka, "Tyre and Vehicle Dynamics," Second edition, Butterworth - Heinemann, 2006

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

CO's	Statements	Bloom's Level
CO1	Develop physical and mathematical models of a mechanical vibrating system	L6
CO2	Indicate the forces and moment acting on tyres	L 4

CO3	Identify the suspension parameters that governs ride comfort	L 2
CO4	Evaluate the vehicle performance in longitudinal direction.	L 5
CO5	Evaluate the lateral dynamics and control in an automobile.	L5

III Year II Semester	VEHICLE BODY ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To acquire knowledge on Different aspects of car body,
2. To acquire knowledge on bus body and commercial vehicle bodies.
3. To acquire knowledge on Role of various aerodynamic forces and moments, measuring instruments in vehicle body design.
4. To acquire knowledge on Material used in body building,
5. To acquire knowledge on Tools used in body repairs and command over vehicle body engineering applications.

UNIT – I
CAR BODY DETAILS:

Types of Car body - Saloon, convertibles, Limousine, Estate Van, Racing and Sports car body terminology - Visibility- regulations, driver's visibility, improvement in visibility and tests for visibility. Driver seat design -Car body construction-Various panels in car bodies. Safety: Safety design, safety equipment for cars. AIS and SAE car body Regulations

UNIT – II
BUS BODY DETAILS:

Types of bus body: based on capacity, distance travelled and based on construction.– Bus body lay out, floor height, engine location, entrance and exit location. Types of metal sections used –Constructional details: Conventional and integral. AIS and SAE bus body Regulations.

UNIT – III
COMMERCIAL VEHICLE DETAILS:

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

UNIT – IV
VEHICLE AERODYNAMICS:

Objectives, Vehicle drag and types. Various types of forces and moments. Effects of forces and moments. Side wind effects on forces and moments. Various body optimization techniques for minimum drag. Wind tunnels – Principle of operation, Types. Wind tunnel testing such as: Flow visualization techniques, Airflow management test – measurement of various forces and moments by using wind tunnel balance.

UNIT – V

BODY MATERIALS, TRIM, MECHANISMS AND BODY REPAIR:
Types and properties of materials used in body construction and insulation -Such as steel sheet, timber, plastics and GRP, Insulation materials. Body trim items-body mechanisms. Hand tools-power tools for body repair. Vehicle corrosion-Anticorrosion methods-Modern painting process procedure.

Text Books:
1. Khurmi. R.S. & Gupta. J.K., "A text book of Machine Design", Eurasia Publishing House (Pvt) Ltd, 2001.
 2. Giri, N.K., "Automobile Mechanics", Khanna publishers, New Delhi, 2007.

Reference Books:
1. Dieler Anselm., The passenger car body, SAE International, 2000
2.Powloski, J., Vehicle Body Engineering, Business Books Ltd., 1998.
3.James E Duffy, Body Repair Technology for 4-Wheelers, Cengage Learning, 2009**.**

COURSE OUTCOMES:
Upon completion of the course, the student will be able to

CO's	Statements	Bloom's Level
CO1	Understand the different aspects of car body	L2
CO2	Differentiate the bus and commercial vehicle bodies.	L4
CO3	Describe the role of various aerodynamic forces and moments, measuring instruments in vehicle body design..	L4
CO4	Identify the materials used in body building	L5
CO5	Select hand tools for body repairs and maintenance.	L3

III Year II Semester	HYBRID AND ELECTRIC VEHICLE TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:
The course should enable the students to:
1. General aspects of Electric and Hybrid Vehicles (EHV), including architectures, modeling, sizing, sub-system design and hybrid vehicle control.
2. Understand about vehicle dynamics,
3. Design the required energy storage devices,
4. Select the suitable electric propulsion systems and
5. Understand of hybrid electric vehicles.

UNIT – I
NEED FOR ALTERNATIVE SYSTEM
Need for hybrid and electric vehicles – main components and working principles of a hybrid and electric vehicles, Different configurations of hybrid and electric vehicles .Comparative study of diesel, petrol, hybrid and electric Vehicles. Advantages and Limitations of hybrid and electric Vehicles. Case study on specification of electric and hybrid vehicles.

UNIT – II
DESIGN CONSIDERATIONS FOR ELECTRIC VEHICLES
Design requirement for electric vehicles- Range, maximum velocity, acceleration, power requirement, mass of the vehicle. Various Resistance- Transmission efficiency- Electric vehicle chassis and Body Design, Electric Vehicle Recharging and Refueling Systems

UNIT – III:
ENERGY SOURCES
Battery Parameters- - Different types of batteries – Lead Acid- Nickel based-Sodium based Lithium based- Metal Air based. Battery Modeling- Equivalent circuits, Battery charging-Quick Charging devices. Fuel Cell- Fuel cell Characteristics- Fuel cell types-Half reactions of fuel cell. Ultra capacitors. Battery Management System

UNIT – IV
MOTORS AND CONTROLLERS
Types of Motors, Characteristic of DC motors, AC single phase and 3-phase motor, PM motors, Switched reluctance motors, Motor Drives and speed controllers, Torque Vectoring, Regenerative Braking. Rectifiers, Inverters, DC/DC converters

UNIT – V
SUBSYTEMS OF HYBRID AND ELECTRIC VEHICLES
Power Split devices for Hybrid Vehicles - Operation modes - Control Strategies for Hybrid Vehicle - Economy of hybrid Vehicles. Steering and Suspension system. Choice of Tires.

Text Books:
1. Iqbal Husain, "Electric and Hybrid Vehicles-Design Fundamentals", CRC Press,2003
2. Mehrdad Ehsani, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles", CRC Press,2005.

Reference Books:
1. James Larminie and John Lowry, "Electric Vehicle Technology Explained "John Wiley & Sons,2003
2. Lino Guzzella, "Vehicle Propulsion System" Springer Publications,2005
3. Ron Hod Kinson, "Light Weight Electric/ Hybrid Vehicle Design", Butterworth Heinemann Publication,2005

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

CO's	Statements	Bloom's Level
CO1	Understand working of different configurations of hybrid and electric vehicles	L3
CO2	Design and develop basic schemes of electric vehicles and hybrid electric vehicles.	L2
CO3	Choose proper energy storage systems for vehicle applications	L2
CO4	Choose a suitable drive scheme for developing an electric hybrid vehicle depending on resources	L3
CO5	Understand basic operation of power-split device in hybrid electric vehicle	L2

III Year II Semester	METAL FORMING & PRESS WORKING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:
The course's goal is to:
 • Gain the fundamental knowledge about metal forming and metal joining processes.
 • Understand the analysis of flow of material and its properties during the processes.
 • Selection the process of metal forming as application.
 • Introduce the theory and practices of metal forming and press working processes.
 • Develop the analytical relation between input and output parameters of process.

UNIT – I:
Introduction: Principle of plastic deformation and yield criteria, Recrystallization, Fundamentals of hot and cold Working processes, advantages and disadvantages; Effect of strain rate on forming process. Methods of metal forming processes, advantages, disadvantages and application.

UNIT – II:
Forging: Classification of forging, closed die forging, Open die forging, drop forging, Machine forging, Load estimation in forging, analysis of forging: sticking friction model, sliding friction model, pre forming operations: Fullering, Drawing, Offsetting, Edging, Flattening, Chamfering, Bending, Swaging, Finishing, Trimming, Defects in forging.
Rolling: Assumptions, Neutral point, deformation angle, Principle of rolling, Rolling stand arrangement, Rolling load calculation, Power required for rolling, Roll passes, Flat rolling, Pipe rolling, Defects in rolled products.

UNIT – III:
Extrusion: Extrusion types, Forward, backward extrusion, Hydrostatic Extrusion, Impact Extrusion, Calculation of force in extrusion, Load estimation in extrusion, Extrusion of tubes, Defects in Extrusion.
Drawing: Wire drawing, Different types of lubricant condition, Drawing load and force calculation, Tube drawing, Types of mandrel, Drawing defects.

UNIT – IV:
Sheet Metal Forming: Sheet metal working-shearing, Major operation, Minor operation, Mechanism of Blanking, Piercing, Load estimation in blanking and piercing, Methods of reducing shear force, Deep Drawing Operation, Design of blank, Load required, Blank holder force, stresses induced, Draw ratio method, Defects in deep drawing operation.
Bending: Principle of bending, Types of bending, Spring back effect.

UNIT – V:

Press Working Fundamentals, Operations, and Machinery: Shearing Theory-Critical stages of shearing, features of a punched hole, slug, burr. Clearance typesand their effects, Clearance for blanking and Piercing, Cutting Force – Methods to reduce cutting force, stripping force.

Presses: Common types of Presses, Main parts of a typical power press, Specification of presses, Comparison of Mechanical, hydraulic and Pneumatic presses. Single action, double action and triple action presses. Press operating parameters – Special purpose presses – Press brake, transfer press, multi slide machine – Press Feeding Mechanisms – Ejection Mechanism.

TEXTBOOKS:
1. Manufacturing Technology, P. N. Rao, Vol. 3, 3rdEdition, TMH Publication
2. Manufacturing Engineering and Technology, S. Kalpakjian, S. Schimid, Pearson Publication.
3. "Techniques of Press working sheet metal",Donald F. Eary. & Edward A. Reed, Prentice-Hall,Inc.,

REFERENCE BOOKS:
1. Mechanical metallurgy by G. W Dieter
2. American Society of Metals – Hand book – Volume 4 (Forming)

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

CO's	Statements	Bloom's Level
CO1	Understand the fundamentals of hot and cold Working processes.	L2
CO2	Learn Forging and Rolling Processes	L3
CO3	Understand different Extrusion and Drawing Processes and their applications.	L3
CO4	Understand the Mechanisms of Sheet metal forming, bending and press working	L2

III Year II Semester	**BATTERY TECHNOLOGY**	L	T	P	C
		3	0	0	3

Unit I:
Introduction
Energy Storage Applications and Electric Vehicles, different Batteries -Lead-acid, Nickel-Metal Hydride, Nickel-Cadmium and lithium-ion. cell requirements and specifications

Unit II:
Battery Characteristics
Cell Voltage under load, Charge and Discharge Rates, Capacity, Impedance, Specific Energy and Power, Efficiency, cycle life, self-discharge and Ragone Plot, Capacity and Pulse Power Testing, Electrochemical Impedance Spectroscopy Testing

Unit III:
Lithium-ion Battery
Battery Materials and their characteristics, Electrochemical Cell and Governing Equations, Electrode Kinetics, Thermodynamics, Solid Phase and Electrolyte Phase, Practical cell measurement – Cell Voltage, Capacity Energy and Power, Cell Formats.

