Department of Mechanical Engineering

CURRICULUM AND SYLLABUS

(2023-2027)

M. Tech. (Executive) Automobile Engineering

Department of Mechanical Engineering

M. Tech. (Executive) in Automobile Engineering

CURRICULUM AND SYLLABUS

Vision Statement of University

Be an internationally acclaimed University recognized for its excellent teaching, research, innovation, outreach and creating top class technocrats and professionals who can serve the mankind as multi skilled global citizen.

Mission Statement of University

- Establish state-of-the-art facilities for world class education and research.
- Conduct scholarly research and creative endeavours that impact quality of life.
- Attract quality staff and students to cater for diverse needs and preferences and widen participation.
- Build a foundation for students to be successful at all levels through high-quality, innovative programs.
- Collaborate with institute, industry, and society to address current issues through research and align curriculum.
- Involve in societal outreach programs to identify concerns and provide sustainable ethical solutions.
- Encourage life-long learning and team-based problem solving through an enabling environment.

Vision of the Department:

To develop engineers of par excellence to meet the ever-changing requirements of industries, motivated towards innovation, entrepreneurship and research in mechanical and allied engineering along with strong human values and ethics for the benefit of society and nation at large.

Mission of the Department:

1. To offer a platform to the students where they will be able to groom themselves technically as industry ready professionals.
2. To develop research environment where students will be motivated to enhance their knowledge to undertake research in mechanical and allied engineering.
3. To collaborate with industries, education institutes of excellence and alumnus to share and exchange latest technology and innovation.

4. To design curriculum to motivate and sensitize students towards environmental issues and respect for human values and ethics.
5. To develop conducive academic environment in the department to attract qualified faculties members from all around the country.

Department of Mechanical Engineering

Program Education Objectives (PEOs)

PEO -1 To provide advanced knowledge for finding solutions of complex practical problems.

PEO-2 To develop research acumen for designing a system with better efficiency and performance.

PEO-3 To prepare students as experts with better communication skills, professional ethics and team spirit for working in multidisciplinary teams.

Department of Mechanical Engineering

PROGRAMME OUTCOMES (POs)

After the completion of programme, student shall be able to:-

PO01 **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineeringproblems.

PO02 **Problem analysis**: Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO03 **Design/development of solutions**: Design solutions for complex engineering problems anddesign system components or processes that meet the specified needs with appropriate consideration for public health and safety, and the cultural, societal, and environmental considerations.

PO04 **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO05 **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO06 **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO07 **Environment and sustainability**: Understand the impact of professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO08 **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.

PO09 **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11 **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principlesand apply these to one's own work, as a memberand leader in a team, to manage projects and in multidisciplinary environments.

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

Department of Mechanical Engineering

PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO 1: Acquire, Develop and Demonstrate knowledge in the area of Automobile Design Automotive Systems, Machine Component Design, Finite Element Method, Thermal Engineering, Manufacturing and Development of Mechanical system.

PSO 2: Apply concepts of learning, Managerial skills, Computational skills and Research methodologies, techniques & tools to solve Industrial problems and become a successful Entrepreneur.

PSO 3: Develop the ability to automate a mechanical system or a process to meet desired needs within realistic constraints such as health, safety and manufacturability.

PSO 4: Apply the research-based knowledge and research methods including design of experiments, analysis and interpretation of data.

Medi-Caps University, Indore
Scheme of M. Tech. - Design Engineering
For the candidates admitted in session 2023-27

Semester I

S.No.	Course Code	Course Name	L	T	P	Credits
1	ME5BS01	Mathematics	4	0	0	4
2	ME5CA02	Advanced Thermodynamics	4	0	4	6
3	ME5PC03	Minor Project-I	0	0	16	8
4	EN5RD01	Research Methodology	4	0	0	4
		Total	**12**	**0**	**20**	**22**
		Total Contact Hours	**32**			

Semester II

S.No.	Course Code	Course Name	L	T	P	Credits
1	ME5EL41	Elective –I: Fluid flow & Heat transfer in I.C. Engines	4	0	0	4
2	ME5CA01	Finite Element Method	4	0	4	6
3	ME5EL42	Elective –II: Alternative fuel & technologies	4	0	0	4
4	ME5PC04	Minor Project-II	0	0	16	8
		Total	**12**	**0**	**20**	**22**
		Total Contact Hours	**32**			

SEMESTER – III

Sr.No.	Course Code	Course Name	L	T	P	Credits
1	ME5CA05	Automotive Transmission & Chassis Systems	4	0	4	6
2	ME5EL43	Elective -III: Advanced Automotive Technology	4	0	0	4

3	EN5HS02	Technical Paper writing	0	0	2	1
	EN5MC01	Value and Ethics	2	0	0	2
4	ME5PC05	Dissertation Phase-I	0	0	20	10
		Total	**10**	**0**	**26**	**23**
		Total Contact Hours	**36**			

SEMESTER – IV

Sr.No.	Course Code	Course Name	L	T	P	Credits
1	ME5CA09	Electric & Hybrid Vehicles	4	0	4	**6**
2	EN5HS01	Entrepreneurship and Management	3	0	0	**3**
3	ME5PC06	Dissertation Phase-II	0	0	32	**16**
		Total	**7**	**0**	**36**	**25**
		Total Contact Hours	**43**			

L : Lecture T : Tutorial P : Practical

Total Credits with NG Courses	**92**

SEMESTER – I

Sr. No.	Course Code	Course Name	L	T	P	Hours	Credits
1	ME5BS01	Mathematics	4	0	0	4	4
2	ME5CA02	Advanced Thermodynamics	4	0	4	8	6
3	ME5PC03	Minor Project-I	0	0	16	16	8
4	EN5RD01	Research Methodology	4	0	0	4	4
		Total	**12**	**0**	**20**	**32**	**22**

Subject Code	Subject Name	Hours per Week			Hours	Credits
		L	T	P		
ME5BS01	Mathematics	4	0	0	4	4

Course Objectives:

1. To equip with the fundamental concepts in vector spaces.
2. To learn how to distinguish different types of numerical methods to solve simultaneous equations and ordinary differential equations.
3. To understand different classification of partial differential equations and finite difference concept to solve PDE.
4. To equip with the fundamental concepts in discrete Fourier transform with algorithm to find it.
5. To solve practical problems in probability distribution and reliability.

