Department of Mechanical Engineering

CURRICULUM AND SYLLABUS

(2023-2027)

M. Tech. (Executive) Design Engineering

Mechanical Engineering

M. Tech. (Executive) Design 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 practica
PEO-2	To develop research acumen for designing a system with better efficiency
PEO-3	To prepare students as experts with better communication skills, profe 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, engineering fundamentals, and an engineering specialization to the sol complex engineeringproblems.
PO02	**Problem analysis**: Identify, formulate, research literature, and analyse engineering problems reaching substantiated conclusions using first princ mathematics, natural sciences, and engineering sciences.
PO03	**Design/development of solutions**: Design solutions for complex engineering p anddesign system components or processes that meet the specified needs with app consideration for public health and safety, and the cultural, societal, and enviro considerations.
PO04	**Conduct investigations of complex problems**: Use research-based knowle research methods including design of experiments, analysis and interpretation and synthesis of the information to provide valid conclusions.
PO05	**Modern tool usage**: Create, select, and apply appropriate techniques, r and modern engineering and IT tools including prediction and modeling to engineering activities with an understanding of the limitations.
PO06	**The engineer and society**: Apply reasoning informed by the contextual kn to assess societal, health, safety, legal and cultural issues and the cor responsibilities relevant to the professional engineering practice.
PO07	**Environment and sustainability**: Understand the impact of professional eng solutions in societal and environmental contexts, and demonstrate the knowle and need for sustainable development.
PO08	**Ethics**: Apply ethical principles and commit to professional ethics and respor and norms of engineering practice.
PO09	**Individual and team work**: Function effectively as an individual, and as a or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication**: Communicate effectively on complex engineering activities engineering community and with society at large, such as, being able to compreh write effective reports and design documentation, make effective presentatic give and receive clear instructions.
PO11	**Project management and finance**: Demonstrate knowledge and understa the engineering and management principlesand apply these to one's own wo memberand leader in a team, to manage projects and in multidisciplinary environr

PO12	**Life-long learning:** Recognize the need for and have the preparation and a engage in independent and life-long learning in the broadest context of tech change.

Department of Mechanical Engineering

PROGRAMME SPECIFIC OUTCOMES (PSOs)

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

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

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

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

Medi-Caps University, Indore
Scheme of M.Tech. -Automobile 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	ME5CD02	Machine Design	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	ME5EL01	Elective I: Kinematics and Dynamics of Machines	4	0	0	4
2	ME5CA01	Finite Element Method	4	0	4	6
3	ME5EL02	Elective II: Mechatronics	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	ME5CD05	Optimisation in Design	4	0	4	6
2	ME5EL03	Elective III: Advanced Strength of Materials	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	ME5CD06	Design of Dynamic Systems	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**

Medi-Caps University
Faculty of Engineering
Syllabus for Master of Technology (Executive) in Design Engineering

SEMESTER – I

Sr. No.	Course Code	Course Name	L	T	P	Hours	Credits
1	ME5BS01	Mathematics	4	0	0	4	4
2	ME5CD02	Machine Design	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 reability, 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, PrasannaSwaminathan, 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		
ME5CD02	**Machine Design**	4	0	4	8	6

Course Learning Objectives (CLOs):
CLO01: To study the basic design principles and apply the knowledge to the design, codes, standards etc.
CLO 02: To study the basic design principles and apply the knowledge to the design concept generation and evaluation.
CLO 03: To study the basic design principles of design for material and manufacturing.
CLO 04: To study the basic design principles of Cost Evaluation, Legal, Ethical and Economical issues in Design.
CLO 05: To study the basic design principles and apply the knowledge to the design of machine element design based on Strength and Distortion Criterion.

Course Outcomes (COs):
CO01: Students will be able to understand the principles and design Considerations of design Process, Concurrent and Computer aided engineering concepts, Design codes and Standards, Copyright, Expert systems etc.
CO02: Students will be able to understand the principles of Creativity and Problem solving, Decision concept evaluation and decision making, Product Architecture, Configuration and Parametric design Concepts.
CO03: Students will be able to understand the principles of manufacturing in design, manufacturing process selection, DFM, DFA, Design for different Manufacturing process, FMEA (failure mode and effect analysis), Concept of total Quality, quality control and assurance, Optimization methods.
CO 04 Students will be able to understand the principles of developing cost estimates, make buy Decision, design to cost, manufacturing cost models, life cycle costing, origin of laws etc.
CO 05 Students will be able to understand the principles of choice of materials and their treatment; Effect of lubrication in mechanical design; Designing for wear and corrosion; Designing for fatigue, creep; Design criterion for fracture.