Unit IV:
Battery Balancing methods
Need for balancing, Active methods – cell bypass, cell to cell, cell to pack, pack to celland passive methods - fixed shunt resistor, switched shuntresistor and switched transistor

Unit V:
Battery Management Systems
Thermal Management: Heating and cooling needs, Influence of battery temperature on battery performance, thermal management methods – air cooling, cooling by dielectric oil and cooling by liquid.
Cell Management: Functionality, technology and topology - centralized, modular, master-slave, distributed, Intelligent cell monitoring,

Text Books:

1. H. J. Bergveld, W. S. Kruijt, and P. H. Notten, "Battery Management Systems: Design by Modelling," Kluwer Academic Publisher, 2002
2. C. Rahn, C.Y. Wang, Battery systems engineering, John Wiley & Sons, 2013
3. John G. Hayes and G. Abas Goodarzi,"Electric Powertrain - Energy Systems, Power
4. Electronics and Drives for Hybrid,Electric and Fuel Cell Vehicles", Wiley 2018
5. James Larminie and John Lowry, "Electric Vehicle Technology Explained, John Wiley and Sons, 2003

III Year II Semester	MACHINE LEARNING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

The course is aimed at

1. Understanding about the learning problem and algorithms
2. Providing insight about neural networks
3. Introducing the machine learning fundamentals and significance
4. Enabling the students to acquire knowledge about pattern recognition.
5. Motivating the students to apply deep learning algorithms for solving real life problems**.**

UNIT I:
LEARNING PROBLEMS AND ALGORITHMS:

Various paradigms of learning problems, Supervised, Semi-supervised and Unsupervised algorithms

UNIT II:
NEURAL NETWORKS:

Differences between Biological and Artificial Neural Networks - Typical Architecture, Common Activation Functions, Multi-layer neural network, Linear Separability, Hebb Net, Perceptron, Adaline, Standard Back propagation Training Algorithms for Pattern Association - Hebb rule and Delta rule, Hetero associative, Auto associative, Kohonen Self Organising Maps, Examples of Feature Maps, Learning Vector Quantization, Gradient descent, Boltzmann Machine Learning

UNIT III:
MACHINE LEARNING – FUNDAMENTALS & FEATURE SELECTIONS & CLASSIFICATIONS:

Classifying Samples: The confusion matrix, Accuracy, Precision, Recall, F1- Score, the curse of dimensionality, training, testing, validation, cross validation, overfitting, under-fitting the data, early stopping, regularization, bias and variance. Feature Selection, normalization, dimensionality reduction, Classifiers: KNN, SVM, Decision trees, Naïve Bayes, Binary classification, multi class classification, clustering

UNIT IV:
DEEP LEARNING: CONVOLUTIONAL NEURAL NETWORKS:

Feed forward networks, Activation functions, back propagation in CNN, optimizers, batch normalization, convolution layers, pooling layers, fully connected layers, dropout, Examples of CNNs**.**

UNIT V:
DEEP LEARNING: RNNS, AUTOENCODERS AND GANS:

State, Structure of RNN Cell, LSTM and GRU, Time distributed layers, Generating Text,
Autoencoders: Convolutional Autoencoders, Denoising autoencoders,
Variational autoencoders, GANs: The discriminator, generator, DCGANs

Reference Books:

1. J. S. R. Jang, C. T. Sun, E. Mizutani, Neuro Fuzzy and Soft Computing - A Computational Approach to Learning and Machine Intelligence, 2012, PHI learning
2. Deep Learning, Ian Good fellow, Yoshua Bengio and Aaron Courville, MIT Press, ISBN: 9780262035613, 2016.
3. The Elements of Statistical Learning. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Second Edition. 2009.
4. Pattern Recognition and Machine Learning. Christopher Bishop. Springer. 2006.
5. Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press. 2017.

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

CO's	Statements	Bloom's Level
CO1	Illustrate the categorization of machine learning algorithms.	L4
CO2	Compare and contrast the types of neural network architectures, activation functions	L3
CO3	Acquaint with the pattern association using neural networks	L3
CO4	Elaborate various terminologies related with pattern recognition and architectures of convolutional neural networks	L2

III Year II Semester	CONDITIONING MONITORING	L	T	P	C
		3	0	0	3

Course Objectives:

- To understand the types of maintenance used and its significance, role of condition based maintenance in industries, familiarize with different condition monitoring techniques and its advantages in industries.
- To implement the basic signal processing techniques.
- To understand the role of vibration monitoring, its methodology and its use in condition monitoring of rotating and reciprocating machines.
- To understand the significance of mechanical fault diagnosis and non-destructive testing techniques in monitoring and maintenance.
- To study condition monitoring of rolling element bearing, gears and tool condition monitoring techniques in machining.

UNIT – I

Introduction to maintenance and condition based maintenance, Definition, system approach, objectives, responsibilities of maintenance department, maintenance strategies, principles of maintenance, concepts of maintainability, availability and reliability, implementation of CBM, comparison of CBM with other maintenance techniques and case studies (overview). Introduction to condition monitoring, basic concept, techniques - visual monitoring, temperature monitoring, vibration monitoring, lubricant monitoring, crack monitoring, thickness monitoring, noise and sound monitoring.

UNIT – II

Basic signal processing techniques Probability distribution and density, Fourier analysis, Hilbert Transform, Cepstrum analysis, Digital filtering, Deterministic / random signal separation, Time-frequency analysis. Wavelet Transform Introduction to Wavelets, Continuous Wavelet Transform (CWT), Discrete Wavelet Transform (DWT), Wavelet Packet Transform (WPT),types of wavelets –Haar wavelets, Shannon wavelets, Meyer wavelets, Daubechies wavelets, Coifman wavelets and applications of wavelets.

UNIT – III

Vibration Monitoring, Introduction, vibration data collection, techniques, instruments, transducers, selection, measurement location, time domain analysis, frequency domain analysis, time-frequency domain analysis and commonly witnessed machinery faults diagnosed by vibration analysis.

Rotating and reciprocating machines, Vibration signals from rotating and reciprocating machines – signal classification, signals, generated by rotating machines, signals generated by reciprocating machines.

UNIT – IV

Mechanical fault diagnosis, Wear monitoring and lubricant analysis - sources of contamination, techniques, Spectrometric, Oil Analysis Procedure (SOAP) and ferrography.

Non-destructive testing techniques, Measurement of surface and subsurface flaws – liquid penetrant inspection, eddy current inspection, radiographic inspection, ultrasonic inspection.

UNIT – V

Condition monitoring of rolling element bearings and gear, Introduction, construction, types of faults, rolling element bearing diagnostics and gear diagnostics. Tool wear monitoring, Introduction, techniques and case studies.

TEXT BOOKS:

1. Robert Bond Randall – Vibration-Based Condition Monitoring – Industrial, Aerospace and Automotive applications, John Wiley & Sons Ltd., 2011
2. R.A.Collacot – Mechanical Fault Diagnosis – Chapman and Hall Ltd., 1977.
3. R.C.Mishra, K.Pathak – Maintenance Engineering and Management, Prentice Hall of India Pvt. Ltd., 2002.
4. K. P. Soman, K. I. Ramachandran, N. G. Resmi – Insight into wavelet from theory to practice, Third Edition, Prentice Hall of India,

REFERENCES BOOKS:

1. John S.Mitchell, Introduction to Machinery Analysis and Monitoring, Penn Well Books,1993.
2. "Hand book of Condition Monitoring" ELSEVIER SCIENCE
3. R. A. Collacott, "Vibration monitoring and diagnosis", Wiley,1979.
4. Rao J.S. "Vibratory Condition Monitoring of Machines ", CRC Press,2000.
5. "Condition Monitoring manual", National Productivity Council, New Delhi.

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

CO's	Statements	Bloom's Level
CO1	Understand the types of maintenance used and its significance, role of condition based maintenance in industries, familiarize with different condition monitoring techniques and its advantages in industries.	L4
CO2	Implement the basic signal processing techniques.	L3
CO3	Understand the role of vibration monitoring, its methodology and its use in condition monitoring of rotating and reciprocating machines.	L3
CO4	Understand the types of maintenance used and its significance, role of condition based maintenance in industries, familiarize with different condition monitoring techniques and its advantages in industries.	L2
CO5	Study condition monitoring of rolling element bearing, gears and tool condition monitoring techniques in machining.	L2

III Year II Semester	ENGINE MANAGEMENT SYSTEMS	L	T	P	C
		3	0	0	3

Course objective: To impart the knowledge of the Spark Ignition and compression ignition engine management systems, engine diagnostics procedure, Computerised electronic fuel injection systems and air flow fuel management strategies.

UNIT-I

Computerized Electronic Fuel Injection: Engine Input Sensors Coolant & Intake Temperature, Crankshaft Position, Camshaft Position, Manifold Absolute Pressure, Throttle Position, Oxygen, Air/Fuel Ratio, Knock Speed& Distance, Battery & Switches Output Devices -Relays, Injector Sequencing & Management, Ignition Operation, Idle Air Control, EGR, EVAP, Waste gate Solenoids, Torque Converter & Speed Control, Malfunction Indicator Light

UNIT -II

Speed Density/Mass Air Flow Fuel Management Strategies: Key ON Mode, Crank Mode, Open & Closed Loop, Wide-Open Throttle, Adaptive Memory Cells, Cruise &Deceleration, Wide-Open Throttle, Key OFF Mode Fuel Injection Systems -Electronic Fuel Systems, Computer Self-Diagnostic Circuits, Electronic Throttle Actuator Control Systems, Fuel Control, Fuel Supply System Control, Injection System Inspection and Maintenance.

UNIT -III

Engine Diagnostic Procedures Fuel System testing, On Board Diagnostics, Monitored &Non Monitored Circuits, Diagnostic Trouble Codes, Digital Engine Control System: Open loop and close loop control system, engine cooling and warm up control, idle speed control, acceleration and full load enrichment, deceleration fuel cut-off. Fuel control maps, open loop control of fuel injection and closed loop lambda control exhaust emission control, on-board diagnostics, diagnostics, future automotive electronic systems, Electronic dash board instruments – Onboard diagnosis system.

UNIT -IV

SI Engine Management: Feedback carburettor system, throttle body injection, multi-point fuel injection and direct injection systems, Layout and working of SI engine management systems like Bosch Mono-jetronic, L-Jetronic and LH-Jetronic. Group and sequential injection techniques. Advantages of electronic ignition systems. Types of solid state ignition systems and their principle of operation, Contactless electronic ignition system, Electronic spark timing control. Three-way catalytic converter, conversion efficiency versus lambda.

UNIT – V

CI Engine Management: Fuel injection system, parameters affecting combustion, noise and emissions in CI engines. Pilot, main, advanced, post injection and retarded post injection. Electronically controlled Unit Injection system. Layout of the common rail fuel injection system. Working of components like fuel injector, fuel pump, rail pressure limiter, flow limiter, EGR valve control in electronically controlled systems.

