M. TECH.

MACHINE DESIGN

SYLLABUS

FOR

CREDIT BASED CURRICULUM

DEPARTMENT OF MECHANICAL ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY

AGARTALA – 799046, INDIA

M.Tech. Machine Design (Syllabus Structure)

Program: M.Tech. Machine Design					
Sl. No.	Course Code	Subject	Credit	Class hours per week	Marks
First Semester					
1		Advanced Machine Design	4	3-1-0	100
2		Computer Aided Design	4	3-1-0	100
3		Analysis and synthesis of Mechanism	4	3-1-0	100
4		Elective –I	4	3-1-0	100
5		Elective –II	4	3-1-0	100
6		Modeling and Analysis Laboratory	2	0-0-3	100
7		Computer Aided Design Laboratory	2	0-0-3	100
8		Technical Writing and Seminar	1	0-0-2	100
		Total	25	28	800
Second Semester					
1		Machine Tool Design	4	3-1-0	100
2		Advanced Vibration	4	3-1-0	100
3		Elective –III	4	3-1-0	100
4		Elective –IV	4	3-1-0	100
5		Machine Tool Laboratory	2	0-0-3	100
6		Advanced Vibration Laboratory	2	0-0-3	100
7		Project Preliminary	3	0-0-6	100
8		Comprehensive Viva Voce	2	0-0-0	100
		Total	25	28	800
Third Semester					
1		Project and Thesis – 1	10	0-0-0	100
Fourth Semester					
1		Project and Thesis – 2	20	0-0-0	300
		Total Credit	80	Total Marks	2000

Electives (M.Tech. Machine Design)					
Elective I					
Sl. No.	Course Code	Subject	Credit	Class hours per week	Marks
1		Advanced Mathematics for Engineers	4	3-1-0	100
2		Soft computing	4	3-1-0	100
3		Artificial Intelligence	4	3-1-0	100
Elective II					
Sl. No.	Course Code	Subject	Credit	Class hours per week	Marks
1		Finite Element Methods	4	3-1-0	100
2		Experimental Stress Analysis for Design	4	3-1-0	100
3		Advanced mechanics of solids	4	3-1-0	100
Elective III					
Sl. No.	Course Code	Subject	Credit	Class hours per week	Marks
1		Robotics	4	3-1-0	100
2		Tribological System Design	4	3-1-0	100
3		Robotics and Automation	4	3-1-0	100
4		Applied Computational Methods	4	3-1-0	100
5		Design Optimization	4	3-1-0	100
Elective IV					
Sl. No.	Course Code	Subject	Credit	Class hours per week	Marks
1		Product Design & Development	4	3-1-0	100
2		Design of Combustion Engine	4	3-1-0	100
3		Mechanics of Composite Materials	4	3-1-0	100
4		Fracture Mechanics	4	3-1-0	100

Program Outcomes for Machine Design M.Tech Program

PO1: An ability to independently carry out research /investigation and development work to solve Machine Design related problem.

PO2: An ability to write and present a substantial technical report/document

PO3: Students should be able to demonstrate a degree of mastery in the area of Machine Design specialization. The mastery should be at a level higher than the requirements in the bachelor program of Mechanical Engineering

PO4: An **ability** to use analytical, numerical, and experimental methodologies to identify, define, and solve Machine Design related Problem**.**

PO5: An ability to apply the acquired knowledge to design / develop mechanical equipment and systems considering environmental, socio-economic and ethical issues.

PO6: An ability to realize the impact of a selected Design and its solutions in terms of scientific, social, environmental, and economic progress.

Programs Specific Outcomes (PSOs)

PSO1: To provide optimal and sustainable solutions by conduct investigation in the areas of numerical analysis, vibration analysis, failure analysis, mechanism synthesis.
PSO2: Understanding the current scenario and Apply Machine Design engineering knowledge, skills and competency in Design and analysis of systems related to Mechanical and allied areas to obtain realistic outcomes.

FIRST SEMESTER
ADVANCED MACHINE DESIGN

Semester: 1st M. Tech.	Credit: 4					
Course Name: Advanced Machine Design	**L**	**T**	**P**	3	1	0

Course Objectives:

1) To adopt a better Design and Machine design process appropriate for production

Syllabus Content

Module 1:

Concurrent Engineering**:** Design Process, Application of Computers for Design, Product Life Cycle, Product Life Cycle Revised with CAD/CAM, Sequential Engineering, Concurrent Engineering Definitions, Features, Advantages, Organizational Structures (Galbraith) Case Studies on Industries which successfully implemented Concurrent Engineering, Collaborative Engineering

Module 2:

Reverse Engineering: Product Development Approaches – Conventional and Non-Conventional Reverse Engineering – Definition, Importance, Steps Involved in it and its Applications Coordinate Measuring Machine (CMM) – Structural Description, Different Probing Systems, Computer Tomography.

Module 3:

Product / Process Re engineering: Definition, She whart-Deeming Cycle (Plan, Do, Check, Action), Phases of Reengineering, Reengineering Leadership, Selecting the Reengineering Team, Business Assessment, Setting the Project Scope, Studying the Problem, Understanding the Current Process, Understanding the Current Information, Architecture Preparing for the Redesign, Travelling through the Process Space, Key Concepts in Information Technology, Data Analysis and Reengineering Project, Redesign Principles.

Module 4:

Loss Function and Design Techniques: Definitions of Quality, Quality Loss Function, Causes of Variation, Average Quality Loss Exploring Nonlinearity, Classification of Parameters, Steps in Designing Performance into a Product, Functional Design: The Traditional Focus, Loss Functions and Manufacturing Tolerances, Concept Design, Parameter Design, Tolerance Design.

Module 5:

Product / Process Optimization: Signal to Noise Ratios for Static Problems, Signal to Noise Ratios for Dynamic Problems Optimization using Signal to Noise Ratios.

Module 6:

Robust Design: Steps in Robust Design, Fundamental Principle, Tools used in robust Design, Application and Benefits of Robust Design.

Text Books:

i) Imad Moustapha, "Concurrent Engineering in Product Design and Development", New Age International (P) Ltd. Publishers

ii) Ibrahim Zeid, "CAD/CAM Theory and Practice", Tata McGraw-Hill Publishing Company Ltd.

iii) Mikell P. Groover and Emory W. Zimmers Jr., "CAD/CAM: Computer-Aided Design and Manufacturing", Prentice Hall of India Pvt. Ltd.

References:

i) P. Radhakrishnan, S. Subramanyan, "CAD/CAM/CIM", New Age International (P) Ltd., Publishers

ii) Vikram Sharma, "Fundamentals of CAD/CAM/CIM", S.K. Kataria and Sons

iii) Daniel P. Petrozzo and John C. Stepper, "Successful Reengineering", Jaico Publishing House

iv) Tapan Bagchi Taguchi, "Methods Expalined – Practical Steps to Robust Design", Prentice Hall, India

Course Outcomes

At the end of course, students will be able to

CO-No.	Course Outcome	Module Covered
1	To be acquainted with the overview of design process correlating the fabrication /production process.	I & II
2	To study the process of production incorporating modern machine design process	III
3	Correlation of a design process to product	IV
4	To find out best solution by application of optimization technique	V
	To incorporate a process of production /member to with stand application hazard and uncertainty by means of robust design	VI

CO-PO Mapping (Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO - 1	PSO - 2
CO-1	3	2	3	2	3	2	2	1
CO-2	2	3	3	3	3	1	3	2
CO-3	2	3	3	3	3	3	3	3
CO-4		1	2	3	1	3	1	2
CO-5	3	2	3	1	2	3	3	3

COMPUTER AIDED DESIGN

Semester: 1st	Credit: 4					
Course Name: Computer Aided Design	**L**	**T**	**P**	3	1	0

Course Objectives:

1) To learn modeling techniques for Computer Aided Design
2) To learn transformation methods for visual clarity of shape of model
3) To learn data exchange formats

Syllabus Content

Module 1:

Introduction-Product life cycle, Role of CAD in design process, CAD hardware and software, Criteria to evaluate CAD softwares, Computer Communications, Principle of networking, classification networks.