Unit-I
Introduction: Considerations of a Good Design, Design Process, Concurrent and Computer aided engineering concepts, Design codes and Standards, Design Review and societal considerations. Need Identification and gathering information: Evaluating Customer requirements and Bench marking, Product Design Specification, Information sources, Copyright, Expert systems.

Unit-II
Concept Generation and Evaluation and Embodiment Design: Creativity and Problem solving, Theory of Inventive Problem solving, Conceptual Decomposition and Axiomatic Design, Decision concept evaluation and decision making. Introduction, Product Architecture, Configuration and Parametric design Concepts, Industrial Design, Ergonomics

and Design for Environment, Modelling and Simulation for engineering design process, Material selection and detailed design. Team Work and Ethics in engineering design, Team formation, functioning, discharge, team dynamics, Ethical issues considered during engineering design process.

Unit-III

Design for Material and Manufacturing – Design for brittle fracture, fatigue failure, design for corrosive resistance, wear, design for plastics. Role of manufacturing in design, Manufacturing process selection, DFM, DFA, Design for different Manufacturing process. Risk reliability and safety, probability approach to design, design for reliability. FMEA (failure mode and effect analysis), Concept of total Quality, quality control and assurance, Optimization methods.

Unit-IV

Cost Evaluation, Legal, Ethical and Economical issues in Design: Methods of developing cost estimates, make buy Decision, design to cost, manufacturing cost models, life cycle costing, origin of laws, type of contracts, liabilities, product liability, protecting intellectual property, codes of ethics, solving ethical conflicts, mathematics of time value of money, cost comparisons, depreciation, taxes, profitability of investments, inflation, sensitivity and Break Even analysis, uncertainty in economic analysis, benefit cost analysis.

Unit-V

Review of Machine element design based on Strength and Distortion Criterion: Review of choice of materials and their treatment; Effect of lubrication in mechanical design. Designing for wear and corrosion; Designing for fatigue, creep; Design criterion for fracture; Application of advanced design criterion to machine elements (like shafts, spur bevel / worm gears); Design of structures, machines and equipment; Dynamic Modeling of mechanical systems; Introduction to machine element design based on vibration failures.

Text Books

1. Kevin Otto and Kristin Wood, " Product design"- Pearson, 2004
2. David G. Ullman, "The Mechanical Design Process" – McGraw Hill, 2003
3. Karl T. Ulrich and Steven D. Eppinger," Product Design and Development" TMH, 2007
4. George E. Dieter," Engineering Design" – McGraw Hill, 2013

Reference Books:

1. Engineering Design Principles, Ken Hurst, Elsevier, 1999.
2. Engineering Design 3rd Ed. Pahl, W Beitz J Feldhusun, K G Grote Springer 2007
3. Richard G Budynas, J Keith Nisbett, Shigley's Mechanical Engineering Design - SIE

List of Experiments

1. Determination of natural frequency of a spring mass system.
2. Determination of natural frequency logarithmic decrement, damping ratio and damping Co-efficient in a single degree of freedom vibrating systems (longitudinal and torsional)
3. Determination of critical speed of rotating shaft.

4. Balancing of rotating masses.
5. Determination of fringe constant of Photo-elastic material using Circular disk subjected diametric compression, Pure bending specimen (four point bending)
6. Determination of equilibrium speed, sensitiveness, power and effort of Porter/Hartnell Governor.
7. Determination of pressure distribution in Journal bearing 8. Experiments on Gyroscope (Demonstration only)

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	ME5EL01	Elective I: Kinematics and Dynamics of Machines	4	0	0	4	4
2	ME5CA01	Finite Element Method	4	0	4	8	6
3	ME5EL02	Elective II: Mechatronics	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		
ME5EL01	**Kinematics and Dynamics of Machine** (Elective I)	4	0	0	4	4

Course Learning Objectives (CLOs)
CLO01: To understand fundamentals of Phases in Design Processes.
CLO02: To understand Modelling of various mechanical systems.
CLO03: To understand the principle of various Theories of failure.
CLO04: To understand the fundamentals design aspects by Goodman, Gerber and Soderberg relations & amp; modified Goodman criteria.
CLO05: To understand Coupler curves, Exact and approximate straight line mechanisms.