TEXT BOOKS:

1. Diesel Engine Management by Robert Bosch, SAE Publications, 3rd Edition, 2004

2. Gasoline Engine Management by Robert Bosch, SAE Publications, 2nd Edition, 2004

REFERENCE BOOKS:

1.Halderman, J. & Linder, J. (2012). Automotive Fuel and Emissions Control Systems (3rd Edition)Upper Saddle River, NJ: Pearson Education.

2.Halderman, J. D. (2011). Diagnosis &Troubleshooting of Automotive Electrical, Electronic, &Computer Systems (6th Edition) Upper Saddle River, NJ: Pearson Education.

3. Understanding Automotive Electronics – Bechfold SAE 1998

4. Automobile Electronics by Eric Chowanietz SAE

5. Fundamentals of Automotive Electronics - V.A.W.Hilliers - Hatchin, London

6.Automobile Electrical & Electronic Equipment (2000) Young, Griffitns - Butterworths, London.

7.Understanding Automotive Electronics, William B. Ribbens, 5th Edition, Newnes, Butterworth– Heinemann, 2001.

8.Automotive Computers & Digital Instrumentation – Robert N. Brandy, Prentice Hall, 2004

9.The Fundamentals of Electrical Systems - John Hartly - Longman Scientific & Technical, 2002.

Course Outcomes: After the completion of the course, the student will be able to

CO's	Statements	Bloom's Level
CO1	Acquire the knowledge about Computerized Electronic Fuel Injection, Battery & Switches Output Devices	L4
CO2	Understand the Air Flow Fuel Management Strategies and electronic fuel systems.	L3
CO3	Describe the Engine Diagnostic Procedures Fuel System testing.	L3
CO4	Analyze the spark ignition and compression ignition management systems.	L2

III Year-II Semester	CFD FOR AUTOMOBILE APPLICATIONS	L	T	P	C
		3	0	0	3

Course Objectives:
- To get Familiarize with the governing equations in CFD and its application areas
- To Understand Elliptic, Parabolic and Hyperbolic partial differential equations and solve the linear equations.
- To Analyse the CFD problem by Finite difference and Finite volume methods and apply different computational Techniques.

UNIT-I
Introduction: Philosophy of Computational Fluid Dynamics (CFD), Impact of CFD and its use as research and design tool. Application areas: Automobile & Engine, Civil engineering, Environmental, Naval Architecture.
Governing Equations of fluid dynamics: Derivation, discussion of their physical meaning, models of the flow, substantial derivative, Divergence of a velocity, Navier-Stokes Equation, Physical boundary conditions, Forms of governing equation suited to CFD

UNIT-II
Mathematical behavior of Partial Differential Equations: Classification of Quasi-Linear PDE, The Eigenvalue Method, Hyperbolic, parabolic & Elliptic equations.
Solution of System of Linear Equations: Algorithms for the solution of linear problems; awareness of typical applications for such software and practical issues associated with implementation. Efficient direct and iterative solution algorithms for large, sparse, linear equation systems.

UNIT-III
Finite difference discretization: Basic aspects of discretization, finite difference method, difference equations, Polynomial Approach; Explicit and Implicit schemes, stability analysis; Grid transformations, transformation of equations
Basic Computational Techniques: Lax-Wendroff Technique, Mac Cormack's Technique, Space Marching, Relaxation Technique, Alternating direction implicit method.

UNIT-IV
Basics of Finite Volume Methods: Finite volume discretization, Approximation of Surface Integrals, Approximation of Volume Integrals, Interpolation schemes, Upwind Interpolation, Linear Interpolation, Quadratic Upwind Interpolation, and Higher-Order Schemes.
Applications of Finite Volume Methods: One-dimensional steady state diffusion, Steady one-dimensional convection and diffusion, Assessment of the central differencing scheme for convection-diffusion problemsand TDMA algorithm.

UNIT-V
Introduction to finite element method: Basics of finite element method, stiffness matrix, Iso-parametric elements, Formulation of finite elements for one dimensional flow and heat transfer problems.

CFD applied to Automobiles: Introduction of automobile parts and its aerodynamics design analysis. Advantages of the CFD used in automobile. Case studies.

Text Books:

1. Computational Fluid Dynamics the Basics with Applications, John D Anderson, Jr., McGraw Hill Book Company.
2. An Introduction to Computational Fluid Dynamics: The Finite Volume Method, H K Versteeg, W Malalasekera, Pearson Education Ltd

References:

1. Numerical Heat Transfer and Fluid Flow, Suhas V Patankar, Hemisphere Publishing Co.
2. Fundamentals of Computational Fluid Dynamics, Tapan K. Sengupta, Universities Press.
3. Computational Method for Fluid Dynamics, Joel H. Ferziger and Milovan Peric, 3rd Edition, Springer, 2002.
4. Computational Fluid Mechanics and Heat Transfer, Dale A. Anderson, John C. Tannehill and Richard H. Pletcher,2nd Edition, Taylor and Francis, 1984.

Course Outcomes: After the completion of the course, the student will be able to

CO's	Statements	Bloom's Level
CO1	Familiarize with the governing equations in CFD and its application areas	L4
CO2	Understand Elliptic, Parabolic and Hyperbolic partial differential equations and solve the linear equations.	L3
CO3	Analyse the CFD problem by Finite difference method and apply different computational Techniques.	L3
CO4	Analyse the CFD problem by Finite volume method and understand different applications	L2
CO5	Familiarize with finite element method and applications of CFD in the design of automobiles.	L2

III Year II Semester	MODELING AND SIMULATION IN MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES: The course's goal is to:
- Learn way of analysing the systems.
- Classification of systems based nature of dynamics and knowledge of elements.
- Develop simulation model for dynamic discrete – event stochastic system.
- Run the model and collect the data.
- Analyse the output data of simulation for specified for performance measures bases on type of simulation and method of output data analysis.

UNIT – I:
System – ways to analyse the system – Model - types of models – Simulation – Definition – Types of simulation models – steps involved in simulation – Advantages & Disadvantages. Parameter estimation – estimator – properties – estimate – point estimate – confidence interval estimates – independent – dependent – hypothesis – types of hypothesis- steps – types 1& 2 errors – Framing – strong law of large numbers.

UNIT – II:
Building of Simulation model – validation – verification – credibility – their timing – principles of valid simulation Modelling – Techniques for verification – statistical procedures for developing credible model. Modelling of stochastic input elements – importance – various procedures – theoretical distribution – continuous – discrete – their suitability in modelling.

UNIT – III:
Generation of random variates – factors for selection – methods – inverse transform – composition – convolution – acceptance – rejection – generation of random variables – exponential – uniform – Weibull – normal Bernoulli – Binomial – uniform – poison. Simulation languages – comparison of simulation languages with general purpose languages – Simulation languages vs Simulators – software features – statistical capabilities – G P S S – SIMAN- SIMSCRIPT –Simulation of M/M/1 queue – comparison of simulation languages.

UNIT – IV:
Output data analysis – Types of Simulation with respect to output data analysis – warm up period- Welch algorithm – Approaches for Steady – State Analysis – replication – Batch means methods – comparisons.

UNIT – V:

Applications of Simulation – flow shop system – job shop system – M/M/1 queues with infinite and finite capacities – Simple fixed period inventory system – New boy paper problem.

TEXTBOOKS:
1. Simulation Modelling and Analysis by Law, A.M. & Kelton, McGraw Hill, 2ⁿᵈEdition, New York, 1991.
2. Discrete Event System Simulation by Banks J. & Carson J.S., PH, Englewood Cliffs, NJ, 1984

REFERENCE BOOKS:
1. Simulation of Manufacturing Systems by Carrie A., Wiley, NY, 1990.
2. A Course in Simulation by Ross, S.M., McMillan, NY, 1990.
3. Simulation Modelling and SIMNET by Taha H.A., PH, Englewood Cliffs, NJ, 1987.)

Course Outcomes: On the completion of the course the student will able to

CO's	Statements	Bloom's Level
CO1	Understand different Simulation models and different steps in simulation.	L1
CO2	Understand the Generation of random variates and its factors for selection	L2
CO3	Compare the different simulation languages with general purpose languages and differentiate Simulation languages vs Simulators.	L2
CO4	Understand the different types of simulation with respect to output data analysis.	L2

III Year II Semester	LEAN MANUFACTURING	L	T	P	C
		3	0	0	3

Course Objectives: Course Objectives: The course should enable the students to understand the Lean and factory simulation, and comparison of Lean manufacturing with other methods. The student also should understand the tools of Lean manufacturing, Value Stream mapping and best practices in Lean manufacturing.

Unit I
Introduction to Lean and Factory Simulation: History of Lean and comparison to other methods – The 7 Wastes, their causes and the effects – An overview of Lean Principles / concepts / tools – Stockless Production.

UNIT-II
The Tools of Lean Manufacturing: Continuous Flow – Continuous Flow Manufacturing and Standard Work Flow – 5S and Pull Systems (Kanban and ConWIP systems) – Error Proofing and Set-up Reduction – Total Productive Maintenance (TPM) – Kaizen Event examples. Toyota production systems, Ford production systems

Unit- III
Value Stream Mapping – Current state: Preparation for building a Current State Value Stream Map – Building a Current State Map (principles, concepts, loops, and methodology) – Application to the factory Simulation scenario.

Unit – IV
Value Stream Mapping – Future State: Key issues in building the Future State Map – Process tips in building the map and analysis of the customer loop, supplier loop, manufacturing loop and information loop – Example of completed Future State Maps – Application to factory simulation – Implementation of lean practices – Best Practices in Lean Manufacturing.

UNIT-V
TQM Tools and Techniques:
The seven traditional tools of quality, new management tools, and six sigma: Concepts, methodology, applications to manufacturing, service sector including IT, Bench marking, Reason to bench mark, Bench marking process, FMEA, Stages, and Types. Quality circles, Quality Function Deployment (QFD), Taguchi quality loss function, TPM, Concepts, improvement needs, Cost of Quality, Performance measures

Text Books:

1. Womack J. P., Jones D.T. and Roos D. – 'The Machine that Changed the World: the Story of Lean Production' – Simon & Schuster, New York – 1996
2. Liker J. K. – 'Becoming Lean' – Industrial Engineering and Management Press – 1998
3. Womack J. P. and Jones D. T. – 'Lean Thinking' – Simon & Schuster, USA – 1996
4. Rother M. and Shook J. – 'Learning to See' – The Lean Enterprise Institute, Brookline, USA – 2003

Course Outcomes: After the completion of the course, the student will be able to

CO's	Statements	Bloom's Level
CO1	Understand the basics of Lean manufacturing and comparison with other methods of manufacturing	L1
CO2	Understand the tools used in Lean Manufacturing and total predictive maintenance	L2
CO3	Appreciate the value stream mapping and Application to the factory Simulation scenario.	L2

III B.Tech II Semester	AUTOMOBILE HVAC	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

Students undergoing this course are expected

1. To provide introduction to students the fundamentals of refrigerant, refrigeration systems and air conditioning controls to automobile applications.
2. To teach students the principle of psychometry.
3. To enable the students to understand heating and cooling load calculations.
4. To develop the knowledge about air distribution systems.
5. To introduces the general servicing of automotive air conditioning systems.