Module 2:

2 – D Modeling-Parametric representation of analytic curves, parametric representation of synthetic curves like Bezier curve, B-spline curve; Representation of synthetic surfaces like Bezier surface, B-spline surface.

Module 3:

Composite shape-NURBS, Inverse problem, Geometric surface analysis, Edgewise docking, Volumetric docking, assessment criterion.

Module 4:

3 – D Modeling-Solid modeling, Boolean operations, Methods, Boundary Representation, Constructive Solid Geometry, Sweep, solid manipulations, solid modeling based applications: mass properties calculations.

Module 5:

Transformations-Transformation of geometric models: translation, scaling, reflection, rotation, homogeneous representation, concatenated transformations, Inverse Transformations, Mapping.

Module 6:

Data Exchange Formats-Introduction to CAD/Cam data exchange formats. Direct and Indirect translators. Neutral file formats: Data Exchange format (DXF), Standard Triangular Languages (STL), Initial Graphics Exchange Specification (IGES).

Text Books:

i) Ibrahbim Zeid, "CAD / CAM Theory and Practice", Tata McGraw Hill Publishing Company

ii) Rogers / Adams, "Mathematical Elements for Computer Graphics". McGraw Hill Education

Reference Books:

i) M.E. Mortenson, "Geometric Modeling", Industrial Press Inc., USA

ii) Jim Browne, "Computer Aided Engineering and Design". New Age International

iii) Rooney and Steadman, "Principles of Computer Aided Design", Routledge publication.

Course Outcomes

At the end of course, students will be able to

CO-No.	Course Outcome	Module Covered
1	Choose suitable CAD hardware and software tools	1
2	Construct abstract models of curves and surfaces	2, 3
3	Construct abstract models of solid entities	4
4	Apply transformations to the models	5
5	Use data exchange formats	6

CO-PO Mapping (Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO - 1	PSO - 2
CO-1	3	2	2					
CO-2	3	2	2					
CO-3	3	2	3					
CO-4	2	3	2					
CO-5	3	1	3					
CO-6	3	2	2					

ANALYSIS AND SYNTHESIS OF MECHANISM

Semester: 1st	Credit: 4					
Course Name: Analysis and Synthesis of Mechanism	**L**	**T**	**P**	3	1	0

Course Objectives:

4) To provide knowledge on fundamental theories used in kinematic analysis and their application in mechanism synthesis.
5) To make students enable to construct mechanisms using kinematic analysis.

Syllabus Content

Module 1:

Basics of Mechanism- Rigid body, Kinematic pairs, Lower pairs connections, Higher pair connections, Kinematic chain, Mechanism, Four bar mechanism, Slider crank mechanism, Transmission, deviation and pressure angles, Equivalent mechanisms

Module 2:

Type Synthesis, Number Synthesis, Dimensional Synthesis- Type synthesis, Number synthesis, Dimensional synthesis, Accuracy points, Spacing of accuracy points, Chebyshev polynomials.

Module 3:

Four Bar Coupler Point Curve- Four bar linkage, coupler curve equation, double points and symmetry, Roberts-Chebyshev theorem

Module 4:

The Euler Savary Equation and Cubic of Stationary Curvature- The Euler Savary equation and the Inflection circle, The cubic of stationary curvature.

Module 5:

Linkage Synthesis with Three Accuracy Points (Geometric Methods)- Concept of poles, relative poles, pole triangle of four bar and slider crank mechanism. Application in position generation, function generation problems.

Module 6:

Linkage Synthesis with Four Accuracy Points (Geometric Methods)- Concept of opposite pole quadrilateral, Center point curve, Circle point curve, Application in position generation problems.

Module 7:

Linkage Synthesis with Three Accuracy Points (Algebraic Method)- Fredeinstain displacement equation of four bar linkage for three accuracy points, Crank-follower linkage synthesis angular velocities and acceleration

Module 8: Linkage Synthesis with Three Accuracy Points- Complex Number Method

Text Books:

i) Richard Scheunemann Hartenberg and Jacques Denavit,"Kinematic Synthesis of Linkages", McGraw-Hill.

Reference Books:

i. Asok Kumar Malik, Amitabh Ghosh,"Kinematic Analysis and Synthesis of Mechanism"
ii. Deh Chang Tao,"Applied Linkage Synthesis", Addison-Wesley Pub. Co.
iii. Rudolf Beyer, "The Kinematic Synthesis of Mechanisms", Chapman & Hall

Course Outcomes

At the end of course, students will be able to

CO-No.	Course Outcome	Module Covered
1	Understand fundamental concepts of mechanisms	1, 2
2	Understand theories and methodologies applied for design of mechanisms	3, 4
3	Synthesize mechanism using 3 accuracy points	5, 7, 8
4	Synthesize mechanism using 4 accuracy points	6

CO-PO Mapping (Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO - 1	PSO - 2
CO-1	1	2	1	1	1	1	1	1
CO-2	1	2	2	2	1	2	2	2
CO-3	3	1	3	3	1	1	3	2
CO-4	3	1	3	3	1	1	3	2
CO-5	1	2	1	1	1	1	1	1
CO-6	1	2	2	2	1	2	2	2

COMPUTER AIDED DESIGN LABORATORY

Semester: 1st	Credit: 2					
Course Name: Computer Aided Design Laboratory	**L**	**T**	**P**	0	0	3

Course Objectives:

1) To learn implementation of CAD algorithms for modeling of geometric entities
2) To learn use of available CAD softwares for modeling and assembly of machine components

List of Experiments:

Exp 1: Implement CAD algorithms for modeling of 2-D enteritis and display the results
Exp 2: Implement CAD algorithm for modeling of composite shape and display the results
Exp 2: Use CAD software for modeling and assembly of machine components
Exp 4: Implement CAD algorithm for transformation of objects
Exp 5: Convert CAD model data from one exchange format to the other format

Course Outcomes

At the end of course, students will be able to

CO-No.	Course Outcome	Exp
1	Model 2-D geometric entities using CAD algorithms	1
2	Apply CAD algorithm for modeling composite shape	2
3	Model and assemble machine components using CAD software	3
4	Apply transformations to the object shapes	4
5	Use data exchange formats for conversion of CAD model data	5

CO-PO Mapping (Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO - 1	PSO - 2
CO-1	3	2	2					
CO-2	3	2	3					
CO-3	3	2	3					
CO-4	3	2	2					
CO-5	3	1	3					
CO-6	3	2	2					

MODELING AND ANALYSIS LAB

Semester: 1st	Credit: 2					
Course Name: Modeling and Analysis Lab	**L**	**T**	**P**	0	0	3

Course Objectives:

1) To acquire basic understanding of Modeling and Analysis software
2) To understand the different kinds of analysis and apply the basic principles to find out the stress and other related parameters of bars, beams loaded with loading conditions.
3) To lean to apply the basic principles to carry out dynamic analysis to know the natural frequency of different kind of beams.
4) To impart the fundamental knowledge on using various analytical tools like ANSYS, FLUENT, etc., for Engineering Simulation.
5) To impart knowledge on how these tools are used in Industries by solving some real time problems using these tools.