Course Outcomes (COs)
CO01: Students will be able to understand different Characteristics of Mechanical design, Considerations in good design.
CO02: Student will be able to understand how to Prevention of failures, failures under Static loading. & amp; dynamic Loading.
CO03: Students will be able to understand the concept of Inversions of Single slider crank chain, double slider crank chain.
CO04: Students will be able to perform CAM Design & amp; SVAJ diagrams.
CO05: Students will understand Analysis and Synthesis of IC Engine and Machine tool components, Engine dynamics.

Unit-I
Analysis Vs. Design: Basic concept, Phases in Design Processes Characteristics of Mechanical design, Considerations in design, Formulations of mechanical design problem, Modelling of mechanical systems: Physical and Mathematical models, Identification of variables and parameters, Numerical simulations.

Unit-II
Failure Analysis: Theories of failure (MNS, MSS, DET), Coulomb-Mohr Theory, Prevention of failures, Understanding failures under Static loading. Dynamic Loading and Its Behaviour: Fatigue strength, S-N curve, Goodman, Gerber and Soderberg relations, modified Goodman.

Unit-III
Introduction to Kinematics: Analysis and Design of Mechanisms, Mechanisms and machines, Mobility of mechanisms, four bar chain, Inversions: Single slider crank chain, double slider crank chain. Velocity and Acceleration Analysis: Instant centers of velocity, velocity of slip, Analytical solutions for velocity analysis, Coriolis Acceleration.

Unit-IV
Graphical Analytical Linkage Synthesis: Two position synthesis for rocker output, Three position synthesis, Position synthesis for more than three positions(four and six bar quick return), Coupler curves, Exact and app6roximate straight line mechanisms. Two position

synthesis for rocker output, Comparison of analytical and graphical two position synthesis, three position syntheses.

Unit-V

Mechanical Component Desing analysis and Balancing: CAM Design: SVAJ diagrams, Double and single dwell cam design. Design of Gears and Bearings, Interference in gears, Differential gear train, Rolling contact, Sliding contact. Primary balancing (Balancing of rotating system), Secondary balancing, balancing for two cylinder engine, multi cylinder engine, 4 cylinder 4stroke engine, 6 cylinder engine, V-ngine.

Unit-VI

Surface Failures: Adhesive, Abrasive, Corrosive, Surface fatigue. Analysis and Synthesis of IC Engine Components: Machine tool and IC engine components, Engine Dynamics, Case studies.

Text Books

1. Kinematics and Dynamics of Machinery -RL. Norton, Tata McGraw Hill, 2009
2. Machine Design an Integrated Approach -RL. Norton, Pearson , 2004
3. Mechanical Engineering Design -Shigley et al., Tat McGraw Hill, 2011

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 Component

Subject Code	Subject Name	Hours per Week			Hours	Credits
		L	T	P		
ME5EL02	**Mechatronics** (Elective-II)	4	0	0	4	4

Course Learning Objectives (CLOs)

CLO01: Students must have basic understanding of mechatronic systems and their applications.
CLO02: Students must be able to understand the principles of different sensors and actuators to be used in mechatronic system
CLO03: Students must understand the basic concepts of analog and digital signals generated from mechatronic systems.
CLO04: Students must be able to develop the basic understanding of various components of mechatronic model of a system.
CLO05: Students must understand the design, programming and working of some basic micro-processors, microcontrollers and programmable logic controllers and the functioning of the electronic components used inside them.

Course Outcomes (COs)

CO01: Students will be able to model mechatronic systems for the given applications.
CO02: Students will be to select appropriate sensor and actuators for a particular application.
CO03: Students will be able to apply the concepts processing of analog and digital signals in designing of mechatronic system.
CO04: Students will be able to design and check the performance of different systems mechanical, electrical and electronic systems.
CO05: Students will be able to select and program micro-processors, micro-controllers and PLCs for the given application.

Unit-I

Introduction to Mechatronics: Definitions of mechatronics, Concept of system, Block diagram of Mechatronic system, Functions of Mechatronics Systems, Measurement systems and Controlling systems, Modelling of Systems, Benefits of mechatronics in manufacturing. Applications. Different mechatronic systems.

Unit II

Sensors Transducers and Actuators :Difference between Sensor and Transducer, Review of different sensors : Displacement, Position and Proximity sensors,Velocity and Motion sensors, Force, Fluid Pressure,Liquid flow and Level sensors, Temperature sensors ,Torque,Light Sensors, Vibration Sensors and Smart Sensors. Performance terminology of sensors, Static and Dynamic characteristics of sensors. Mechanical Actuation Systems – Kinematic chains, Cams, Gears, Richet and Pawl, Belt and Chain Drives, Electrical Actuation Systems –Mechanical Switches, Solid State Switches, Solenoids, DC and AC motors, Stepper

Motors, Servo motor, Thyristors, Triacs, Hydraulic and Pneumatic Actuators, Piezoelectric actuators.