UNIT I:
REFRIGERATION

Introduction - Methods of Refrigeration - Air Refrigeration System and its Applications - Vapour Compression Refrigeration System - Vapor Absorption Refrigeration System - Applications of Refrigeration & Air Conditioning - Automobile Air Conditioning - Air Conditioning for Passengers, Isolated Vehicles and Transport Vehicles - Applications Related with Very Low Temperatures. Classification, Properties and Selection Criteria - Commonly Used Refrigerants - Alternative Refrigerants - Eco-Friendly Refrigerants - Applications of Refrigerants - Refrigerants Used in Automobile Air Conditioning

UNIT II:
PSYCHOMETRY

Psychometric Properties, Tables, Charts - Psychometric Processes - Comfort Charts - Factors Affecting Comfort - Effective Temperature - Ventilation Requirements.

UNIT III
AIR CONDITIONING SYSTEMS AND LOAD ANALYSIS

Classification and Layouts - Central / Unitary Air Conditioning Systems - Components Like Compressors, Evaporators, Condensers, Expansion Devices, Fan Blowers, Heating Systems Etc. Load Analysis - Outside & Inside Design Consideration - Factors Forming the Load on Refrigeration & Air Conditioning Systems - Cooling & Heating Load Calculations - Load Calculations for Automobiles - Effect of Air Conditioning Load on Engine Performance.

UNIT IV:
AIR DISTRIBUTION SYSTEMS
Distribution Duct System, Sizing, Supply / Return Ducts - Types of Grills, Diffusers, Ventilation, Air Noise Level - Layout of Duct Systems for Automobiles and their Impact on Load Calculations. Air Routine & Temperature Control - Objectives - Evaporator Care Air Flow - Through the Dash Recirculating Unit - Automatic Temperature Control - Controlling Flow - Control of Air Handling Systems.

UNIT V:
AIR CONDITIONING SERVICE AND CONTROL
Air Conditioner Maintenance & Service - Servicing Heater System - Removing & Replacing Components - Trouble Shooting of Air Conditioning System -Compressor Service, Methods of Dehydration, Charging & Testing. Air Conditioning Control - Common Control Such as Thermostats- Humidistat Us - Control Dampers - Pressure Cutouts and Relays

COURSE OUTCOMES: Attending the laboratory the students shall be able to:

CO's	Statements	Bloom's Level
CO1	Understand the different Air refirgerations systems and their applications.	L2
CO2	learn Psychrometry properties and ventilation requirements.	L3
CO3	Understand Air-Conditioning systems and load analysis	L2
CO4	Learn Air-Conditioning Service and Control	L3

III B.Tech II Semester	SENSORS AND ACTUATORS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

The objective of this course is to make the students to list common types of sensor and actuators used in automotive vehicles.

UNIT I:
INTRODUCTION TO MEASUREMENTS AND SENSORS:
Sensors: Functions- Classifications- Main technical requirement and trends Units and standards Calibration methods- Classification of errors- Error analysis- Limiting error- Probable error Propagation of error- Odds and uncertainty- principle of transduction- Classification. Static characteristics- mathematical model of transducers- Zero, First and Second order transducers Dynamic characteristics of first and second order transducers for standard test inputs

UNIT II:
VARIABLE RESISTANCE AND INDUTANCE SENSORS:
Principle of operation- Construction details- Characteristics and applications of resistive potentiometer- Strain gauges- Resistive thermometers- Thermistors- Piezoresistive sensors Inductive potentiometer- Variable reluctance transducers:- EI pick up and LVDT.

UNIT III:
 VARIABLE AND OTHER SPECIAL SENSORS:
Variable air gap type, variable area type and variable permittivity type- capacitor microphone Piezoelectric, Magnetostrictive, Hall Effect, semiconductor sensor- digital transducers- Humidity Sensor. Rain sensor, climatic condition sensor, solar, light sensor, antiglare sensor.

UNIT IV:
AUTOMOTIVE ACTUATORS:
Electromechanical actuators- Fluid-mechanical actuators- Electrical machines- Direct-current machines- Three-phase machines- Single-phase alternating-current Machines - Duty-type ratings for electrical machines. Working principles, construction and location of actuators viz. Solenoid, relay, stepper motor etc.

UNIT V:
AUTOMATIC TEMPERATURE CONTROL ACTUATORS:
Different types of actuators used in automatic temperature control- Fixed and variable displacement temperature control- Semi Automatic- Controller design for Fixed and variable displacement type air conditioning system.

TEXT BOOKS:
1. Doebelin's Measurement Systems: 7th Edition (SIE),Ernest O. DoebelinDhaneshN.Manik McGraw Hill Publishers, 2019.
2. Robert Brandy, " Automotive Electronics and Computer System", Prentice Hall,2001
3. William Kimberley," Bosch Automotive Handbook", 6th Edition, Robert Bosch GmbH, 2004.
4. Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive, 5th Edition, 2007, ISBN No: 978-3-658-01783-5.

REFERENCES:
1. James D Halderman, " Automotive Electrical and Electronics" , Prentice Hall, USA, 2013
2. Tom Denton, "Automotive Electrical and Electronics Systems," Third Edition, 2004, SAE International.
3. Patranabis.D, " Sensors and Transducers", 2nd Edition, Prentice Hall India Ltd,2003
4. William Ribbens, "Understanding Automotive Electronics -An Engineering Perspective," 7th Edition, Elsevier Butterworth-Heinemann Publishers, 2012.

COURSE OUTCOMES: At the end of the course, the student will be able to

CO's	Statements	Bloom's Level
CO1	List common types of sensor and actuators used in vehicles.	L2
CO2	Design measuring equipment's for the measurement of pressure force, temperature and flow.	L3
CO3	Generate new ideas in designing the sensors and actuators for automotive application	L3
CO4	Understand the operation of the sensors, actuators and electronic control.	L2

III B.Tech II Semester	TWO & THREE WHEELERS	L	T	P	C
		3	0	0	3

Course Objectives:
The objective of this course is to make the students to know and understand the constructional details, operating characteristics and design aspects of Two and
Three wheelers.

UNIT I INTRODUCTION
Classifications- design considerations –weight and dimension limitations – requirements, stability problems, gyroscopic effect- pendulum effect of two and three wheelers.

UNIT II POWER UNITS, IGNITION SYSTEMS ELECTRICAL &BRAKING SYSTEMS
2 stoke and 4 stoke engines. Design criteria for engines – design of cylinders, cylinder head, cooling fins, crank case, connecting rod and crank shaft. Carburetor types. Wiring layout for two wheelers. Braking system in two wheelers, Fundamentals of EFI.

UNIT III CLUTCHES AND TRANSMISSION
Types of clutches. Design of clutch system. Gears for two and three wheelers. Design of gear box and gear change mechanism. Belt, chain and shaft drive. Freewheeling devices, starting systems.

UNIT IV FRAMES, SUSPENSION, WHEELS AND TYRES
Types of frames. Wheel frames- construction design of frames for fatigue strength, torsional stiffness and lateral stability. Front and rear forks. Springs for suspension, Dampers, constructional details of wheel and tyres.

UNIT V THREE WHEELERS
Auto rickshaws - Pick-Ups and delivery type vehicle, frames and transmission, wheel types, wheel mountings attachment, tyre types. Brake systems.

REFERENCES
1. 'Cycle Motor Manual', Templeton Press Ltd., London, 1992.
2. Irving P.E., "Motor Cycle Engineering", Temple Press Book, London, 1964
3. Johns.B.A., 'Motorcycles', Good Heart will, 1984.
4. M.M.Griffin., 'Motor cycles from inside and outside', Prentice Hall Inc, New Jersey, 1978.
5. Marshal Cavandedish, 'Encyclopedia of Motor cycling', New York, 1989
6. Servicing Manuals- various motor cycles, Scooters, Mopeds and three wheelers.
7. Srinivasan.S., 'Motor cycle, Scooter, Mopeds', New century book house, 1988

Course Outcomes:

Students will have the basic knowledge on various two wheelers and its technology along with its functions. At the end of the course the students will have thorough knowledge over different frames, suspension system and transmission unit used on various two and three wheeler vehicles.

		L	T	P	C
III B.Tech II Semester	**HYBRID AND EV TECHNOLOGY**	3	0	0	3

Course Objectives: The course should enable the students to:

- General aspects of Electric and Hybrid Vehicles (EHV), including architectures, modeling, sizing, sub-system design and hybrid vehicle control.
- Understand about vehicle dynamics,
- Design the required energy storage devices,
- Select the suitable electric propulsion systems and understand the hybrid electric vehicles.

UNIT I
INTRODUCTION
Need for hybrid and electric vehicles – main components and working principles of a hybrid and electric vehicles, Different configurations of hybrid and electric vehicles. Comparative study of diesel, petrol, hybrid and electric Vehicles. Advantages and Limitations of hybrid and electric Vehicles. Case study on specification of electric and hybrid vehicles.

UNIT II
DESIGN CONSIDERATIONS FOR ELECTRIC VEHICLES
Design requirement for electric vehicles- Range, maximum velocity, acceleration, power requirement, mass of the vehicle. Various Resistance- Transmission efficiency- Electric vehicle chassis and Body Design, Electric Vehicle Recharging and Refuelling Systems.

UNIT III
ENERGY SOURCES
Battery Parameters- - Different types of batteries – Lead Acid- Nickel Metal Hydride - Lithium ion- Sodium based- Metal Air. Battery charging- Quick Charging devices. Battery Management System.
Polymer Exchange Membrane Fuel Cell- Characteristics- Half reactions of fuel cell. Cells in series and parallel- water management - Thermal Management.

UNIT IV
MOTORS
Characteristics of DC motors (Brush and Brushless), AC single phase and 3-phase motor, PM motors, Switched reluctance motors, Motor Drives and speed controllers, Torque Vectoring, Regenerative Braking. Rectifiers, Inverters, DC/AC converters.