List of Experiment:

Exp 1: Study of a FEA package and modeling and stress analysis of:

a) Bars of constant cross section area, tapered cross section area and stepped bar
b) Trusses – (**Minimum 2 exercises of different types**)
c) Beams – Simply supported, cantilever, beams with point load, UDL, beams with varying load etc (**Minimum 6 exercises different nature**)
d) Stress analysis of a rectangular plate with a circular hole

Exp 2: Thermal Analysis – 1D & 2D problem with conduction and convection boundary conditions (Minimum 4 exercises of different types)

Exp 3: Dynamic Analysis to find

a) Fixed – fixed beam for natural frequency determination
b) Bar subjected to forcing function
c) Fixed – fixed beam subjected to forcing function

Exp 4: (only for demo and oral exam)

1) Demonstrate the use of graphics standards to import the model from modeler to solver
2) Demonstrate one example of contact analysis to learn the procedure to carry out contact analysis. 3) Demonstrate at least two different type of example to model and analyze bars or plates made from composite material

Course Outcomes

At the end of course, students will be able to

CO-No.	Course Outcome	Exp
1	Use the modern tools to formulate the problem, and able to create geometry, descritize, apply boundary condition to solve problems of bars, truss, beams, plate to find stress with different loading conditions.	Exp 1 to 4
2	Demonstrate the deflection of beams subjected to point, uniformly distributed and varying loads further to use the available results to draw shear force and bending moment diagrams.	Exp-1
3	Analyze the given problem by applying basic principle to solve and demonstrate 1D and 2D heat transfer with conduction and convection boundary conditions.	Exp-2
4	Able to appreciate the utility of the tools like Solid works, ANSYS or FLUENT in solving real time problems and day to day problems	Exp-1 to 4
5	Use of these tools for any engineering and real time applications.	Exp-4
6	Acquire knowledge on utilizing these tools for a better project in their curriculum as well as they will be prepared to handle industry problems with confidence.	Exp-4

CO-PO Mapping (Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO - 1	PSO - 2
CO-1	3	3	3	3	3	3	3	3
CO-2	3	2	3	1	1	1	1	1
CO-3	3	2	2	1	1	1	1	2
CO-4	3	2	3	1	1	1	1	1
CO-5	3	2	3	1	1	1	1	1

TECHNICAL WRITING AND SEMINAR

Semester:1st	Credit:4					
Course Name: Technical Writing and Seminar	**L**	**T**	**P**	3	1	0

Course Objectives:

1) To develop comprehensive technical communication skill.
2) To develop competency for communicating technical projects.

Syllabus Content:

Module 1:

Report writing and other business communications: project writing, technical proposal, report Writing (Business and Technical Report), journal writing (Research Article), technical description.

Module 2:

Miscellaneous correspondence: process of communication, barriers in communication, written communication business letters (Quotations, Orders, Tenders, Complaint, Responding/reply to enquiry), email (email etiquettes), minutes, memorandum, circular, notice, agenda.

Module 3:

Job based communication: Job application, resume writing, profile summary and employment interview, presentation skills.

Module 4:

Seminar presentation: seminar preparation on: various technical innovations, recent developments in the field of automotive technology, topics of universal importance. Presentation of seminar on audio visual mode.

Text Books:

i) Sharma R C., Mohan Krishna, Business Correspondence and Report Writing. 5th ed. Chennai: Mc Graw Hill Education (India) Pvt. Ltd,2016.

Reference Books:

i) Padmaja T.V.S., Pfeiffer William Sanborn. Technical Communication. 6th ed. Noida: Pearson, India Education Services Pvt. Ltd, 2008.
ii) Anderson V. Paul, Technical Communication.6th ed. New Delhi: Cengage Learning, 2010.

Course Outcomes:

CO-No.	Course Outcome	Module Covered
1	Ability of narrating any technical concept, communicating research article.	1
2	Develop overall experience of handling any official, business correspondence.	2
3	Self-development to communicate for any job prospects.	3
4	Ability to represent project report, thesis, technical view point.	4

CO-PO Mapping (Rate: scale of1to3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2
CO-1	3	1	3	1	2	2	2	1
CO-2	3	2	3	2	1	2	2	2
CO-3	2	3	3	2	2	3	2	2
CO-4	1	3	3	1	2	3	2	1

SECOND SEMESTER
MACHINE TOOL DESIGN

Semester: 2nd M.Tech.	Credit: 4					
Course Name: Machine Tool Design	**L**	**T**	**P**	3	1	0

Course Objectives:.

1) Skill for reasoning and application of machine tools.

Syllabus content

Module 1:

Introduction to Machine Tools, General Principals of Machine Tool Design: Types and capabilities of machine tools, Constructional and operational features, Techno-Economical Prerequisites for undertaking the Design of New Machine Tool, General Requirements of Machine Tool Design, Engineering Design Process Applied to Machine Tools.

Module 2:

Machine Tool Drives- Working and auxiliary motions in machine tools, Mechanical transmission and its elements, Aim of Speed and Feed Rate Regulation, Stepped regulation of speed: Design of speed box, Design of Feed Box, Construction of speed charts, Development of gearing diagram, Determination of gear teeth, module, shaft sizes, centre distances.

Module 3:

Design of Machine Tool Structures and guide ways - Functions of Machine Tool Structures and Their Requirements, Design criteria for Machine Tool Structures, Materials of Machine Tool Structures Static and Dynamic Stiffness, Profiles of Machine Tool Structures, Basic Design Procedure of Machine Tool Structures, Design of Beds, Columns, Bases and Tables, Functions and types of guide ways, Design of sideways,

Module 4:

Design of Spindles and Spindle Supports- Functions of Spindle Unit and Requirements, Materials of Spindles, Effect of Machine Tool Compliance on Machining Accuracy, Design Calculations of Spindle

Module 5:

Acceptance Tests on Machine Tools- Significance, Performance and geometrical tests on lathe, milling, drilling and shaping machines.

Text Books:

i) N.K. Mehta, “Machine Tool Design and Numerical Control” Second Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1984

ii) S.K. Basu and D.K. Pal, “Design of Machine Tools”, Fourth Edition, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 1990.