Unit III

Analog and Digital Signal Conditioning: Difference between Analog and Digital signals, *Analog Signal Processing*: Operational amplifier and its ideal model, Different types of OP amplifiers, Protection, Filtering, Wheatstone bridge, Pulse Modulation,*Digital Signal Processing:* Digital signal, Conversion of Analog and Digital signals and vice versa, Multiplexers, Data acquisition : Quantization theory,Boolean algebra to represent Digital logic, Logic gates and its types, application of logic gates, Combinational and Sequential logic. Flip flops and its applications, Counters and Timers.

Unit IV

System Models : Mathematical models, Building blocks for – Mechanical Systems, Electrical Systems, Fluid systems and Thermal systems, Engineering – Rotational Translation system, Electromechanical systems, Hydraulic Mechanical systems, Modelling dynamic systems and measuring response of first and second order systems,Transfer function and Frequency responsefor- first order, second order, systems with feedback loops frequency response, bode plots,performance specifications,stability,Closed loop controllers. Integrated Circuit System Design – Example of Digital tachometer.

Unit V

Microprocessors, Microcontrollers and Programmable Logic Controllers: Microprocessor- Architecture of Intel 8085, Different types of registers, programming of Intel 8085, Microcontroller architecture of Intel 8051, Selecting a microcontroller and its applications. Programmable Logic Controllers (PLCs): Architecture, Different programming methods, Basics of Ladder logic Programming, Logics, Timers and Counters, Shift registers, Application on real time industrial automation systems.

Text Books:

1. W. Bolton, Mechatronics, Electronic control systems in mechanical and electrical engineering, Pearson Education, 5/e, 2011.
2. David G. Alcaiatore and Michel B. Histand, Introduction to Mechatronics and Measuring Systems, Mc. Graw Hill Int. Edition, 3/e, 2006.
3. NitaigourPremchandMahalik, Mechatronics-*Principles,Concepts,Applications,* Tata McGraw Hill.
4. K.P. Ramchandran, G.K. Vijayraghvan, M.S. Balasundram, Mechatronics-*Integrated mechanical Electronics Systems,* Wiley India Pvt. Ltd. ,Istedition, 2008

Reference Books:

1. Mechatronics-Integrated technologies for intelligent machines, Oxford University Press, Ist Edition, 2008.
2. Robert H. Bishop. The Mechatronics Handbook, CRC Press, 2/e, 2007.

3. Craig K. C. and Stolfi, F. R., Introduction to Mechatronic System Design with Applications, IEEE Educational Activities Department, 1994.

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	ME5CD05	Optimisation in Design	4	0	4	8	4
2	ME5EL03	Elective III: Advanced Strength of Materials	4	0	4	4	4
3	EN5HS02	Technical Paper writing	0	0	2	2	1
4	EN5MC01	Value and Ethics	2	0	0	2	2
5	ME5PC05	Dissertation Phase-I	0	0	20	20	10
		Total	**10**	**0**	**6**	**36**	**21**

Subject Code	Subject Name	Hours per Week			Hours	Credits
		L	T	P		
ME5CD05	**Optimization in Design**	4	0	4	8	4

Course Learning Objectives (CLOs)

CLO01: Students must understand the importance of optimization in component design and the different unconstrained optimization techniques.
CLO02: Students must understand different constrained optimization techniques.
CLO03: Students must understand different advanced optimization techniques.
CLO04: Students must learn the optimization of static load carrying structures for given load conditions.
CLO05: Students must understand the requirement of optimization for dynamic systems.

Course Outcomes (COs)

CO01: Students will be able to identify the unconstrained nature of problem and applyappropriate optimization technique.
CO02: Students will be able to identify the constrained nature of problem and applyappropriate optimization technique
CO03: Students will be able to select and apply appropriate advanced optimization technique to a given problem.
CO04: Students will be able to optimize the systems subjected to static loads.
CO05: Students will be able to optimize the systems subjected to dynamic loads.

Unit I

Unconstrained optimization techniques - Introduction to optimum design - General principles of optimization – Problem formulation & their classifications - Single variable and multivariable optimization, Techniques of unconstrained minimization – Golden section, Random, pattern and gradient search methods – Interpolation methods.