UNIT V
SUBSYSTEMS OF HYBRID AND ELECTRIC VEHICLES
Power Split devices for Hybrid Vehicles - Operation modes - Control Strategies for Hybrid Vehicle- Economy of hybrid Vehicles. Choice of Tires.

TEXT BOOKS:

1. Iqbal Husain, "Electric and Hybrid Vehicles-Design Fundamentals", CRC Press, 2003
2. Mehrdad Ehsani, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles", CRC Press, 2005.

REFERENCES:

1. James Larminie and John Lowry, "Electric Vehicle Technology Explained "John Wiley &Sons,2003
2. Lino Guzzella, "Vehicle Propulsion System" Springer Publications,2005
3. Ron Hokinson, "Light Weight Electric/ Hybrid Vehicle Design", Butterworth HeinemannPublication,2005

COURSE OUTCOMES: At the end of the course, the student will be able to

CO's	Statements	Bloom's Level
CO1	Explain the Electric and hybrid vehicle operation and architectures	L2
CO2	Design of hybrid and electric vehicles.	L3
CO3	Understand the Energy requirement for vehicles.	L3
CO4	Learn the Vehicle characteristics, operating modes, and performance parameters of the vehicle	L2

III Year-II Semester	ALTERNATIVE FUELS FOR AUTOMOBILES	L 3	T 0	P 0	C 3

Course Objectives: To impart the necessity of finding alternative energy sources for automobiles. To understand merits and demerits, performance characteristics of various sources of fuels and their comparison.

UNIT I   CONVENTIONAL FUELS FOR I.C. ENGINES
Petroleum based conventional fuels for SI and CI engine, Demand and Availability of crude oil – vehicle population increase – national and international standards for conventional and alternative fuels.
Desirable characteristics of SI Engine fuels – Petrol – Properties, Specification, chemical structure, 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   ALCOHOLS AS FUELS
Availability of different alternative fuels for engines. Alcohols – Properties, Production methods and usage in engines. Blending, dual fuel operation, surface ignition, spark ignition and oxygenated additives. Performance, combustion and emission Characteristics in engines. Advantages and disadvantages of alcohol fuels

UNIT III   VEGETABLE OILS AND BIODIESEL AS FUELS
Properties of Vegetable oils and biodiesel- Methods of using vegetable oils – Blending, preheating, and emulsification – Preparation of biodiesel from non-edible, edible oil and Algae - Performance, combustion and emission Characteristics in diesel engines. Advantages and disadvantages of Vegetable oils and biodiesel

UNIT IV   HYDROGEN AS FUEL
Hydrogen – Properties, Production methods, storage and safety aspects. Issues & limitation in Hydrogen. Methods of using hydrogen in engines. Performance, combustion and emission Characteristics in engines. Advantages and disadvantages of Hydrogen fuel.

UNIT V   BIOGAS, CNG AND LPG AS FUELS
Biogas, Compressed Natural gas (CNG) and LPG – Properties and production methods. CO2 and H2S scrubbing in Biogas, Modifications required for use in Engines- Performance, combustion and emission Characteristics in engines. Advantages and disadvantages of Gaseous fuels. Working of LPG and CNG kits used in automotive engines.

REFERENCES
1. Arumugam S. Ramadhas, "Alternative Fuels for Transportation" CRC Press, 2011.
2. Ayhan Demirbas and M. Fatih Demirbas, "Algae Energy-Algae as a New Source of Biodiesel", Springer-Verlag London Limited 2010.

3. Ayhan Demirbas, 'Biodiesel A Realistic Fuel Alternative for Diesel Engines', Springer-Verlag London Limited 2008
4. David M. Mousdale, "Introduction to Biofuels", CRC Press, 2015.
5. Ganesan.V., "Internal Combustion Engineering", Tata McGraw-Hill Publishing Co., New Delhi, 2003.
6. Gerhard Knothe, Jon Van Gerpen, Jargon Krahl, The Biodiesel Handbook, AOCS Press Champaign, Illinois 2005.
7. M. K. Gajendra Babu and K. A. Subramanian, "Alternative Transportation Fuels-Utilisation in Combustion Engines", CRC Press, 2013.
8. M.L. Mathur, R.P.Sharma "Internal combustion engines", Dhanpatrai publication, 2003.
9. Richard L Bechtold P.E., Alternative Fuels Guide book, Society of Automotive Engineers, 1997 ISBN 0-76-80-0052-1.

COURSE OUTCOMES: At the end of the course, the student will be able to

CO's	Statements	Bloom's Level
CO1	Possess a comprehensive understanding of available alternative fuels for IC engines. They will possess complete knowledge on producing different biofuels, modifying them and using them in IC engines	L2
CO2	Acquire the skills in developing new technologies for alternative fuels efficiently in IC engines.	L3
CO3	Demonstrate the importance of using alternative fuels for sustainable energy supply and for emission control in IC engines.	L3

III Year-II Semester	**VEHICLE EVALUATION LAB**	L	T	P	C
		0	0	3	1.5

(Minimum 6 Experiments)
(Demonstration of these standards for the identified tests also permitted)

1. Brake Performance Evaluation for 4 -Wheelers (as per IS 11852-2001, Part 1 to 8, and IS 11852-2003, Part 9) Brake Performance
2. Pass-by Noise Level Measurement Test for all vehicles (as per IS 3028-1998)
3. Interior Noise Level Measurement Test for N2 / N3 and M2 / M3 category of vehicles (as per AIS 020)
4. Turning Circle Diameter Check for all vehicles other than 2- Wheelers (as per IS 12222-2011)
5. Steering Effort Measurement for all vehicles other than 2- Wheelers (as per IS 11948-1998)
6. Hood Latch Test (for all four wheelers fitted with a front bonnet) (as per IS 14226-1995)
7. Stationary Noise Level Measurement (as per ISO 5130:1982(E), IS 10399:1998 for all vehicles
8. Tell Tale Symbols Checks (as per AIS: 071-2009)
9. Range Test for LPG / CNG fuelled vehicles (as per AIS 055) Physical Verification Tests for All type of vehicles (as per CMVR)
10. Vehicle Weighment for all vehicles (as per IS 11825-1986) Wheel Guard Measurement for Passenger Cars (as per IS 13943-1994)
11. Safety Checks for CNG / LPG fuelled vehicles (as per AIS 026, AIS 027 and AIS 028)
12. Acceleration performance of 2 wheeler (as per IS 10407: 1998)
13. Acceleration performance of automotive vehicles other than 2 & 3 wheelers (as per IS 11851:1986)
14. Fuel efficiency test Highway fuel consumption City fuel consumption
15. Manoeuvrability on Serpentine Course
16. Bus body code as per AIS:052
17. Truck code as per AIS:093
18. Ambulance code as per AIS:125
19. School Bus as per AIS:063
20. Sleeper Coach as per AIS:119
21. Double Decker Buses as per AIS:139

Note: 1. The institute must have tie-up with any two/three/four wheeler workshop to carryout certain tests
2. The institute must have standard two/three/four wheeler chassis dynamometer

III Year-II Semester	VEHICLE MAINTENANCE LABORATORY	L	T	P	C
		0	0	3	1.5

OBJECTIVES:
- To study the various maintenance, the reconditioning of vehicle parts.
- To train the structures in identifying the fault and rectification.
- To impart the fundamental knowledge in evaluation and maintenance.
- To know about the various methods of maintaining vehicles and their subsystems.

STUDY EXPERIMENTS: (Atleast 3 of 6 experiments)
1. Study and layout of an automobile repair, service and maintenance shop.
2. Safety aspects with respect to man, machine and tools.
3. General procedures for servicing and maintenance schedule.
4. Fault diagnosis and service of transmission system
5. Fault diagnosis and service of Electrical system like battery, starting system, charging system, lighting system etc.
6. Fault diagnosis and service of vehicle air conditioning system

LIST OF EXPERIMENTS (Atleast 8 of 10 experiements)
1. Minor and major tune up of gasoline and diesel engines.
2. Calibration of Fuel injection pump.
3. Calibration of fuel injection nozzle and tester
4. Removal and fitting of tire and tube.
5. Fault diagnosis of ignition system and spark plug cleaner & tester
6. Adjustment of pedal play in clutch, brake, hand brake lever and steering wheel.
7. Wheel alignment procedure for servicing and maintenance.
8. Fault diagnosis of brake/clutch
9. Calibration of head lamp aligner
10. Calibration of Re-facer of valve.

Course Outcomes: At the completion of the course, the student should be able to
- Understand the various maintenance the reconditioning of vehicle parts.
- Analyse the structures in identifying the fault and rectification.
- Acquire the fundamental knowledge in evaluation and maintenance.
- Understand the various methods of maintaining vehicles and their subsystems.

III Year-II Semester	AUTOMOBILE ECU SENSORS AND ACTUATORS LAB	L	T	P	C
		0	0	3	1.5

1. NI cDAQ-9178 (DAQ System with Analog/Digital I/O)

- **Exp 1:**
  Conduct an experiment to monitor and control real-time data from multiple sensors using the NI cDAQ-9178 system.
- **Exp 2:**
  Perform analog signal acquisition and generate corresponding digital output control for a basic mechatronic application using NI cDAQ-9178.

2. NI myRIO-1900 (with Encoder, IR, Ultrasonic, Servo Motor)

- **Exp 3:**
  Implement closed-loop control to maintain the speed and position of a servo motor using encoder feedback on NI myRIO.
- **Exp 4:**
  Design and test an obstacle detection system using ultrasonic and infrared sensors interfaced with NI myRIO.

3. Transducer Trainer Kit (Loadcell, LVDT, Pressure, IR, Ultrasonic)

- **Exp 5:**
  Conduct an experiment to measure and calibrate force using a load cell and appropriate signal conditioning circuitry.
- **Exp 6:**
  Determine the linear displacement of a moving object using an LVDT sensor and analyze the processed signal.

4. Siemens S7-1500 PLC with CIROS Software

- **Exp 7:**
  Simulate and program a conveyor-based sorting system using Siemens S7-1500 PLC and CIROS software.
- **Exp 8:**
  Design and simulate an automated bottle filling and capping process using ladder logic programming in CIROS with Siemens PLC.

5. ARB Waveform Generator

- **Exp 9:**
  Generate custom electrical signals using the ARB function generator and analyze their characteristics using an oscilloscope.
- **Exp 10:**
  Test and evaluate the response of sensors to arbitrary excitation signals produced by the ARB waveform generator

MINORS	BASIC AUTOMOBILE ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives:

The course imparts the principles of automobile systems and provides the salient features of safety, emission and service of automobiles.