References Books:

i) G.C. Sen and A. Bhattacharya, "Principles of Machine Tools", Second Edition, New Central Book Agency (P) Ltd., Kolkata, 1988.

ii) F. Koenigsberger, "Design Principles of Metal Cutting and Machine Tools", Edition 1964,Pergamon Press Ltd., London. 5. H.C.Town, "The Design and Construction of Machine Tools"

Course Outcomes

At the end of course, students will be able to

CO-No.	Course Outcome	Module Covered
1	To earn skill to apply right machine tool in fabrication /production process	1
2	To study the design process of speed regulatory and driving mechanism of machine tools	II
3	To know the design process of the guide ways of machine tool along with the structures as associated	III
4	To know and select the proper speed and feed mechanism for machine tool	IV,V
5	To know the process of testing and acceptance of machine tools	VI

CO-PO Mapping (Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO - 1	PSO - 2
CO-1	1	3	2	3	3	1	3	2
CO-2	2	3	3	3	3	2	3	3
CO-3	3	3	3	3	3	3	3	2
CO-4	1	3	2	1	1	3	2	3
CO-5	3	3	3	3	2	3	3	3

ADVANCED VIBRATION

Semester: 2nd	Credit: 4					
Course Name: Advanced Vibration	**L**	**T**	**P**	3	1	0

Course Objectives:

1. Ability of perform harmonic analysis of systems with Fourier series expansions, frequency domain representations. Analysis of systems under hysteresis damping, coulomb damping and other different types of damping.
2. The ability to analyze and solve two degree of freedom systems with or without damping using Transfer function approach, problems using Laplace transforms.
3. To develop ability for analyzing response of systems under periodic force of irregular form, non periodic force. Understanding the convolution integral. Understanding the control of vibrations.
4. Ability to use different approach, Eigen value problem approach to generate the equation of motion for systems undergoing multidegree of freedom vibration. Understanding and performing Modal Analysis.
5. Understanding and analyzing vibration of continuous systems.
6. Understanding and performing numerical integration methods in vibration analysis. Develop ability to analyze a vibrating system with Finite Element Methods.

Syllabus Content

Module 1:

Free and forced vibration of systems. Rayleigh's energy methods. Characteristics Roots, root locus representations. Energy dissipated in viscous damping. Construction of dampers with linearization of non linear damper. Forced Vibration analysis of systems with hysteretic damping and coulomb damping. Harmonic analysis, Fourier series analysis, frequency spectrum, time and frequency domain representations.

Module 2:

Free and forced vibration analysis of two degree of freedom systems, coordinate coupling, semi definite systems. Self excitation and stability analysis of systems. Solutions of systems using Laplace transformations, frequency transfer functions. Related Numerical problems.

Module 3:

Response of first and second order systems under general periodic force. Response of systems under irregular periodic force, non periodic force. Response to an impulse, general forcing conditions, base excitations. Transient and steady state response. Vibration control, natural frequency control, vibration isolations, vibration absorbers. Solving related numerical problems.

Module 4:

Modeling of multi degree of freedom systems *(free, forced, damped and undamped)*. Stiffness, flexibility and inertia influence coefficients. Lagrange's equations. Eigen value

problem, solution of characteristics equations, orthogonality of normal modes. Modal analysis of undamped and damped systems undergoing forced vibrations. Standard Eigen value problems, Raleigh's Formula, Jacobi's method, Dunkerley's Formula. Solving related problems.

Module 5:

Transverse vibration of string and cable, Longitudinal vibration of rods, torsional vibration of shafts, Lateral Vibration of Beams (*Timoshenko, Euler Bernoulli Beam*), Membrane vibrations. Application of Rayleigh- Ritz method. Related problems.

Module 6:

Finite difference methods for simple systems. Central difference methods, Runge – Kutta method for single degree and multi degree of freedom systems. Response to irregular forcing conditions using numerical methods. Finite difference methods for continuous systems. Equation of motion of an element, mass, stiffness matrix and force vector formulations. Transformation of element matrices. Equation of motion of systems using finite elements, imposing boundary conditions. Problems solving with different systems.

Text Books:

i) "Mechanical Vibrations", S.S Rao; Pearson Publication.

Reference Books:

i) Mechanical Vibrations; Dr. Debabrata Nag; WILLEY INDIA

ii) Mechanical Vibrations; J. S. Mehta & A.S. Kailey. S. Chand Publication

iii) Theory of Vibrations with Applications; William. T. Thomson. Pearson

Course Outcomes

At the end of course, students will be able to

CO-No.	Course Outcome	Module Covered
1	Ability of perform harmonic analysis of systems with Fourier series expansions, frequency domain representations. Analysis of systems under hysteresis damping, coulomb damping and other different types of damping.	1
2	The ability to analyze and solve two degree of freedom systems with or without damping using Transfer function approach, problems using Laplace transforms.	2
3	To develop ability for analyzing response of systems under periodic force of irregular form, non periodic force. Understanding the convolution integral. Understanding the control of vibrations.	3

4	Ability to use different approach, Eigen value problem approach to generate the equation of motion for systems undergoing multidegree of freedom vibration. Understanding and performing Modal Analysis.	4
5	Understanding and analyzing vibration of continuous systems.	5
6	Understanding and performing numerical integration methods in vibration analysis. Develop ability to analyze a vibrating system with Finite Element Methods.	6

CO-PO Mapping (Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO - 1	PSO - 2
CO-1			2	3			2	
CO-2			3	3			2	
CO-3			2	3			3	3
CO-4	3		3	3			2	
CO-5	3		3	3			2	
CO-6	3		3	3			3	3

ADVANCED VIBRATION LABORATORY

Semester: 2nd	Credit: 2					
Course Name: Advanced Vibration Laboratory	**L**	**T**	**P**	0	0	3

Course Objectives:

1) To provide the knowledge about advanced vibration analysis techniques and practical approach to analyze and resolve any problems of vibrating systems.
2) Understanding the approach for Control of systems and ability to analyze a system from its responses.

List of Experiments

Exp 1 Vibration analysis of Beams under different boundary conditions (Free Vibration and Vibration due to Impact)

Exp 2 Frequency analysis of vibrating systems with FFT Analyzer under different loading conditions.

Exp 3 Numerical analysis of the response systems with SCILAB.

Exp 4 Modeling and Designing of Advanced Combination Cams and their response investigation (experimentally/ with CAD model).

Exp 5 Control system designing for an inverted pendulum and modeling with software packages like MATLAB/ SCILAB.

Exp 6 Magnetic levitation analysis and modeling with software packages like MATLAB/ SCILAB.

Exp 7 Vibration analysis of Clamped/ reinforced natural fiber composites after developing the same OR any standard practical problem solving.

Exp 8 Unbalance response analysis of rotating systems with the response of its supports.

Course Outcomes

At the end of course, students will be able to

CO-No.	Course Outcome (4 to 6)	Experiment
1	nalyzing and understanding the responses of continuous systems under different boundary conditions.	1,2,8
2	Ability to use software packages, advanced vibration analysis tools to analyze and understand its responses.	2 - 6
3	Ability to Design Control systems and simulating its responses. Ability to analyze any systems response with numerical approach.	3,5,6
4	Ability to solve any practical problems observed in systems due to vibration, analyzing the vibration characteristics of natural fiber	7,8

	composites to enhance their uses.	