Unit-I

Linear algebra: Vector spaces, subspaces, Sum and direct sum of subspaces, Linear span, Linear dependence, independence and their basic properties, Basis, Linear transformations and their representation as matrices, the algebra of linear Transformations, The rank- nullity theorem, Eigen value analysis.

Unit-II

Numerical Methods: Solution of linear system of algebraic equation solution using Gauss elimination and Gauss sedial methods, ill conditioned matrix, method to improve accuracy of ill conditioned system, Power method to solve Eigen value problems. Concept of explicit and implicit methods, Solution of differential equation using multi-step methods: Runge-Kutta and Predictor-Corrector methods, shooting method to solve boundary value problems, Lagrange interpolation, splines interpolation.

Unit-III

Partial differential equations: Characteristics and classification of second order PDEs. Separation of variables. Numerical solution of PDE(Laplace , Poisson, Heat, Wave) using finite difference methods: Elliptic partial differential equations, Parabolic PDE, Crank–

Nicholson Method(Two-Dimensional Parabolic PDE), Hyperbolic PDE (Two-Dimensional Hyperbolic PDE).

Unit-IV

Fourier transform: Review of Fourier transform, Discrete Fourier Transform (DFT), Fast Fourier Transform (FFT), Short time Fourier Transform (STFT) and their properties.

Unit-V

Probability distribution and Reliability: Probability distribution with the Concept of continuous distribution functions, Normal distribution, Exponential distribution, Memory less property, Hypo exponential, Weibull distribution. Introduction to reliability, Measure of reliability, reliability functions, derivation of reliability function, failure rate and failure models, mean time to system failure (MTSF), Failure time distribution. System configuration: series and parallel, k out of n systems, Redundancy.

Text/Reference Books

1. S. P. Venkateshan, Prasanna Swaminathan, Computational Methods in Engineering, Ane Books
2. Steven C. Chapra, Numerical Methods for Engineering, Mc-Graw Hill Education.
3. Gilbert Strang, Computational Science and Engineering, Wellesley-Cambridge Press.
4. B. S. Grewal, Higher Engineering Mathematics, Khanna Publ.
5. T. Veerajan, Probability, Statistics and Random Processes, Tata McGraw Hills, New
6. Delhi, 2002.
7. E. Balagurusamy, Reliability Engineering, Tata McGraw-Hill Education, 1984.
8. A.k. Sharma, Linear Algebra, , Discovery Publishing House, 2007.
9. ShrinivasanKeshav ,Mathematical Foundation of computer networking , Pearson Eduaction, 2013.

Course Outcomes:

After completion of this course the students shall able to:

CO 1. Well understand and remember the fundamental concept of Vector spaces, subspaces, , Linear dependence, independence , numerical concept , PDE and Fourier transform , probability and reliability.

CO 2. Apply and Implement the numerical concept in solution of simultaneous , ordinary and partial differential equation by explicit and implicit methods.

CO 3. Analyze the system on basis of probability to check reliability.

CO 4. Evaluate the Fourier transform of functions and follow FFT algorithms.

Subject Code	Subject Name	Hours per Week			Hours	Credits
		L	T	P		
ME5CA02	**Advanced Thermodynamics** (Common to Automobile Engg. / Thermal Engg.)	4	0	4	8	6

Course Learning Objectives (CLOs)

CLO01: Develop a deep understanding of exergy and its significance in thermodynamics, including the concept of work potential, irreversibility, and second law efficiency.

CLO02: Gain proficiency in thermodynamic property relations, partial derivatives, Maxwell relations, and Clapeyron equation, enabling the analysis of various thermodynamic processes.

CLO03: Acquire knowledge of chemical reactions, combustion processes, and the application of the first and second law of thermodynamics to analyze reacting systems.

CLO04: Understand the properties of gas mixtures, including Avogadro's Law, equation of state, and the behaviour of mixtures under different conditions.

CLO05: Analyze and evaluate vapour and combined power cycles, including their second law analysis and the consideration of cogeneration in combined gas-vapour power cycles.

Unit-I

Exergy: Work potential of energy, Reversible work and irreversibility, second law efficiency, exergy change of system, exergy transferred by Heat, Work & Mass, Exergy balance in open and close system.

Unit-II

Thermodynamics Property Relations: partial derivatives, Maxwell relations, Clapeyron Equation, General relations for du, dh, ds, Cv&Cp, Joule Thomson coefficient, Δh, , Δu, Δs for real gases.

Unit-III

Chemical Reactions: Fuels and combustion, Theoretical & actual combustion processes, enthalpy of formation & enthalpy of combustion, First & Second law analysis of reacting system, Adiabatic flame temperature.

Unit-IV

Properties of Gas Mixtures: Avogadro's Law, equation of state, Virial expansions, Law of corresponding states, Dalton's law of partial pressure, internal energy, enthalpy & specific heats of gases forming mixture, entropy of mixture of gases, Gibbs Function.

Unit-V

Vapour & combined Power cycle: Second law analysis of vapour power cycles, Cogeneration combined Gas Vapour Power cycles, Second law analysis of Gas power cycles.

Text Books

1. Thermodynamics:- An Engineering approach "Yunus A. Cengel& Michael A. Boles", McGraw Hill Educations.
2. Thermal Science "Merle C. Potter & Elaine P. Scolt", Cengatge Learning 3. Engineering Thermodynamics "P K Nag", McGraw Hill Educations

Course Outcomes (COs)

CO01: Students will be able to apply the concept of exergy and perform exergy analyses for different systems, helping them identify areas for improving energy efficiency and reducing irreversibility.

CO02: Graduates will demonstrate proficiency in using property relations and equations to analyze and solve complex thermodynamic problems, such as determining thermodynamic properties and behaviour of substances under various conditions.