UNIT – I:

Engines – Classification

INTRODUCTION: Components of four wheeler automobile – chassis and body – power unit – power transmission – rear wheel drive, front wheel drive, 4 wheel drive – types of automobile engines, engine construction, turbo charging and super charging – engine lubrication, splash and pressure lubrication systems, oil filters, oil pumps – crank case ventilation

UNIT – II:

TRANSMISSION SYSTEM: Clutches, principle, types, cone clutch, single plate clutch, multi plate clutch, magnetic and centrifugal clutches, fluid fly wheel – gear boxes, types, sliding mesh, construct mesh, synchro mesh gear boxes, epicyclic gear box, over drive torque converter. propeller shaft – Hotchkiss drive, Torque tube drive, universal joint, differential rear axles – types – wheels and tyres.

UNIT – III:

STEERING SYSTEM: Steering geometry – camber, castor, king pin rake, combined angle toe-in, center point steering. types of steering mechanism – Ackerman steering mechanism, Davis steering mechanism, steering gears – types, steering linkages.

UNIT – IV:

SUSPENSION SYSTEM: Objects of suspension systems – rigid axle suspension system, torsion bar, shock absorber, Independent suspension system.

BRAKING SYSTEM: Mechanical brake system, hydraulic brake system, master cylinder, and wheel cylinder tandem master cylinder requirement of brake fluid, pneumatic and vacuum brakes.

ELECTRICAL SYSTEM: Charging circuit, generator, current – voltage regulator – starting system, Bendix drive mechanism solenoid switch, lighting systems, horn, wiper, fuel gauge – oil pressure gauge, engine temperature indicator.

UNIT – V:

ENGINE SPECIFICATIONS AND SAFETY SYSTEMS: Introduction- engine specifications with regard to power, speed, torque, cylinder arrangement, lubrication and cooling.
Safety: Introduction, safety systems - seat belt, air bags, bumper, anti-lock brake system (ABS), Suspension sensors, traction control, central locking and electric windows, speed control.

TEXT BOOKS:

1. Automotive Mechanics – Vol. 1 & Vol. 2 / Kirpal Singh/standard publishers

2. Automobile Engineering / William Crouse/TMH Distributors

3. Automobile Engineering/P.S Gill/S.K. Kataria & Sons/New Delhi.

REFERENCES:

1. Automotive Engines Theory and Servicing/James D. Halderman and Chase D. Mitchell Jr., / Pearson education Inc.

2. Automotive Engineering / K Newton, W.Steeds& TK Garrett/SAE

3. Automotive Mechanics : Principles and Practices/ Joseph Heitner/Van Nostrand Reinhold

4. Automobile Engineering / C Srinivasan/McGraw-Hill.

Course Outcomes:
The student after undergoing the course, shall learn about transmission, steering, suspension, braking and safety and should know the vehicle troubleshooting.

		L	T	P	C
MINORS	**IC ENGINES**	3	0	0	3

Course Objectives:
- To impart the knowledge and providing holistic view on IC Engines and its developments
- To enable the students to calculate the performance and testing of IC engines
- To fetch with SI & CI fuelling system and combustion behaviour and its advancements to meet the stringent emission norms
- Understanding the formation and control strategies of SI and CI Engine emissions

UNIT-I:
Engine Principles: Introduction, Comparison of Air Standard and Actual Cycles, Constructional Details of Four Stroke SI and CI Engines, Working Principle, Actual Indicator Diagram, Two Stroke Engine Construction and Operation, Comparison of Four Stroke and Two Stroke Engine Operation, Firing Order and Its Significance.

UNIT-II:
ENGINE TESTING & PERFORMANCE
Engine Performance Testing & Numerical- methods and Performance Characteristics; Performance Maps. Lubrication and Cooling systems, Introduction to Supercharging and Turbocharging; Introduction to Engine Cooling and Lubrication

UNIT-III:
SI ENGINE COMBUSTION
Carburettor Working Principle, Requirements of an Automotive Carburettor, and types, Fuel Injection Systems; Pre-mixed charge combustion, SI Engine Combustion Conceptual models, Knocking Combustion

UNIT-IV:
CI ENGINE COMBUSTION
Fuel Injection and Spray Structure: Fuel Atomization. Diesel Combustion Process Characterization: Ignition Delay, Effect of Engine and Operational Parameters on Delay, Pre-mixed Combustion and Mixing Controlled Combustion.

UNIT-V:
ADVANCED COMBUSTION MODES

GDI, Flexi Fuel, CAI, Introduction to Low Temperature Combustion Like: Homogeneous Charge Compression Ignition(HCCI), Fuel Stratified Charge combustion/ Reactivity Controlled Compression Ignition (RCCI) and Pre-mixed Charge Compression (PCCI) technologies.

Text Books:
1. IC Engines, M.L. Mathur & R.P. Sharma, Dhanpath Rai & Sons
2. Engine Emissions, Pollutant Formation and Advances in Control Technology, B.P. Pundir, Narosa Publishing House

Reference Books:
1. IC Engines Fundamentals, John B. Heywood, Mc Graw Hill Publications
2. Engineering Fundamentals of I C Engines, WiliardW.Pulkrabek, Prentice Hall Publications

Course Outcomes: At the end of the course, the students should be able to
- Differentiate the ideal, air standard cycles and actual thermodynamic cycles.
- Evaluate the Engine performance based on the experimental data
- Analyse the fueling system and combustion behaviour of SI engine
- Analyse the fueling system and combustion behaviour of CI engine
- Explain the formation of emissions and its control strategies of bot SI & CI Engines.

MINORS	VEHICLE BODY ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives:

- To make students familiar with car body details and vehicle aero dynamics
- To understand the bus body details, Commercial vehicle details, Body materials, Trim and Mechanisms

UNIT-I Car Body Details

Types: Saloon, Convertibles, Limousine, Estate Car, Racing and Sports Car. Visibility: Regulations, Driver's Visibility, Tests for Visibility, Methods of Improving Visibility and Space in Cars. Safety: Safety Design, Safety Equipment's for Cars. Car Body Construction; Design Criteria, Prototype Making, Initial Tests, Crash Tests on Full Scale Model, Dummies and Instrumentation

UNIT-II Vehicle Aerodynamics

Objectives. Vehicle Drag and Types; Various Types of Forces and Moments, Effects of Forces and Moments, Side Wind Effects on Forces and Moments, Various Body Optimization Techniques for Minimum Drag, Wind Tunnel Testing: Flow Visualization Techniques, Scale Model Testing, Component Balance to Measure Forces and Moments.

UNIT-III Bus Body Details

Types: Mini Bus, Single Decker, Double-Decker, Two Level and Articulated Bus. Bus Body Layout; Floor Height, Engine Location, Entrance and Exit Location, Seating Dimensions. Constructional Details: Frame Construction, Double Skin Construction, Types of Metal Sections used, Regulations, Conventional and Integral Type Construction.

UNIT-IV Commercial Vehicle Details

Types of Body; Flat Platform, Drop Side, Fixed Side, Tipper Body, Tanker Body, Light Commercial Vehicle Body Types. Dimensions of Driver's Seat Relation to Controls. Drivers Cab Design.

UNIT-V Body Materials, Trim and Mechanisms

Steel Sheet, Timber, Plastic, GRP, Properties of Materials; Corrosion, Anticorrosion Methods. Selection of Paint and Painting Process. Body Trim Items. Body Mechanisms

Text Books

1. James E Duffy, "Modern Automotive Technology", Goodheart-Wilcox; Seventh Edition, 2011

2. Jack Erjavec, "Automotive Technology – A systems approach", Cengage Learning, 2009,

Reference Books:

1. Geoff Davies, Materials for Automotive Bodies, Elsevier, Butterworth Heinemann, ISBN 0 7506 5692 1, 2003
2. Body Engineering , S. F. Page
3. Automotive Chassis – P.M. Heldt, Chilton & Co. 1952

Course Outcomes: After the completion of the course, the students should be able to

- Understand car body details and vehicle aero dynamics
- understand the bus body details, Commercial vehicle details, Body materials, Trim and Mechanisms

MINORS	AUTOMOBILE ELECTRICAL & ELECTRONICS ENGINEERING	L	T	P	C
		3	0	0	3

Course objective: To acquire the knowledge of Batteries and Accessories, Starting system, Charging system, fundamentals of automotive electronics, Sensors and actuators.

UNIT-I
Batteries and Accessories:

Principle and Construction of Lead Acid Battery, Characteristics of battery, rating capacity and Efficiency of Batteries, Various Tests on Batteries, Maintenance and Charging. Lighting System: Insulated and Earth Return System, Details of Head Light and Side Light, LED Lighting System, Head Light Dazzling and Preventive Methods – Horn, Wiper System andTrafficator.

UNIT-II
Starting System

Condition at Starting, Behavior of Starter during Starting, Series Motor and its Characteristics, Principle and Construction of Starter Motor, Working of Different Starter Drive Units, Care and Maintenances of Starter Motor, Starter Switches.

UNIT-III
Charging System

Generation of Direct Current, Shunt Generator Characteristics, Armature Reaction, Third Brush Regulation, Cutout. Voltage and Current Regulators, Compensated Voltage Regulator, Alternators Principle and Constructional Aspects and Bridge Rectifiers, New Developments.

UNIT-IV
Fundamentals of Automotive Electronics

Current Trends in Automotive Electronic Engine Management System, Electro Magnetic Interference Suppression, Electromagnetic Compatibility, Electronic Dashboard Instruments, Onboard Diagnostic System, Security and Warning System.

UNIT-V
Sensors & Actuators

Types of Sensors: Sensor for Speed, Throttle Position, Exhaust Oxygen Level, knock, Manifold Pressure, Crankshaft Position, Coolant Temperature, Exhaust Temperature, Impact sensor, Air Mass Flow for Engine Application. Solenoids, Stepper Motors, Relay.

Text Books
1. Young A.P. & Griffiths. L. "Automotive Electrical Equipment", ELBS & NewPress-1999.
2. William B.Riddens "Understanding Automotive Electronics", 5th edition -Butter worth Heinemann Woburn,1998.

References
1. Bechhold "Understanding Automotive Electronics", SAE,1998.
2. Crouse, W.H "Automobile Electrical Equipment", McGraw-Hill Book Co., Inc., New York, 3rd edition, 1986.
3. Judge A.W "Modern Electrical Equipment of Automobiles", Chapman & Hall, London,1992.
4. Kholi.P.L "Automotive Electrical Equipment", Tata McGraw-Hill Co., Ltd., New Delhi,1975.
5. Robert Bosch "Automotive Hand Book", SAE (5th Edition),2000.

Course Outcomes: After the completion of the course, the student should be able to acquire the knowledge of Batteries and Accessories, Starting system, Charging system, fundamentals of automotive electronics, Sensors and actuators.