CO-PO Mapping (Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO - 1	PSO - 2
CO-1			3					
CO-2	3		3					
CO-3			3				2	
CO-4	3		3	3	2	2		

MACHINE TOOL LAB

Semester: 2nd Sem	Credit: 2					
Course Name: Machine Tool Lab	**L**	**T**	**P**	0	0	3

Course Objectives:

1) Ability enhancement for the design of various components of structures, guide ways, spindles of machine tools

List of Experiments:

Exp 1: General requirement of Machine tools

Exp 2: Define working and auxiliary motion motion of various machine Tool

Exp 3: Different Mechanism for transforming rotary motion to translator

Exp 4: Write Design procedure of Gear box design

Exp 5: Draw a neat schematic diagram of herringbone gear and Explanation

Exp 6. Speed chart Construction

Course Outcomes

At the end of course, students will be able to

CO-No.	Course Outcome	Exp
1	To gain the knowledge of different drives and mechanisms used in machine tools	1,2
2	To minimize the complexity of the problem	2
3	To gain the knowledge of design of structures	2
4	To gain the knowledge of design of gear boxes & feed boxes used in machine tools	2,4
5	To adopt & implement the recent trends required as per the applications	2,3,4

CO-PO Mapping (Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO - 1	PSO - 2
CO-1	3	2	2	3	2	2	2	2
CO-2	2	2	3	2	2	1	1	1
CO-3	2	2	3	1	2	2	2	2
CO-4	2	2	2	3	1	1	1	2
CO-5	3	1	3	1	2	1	2	1

COMPREHENSIVE VIVA

Semester: 2nd	Credit: 4					
Course Name: Comprehensive Viva	**L**	**T**	**P**	0	0	0

Course Objectives:

1) To assess the overall knowledge of the student in the field of Machine Design domain acquired over one year of study in post graduate program.

Course Outcomes

At the end of the course, students will be able to

CO-No.	Course Outcome
1	Comprehend any given problem / concept related to Machine Design domain.
2	Recall, recognize, visualize, demonstrate, criticize and appraise the concepts related to automotive engineering domain.

CO-PO Mapping (Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2
CO-1	3	3	2	1	2	2	2	2
CO-2	3	2	2	2	1	2	2	2

PROJECT PRELIMINARY

Semester: 2nd	Credit: 6					
Course Name: Project Preliminary	**L**	**T**	**P**	0	0	0

Course Objectives:

1) To provide the opportunities to the student to demonstrate and develop concept/project in the respective Engineering Domain
2) To enable a student to work in cutting edge research problems in harmony.
3) To inculcate the practice of carrying research with ethics and safety.

Course Outcomes

CO-No.	Course Outcome
1	1. Undergo literature survey in the chosen field of research
2	. Approach and identify a research problem and able to analyze the scope of research
3	3. Develop a research methodology to proceed with the research
4	Summarize and Present a technical presentation with proper reference

CO-PO Mapping (Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2
CO-1	2	3	3	2	2	2	2	2
CO-2	3	3	3	2	1	2	2	2
CO-3	3	3	3	2	2	3	2	2
CO-4	2	3	3	1	2	3	2	1

THIRD SEMESTER
PROJECT AND THESIS-I

Semester: 3rd	Credit: 10					
Course Name: Project and Thesis – I	**L**	**T**	**P**	0	0	0

Course Objectives:

1) To provide the opportunities to the student to demonstrate and develop concept/project in the respective Engineering Domain
2) To enable a student to work in cutting edge research problems in harmony.
3) To inculcate the practice of carrying research with ethics and safety.

Course Outcomes

CO-No.	Course Outcome
1	Intensive literature survey and identify the research problems related to Material Science and Engineering.
2	Communicate and discuss research ideas
3	Develop a systematic model/approach to analyze and solve the research problems.
4	Outline the past, present and expected outcome based on systematic survey.
5	Conduct preliminary experiments / theoretical evaluation to certain extent.
6	Summarize their survey, research problem identification, approach, ,expected outcome and attained results with interpretation by means of oral presentation and written reports

CO-PO Mapping (Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2
CO-1	3	3	3	1	2	2	1	2
CO-2	3	2	3	1	2	1	1	1
CO-3	3	3	3	2	3	2	2	2
CO-4	3	3	3	2	3	3	2	1
CO-5	3	3	3	1	2		1	1
CO-6	3	3	3	2	3	1	2	2

FOURTH SEMESTER
PROJECT AND THESIS-II

Semester: 4th	Credit: 20					
Course Name: Project and Thesis-II	**L**	**T**	**P**	0	0	0

Course Objectives:

1) To provide the opportunities to the student to demonstrate and develop concept/project in the respective Engineering Domain
2) To enable a student to work in cutting edge research problems in harmony.
3) To inculcate the practice of carrying research with ethics and safety.

Course Outcomes

CO-No.	Course Outcome
1	Survey, approach, identify and demonstrate the research / industrial problems using various available modern tools and techniques
2	Develop and validate a systematic model/processto analyze and solve the research problems.
3	Outline the past, present and expected performance / outcome of a material / product / process / model / system(s) in Engineering domain in confirmation to the standard of safety and environmental, economic and ethical yardstick.
4	Conduct experiments and theoretical evaluation extensively
5	4. Analyze, summarize, infer based on extensive research and communicate their chosen domain problems and result optimistically by means of oral presentation and written dissertation reports
6	5. Present and publish their findings as technical manuscript in technical conference/ indexed research journals ethically.

CO-PO Mapping (Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2
CO-1	3	2	3	1	1	2	1	2
CO-2	3	2	3	2	2	1	1	1
CO-3	3	3	3	2	3	2	2	3
CO-4	3	2	3	2	3	3	2	2
CO-5	3	3	3	2	2	1	3	2
CO-6	2	3	3	3	3	2	3	3

ELECTIVE- I
ADVANCED MATHEMATICS FOR ENGINEERS

Semester: 1st M. Tech.	Credit: 4					
Course Name: Advanced mathematics for engineers	**L**	**T**	**P**	3	1	0

Course Objectives:

1) Solving optimization problems, boundary value problems viz. Heat equation, Wave equation & mathematical modeling which are very useful in Engineering field.
2) Simulation modeling is used to solve mathematical models based on probabilistic and statistical methods related to real-world problems safely and efficiently.
3) To solve homogeneous, non-homogeneous linear equation & numerical solution of partial differential equation.

Syllabus Content

Module 1:

Calculus of Variations: Variation and its properties, Euler's equation, Conditional extreme, Isoperimetric problems, Functional dependent on first and higher order derivatives, Functional dependent on functions of several independent variables, Some applications-Direct methodsRitz and Kantorovich methods, Eulers finite difference method.

Module 2:

Laplace Transform & Fourier Transform: Applications of fourier transform in solving initial & boundary value problems. Laplace equation, Heat equation & wave equation.

Module 3:

Hankel's Transform: Eliminating properties of Hankel transform, Hankel inversion, and transform theorem, Hankel transform of derivatives of functions, Parsevel's theorem.

Module 4:

Simulation: Types, case studies in various fields using simulation technique, simulation software's used, use of mathematical models based on probabilistic and statistical methods.

Module 5:

Partial Differential Equation: Formation of PDE, Solution of PDE, Equation solvable by direct integration, linear equation of first order, Non-linear equation of first order, Charpit's method, Homogeneous linear equations with constant co-efficient, Non-homogeneous linear equation, Non-linear equation of second order.

Module 6:

Solution of parabolic & Hyperbolic equations: Implicit & Explicit schemes, ADI methods, Nonlinear parabolic equations – iteration method, Solution of elliptic equation-Jaccobi method, Gauss Seidel & SOR method, Ricardson method, RKF4 method, Galarkin's method.

Module 7:

Introduction to finite element method & scope.