CO03: Students will understand the principles of chemical reactions and combustion processes, allowing them to perform thermodynamic analysis and predict the performance of reacting systems.

CO04: Upon completion, students will be able to apply thermodynamic concepts to gas mixtures, enabling them to analyze the behaviour of mixtures and understand the interactions between individual gases.

CO05; Students will be capable of performing second law analyses of vapour and combined power cycles, and they will have the skills to assess the performance and efficiency of these cycles, including cogeneration applications.

List of Experiments:

1. MATLAB programming for problem solving of Fluid Mechanics, Thermal Engineering and Heat Transfer Problems
2. C programming for problem solving of Fluid Mechanics, Thermal Engineering and Heat Transfer Problems
3. Solving Thermal Engineering problems using available packages such as T K Solver: ANSYS, CFX, STARCD, MATLAB, FLUENT etc.

Subject Code	Subject Name	Hours per Week			Hours	Credits
		L	**T**	**P**		
ME5PC03	**Minor Project-I**	0	0	16	16	8

Students should model, analyze and animate /fabricate a functional model of any component, sub system or a mechanism used in automobile. They should prepare a mini project report and submit it.

Subject Code	Subject Name	Hours per Week			Hours	Credits
		L	T	P		
EN5RD01	**Research Methodology**	4	0	0	4	4

Unit-I

Introduction to Research Techniques : Meaning of research, objectives of research, motivation in research, types of research-Introduction to experimental test bed, algorithmic research, simulation research, mathematical modelling approach, characteristics and prerequisites of research, significance of research, research process, Sources of research problem, criteria of identifying the problem, necessity of defining the problem, errors in selecting research problem, technique involved in defining the problem, Report and paper writing.

Unit-II

Scientific Research and Statistical analysis: Introduction: Nature and objectives of research, types and methods of research; empirical and experimental research, study and formulation of a research problem. Statistical analysis: Measures of central tendency and dispersion,-mean, median, mode, range, mean and standard deviations, computing correlation in variables, linear and non-linear regression.

Unit-III

Probability and Probability distributions: Classical, relative frequency and axiomatic definitions of probability, addition rule and conditional probability, multiplication rule, total probability, Bayes'Theorem and independence. Probability distributions: binomial, poison, geometric, negative binomial uniform exponential, normal and log normal distribution.

Random Variables: Discrete, continuous and mixed random variables, probability mass, probability density and cumulative distribution functions, mathematical expectation, moments, probability and moment generating function, median and quintiles, Markov inequality, correlation and regression, independence of random variables.

Unit-IV

Sampling &Distributions: Central Limit Theorem, distributions of the sample mean and the sample variance for a normal population, Chi-Square, t and F distributions, problems. Hypothesis Testing: Basic ideas of testing hypothesis, null and alternative hypotheses, the critical and acceptance regions, two types of error, tests for one sample and two sample problems for normal populations, tests for proportions, Chi-square goodness of fit test and its applications. Software and Tools to be learnt: Statistical packages like SPSS and R.

Unit-V

Simulation and Soft Computing Techniques: Introduction to soft computing, Artificial neural network, Genetic algorithm, Fuzzy logic and their applications, Tools of soft computing, Need for simulation, types of simulation, simulation language, fitting the problem to simulation study, simulation models, verification of simulation models, calibration and validation of models, Output analysis. Introduction to MATLAB, NS2, ANSYS, Cadence etc(Department Specific).

Reference Books

1. R. Panneerselvam, " Research Methodologies," PHI.
2. Best John V. and James V Kahn: Research in Education, Wiley eastern, 2005.
3. S.P. Sukhia, P.V. Mehrotra, and R.N. Mehrotra: Elements of Educational Research, PHI publication, 2003.
4. K. Setia: Methodology of Research Education, IEEE publication, 2004.
5. C.R. Kothari: Research methodology, Methods and Techniques, 2000.
6. Jerry Banks, John S. Carson, Barry.L. Nelson David. M. Nicol, " Discrete-Event System Simulation", Prentice-Hall India.
7. V.K. Rohatgi, A.K. Md.E.Saleh, An Introduction to Probability and Statistics, Johm Willey, 2011.
8. S.M. Ross, A First Course in Probability, 8 th Edition, Prentice Hall, 2009

SEMESTER II

Sr. No.	Course Code	Course Name	L	T	P	Hours	Credits
1	ME5EL41	Elective –I: Fluid flow & Heat transfer in I.C. Engines	4	0	0	4	4
2	ME5CA01	Finite Element Method	4	0	4	8	6
3	ME5EL42	Elective –II: Alternative fuel & technologies	4	0	0	4	4
4	ME5PC04	Minor Project-II	0	0	16	16	8
		Total	**12**	**0**	**20**	**32**	**22**

Subject Code	Subject Name	Hours per Week			Hours	Credits
		L	T	P		
ME5EL41	**Fluid Flow and Heat Transfer in IC Engines**	4	0	0	4	4

Course Learning Objectives (CLOs)

CLO01: Students must be able to understand various automotive electronic components and its applications in real world.

CLO02: Students must be able to understand the types, principle and operation of engine management system.

CLO03: Student must be able to understand the driveline control system and its applications in real world.

CLO04: Students must be able to understand the working of various intelligent transportation systems.

CLO05: Students must be able to understand the construction, working, types and performance of hybrid vehicles.

Course Outcomes (COs)

CO01:Students will be able to understand various automotive electronic components and its applications in real world.

CO02: Students will be able to understand the types, principle and operation of engine management system.

CO03: Students will be able to understand the driveline control system and its applications in real world.

CO04: Students will be able to understand the working of various intelligent transportation systems.

CO05: Students will be able to understand the construction, working, types and performance of hybrid vehicles.