MINORS	ELECTRICAL VEHICLES AND HYBRID TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives: The course should enable the students to:

- General aspects of Electric and Hybrid Vehicles (EHV), including architectures, modeling, sizing, sub-system design and hybrid vehicle control.
- Understand about vehicle dynamics,
- Design the required energy storage devices,
- Select the suitable electric propulsion systems and understand the hybrid electric vehicles.

UNIT I

INTRODUCTION

Need for hybrid and electric vehicles – main components and working principles of a hybrid and electric vehicles, Different configurations of hybrid and electric vehicles. Comparative study of diesel, petrol, hybrid and electric Vehicles. Advantages and Limitations of hybrid and electric Vehicles. Case study on specification of electric and hybrid vehicles.

UNIT II

DESIGN CONSIDERATIONS FOR ELECTRIC VEHICLES

Design requirement for electric vehicles- Range, maximum velocity, acceleration, power requirement, mass of the vehicle. Various Resistance- Transmission efficiency- Electric vehicle chassis and Body Design, Electric Vehicle Recharging and Refueling Systems.

UNIT III

ENERGY SOURCES

Battery Parameters- - Different types of batteries – Lead Acid- Nickel Metal Hydride - Lithium ion- Sodium based- Metal Air. Battery charging- Quick Charging devices. Battery Management System.

Polymer Exchange Membrane Fuel Cell- Characteristics- Half reactions of fuel cell. Cells in series and parallel- water management - Thermal Management.

UNIT IV

MOTORS

Characteristics of DC motors (Brush and Brushless), AC single phase and 3-phase motor, PM motors, Switched reluctance motors, Motor Drives and speed controllers, Torque Vectoring, Regenerative Braking. Rectifiers, Inverters, DC/AC converters.

UNIT V

SUBSYSTEMS OF HYBRID AND ELECTRIC VEHICLES

Power Split devices for Hybrid Vehicles - Operation modes - Control Strategies for Hybrid Vehicle- Economy of hybrid Vehicles. Choice of Tires.

TEXT BOOKS:

1. Iqbal Husain, "Electric and Hybrid Vehicles-Design Fundamentals", CRC Press, 2003

2. Mehrdad Ehsani, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles", CRC Press, 2005.

REFERENCES:

1. James Larminie and John Lowry, "Electric Vehicle Technology Explained "John Wiley &Sons,2003

2. Lino Guzzella, "Vehicle Propulsion System" Springer Publications,2005

3. Ron Hokinson, "Light Weight Electric/ Hybrid Vehicle Design", Butterworth HeinemannPublication,2005

Course Outcomes: The students able to understand

- Electric and hybrid vehicle operation and architectures
- Design of hybrid and electric vehicles.
- Energy requirement for vehicles.
- Vehicle characteristics, operating modes, and performance parameters of the vehicle
- Different subsystems of hybrid and electric vehicles

MINORS	AUTOMOBILE POLLUTION AND ITS EFFECTS	L	T	P	C
		3	0	0	3

Course objective: To impart the knowledge of different regulatory test procedures, pollutants and particulates. The student should acquire understanding about SI engine and CI engine emissions and different emission control techniques.

UNIT I

Laws and Regulation: Historical background, regulatory test procedures (European cycles). European statutory limits, Pollutants: Carbon and Nitrogen compounds-($CO.CO_2$ NOx), Hydrocarbons. Volatile compounds, evaporative emissions, particulates.

UNIT-II

SI engine emissions: Mechanism & formation of HC, CO and NOx in SI engines. Engine operating variables affecting pollutants.

CI engine emissions: Mechanism & formation of HC, CO and NOx, and Soot in CI engines. Factor affecting emission formation.

UNIT-III

Emission Control Techniques in SI Engines:

Lean burn & stratified charge engines. Multipoint fuel injection and gasoline direct injection systems, exhaust gas composition, catalytic convertors, positive crank case ventilation and evaporative emission control.

UNIT-IV

Emission Control Techniques in CI Engines:

Common rail fuel injection in diesel engines. Post combustion treatments:exhaust gas recirculation, particulate traps, particulates trap regeneration,installation of catalysts in exhaust lines treatment, diesel oxidation converter.

UNIT-V

Health and environmental effects: Effects of HC, CO, NOx, SOx, CO_2 and PM emissions from SI and CI engine on living beings. Effect on environment, Acid rain formation, climate change.

TEXT BOOKS:

1. Internal Combustion Engine Fundamentals/Heywood/Mc Graw Hill
2. Internal combustion engines and air pollution/ Edward Frederic Obert/ Intext Educ. Pub
3. Bosch – Gasoline fuel injection /Bosch Publications

4. Bosch – Diesel fuel injection /Bosch Publications
5. Engine emissions – B. P. Pundir, Narosa Publishers

REFERENCES:

1. Automobiles and Pollution /PaulDegobert/ OPHRYS
2. SAE Surface Vehicle Emissions Standards Manual/ Society of Automotive Engineers
3. Automobile Pollution, Concerns, Priorities, and Challenges/ Shyam Kishor Agarwal/ APH Publishing
4. Diesel engine operation manual /V.L. Maleev/CBS Pub
5. Engine emission /Springer and Patterson/Plenum Press
6. Internal Combustion Engines /Heins Aeisth /SAE Publications.

Course outcome: The students completing this course will be in a position to derive various measures to be taken to reduce the exhaust gas pollutants coming out of automobiles to meet the laws and regulations in practice.

HONORS	NOISE, VIBRATIONS AND HARSHNESS	L	T	P	C
		3	0	0	3

Course Objectives:
- To acquire the knowledge in basic of vibration and noise
- To Understand the effect of noise an human comfort and environment
- To know the methods of vibration and noise measurement.

UNIT I
FUNDAMENTALS OF ACOUSTICS AND NOISE, VIBRATION
Theory of Sound—Predictions and Measurement, Sound Sources, Sound Propagation in the Atmosphere, Sound Radiation from Structures and Their Response to Sound, General Introduction to Vibration, Vibration of Simple Discrete and Continuous Systems, Random Vibration, Response of Systems to Shock, Passive Damping

UNIT II
EFFECTS OF NOISE, BLAST, VIBRATION, AND SHOCK
General Introduction to Noise and Vibration Effects on People and Hearing Conservation, Sleep Disturbance due to Transportation Noise Exposure, Noise-Induced Annoyance, Effects of Infrasound, Low-Frequency Noise, and Ultrasound on People, Auditory Hazards of Impulse and Impact Noise, Effects of Intense Noise on People and Hearing Loss, Effects of Vibration on People, Effects of Mechanical Shock on People, Rating Measures, Descriptors, Criteria, and Procedures for Determining Human Response to Noise.

UNIT III
VEHICLE NOISE AND VIBRATION—SOURCES, PREDICTION, AND CONTROL
Introduction to Vehicle Noise and Vibration Sources, Internal Combustion Engine Noise Prediction and Control—Diesel, Exhaust and Intake Noise and Acoustical Design of Mufflers, Tire/Road Noise—Generation, Measurement, and Abatement, Aerodynamic Sound Sources in Vehicles—Prediction and Control, Transmission and Gearbox Noise and Vibration Prediction and Control, Brake Noise Prediction and Control.

UNIT IV
VEHICLEINTERIOR NOISE AND VIBRATION SOURCES - PREDICTION AND CONTROL
Introduction to Vehicle Interior Noise and Vibration Sources, Automobile, Bus, and Truck Interior Noise and Vibration Prediction and Control, Noise and Vibration in Off-Road Vehicle Interiors-Prediction and Control,

UNIT V
NOISE AND VIBRATION TRANSDUCERS, SIGNAL PROCESSING, AND MEASURING TECHNIQUES
Introduction to Noise and Vibration Transducers, Measuring Equipment, Measurements, Signal Acquisition, and Processing, Acoustical Transducer Principles and Types of Microphones, Vibration Transducer Principles and Types of Vibration Transducers, Sound Level Meters, Noise Dosimeters, Analyzers and Signal Generators, System for Data Acquisition, Noise and Vibration Measurements, Noise and Vibration Data Analysis, Calibration of Measurement Microphones, Calibration of Shock and Vibration Transducers, Metrology and Traceability of Vibration and Shock Measurements.

TEXT BOOKS:
1. Clarence W. de Silva , "Vibration Monitoring, Testing, and Instrumentation ",CRC Press, 2007
2. David A.Bies and Colin H.Hansen "Engineering Noise Control: Theory and Practice "Spon Press, London, 2009

REFERENCES:
1. Allan G. Piersol ,Thomas L. Paez "Harris' Shock and Vibration Handbook", McGraw-Hill , New Delhi, 2010
2. Colin H Hansen "Understanding Active Noise Cancellation" , Spon Press , London 2003
3. Matthew Harrison "Vehicle Refinement: Controlling Noise and Vibration in Road Vehicles ", Elsevier Butterworth-Heinemann, Burlington, 2004

Course Outcome:
At the end of the course, the student will understand the sources, effects, prediction, control techniques, measurement techniques of noise, vibration pertain to an automobile.

HONORS	AUTOMOBILE SAFETY	L	T	P	C
		3	0	0	3

Course objective: To impart the knowledge of the safety concepts, comfort and convenience system, driver assistance system and other requirements of automotive safety**.**

UNIT-I
INTRODUTION
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 AND FATIGUE ASPECTS
Design of body, forces in roll over, head on impact, plastics collapse and analysis, fatigue and vibration, test on box sections, structural vibration.

UNIT-III
SAFETY CONCEPT
Active safety: driving safety, conditional safety, perceptibility safety, operating safety- crash safety
Passive safety: exterior safety, interior, safety, deformation behaviour of vehicle body, speed and acceleration characteristics of passenger compartment on impact.
Safety equipment: Seat belt, regulations, automatic seat belt tightened system, Anti-locking braking system(ABS), Speed limiting device(SLD)

Automatic traction control, automatic vehicle stability control, Collapsible steering system, tilt able steering system, air bags system, bumpers design for safety.

UNIT-IV
COLLISION WARNING AND AVOIDANCE
Collision warning system, causes of rear end collision, frontal object detection, rear vehicle object detection, braking system interactions.

UNIT-V
COMFORT AND CONVENIENCE SYSTEM
Steering and mirror adjustment system, central locking system, tyre pressure monitoring and control system, rain sensor system, automatic climate control systems, environment information system.

TEXT BOOKS:
1. Bosch /Automotive Handbook/5th edition /SAE publication
2. Junsz Pawlowski/Vehicle Body Engineering/Business book limited, 1989.
3. Ronald K Jurgen/Navigation and Intelligent Transportation Systems-Progress in Technology/ Automotive Electronics Series, SAE. USA,1998.