Text Books:

i) Calculus of Variations with Applications, Gupta A.S, Prentice Hall India Learning Private Limited.
ii) Stochastic Modeling: Analysis & Simulation, Barry L Nelson, Dover Books on Mathematics.
iii) Advanced Differential Equations, M.D. Raisinghania, S Chand Publishing.
iv) Numerical Analysis, S.A.Mollah, Books & Allied Ltd

Reference Books:

i) Advanced Engineering Mathematics, E. Kreyszig, John Wiley & Sons.
ii) Numerical Methods in Engineering and Science, B. S. Grewal, Khanna Publishers.
iii) Advanced Engineering Mathematics, H. K. Dass, S. Chand Publishing

Course Outcomes

CO-No.	Course Outcome	Module Covered
1	Students will be able to analyze and solve optimization problems in Engineering using different techniques.	**1**
2	Students will be able to solve the boundary value problems viz. Heat equation, wave equation	**2, 3**
3	tudents will learn to analyze and compute mathematical models based on probabilistic and statistical methods	**4, 7**
4	Student can be able to solve homogeneous, non-homogeneous linear equations arising in Engineering problems	**5**
5	tudent can be able to solve the problems of partial differential equation using numerical techniques	**6, 7**

CO-PO Mapping (Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2
CO-1	3	-	2	3	2	-	-	-
CO-2	3	1	1	3	2	-	-	-
CO-3	3	2	2	3	2	-	-	-
CO-4	2	-	1	3	2	-	-	-
CO-5	1	-	1	3	2	-	-	-

SOFT COMPUTING

Semester: 1st Sem	Credit: 4					
Course Name: Soft Computing	**L**	**T**	**P**	3	1	0

Syllabus content

Module 1:

Introduction to Soft Computing, Evolution of Computing ,Soft Computing Constituents , From Conventional Artificial Intelligence to Computational Intelligence, Machine LearningBasics.

Module 2:

Fuzzy sets and Fuzzy logic: Introduction, Fuzzy sets versus crisp sets, operations on fuzzy sets,Extension principle, Fuzzy relations and relation equations, Fuzzy numbers, Linguistic variables, Fuzzy logic, Linguistic hedges, Applications, fuzzy controllers, fuzzy patternrecognition, fuzzy image processing, fuzzy database.

Module 3:

Artificial Neural Network: Introduction, basic models, Hebb's learning, Adaline, Perceptron, Multilayer feed forward network, Back propagation, Different issues regarding convergence ofMultilayer Perceptron, Competitive learning, Self Organizing Feature Maps, AdaptiveResonance Theory, Associative Memories

Module 4:

Evolutionary and Stochastic techniques: Genetic Algorithm (GA), different operators of Genetic Algorithm, Analysis of selection operations, Hypothesis of building Blocks, Schema theorem and convergence of Genetic Algorithm, Simulated annealing and Stochastic models,Boltzmann Machine, Applications. Rough Set: Introduction, Imprecise Categories Approximations and Rough Sets, Reduction on of Knowledge, Decision Tables, and Applications.

Module 5:

Hybrid Systems :Neural,Network,Based Fuzzy Systems, Fuzzy Logic,Based Neural Networks, Genetic Algorithm for Neural Network Design and Learning, Fuzzy Logic and Genetic Algorithm for Optimization,

Text Book

i) Amit Konar, “Computational Intelligence: Principles, Techniques and Applications”, Springer

Reference Books:

i) Mitchell Melanie, “An Introduction to Genetic Algorithm”, Prentice Hall.
ii) David E. Goldberg, “Genetic Algorithms in Search, Optimization and Machine Learning”, Addison Wesley.
iii) S. Haykin, “Neural Networks”, Pearson Education, 2ed.
iv) S. Rajasekaran& G. A. V. Pai , Neural Networks, Fuzzy logic, and Genetic Algorithms, PHI.
v) Fuzzy Sets and Fuzzy Logic, Klir& Yuan, PHI.
vi) Rough Sets, Z. Pawlak, Kluwer Academic Publisher.
vii) Neural Networks, Fuzzy logic, and Genetic Algorithms, S. Rajasekaran and G. A. V. Pai, PHI.
viii) Intelligent Hybrid Systems, D. Ruan, Kluwer Academic Publisher.

Course Outcomes

At the end of course, students will be able to

CO-No.	Course Outcome	Module Covered
1	Develops students' skill in neuro-fuzzy engines to handle machine learning in presence of uncertainty with nature inspired algorithms.	I,IV
2	Provides solution to real world problems with approximate reasoning using fuzzy logic.	II, III,V
3	Instills the scope of optimization in engineering design using evolutionary computation.	VI,VII
4	Demonstrates the scope of the subject in all aspects of science, humanities and engineering.	VIII
5	Emphasizes the necessity of soft techniques in engineering industry, where mathematically hard techniques are difficult to realize in absence of sufficient data.	IX,XI
6	Understanding the deep learning and processing high dimensional data	X

CO-PO Mapping (Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO - 1	PSO - 2
CO-1	1	2	1	1	1	1	1	1
CO-2	2	2	1	2		2	2	2
CO-3	2	2	2	2	1	1	2	2
CO-4	2	3	2	3	1	1	2	2
CO-5	3	3	3	1	1	1	2	1
CO-6	2	3	3	2	1	2	2	2

ARTIFICIAL INTELLIGENCE

Semester: 1st Sem	Credit: 4					
Course Name: Artificial Intelligence	**L**	**T**	**P**	3	1	0

Syllabus Content

Module 1:

Introduction to AI and intelligent agents, Problem Solving: Solving Problems by Searching, heuristic search techniques, constraint satisfaction problems, stochastic search methods, Game playing: min max, alpha beta pruning, Knowledge and Reasoning: Building a Knowledge Base: Propositional logic, first order Logic, situation calculus, Theorem Proving in First Order Logic.

Module 2:

Uncertain Knowledge and Reasoning, Overview of Probability Theory, Bayes Networks, Undirected Graphical Models, Template Based Representations, Exact Inference: Variable Elimination, Clique Trees, Belief Propagation, Tree Construction, Baye's Theorem, Dempster- Shafer theory of evidence.

Module 3:

Introduction to Optimization, Approximate Inference: Sampling, Markov Chains, Maximum A posteriori Probability (MAP) Inference, Inference in Temporal Models, Introduction to learning graphical models, Parameter Estimation, Bayesian Networks and Shared Parameters.

Module 4:

Learning: Overview of different forms of learning, Learning Decision Trees, EM, Hidden Variables, Decision Problems, Neural Networks, ANN, McCulloch Pitts Model, Perceptron Network.

Module 5:

Statistical learning methods, k-nearest neighbor algorithm, Naïve Bayes classifier, Introduction to Natural Language Processing.

Module 6:

Fuzzy Logic: operations of Fuzzy sets, Variables inference techniques, defuzzification techniques, basic Fuzzy interference algorithm, application of fuzzy logic , Fuzzy system design implementation.

Text book:

i) Artificial Intelligence and Soft Computing by Amit Konar, CRC Press, Taylor and Francis

ii) Artificial Intelligence: A Modern Approach by S.Russell and P. Norvig.

Reference Books:

i) Nils J. Nilsson, Artificial Intelligence: A New Sythesis, Morgan,Kaufmann.

ii) Probabilistic Graphical Models, by Daphne Koller and Nir Friedman, MIT Press.

iii) References:

iv) Neural Network Design, Hagan, Demuth and Beale, Vikas PublishingHouse

v) Fundamentals of Artificial Neural Networks, Mohamad H Hassoum.PHI

vi) Fuzzy Set Theory & its Applica tion, H.J. Zimmerman Allied PublishedLtd.