Unit II

Constrained optimization techniques Optimization with equality and inequality constraints - Direct methods – Indirect methods using penalty functions, Lagrange multipliers - Geometric programming.

Unit III

Advanced optimization techniques Multi stage optimization – dynamic programming; stochastic programming; Multi objective optimization, Genetic algorithms and Simulated Annealing techniques; Neural network & Fuzzy logic principles in optimization.

Unit IV

Static applications Structural applications – Design of simple truss members - Design applications – Design of simple axial, transverse loaded members for minimum cost, weight – Design of shafts and torsionally loaded members – Design of springs.

Unit V

Dynamic applications Dynamic Applications – Optimum design of single, two degree of freedom systems, vibration absorbers. Application in Mechanisms – Optimum design of simple linkage mechanisms.

Text Book/ References:

1. Rao, Singaresu, S., "Engineering Optimization – Theory & Practice", New Age International (P) Limited, New Delhi, 2000.
2. Johnson Ray, C., "Optimum design of mechanical elements", Wiley, John & Sons, 1990.
3. Kalyanamoy Deb, "Optimization for Engineering design algorithms and Examples", Prentice Hall of India Pvt. 1995.
4. Goldberg, D.E., "Genetic algorithms in search, optimization and machine", Barnen, Addison-Wesley, New York, 1989.

List of Experiments:

1. Introduction to Optimization
2. Introduction to MATLAB
3. Classical Optimization Techniques
4. Unconstrained Optimization: Elimination Methods
5. Unconstrained Optimization: Interpolation Method
6. Unconstrained Optimization: Direct Root Methods
7. Constrained Optimization: Equality Constraints
8. Constrained Optimization: Inequality Constraints

Subject Code	Subject Name	Hours per Week			Hours	Credits
		L	T	P		
ME5EL03	**Advanced Strength of Materials** (Elective III)	4	0	0	4	4

Course Learning Objectives (CLOs)

CLO01: Students must have understanding of the advanced concept of elasticity and stress-strain behaviour of materials.

CLO02: Students must be able to Analyze stresses and strains at a point: transform stresses and strains, determine principal stresses and strains and principal directions for 3D problems.

CLO03: Students must be able to understand the approximate theories of strength of materials for engineering stress and strain analyses of open and closed thin-walled sections subjected to torsion and unsymmetrical bending.

CLO04: Students must be able to analyze curved beam, beams on elastic foundation, shear deformation of beams, and stress concentration problems.

CLO05: Students must be able to understand the failure analysis using classical plasticity theory and fracture mechanics.

Course Outcomes (COs)

CO01: Students will be able to analyze advanced concept of stress and strain in structural problems.

CO02: Students will be able to apply the concept of different elastic functions to solve complex problems.

CO03: Students will be able to evaluate the influence of various geometric and loading parameters in plane stress and plane strain problems.

CO04: Students will be able to perform stress analysis and design of beams subjected tobending and shearing loads using several methods.

CO05: Students will be able to Implement advanced concept of solid mechanics in torsion, plates and shells.

Unit I Elasticity

Stress-Strain relations and general equations of elasticity in Cartesian, Polar and curvilinear coordinates, differential equations of equilibrium-compatibility-boundary conditions-representation of three-dimensional stress of a tension generalized hook's law - St. Venant's principle – plane stress - Airy's stress function. Energy methods.

Unit II Shear Center and Unsymmetrical Bending

Location of shear center for various thin sections - shear flows. Stresses and Deflections in beams subjected to unsymmetrical loading-kern of a section.

Unit III Stresses in Flat Plates and Curved Members

Circumference and radial stresses – deflections - curved beam with restrained ends - closed ring subjected to concentrated load and uniform load - chain links and crane hooks. Solution

of rectangular plates – pure bending of plates – deflection – uniformly distributed load – various end conditions.

Unit IV Torsion of Non-Circular Sections

Torsion of rectangular cross section - St.Venants theory - elastic membrane analogy - Prandtl's stress function - torsional stress in hollow thin walled tubes.

Unit V Stresses in Rotating Members and Contact Stresses

Radial and tangential stresses in solid disc and ring of uniform thickness and varying thickness allowable speeds. Methods of computing contact stress- deflection of bodies in point and line contact applications.