Course Outcomes: After the completion of the course, the student will be able to

- Understand the design of the automobile body for safety and different safety standards
- Design the automobile body with respect to safety and fatigue aspects
- Understand active and passive safety systems
- Familiarize with different comfort and convenience systems

HONORS	SPECIAL PURPOSE VEHICLES	L	T	P	C
		3	0	0	3

Course Objectives:
- To enhance the knowledge of the students about the various equipment's used in earth moving, applications.
- To understand the construction and working of the vehicle for constructional application
- To describe the working nature of farm equipment's based on their application.
- To discriminate the various industrial vehicles based on the purpose.
- To acquire the knowledge on the functioning of military vehicle.

UNIT I
EARTH MOVING EQUIPMENTS
Construction layout, capacity and applications of dumpers, articulated haulers, front-end loaders, backhoe loaders, bulldozers, scrappers, motor graders, skid steer loaders ,excavator, hydraulic shovels, bucket conveyors , surface miners – high wall Miners. Selection criteria of prime mover for dumpers.

UNIT II
CONSTRUCTIONAL EQUIPMENTS
Construction layout, capacity and applications of cranes – types , Articulated Trucks ,concrete ready mixer, trenchers, Asphalt Pavers , road recliners, Compactors – types , draglines, drillers, borewell machine .

UNIT III
FARM EQUIPMENTS
Tractors – Main components. Working attachment of tractors – Auxiliary equipment –- Top lifting harvesters. General description, working, specification and functions paddy harvesting machines, Sugarcane harvesting, feller bunchers, forest machines.

UNIT IV
INDUSTRIAL VEHICLES
Constructional features, capacity and working of fork lifts, Utility vehicles, towing vehicles, man-lift chassis, scissor lift trucks, material handlers, recliners, Street sweepers.

UNIT V
MILITARY AND COMBAT VEHICLES
Special features and constructional details of Main Battle tank, gun carriers, transport vehicles, Armoured vehicle-launched bridge, amphibious bridging vehicle, communication vehicles.

TEXT BOOKS:

1. Abrosimov. K. Bran berg.A. andKatayer.K."Road making Machinery ", MIR Publishers, Moscow, 1971.
2. Rodichev and G.Rodicheva, Tractor and Automobiles, MIR Publishers, 1987.
3. Wong.J.T., "Theory of Ground vehicles ", John Wiley & Sons, New York, 1987.

REFERENCES:

1. B. Geleman and M. Moskovin, Farm tractors, MIR publishers, Moscow.
2. Bart H Vanderveen, Tanks and Transport vehicles, Frederic Warne and Co ltd., London.
3. Kolchin, A., and V.Demidov, Design of Automotive Engines for Tractor, MIR Publishers, 1972.
4. Peurifoy R.L "Construction Planning, Equipment and Methods", Tata McGraw-Hill, New Delhi, 2002.
5. Wong J "Terramechanics and Off-Road Vehicle Engineering", Butterworth-Heinemann, 2009

Course Outcomes: After the completion of the course, the student will be able to

- Acquire the knowledge about the various equipment's used in earth moving, applications.
- Understand the construction and working of the vehicle for constructional application
- Describe the working nature of farm equipment's based on their application.
- Discriminate the various industrial vehicles based on the purpose.
- Acquire the knowledge on the functioning of military vehicle.

HONORS	AUTOMOBILE CERTIFICATION AND HOMOLOGATION	L	T	P	C
		3	0	0	3

Course objective: To understand the classifications of vehicles, different Vehicle Performance and Road and Track Testing procedures. Analyse the procedures for Active and Passive Safety testing and components testing.

UNIT I
Introduction
Specification & Classification of Vehicles, Regulations overview(ECE, FMVSS, AIS, CMVR, ADR), Type approval and Conformity of Production, Engine and Vehicle specifications, Two Wheeler certification.

UNIT II
Vehicle Performance Testing
Methods for evaluating vehicle performance- energy consumption (well to wheel) in conventional automobiles, performance, emission and fuel economy, Operation at full load and part load conditions, effect of vehicle condition, tyre and road condition and traffic condition and driving habits on fuel economy, Gradeability test, Turning circle diameter test, Steering Impact test, Steering effort test.

UNIT III
Road and Track Testing:
Initial inspection, PDI, engine running in and durability, intensive driving, maximum speed and acceleration, brake testing on the road, hill climbing, handling and ride characteristics, safety, mechanism of corrosion, three chamber corrosion testing, wind tunnel testing, road testing, test tracks, coast down test, Portable exhaust measurement system.

UNIT IV
Active and Passive Safety Testing:
Wheel rim testing for cornering and radial fatigue, Fire resistance test, bumper test, crash test, side impact test, rollover test, safety belt test, Airbag test, Safety belt anchorages, Seat anchorages & head restraints, Occupant protection Impact test, Side door intrusion test.

UNIT V
Components Testing:
Size and Ply rating of tyres, Safety Glasses, Wind screen wiping system, Hydraulic brake hose, Hydraulic brake fluid, Rear view mirror specification (Exterior), Rear view mirror specification (Interior), Wheel rims, Wheel nut, Wheel discs & hub caps, Safety belt assemblies, Safety belt anchorages, Seat anchorages & head restraints, door locks & door retention.
Overview and study of testing standards like; AIS testing standards, Euro Standards, SAE standards. ISO26262 standards for functional safety of electrical and/or electronic systems in automobiles.

TEXT BOOKS
1. Raymond M. Brach and R. Matthew Brach, "Vehicle Accident Analysis and Reconstruction Methods", SAE International, 2011
2. Automotive Industry Standards, AIS

REFERENCES
1. Ulrich Seiffert and Lothar Wech, "Automotive Safety Handbook", SAE International, 2007
2. ISO Standards, ICS: 43.020, 43.040, 43.100

Course Outcomes: After the completion of the course, the student will be able to
- Understand the specifications and Classifications of the vehicles
- Understand the Methods for evaluating vehicle performance
- Describe the different road and track testing.
- Understand the Active and Passive Safety testing and Components testing.

HONORS	VEHICLE INFOTRONICS	L	T	P	C
		3	0	0	3

Course objective: To impart the knowledge of Smart Control of Vehicle dynamics, Global Positioning systems, Driver assistance systems, Intelligent Vehicle and Adaptive control systems and other systems pertaining to Vehicle Infotronics.

UNIT-I Overview of Infotronics
Concept of Infotronics, Web-enabled Vs Web Based systems, Applications of Infotronics, Vehicle buses and protocols – LIN, CAN, MOST &Flexray.

UNIT-II Systems in vehicle
Smart control of Vehicle[ESP] dynamics, drive Electronic Throttle control by wire, active suspensions/mounting system, Automated Guided Vehicles(AGV), Multi-disciplinary optimization in Vehicles (MDO) and advanced propulsion systems(APS), Radio Communication Technologies For Vehicle Information Systems, IEEE 802.11 and DSRC.

UNIT-III Telematics
Global positioning systems, geographical information systems, navigation systems, automotive vision system, road recognition, driver assistance systems.

UNIT-IV Intelligent vehicle Control
Active and Semi active suspensions/Mounts for NVH, Optimization and stability of Hydraulic Engine mounts and Bushing in Vehicle, Rollover control and Active stability control, combined control of ride comfort in passenger cars, Active Roll over control in hydraulically actuated articulated vehicles, intelligent drive by wire vehicles, Design and realization of seer and brake by wire.

UNIT-V Adaptive Control System
Conventional control schemes, system model for adaptive control, Design of self-tuning controllers, ACC overview, system based on ACC, Stop and Go, Anti- collision system, Impact of ACC on traffic and drivers, Adaptive noise control, automatic and adaptive control of highway traffic and moving vehicles. Power steering and power window: Requirements, Introduction, characteristics.

TEXT BOOKS:
1. Intelligent Vehicle Technology by L VlACIC, M PARENT, F HARA, Butterworth-Heinemann publication.
2. Navigation and Intelligent transportation systems By Ronald K. Jurgen, SAE.

REFERENCE BOOKS:
1. Robert Bosch, Automotive Hand Book by SAE
2. Understanding Automotive Electronics by Willam B. Ribbens, SAE
3. Understanding Automotive Electronics by Bechhold, SAE.

Course Outcomes: After the completion of the course, the student will be able to
- Acquire the knowledge about Infotronics and its applications
- Understand the Smart control of Vehicle dynamics and Radio Communication Technologies for Vehicle Information Systems.
- Describe the global positioning systems and driver assistance systems.
- Understand the Intelligent Vehicle and Adaptive control systems.

HONORS	MATERIALS AND AUTOMOTIVE MANUFACTURING TECHNIQUES	L	T	P	C
		3	0	0	3

Course objective: To impart the knowledge of common engineering materials and processes with relevance to automotive applications. The student shall learn about battery materials and technology, primary and secondary processes for automotive applications and Futuristic technology and material for automotive applications.

UNIT-I

Introduction to common engineering materials; metallic and non-metallic automotive materials. Materials and processes with relevance to automotive applications. Advanced materials, light weight material, nano material and synthesis and in-situ materials for automotive applications, corrosion, Standards for automotive materials.

UNIT-II

High strength low alloy steels (HSLA), Advanced high strength steels, dual phase steels, martensitic steels, Advanced plastics and composites, Novel material for automotive applications, ultra-light weight material, Graphene - Case studies.

UNIT-III

Battery materials and technology, case studies related to automotive applications. Case studies on crank shaft, connecting rod, piston, gear and gear box, propeller shaft.

UNIT-IV

Primary and secondary processes for automotive applications – casting, forging, heavy and sheet forming, hard and soft machining, moulding, surface modification processes and Heat Treatment, Joining methods for automotive applications .Case studies on Vehicle body materials- G.I and Interstitial Free Steel processes, Power train components -Tailor Welded Blank.

UNIT-V

Futuristic technology and material for automotive applications, Designing hybrid materials- material for auto piloting, manufacturing considerations for various lightweight automotive structures , 3D printing-materials, processes and applications. Case studies on Li-ion battery, polymer composites and sensor materials.

Text Books:

1. Michel F Ashby, "Material Selection in Mechanical Design", Butterworth Heinemann, 2007.
2. Michel F Ashby, "Material and Design: The Art and Science of Material Selection in Product Design", Butterworth Heinemann, 2008.
3. John Mortimer, "Advanced Manufacturing in the Automotive Industry" Springer, 1997.
4. Harry Peck, "Design for Manufacturing", Pitman Publications, 1983.
5. Cantor B, Johnston, Colin Grant and Patrick, "Automotive Engineering: Lightweight, Functional and Novel Materials", Taylor & Francis Ltd, 2008.

Course Outcomes: After the completion of the course, the student shall acquire the knowledge of common engineering materials and processes with relevance to automotive applications. The student should be able to learn about battery materials and technology, primary and secondary processes for automotive applications and Futuristic technology and material for automotive applications.