Course Outcomes

At the end of course, students will be able to

CO-No.	Course Outcome	Module Covered
1	Solve basic AI based problems and construct logical building blocks for problem formulation.	I,II
2	Acquaint with Knowledge Representation and decision under uncordiality.	II, III
3	Apply Optimization and inferencing with available knowledge.	III
4	Pragmatic approach of Machine learning and fuzzy knowledge representation.	III,IV,VI
5	Apply AI techniques to real-world problems to develop intelligent systems.	IV,V
6	Select appropriately from a range of techniques when implementing intelligent system	V

CO-PO Mapping (Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO - 1	PSO - 2
CO-1	1	1	1	1	1	1	1	1
CO-2	2	2	1	2	2	2	2	2
CO-3	2	2	2	2	1	1	2	3
CO-4	2	3	2	3	1	1	2	3
CO-5	3	3	3	1	1	1	2	1
CO-6	3	3	3	2	2	2	3	2

ELECTIVE II
FINITE ELEMENT METHODS

Semester: 1st	Credit: 4					
Course Name: Finite Element Methods	**L**	**T**	**P**	3	1	0

Course Objectives:

1) Enable the student to analyze the engineering problems in the design process of solids and their structure.
2) Make the students to apply the knowledge of mathematics, science and engineering to do the analysis of simple and complex elastic structures using the finite element analysis
3) Derive the finite element equations for different mechanical elements.
4) Learn and apply finite element solutions to structural, thermal, dynamic problem to develop the knowledge and skills needed to effectively evaluate finite element analysis.

Syllabus Content

Module 1:

Introduction to FEM, basic concepts, historical back ground, applications of FEM, general description, comparison of FEM with other methods, variational approach, Glerkin's Methods. Co-ordinates, basic element shapes, interpolation function, Virtual energy principle, Rayleigh – Ritz method, properties of stiffness matrix, treatment of boundary conditions, solution of system of equations, shape functions and characteristics, Basic equations of elasticity, strain- displacement relations.

Module 2:

1-D Structural Problems: Axial bar element – stiffness matrix, load vector, temperature effects, Quadratic shape functions and problems. Analysis of Trusses: Plane Trusses and Space Truss elements and problems, Hermite shape functions **–** stiffness matrix – Load vector – Problems.

Module 3:

2-D Problems: CST, LST, force terms, Stiffness matrix and load vectors, boundary conditions, Isoparametric elements – quadrilateral element, shape functions – Numerical Integration. Finite element modeling of Axi-symmetric solids subjected to Axi-symmetric loading with triangular elements. 3-D Problems: Tetrahedran element – Jacobian matrix – Stiffness matrix.

Module 4:

Steady state heat transfer: One dimensional heat conduction, Boundary condition, One dimensional element, Functional approach for heat conduction, ,Galarkins approach for heat conduction, One dimensional heat transfer in thin Fins, Two dimensional steady state heat conduction.

Module 5:

Scalar Field Problems: 1-D Heat conduction-Slabs – fins – 2-D heat conduction problems – Introduction to Torsional problems. Dynamic considerations, Dynamic equations – consistent mass matrix – Eigen Values, Eigen vector, natural frequencies – mode shapes –

modal analysis**.**

Text Books:

i) Finite Element Methods: Basic Concepts and applications, Alavala, PHI.

ii) Introduction to Finite Elements in Engineering, Chandrupatla, Ashok and Belegundu, Prentice – Hall

Reference Books:

i) Concepts and Application of Finite Elements Analysis, Cook, Malkus and Plesha, Wiley.

ii) Bathe K.J., "Finite Element Procedures in Engineering Analysis", Prentice Hall of India

iii**)**O.C.Zienkiewicz, R.L.Taylor & J.Z.Zhu, "The Finite Element Method its Basis and Fundamentals", Butterworth-Heinemann,Elsevier

iv) Finite Element Method, J N Reddy, McGraw Hill International Edition.

Course Outcomes

At the end of course, students will be able to

CO-No.	Course Outcome	Module Covered
1	Apply and understand the basic concepts of Finite element analysis procedure.	1, 2, 3 , 4
2	Analyze and build FEA model for complex engineering problems.	5
3	Knowledge of mathematics and engineering in solving the problems related to structural and heat transfer	4, 5
4	Develop element characteristic equation and generation of global equation	1, 2, 3, 4
5	Identify the application and characteristics of FEA elements such as bars, beams, plane and isoparametric elements	2, 3
6	Use the commercial FEA packages like ANSYS for solving real life structural thermal, dynamic problems etc.	5

CO-PO Mapping (Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO - 1	PSO - 2
CO-1	3	3	3	3	3	3	3	3
CO-2	3	3	2	3	2	3	2	1
CO-3	3	3	3	3	3	2	1	1
CO-4	2	2	3	3	2	3	2	2
CO-5	3	2	3	3	3	3	1	1

EXPERIMENTAL STRESS ANALYSIS FOR DESIGN

Semester: 1st	Credit: 4					
Course Name: Experimental Stress Analysis for Design	**L**	**T**	**P**	3	1	0

COURSE OBJECTIVES:

1. To understand the science behind working of a strain gauge.
2. To Understanding the practical applications of a strain gauge.
3. To understand the calibration ofstrain gauges.
4. To study the importance of different Non-Destructive Testing**.**

Course Content

Module 1:

INTRODUCTION AND STRAIN MEASUREMENT METHODS: Strain gauge, principle, types, performance and uses-Moire Fringe - Hydraulic jacks and pressure gauges –load cells – Proving Rings –Calibration of Testing Machine.

Module 2:

ELECTRICAL RESISTANCE STRAIN GAUGES**:** Introduction – gauge construction – strain gauge adhesives - mounting methods – gauge sensitivities and gage factor – performance characteristics of wire and foil strain gauges – environmental effects - Analysis of strain gauge data – the three-element rectangular rosette – the delta rosette – correction for transverse sensitivity.

Module 3:

NON – DESTRUCTIVE TESTING: Load testing on structures, buildings, bridges and towers – Rebound Hammer – acoustic emission –ultrasonic testing principles and application– Holography – use of laser for structural testing – Brittle coating

Module 4:

PHOTO ELASTICITY: Introduction – the stress optic law – effects of stressed model in apolariscope for various arrangements - Fringe Multiplication with Partial Mirrors.