Unit-I

Introduction: Basics Laws, Solution of Navier Stokes Equation, Couette Flow, Hagen Poiseuille Flow, Low Reynolds's Flow, Stokes Flow, propagation of infinitesimal waves

Unit-II

Laminar and Turbulent Flows: Laminar boundary layer, displacement, momentum and energy thickness, Prendtl mixing length theory, Turbulent flow, governing equation, shear stress model, universal velocity distribution law, fully developed turbulent flow.

Unit-III

Compressible Flow: Basic Equations, steady isentropic flow in non-parallel sided ducts neglecting friction, mass flow through an orifice or convergent divergent nozzles, condition for maximum discharge, De Laval nozzle

Unit-IV

Engine Lubrication: Sources of losses in engine, effects of engine variables on friction, theory of lubrication, functions of lubrications, relationship between shear stress and pressure gradient, hydrodynamic lubrication, Dash-pot mechanism: movement of piston in Dash-pot, viscous resistance

Unit-V

Convective Heat Transfer: Convective Heat Transfer - Parallel Flow (Hagen – Poiseuille Flow), Sudden acceleration of a Flat Plate, Creeping flow, Mass transfer Diffusion, combined Heat and Mass Transfer, Heat transfer in Porous Media.

Text Books:

1. Fluid Mechanics and hydraulic machines; S C Gupta, Pearson Education.
2. Fluid Mechanics, John F Douglas, Pearson Education.
3. Viscous Fluid Flow; Frank M. White,, 3rd Edition, McGraw Hill, 2011.
4. I C Engines; V Ganeshan, McGraw Hills.
5. Heat transfer, J P Holman & Sovik Bhattacharya, McGraw Hills.

Subject Code	Subject Name	Hours per Week			Hours	Credits
		L	T	P		
ME5CA01	**Finite Element Method** (Common to All)	4	0	4	8	6

Course Learning Objectives (CLOs)

CLO01: Students must understand the concept of various methods of mathematical modelling of an engineering problems and Concept of Finite Element Method

CLO02: Students must be able to understand the concept of 1-D Finite Element Modelling

CLO03: Student must be able to understand the concept of 2-D Finite Element Modelling

CLO04: Students must be able to develop Finite Element Model of load bearing structures like trusses and frames.

CLO05: Students must be able understand the applications of Finite Element Method in different domains.

Course Outcomes (COs)

CO01: Students will be able to use suitable method to model the given problem and find solution thereof and basics of Finite Element Methods.

CO02: Students will be able to identify the boundary conditions and analyze structures by converting them in Finite Element Models using one-dimensional elements.

CO03: Students will be able to identify the boundary conditions and analyze structures by converting them in Finite Element Models using two-dimensional elements.

CO04: Students will be able to identify boundary conditions and analyze multi-element load carrying structures using Finite Element Modelling.

CO05: Students will be able to develop to analyze problems in domains like Fluid flow, Heat transfer and Vibrating bodies developing Finite Element Models.

Unit-I

Introduction to FEM, Mathematical Models and Approximations: History of FEM and applicability to mechanical engineering design problems: Review of elasticity. Mathematical models for structural problems: Equilibrium of continuum-Differential formulation, Energy Approach Integral formulation, Principle of Virtual work Variational formulation. Overview of approximate methods for the solution of the mathematical models, Residual methods and

weighted residual methods, Ritz, Rayleigh-Ritz and Gelarkin's methods.Philosophy of solving continuum problems using Finite Element method.

Unit-II

Finite Element Formulation: Generalized FE formulation based on weighted residual methodand through minimization of potential, displacement based formulation, Concept of Discretization, Interpolation, Formulation of Finite element characteristic matrices and vectors, Compatibility conditions, Assembly and boundary considerations, Concept of Shape Functions.

Unit-III

FE Analysis for One Dimensional Structural problems: Structural problems with one dimensional geometry. Bar element: formulation of stiffness matrix, consistent and lumped load vectors. Boundary conditions and their incorporation: Elimination method, Penalty Method, Introduction to higher order elements and their advantages and disadvantages. Formulation for Truss elements, Case studies involving hand calculations with an emphasis on Assembly, boundary conditions, contact conditions and multipoint constraints. Beams and Frames: Review of bending of beams, interpolation for beam elements and formulation of FE characteristics, Plane and space frames and examples problems involving hand calculations. Algorithmic approach for developing computer codes involving 1-D elements.

Unit-IV

FE analysis of Two dimensional Problems: Interpolation in two dimensions, natural coordinates, Isoparametric representation, Concept of Jacobian. Finite element formulation for plane stress plane strain and axi-symmetric, Fluid Flow problems; Triangular and Quadrilateral elements, higher order elements, subparametric, Isoparametric and superparametric elements. Formulation of plate bending elements using linear and higher order bending theories, Shell elements, General considerations in finite element analysis of design problems, Choosing an appropriate element and the solution strategies.

Introduction to pre and post processing of the results and analysis. Three Dimensional Problems: Finite element formulation for 3-D problems, mesh preparation, tetrahedral and hexahedral elements, case studies.

Unit-V

FEM in Heat Transfer and Fluid Mechanics problems: Finite element solution for one dimensional heat conduction with convective boundaries. Formulation of element characteristics and simple numerical problems.Formulation for 2-D and 3-D heat conduction problems with convective boundaries.Introduction to thermo-elastic contact problems. Finite element applications in potential flows; Formulation based on Potential function and stream function. Design case studies.

Dynamic Analysis: FE formulation in dynamic problems in structures using Lagragian Method, Consistent and lumped mass models, Formulation of dynamic equations of motion, Modelling of structural damping and formulation of damping matrices, Model analysis, Mode superposition methods and reduction techniques.

Text Books

1. Seshu P, Textbook of Finite Element Analysis, PHI. 2004
2. Reddy, J.N., Finite Element Method in Engineering, Tata McGraw Hill, 2007.
3. SingiresuS.Rao, Finite element Method in Engineering, 5ed, Elsevier, 2012
4. Zeincowicz, The Finite Element Method 4 Vol set, 4th Edition, Elsevier 2007.
5. Alavala C.R., Finite Element Methods, PHI, 2009.
6. Moaveni S. PHI, 2009

List of Experiments:

1. Introduction to Finite Element Analysis
2. Introduction to FEA package
3. Analysis of a truss
4. Stress analysis of beams
5. Stress analysis of a plate with circular hole
6. Analysis of a corner bracket
7. Model analysis of a cantilever beam
8. Harmonic analysis of simple systems
9. Conductive heat transfer analysis of a 2D Components.