Text References:

1. Arthur P Boresi, Richard J. Schmidt, “Advanced mechanics of materials”, John Wiley, 2002.
2. Timoshenko and Goodier, "Theory of Elasticity", McGraw Hill.
3. Robert D. Cook, Warren C. Young, "Advanced Mechanics of Materials", Mc-millan pub. Co.1985.
4. Srinath. L.S., “Advanced Mechanics of solids”, Tata McGraw Hill, 1992.
5. G H Ryder Strength of Materials Macmillan, India Ltd, 2007.
6. Allan F. Bower, “Applied Mechanics of Solids”, CRC press – Special Indian Edition -2012, 2010
7. K. Baskar and T.K. Varadan, “Theory of Isotropic/Orthotropic Elasticity”, Ane Books Pvt. Ltd., New Delhi, 2009

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	0	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	ME5CD06	Design of Dynamic Systems	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		
ME5CD06	**Design of Dynamic Systems**	4	0	4	8	6

Course Learning Objectives (CLOs)

CLO1: To study the basic of modelling and simulation of dynamic Systems.
CLO2: To study the modelling of systems involving continuous medium & amp; elements of analytical mechanics.
CLO3: To study the dynamics of non-linear systems & numerical analysis of dynamical systems.
CLO4: To study the multi-degree of freedom system analysis using numerical methods.
CLO5: To study the Nonlinear Vibration.

Course Outcome (COs)

After completion of this course the students shall able to:
CO1: Understand modelling and simulation of dynamic Systems.
CO2: Understand modelling of systems involving continuous medium & amp; elements of analytical mechanics.
CO3: Understand dynamics of non-linear systems & numerical analysis of dynamical systems.
CO4: Understand multi-degree of freedom system analysis using numerical methods.
CO5: Understand the Nonlinear Vibration.

Unit I

Introduction to Modelling and Simulation, Modelling of Dynamic Systems, Basic System Models System Models of Combined Systems, Dynamic Response and System Transfer Function, Block diagram, Signal flow diagram, State Space formulation and Frequency response, Simulation and Simulation application.

Unit II

Elements of analytical mechanics; classification of constrains, Principles of virtual work, Lagrange's first equation. Lagrange's second equation. Hamilton's equations. Nonholonomic mechanical system dynamics, Routh and Gibbs equation, Kane dynamics with application to multi body systems like mechanisms and manipulators. Modelling of systems involving continuous medium. Hamilton's principle for continuous medium.

Unit III

Analysis of linear dynamics, stability analysis, state-space analysis, dynamics of non-linear systems, geometric aspects and bifurcation analysis for one and two dimensional flows, introduction to perturbation techniques, discrete-time dynamical systems, numerical analysis of dynamical systems.

Unit IV

Multi-degree of freedom system Numerical Methods: Rayleigh's method, Dunkerley's method, Stodola's method, Matrix iteration method. Multi degrees of freedom systems: Exact analysis. Un-damped free vibrations. Influence numbers and Maxwell's reciprocal theorem, torsional vibrations of multi- rotor system, vibrations of geared systems. Continuous systems: Vibrations of strings, longitudinal vibrations of bars, torsional Vibrations of circular shafts.

Unit V

Nonlinear Vibration: Various Examples. Perturbation method, forced vibrations with nonlinear spring forces, Jump phenomenon. Self-Excited Vibrations: Elementary idea of stable and unstable oscillations, self-excited vibrations caused by dry friction, various examples.

Text Books:

1. Modeling and Simulation of Dynamic Systems 1st Edition by Robert L. Woods, Kent L. Lawrence.
2. Modeling and Analysis of Dynamic Systems, Second Edition
3. Ramin S. Esfandiari, Bei Lu Thomson, W.T., Theory of Vibration with Applications, C.B.S Pub & distributors.
4. Singiresu Rao, Mechanical Vibrations, Pearson Education.
5. G. K. Grover, "Mechanical Vibration, Nemchand and Bross, Roorkee.
6. Ambekar A.G., Mechanical Vibrations and Noise Engineering, PHI

List of Experiments

1.Experimenton Performance Characteristic Curves of Watt Governor
2. Experiment on Performance Characteristic Curves of Porter Governor
3. Experiment on Performance Characteristic Curves of Proell Governor
4. Experiment on Performance Characteristic Curves ofHartnell Governor
5. Estimation of Gyroscopic Couple & Understanding of Gyroscopic Effects on a rotating disc.
6. Static and Dynamic Balancing of Rotating Masses
7. SingleDOF (DegreesofFreedom) of spring MassUndampedSystems
8. Single DOF (Degrees of Freedom) of Spring Mass damped Systems
9. Undamped Torsional Vibrations of Single Rotor System
10.Free and Forced Vibration of Simply Supported Cantilever Beam

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	0	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.