Subject Code	Subject Name	Hours per Week			Hours	Credits
		L	T	P		
ME5EL42	**Alternative Fuels and Technologies** (Elective-II)	4	0	0	4	4

Course Learning Objectives (CLOs)

CLO01: Students must understand the properties and applications of gaseous fuels in automobiles.

CLO02: Students must be able to understand the properties and applications of alcohol fuels in automobiles.

CLO03: Student must be able to understand the properties and applications of bio-fuels in automobiles.

CLO04: Students must be able to understand the fundamentals and applications of solar technology in automobiles.

CLO05: Students must be able to understand the fundamentals and applications of fuel cell technology in automobiles.

Course Outcomes (COs)

CO01:Students will be able to understand the properties and applications of gaseous fuels in automobiles.

CO02: Students will be able to understand the properties and applications of alcohol fuels in automobiles.

CO03: Students will be able to understand the properties and applications of bio-fuels in automobiles.

CO04: Students will be able to understand the fundamentals and applications of solar technology in automobiles.

CO05: Students will be able to understand the fundamentals and applications of fuel cell technology in automobiles.

Unit - I

GASEOUS FUELS: Properties, composition, production, storage, engine modifications, combustion, performance and emission characteristics in SI and CI engines, advantages and disadvantages of CNG, HCNG, LPG and hydrogen.

Unit – II

ALCOHOL FUELS: Properties, composition, production, storage, engine modifications, blends, combustion, performance and emission characteristics in SI and CI engines, advantages and disadvantages of methanol ethanol, butanol, DME and DEE.

Unit –III

BIO-FUELS: Properties, composition, production, engine modifications, treatment, blends, performance and emission characteristics, advantages and disadvantages of straight vegetable oils, bio-diesel and biogas.

Unit – IV

SOLAR TECHNOLOGY: Fundamentals of solar energy conversion, solar cells, optical engineering, photo electrochemical cells, thermoelectric generators, energy storage, distribution systems, design of solar panels for automobiles and cost analysis.

Unit -VFUEL CELL TECHNOLOGY: Fuel cell thermodynamics, operating principle, fuel cell technologies, fuel cell performance characteristics, fuel reforming and fuel cells for automotive applications.

Text Book/ References:

1. Thipse S S, “Alternate Fuels – Concepts, Technologies and Developments”, Jaico Publishing House, New Delhi, 2010.
2. Jack Erjavec and Jeff Arias, “Alternative Fuel Technology – Electric, Hybrid and Fuel Cell Vehicles”, Cengage Learning Pvt. Ltd., New Delhi, 2007.
3. Fuel Cells for automotive applications – professional engineering publishing, UK, 2004.
4. Mehrdad Ehsani, Yimin Gao, sebastien E. Gay and Ali Emadi, “Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design”, CRC Press, 2005.
5. Matthew M M, “Fuel Cell Engines”, John Wiley & Sons, Inc., New Jersey, 2008.

Subject Code	Subject Name	Hours per Week			Hours	Credits
		L	**T**	**P**		
ME5PC04	**Minor Project-II**	0	0	16	16	8

Students should model, analyze and animate /fabricate a functional model of any component, sub system or a mechanism used in automobile. They should prepare a mini project report and submit it.

SEMESTER – III

Sr. No.	Course Code	Course Name	L	T	P	Hours	Credits
1	ME5CA05	Automotive Transmission & Chassis Systems	4	0	4	8	4
2	ME5EL43	Elective -III: Advanced Automotive Technology	4	0	0	4	6
3	EN5HS02	Technical Paper writing	0	0	2	2	1
4	EN5MC01	Value and Ethics	2	0	0	2	0
5	ME5PC05	Dissertation Phase-I	0	0	0	20	10
		Total	**10**	**0**	**6**	**36**	**21**

Subject Code	Subject Name	Hours per Week			Hours	Credits
		L	T	P		
ME5CA05	**AUTOMOTIVE CHASSIS & TRANSMISSION SYSTEMS**	4	0	4	8	4

Course Learning Objectives (CLOs)

CLO01: Students must understand the construction of frame, front axle, steering system and its mechanisms and applications.

CLO02: Students must be able to understand the construction and working of types of suspension and braking systems.

CLO03: Student must be able to understand the construction and working of clutch, gearbox, differential and driveline.

CLO04: Students must be able to understand various hydrostatic and hydrodynamic drives and its application in automobiles.

CLO05: Students must be able to understand different kinds of automotive transmissions, their control and applications.

Course Outcomes (COs)

CO01:Students will be able to understand the construction of frame, front axle, steering system and its mechanisms and applications.

CO02: Students will be able to understand the construction and working of types of suspension and braking systems.

CO03: Students will be able to understand the construction and working of clutch, gearbox, differential and driveline.

CO04: Students will be able to understand various hydrostatic and hydrodynamic drives and its application in automobiles.

CO05: Students will be able to understand different kinds of automotive transmissions, their control and applications.

UNIT I – FRAME, FRONT AXLE & STEERING SYSTEM

Basic construction of chassis, Types of Chassis layout, with reference to Power Plant location anddrive, various, types of frames, Loads acting on vehicle frame, materials for frames, Testing of frames, Types of Front Axles and Stub Axles, Front Wheel Geometry – Castor,

Camber, King Pin Inclination and Toe–in, Toe-out. Slip Angle, Over–Steer and Under–Steer, Reversible and Irreversible Steering, Power–Assisted Steering, Steering of Crawler Tractors.

UNIT II – SUSPENSION AND BRAKING SYSTEM

Factors influencing ride comfort – Independent suspension- Rubber, pneumatic, hydro-elastic suspension, shock absorbers. Braking torque developed by leading and trailing shoes – Disc brake theory – Factors affecting brake performance – Engine Exhaust Brake – Power brake Regenerative braking, Hydraulic Braking System, Mechanical Braking System, Pneumatic Braking System, Power–Assisted Braking System, Servo Brakes, Retarders, Anti–Lock Braking System.

UNIT III – CLUTCH, GEAR BOX, DIFFERENTIAL & DRIVE-LINE

Different types of clutches and requirement of transmission system – Principle, construction, torque capacity and design aspects of friction clutches – Objective of the gear box -Different types of gear box-Determination of gear box ratios. Universal joints, Final drive – Different types, double reduction and twin speed final drives, Rear axle construction – Full floating, three quarter floating and semi-floating arrangements, Differential principle – Constructional details of differential unit, helical gear and hypoid gear final drive. Double reduction and twin speed final drives, Non–Slip differential, differential locks, and Final drive of Crawler Tractors

UNIT IV- HYDRO-DYNAMIC & HYDRO-STATIC DRIVES

Fluid coupling and Torque converters: Principle, construction and performance – Reduction of drag torque in fluid coupling – Converter couplings – Multi-stage and poly-phase torque converters – Construction and working principle of typical Janny hydro-static drive.

UNIT V- AUTOMATIC TRANSMISSION CONTROL & APPLICATIONS

Dual-clutch automatic transmission, Automated Manual transmission, Continuously Variable Transmission (CVT), Mercedes Benz automatic transmission – Hydraulic control systems of automatic transmission.

TEXT BOOKS/REFERENCES:

1. Naunheimer H, Bertsche B, Ryborz J and Novak W, “Automotive Transmissions”, Springer, 2011.

2. Crouse. W.H., Anglin. D.L, Automotive Transmission and Power Trains construction, McGraw Hill, 1976

3. Judge. A.W., Modern Transmission systems, Chapman and Hall Ltd., 1990

4. P.M.Heldt, "Automotive Chassis", Chilton Co., New York, 1982.

5. Halderman, "Automotive Chassis Systems", Fifth Edition, Prentice Hall, 2008.

6. Genta, Giancarlo and Morello L, "The Automotive Chassis Vol 1

List of Experiments:-

1. Study of transmission of front and rear vehicles
2. Study of front and rear wheel drive vehicles
3. Study of various gearboxes and pre-synchronization devices
4. Study of different types of clutches
5. Study of fluid coupling, torque converter and hydrodynamic drives
6. Study of different components of chassis and different types of frame and its trouble shooting
7. Study of construction of front and rear axle
8. Study of construction of Rigid axle suspension and Independent suspension
9. Study of construction of different types of brakes
10. Study of construction of wheels and tyres.

Subject Code	Subject Name	Hours per Week			Hours	Credits
		L	T	P		
ME5EL43	**Advanced Automotive Technology** (Elective-III)	4	0	0	4	4

Course Learning Objectives (CLOs)

CLO01: Students must be able to understand various automotive electronic components and its applications in real world.

CLO02: Students must be able to understand the types, principle and operation of engine management system.

CLO03: Student must be able to understand the driveline control system and its applications in real world.

CLO04: Students must be able to understand the working of various intelligent transportation systems.

CLO05: Students must be able to understand the construction, working, types and performance of hybrid vehicles.

Course Outcomes (COs)

CO01:Students will be able to understand various automotive electronic components and its applications in real world.

CO02: Students will be able to understand the types, principle and operation of engine management system.

CO03: Students will be able to understand the driveline control system and its applications in real world.

CO04: Students will be able to understand the working of various intelligent transportation systems.

CO05: Students will be able to understand the construction, working, types and performance of hybrid vehicles.

Unit I Fundamentals of Automotive Electronics

Components for electronic engine management system, open and closed loop control strategies,PID control, Look up tables, introduction to modern control strategies like Fuzzy

logic and adaptivecontrol. Switches, active resistors, Transistors, Current mirrors/amplifiers, Voltage and currentreferences, Comparator, Multiplier. Amplifier, filters, A/D and D/A converters.

Unit II Sensors & Actuators

Inductive, Hall Effect, thermistor, piezo electric, piezo resistive, based sensors. Throttle position, mass air flow, crank shaft position, cam position, engine speed sensor, exhaust oxygen level (twostep, linear lambda and wideband), knock, and manifold temperature and pressure sensors. Solenoid,relay (four and five pin), stepper motor.

Unit III Engine Management System

SI engine management:Types andtheir principle of operation, Contactless (BREAKERLESS) electronic ignition system, Electronicspark timing control. CI engine management, Types and systems, parameters affecting, Digital engine control system:Fuel control maps, open loop and closed loop control – Integrated enginecontrol system, Electromagnetic compatibility – EMI Suppression techniques – Electronic dashboard instruments – On-board diagnosis system.

Unit IV Driveline control system

Speed control – cylinder cut - off technology, Gear shifting control – Traction / braking control,brake-by-wire – Adaptive cruise control, throttle by wire. Steering - power steering, collapsible andtillable steering column – steer by wire.

Unit Vintelligent transportation system

Traffic routing system - Automated highway systems - Lane warning system – Driver InformationSystem, driver assistance systems - Data communication within the car, Driver conditioningwarning - Route Guidance and Navigation Systems – vision enhancement system - In-VehicleComputing –Vehicle Diagnostics system – Hybrid / Electric and Future Cars – Case studies.

Text and Reference Books:

1. Rashid, M.H., "Power Electronics – Circuits, Devices and Applications", Prentice Hall of India, Third Edition, New Delhi, 2011.

2. Sen .P C, "Power Electronics", Tata Mc Graw Hill Education, Twelfth Edition .

3. "Bosch' Automotive Handbook", 8th Edition

4.Davide Andrea," Battery Management Systems for Large Lithium-ion Battery Packs" Artech House, 2010 .

5. Bosch Hand Book of Gasoline Engine Management, Motronic System

6. Bosch Hand Book of Diesel Engine Management, Bently Publishers

7. Automotive Electrical/ Electronics system and Components, Ten Denton, 3rd Edition 2004.

Subject Code	Subject Name	Hours per Week			Hours	Credits
		L	T	P		
EN5HS02	**Technical Paper Writing**	0	0	2	2	1

- Report writing, various formats
- Plagiarism
- How to make a synopsis
- Reading techniques
- Making a hypothesis
- Writing abstract and Summary
- Paraphrasing
- Building thoughts
- Chapterization
- Formatting
- Oral presentation
- How to make good ppts
- Viva voce/ interviews
- Importance of syntax and semantics, Mechanics of writing, Proof reading

Text Books:

1. C.R Kothari. Research Methodology. Sultan Chand & Sons, New Delhi.
2. Day R A. How to Write and Publish a Scientific Paper. Cambridge University Press.
3. Sharma RC and Krishna Mohan, Business correspondence and report writing, Tata Mc Graw Hill.
4. Murphy Herta A, Herberrt W Hildebrandt, Jane P Thomas. Effective Business Communication. Tata Mc Graw Hill.
5. Rizvi Ashraf. Effective Technical Communication. Tata Mc Graw Hill.
6. KoneruAruna. Professional Communication, McGraw Hill

Subject Code	Subject Name	Hours per Week			Hours	Credits
		L	T	P		
EN5MC01	Values & Ethics	2	0	0	2	0

Unit-I

Human Values

Morals, Values and Ethics, Integrity, Work Ethic, Honesty, Courage, Empathy , Self-Confidence , Character.

Unit-II

Engineering Ethics

Senses of Engineering Ethics, variety of moral issued, types of inquiry, moral dilemmas, moral autonomy, Kohlberg's theory, Gilligan's theory, consensus and controversy, Models of Professional Roles, theories about right action, Self-interest, customs and religion, uses of ethical theories, Valuing Time, Co-operation, Commitment.

Unit-III

Engineering As Social Experimentation

Engineering as experimentation, engineers as responsible experimenters, codes of ethics, a balanced outlook on law, the challenger case study

Unit-IV

Safety Responsibilities and Rights

Safety and risk, assessment of safety and risk, risk benefit analysis and reducing risk, the three mile island and Chernobyl case studies.

Unit-V

Global Issues

Multinational corporations, Environmental ethics, computer ethics, weapons development, engineers as managers, consulting engineers, engineers as expert witnesses and advisors, moral leadership.

Text Books

1. Mike Martin and Roland Schinzinger, “Ethics in Engineering”, McGraw-Hill, NewYork 1996.
2. Govindarajan M, Natarajan S, Senthil Kumar V. S, “Engineering Ethics”, PrenticeHall of India, New Delhi, 2004.

Reference Books

1. Charles D. Fleddermann, “Engineering Ethics”, Pearson Education / Prentice Hall, New Jersey, 2004 (Indian Reprint now available).
2. Charles E Harris, Michael S. Protchard and Michael J Rabins, “Engineering Ethics – Concepts and Cases”, Wadsworth Thompson Leatning, United States, 2000 (India Reprint now available)
3. John R Boatright, “Ethics and the Conduct of Business”, Pearson Education, NewDelhi, 2003.
4. Edmund G Seebauer and Robert L Barry, “Fundamentals of Ethics for Scientists andEngineers”, Oxford University Press, Oxford, 2001.

Subject Code	Subject Name	Hours per Week			Hours	Credits
		L	**T**	**P**		
ME5PC05	**Dissertation Phase-I**	0	0	20	20	10

Students should model, analyze and animate /fabricate a functional model of any component, sub system or a mechanism used in automobile. They should prepare a thesis report and submit it.

SEMESTER-IV

Sr. No	Course Code	Courses	L	T	P	Hrs.	Credits
1	ME5CA09	Electric & Hybrid Vehicles	4	0	4	8	6
2	EN5HS01	Entrepreneurship and Management	3	0	0	3	3
3	ME5PC06	Dissertation Phase-II	0	0	32	32	16
Total			7	0	4	43	25

Subject Code	Subject Name	Hours per Week			Hours	Credits
		L	T	P		
ME5CA09	**Electric & Hybrid Vehicles**	4	0	4	8	6

Course Learning Objectives (CLOs)

CLO01: Students must understand the basics of electric and hybrid electric vehicles, their architecture, technologies and fundamentals.

CLO02: Students must be able to understand hybrid electric vehicle architecture, design and component sizing and the power electronics devices used in hybrid electric vehicles.

CLO03: Student must be able to understand various electric drives suitable for hybrid electric vehicles.

CLO04: Students must be able to understand different energy storage technologies used for hybrid electric vehicles and their control.

CLO05: Students must be able to understand hybrid vehicle configuration by different techniques, sizing of components and design optimization and energy management.

Course Outcomes (COs)

CO01:Students will be able to understand the architecture and vehicle dynamics of electric and hybrid vehicles.

CO02: Students will be able to Analyze and model the power management systems for electric and hybrid vehicles.

CO03: Students will be able to understand thepower electronics based control strategies for electric and hybrid vehicles.

CO04: Students will be able to design various components of electric and hybrid vehicles with environment concern.

CO05: Students will be able to investigatethe issues in mathematical domain related to grid interconnections of electric and hybrid vehicle.

Unit-I

Introduction to electric vehicles: Need for electric vehicles - Types – Cost and Emissions – Electric Vehicle Technology – layouts, cables, components, Controls. Batteries – overview

and its types. Battery plug-in and life. Ultra-capacitor, Charging – Methods and Standards. Alternate charging sources – Wireless & Solar.

Unit-II

Electric Vehicle Motors: Motors (DC, Induction, BLDC) – Types, Principle, Construction, Control. Electric Drive Trains (EDT) – Series HEDT (Electrical Coupling) – Power Rating Design, Peak Power Source (PPS); Parallel HEDT (Mechanical Coupling) – Torque Coupling and Speed Coupling. Switched Reluctance Motors (SRM) Drives – Basic structure, Drive Convertor, Design.

Unit-III

Electronics and Sensor-less control in EV: Diodes, Thyristors, BJTs, MOSFETs, IGBTs, Convertors, Inverters. Safety – Risks and Guidance, Precautions, High Voltage safety, Hazard management. Sensors - Self-Drive Cars, Hacking; Sensor less – Control methods-Phase Flux,Linkage-Based Method, Phase Inductance- Based, Modulated Signal Injection, Mutually Induced Voltage-Based, Observer-Based.

Unit-IV

Hybrid Vehicles: Types of hybrid vehicles, their layoutand Architecture – Series, Parallel and Series-Parallel Hybrid, Propulsion systems and components. Regenerative Braking, Economy, Vibration and Noise reduction. Hybrid Electric Vehicles System – Analysis and its Types, Controls.

Unit-V

Fuel Cells for Electric vehicles:– Introduction to fuel cells. Technologies & types of fuel cells. Operation principles, Potential and I-V curve, Fuel and Oxidation Consumption, Fuel cell Characteristics – Efficiency, Durability, Specific power, Factors affecting. Lifetime cost of Fuel cell Vehicle – System, Components, maintenance.

Text Books:

1. Hybrid Electric Vehicle System Modelling and Control - Wei Liu, General Motors, USA, John Wiley & Sons, Inc., 2017.

2. Hybrid Electric Vehicles – Teresa Donateo, Published by ExLi4EvA, 2017

3. Electric and Hybrid Vehicles Power Sources, Models, Sustainability, Infrastructure and the Market Gianfranco Pistoia Consultant, Rome, Italy, Elsevier Publications, 2017.

4. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, MehrdadEhsaniYiminGao Stefano Longo Kambiz M. Ebrahimi, Taylor & Francis Group, LLC, 2018.

5. Hybrid, Electric & Fuel-Cell Vehicles Jack Erjavec, Delmar, Cengage Learning.

6. Electric and Hybrid Vehicles, Tom Denton, Taylor & Francis, 2018.

List of Experiments:

1. Study of various components of an electric car
2. Demonstration of wiring layout of electric vehicle
3. V/f control of three-phase induction motor
4. Speed control of BLDC motor in a two wheeler
5. Speed control of SRM motor in a three wheeler
6. Simulation of Four quadrant operation of three-phase induction motor
7. Current/Voltage Control of an Electric vehicle
8. Sensor & Actuators in an Electric Vehicle
9. Control Circuit of an induction motor

Subject Code	Subject Name	Hours per Week			Hours	Credits
		L	T	P		
EN5HS01	**Entrepreneurship and Management**	3	0	0	3	3

Unit-I: Introduction to Entrepreneurship

Definition and Meaning, Concept and Need of Entrepreneurship; Role of entrepreneurship in Economic Development; Factor Affecting Entrepreneurial Growth – Economic, Non-Economic Factors, Managerial vs. entrepreneurial approach, Entrepreneur vs. Intrapreneur, Types of Entrepreneurs, Traits/Qualities of an Entrepreneurs, Characteristic of successful entrepreneurs, Entrepreneurship process, Women as Entrepreneurs, Ethics and Social Responsibilities; Entrepreneurial challenges.

Unit-II: Creating and Starting the Venture Business plan

Meaning, Significance, contents, formulation and presentation of Business Plan, implementing business plans. Marketing plan, financial plan and the organizational plan, Launching Formalities, Common errors in Business Plan formulation.

Unit: III- Innovation and Entrepreneurship

Entrepreneurship and Innovation. The Innovation Concept, Importance of Innovation for Entrepreneurship, Source of Innovation for Opportunities, The Innovation Process, Product life cycle, new product development process, Creativity and innovation in product modification/ development.

Unit-IV-Introduction to Management and Organization

Concept and differences between industry, commerce and business. Various types of ownership in the organization– Definition, Characteristics, Merits & Demerits, Single ownership, Partnership, Cooperative Organizations, Joint Stock Companies, Government owned. Difference between management and administration. Management as a science and as an art, different types of leadership models-Autocratic Leader, Democratic Leader, Free Rein Leader, Freelance Leader.

Unit-V–Functions of Management Planning

Definition, Types of Planning, Steps in planning process. Nature and Purpose of Organizing: Staffing, Line and Staff Relationship, Line-Staff Conflict, Directing: definition and importance, Controlling: Concept and Process of Control, Control Techniques, Control as a Feedback System.

Text Books

1. Rajeev Roy, Entrepreneurship, Oxford University press.
2. Stephen P. Robbins, David A. Decenzo, Sanghmitra Bhattacharya, Madhushree Nanda Agarwal, Fundamentals of Management, Pearson Education.
3. Robbins, Management, Pearson Education.
4. Harold Koontz, O'Donnell, Heinz Weihrich, Essentials of Management. Tata McGraw Hill.
5. Stoner, Management, PHI Learning.
6. Vasant Desai, Small scale Industries and Entrepreneurship, Himalaya Publishing House.
7. Gupta C.B. Khanks S.S., Entrepreneurship and Small Business Management, Sultan Chand & Sons, New Delhi.

References

1. Greene, Entrepreneurship, Cengage learning.
2. B. K. Mohanty Fundamentals of Entrepreneurship PHI.
3. Barringer, Entrepreneurship Pearson education.
4. Desai Vasant, Dynamics of Entrepreneurship Development and Management, Himalaya Publishing House
5. David H Holt Entrepreneurship: New Venture Creation, PHI.
6. Satyaraju, Parthsarthy, Management Text and Cases, PHI Learning.
7. Kanishka Bedi, Management and Entrepreneurship, Oxford Higher Education.

Subject Code	Subject Name	Hours per Week			Hours	Credits
		L	**T**	**P**		
ME5PC06	**Dissertation Phase-II**	0	0	32	32	16

Students should model, analyze and animate /fabricate a functional model of any component, sub system or a mechanism used in automobile. They should prepare a thesis report and submit it.