Module 5:

EXPERIMENTS IN MATERIAL TESTING: Introduction - To Plot a Graph Between Actual Stress and Actual Strain for a Sample Under Tension Using UTM - Buckling Test on Columns Using UTM - Determination of Shear Centre of a Channel Section - Creep Test - Fatigue Test - Determination of Young's Modulus and Poisson's Ratio - Determination of Shear Modulus - Calibration of a Proving Ring - Calibration of a Photo elastic Model for Stress Fringe

Text Books:

1. Srinath,L.S. M.R. Raghavan, K. Lingaiah, G. Gargesa, B. Pant, and K.

Ramachandra, "Experimental Stress Analysis", Tata McGraw Hill,1984.
2. Sirohi,R.S. Radhakrishna,H.C. "Mechanical Measurements", New Age International (P) Ltd. 1997
3. BrayD.E. &StanleyR. K, "Non-destructive Evaluation", McGraw Hill Publishing Company, N.Y.1989

References Books:

1. K. Ramesh, Digital Photoelasticity – Advanced Techniques and Applications,Springer,2000.
2. George Hamor Lee, "An Introduction Experimental Stress Analysis", John Wiley & Sons Publishers,1950.
3. Alessandro Freddi, "Experimental Stress Analysis for materials and structures", Springer

Course Outcomes

At the end of course, students will be able to

CO's	Course Outcomes	Module Covered
1	To understand the mechanical properties of strain gauges andapplications	1
2	To understand the design and performance of strain gauges	1,2
3	To understand the methods of Non-Destructive testing	3
4	To understand the methods of photo elasticity and models	4
5	To have a brief idea regarding experiments in material testing.	5

CO-PO Mapping (Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO - 1	PSO - 2
CO-1	2	2	1	1	2	1	2	2
CO-2	2	2	2	2	2	2	2	2
CO-3	3	2	2	3	2	1	3	2
CO-4	3	2	3	3	2	1	3	2
CO-5	3	2	2	1	2	1	1	1
CO-6	3	2	2	2	2	2	2	2

ADVANCED MECHANICS OF SOLID

Semester: 1st	Credit: 4					
Course Name: Advanced Mechanics of Solid	**L**	**T**	**P**	3	1	0

Course Objectives:

1. To impart concepts of stress and strain tensor.
2. To study the basic solution methods in theory of elasticity.
3. To familiarize with solution of axisymmetric problems in elasticity and solution of advanced bending problems.
4. To familiarize the solution of torsion problem of non circular bars.

Syllabus Content

Module 1: Introduction to stress analysis in elastic solids - stress at a point – stress tensor – stress components in rectangular and polar coordinate systems - Cauchy‟s equations – stress transformation – principal stresses and planes - hydrostatic and deviatoric stress components, octahedral shear stress - equations of equilibrium Displacement field – engineering strain - strain tensor (basics only)

Module 2: Constitutive equations – generalized Hooke‟s law – equations for linear elastic isotropic solids - relation among elastic constants – Boundary conditions – St. Venant‟s principle for end effects – uniqueness theorem 2-D problems in elasticity - Plane stress and plane strain problems – stress compatibility equation - Airy‟s stress function and equation

Module 3: Equations in polar coordinates (2D) – equilibrium equations, strain-displacement relations, Airy‟s equation, stress function and stress components , Application of stress function to Lame‟s problem and stress concentration problem of a small hole in a large plate (only stress distribution) Axisymmetric problems – governing equations

Module 4: Strain energy of deformation – special cases of a body subjected to concentrated loads, moment or torque - reciprocal relation – strain energy of a bar subjected to axial force, shear force, bending moment and torque

Module 5: Castigliano‟s first and second theorems – virtual work principle – minimum potential energy theorem. Torsion of non-circular bars: Saint Venant‟s theory - solutions for circular and elliptical cross-sections

Module 6: Prandtl‟s method - solutions for circular and elliptical cross-sections - membrane analogy. Torsion of thin walled tubes, thin rectangular sections, rolled sections and multiply connected sections

Text Books:

1. L. S. Sreenath, Advanced Mechanics of Solids, McGraw Hill,2008

2. S. M. A. Kazimi, Solid Mechanics, McGraw Hill,2008

3. S. Jose, Advanced Mechanics of Materials, Pentagon Educational Services,20

Reference Books:

1. U. Saravanan, Advanced Solid Mechanics, NPTEL

2. S. Anil Lal, Advanced Mechanics of Solids, Siva Publications and Distributions, 2017.

3. S. P. Timoshenko, J. N. Goodier, Theory of elasticity, McGraw Hill,1970

4. R.J. Atkin, and N. Fox, An introduction the theory of elasticity, Longman,1

Course Outcomes:

CO-No.	Course Outcome At the end of course, student should able to	Module Covered
1	udents will be able to solve problems in elasticity using fundamental equations viz., equilibrium equation, strain displacement relations, compatibility conditions and stress – strain relations.	**1**
2	udents will be able to Identify the principal planes corresponding to each principal stress/strain.	**2**
3	Students will be able to demonstrate the procedure for solving 2-D problems in elasticity.	**2**
4	Students will be able to compute hoop stress, radial stress and radial displacement for thick cylinders subjected to internal and external pressure and rotating discs.	**3**
5	Students will be able to comprehend the usage of energy methods for solving structural problems. Energy principles like Castigliano‟s theorem, principle of virtual work etc. for solving simple problems	**4**
6	Students will be able to Solve problem on torsion of noncircular shafts including solid bars, thin walled tubes, rectangular sections, rolled sections and multiply connected sections. The nature of stress developed in circular shaft and non circular shafts	**5,6**

CO-PO Mapping (Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2
CO-1	1	2	2	1	1	1	1	1
CO-2	2	1	3	2	1	1	3	2
CO-3	2	1	3	2	1	1	1	2
CO-4	2	1	3	2	1	1	1	2
CO-5	1	1	2	1	2	3	1	1
CO-6	3	2	2	1	1	2	1	1

ELECTIVE - III
ROBOTICS

Semester: 2nd Sem	Credit: 4					
Course Name: Robotics	**L**	**T**	**P**	3	1	0

Course Objectives:

1) Application of Robot and automation process in fabrication and production entangling design/selection process.

Syllabus content

Module 1:

Introduction: Automation & robotics, Robotic System & Anatomy Classification, Future Prospects

Module 2:

Robotic Application in Manufacturing: Material transfer, Machine loading & unloading, Processing operations, Assembly & Inspectors

Module 3:

Social Issues and Economics of robotics Drives: Control Loops, Basic Control System Concepts & Models, Control System Analysis, Robot Activation & Feedback Components, Position & Velocity Sensors, Actuators , Power Transmission Systems.

Module 4:

Robot &its Peripherals: End Effecters - types, Mechanical & other grippers, Tool as end effecter

Module 4:

Sensors: Sensors in Robotics, Tactile Sensors, Proximity & Range Sensors, Sensor Based Systems

Module 5:

Robotic Cell Design & Control. Robot Kinematics: Coordinate Frames, Rotations, Homogeneous Coordinates, Arm Equation of Planer Robot, Four axis SCARA Robot, TCV, Inverse Kinematics of Planer Robot, Four Axis SCARA Robot.

Module 6:

Trajectory Planning & Robot Dynamics: Manipulator Path Control- Linear, Quadratic and Cubic Interpolation, Work Space Analysis, Robot Dynamics –Langrangian Dynamics of one and two link robot arm

Module 7:

Machine Vision: Introduction, Low level & High level vision, Sensing & Digitizing, Image processing & analysis, Segmentation, Edge detection, Object description & recognition, Interpretation, Noises in Image, Applications

Module 8:

Programming For Robots: Methods, Robot programmed as a path in space, Motion interpolation, level & task level languages, Robot languages; Programming in suitable languages Characteristics of robot

Text Books:

i) Yorem Koren, "Robotics for Engineers"
ii) J. F. Engelberger, "Robotics in Practice"
iii) Ulrich Rembolds, ChristialBlume, "Computer Integrated Manufacturing Technology and Systems"

References Books:

i) Beckwith and Lewisbuck, "Mechanical Measurements"
ii) K. Ogata,"Modern Control Engineering",PHI
iii) Benjamin Kuo, "Automatic Control Systems", Wiley India
iv) Richard D. KIafter et al, "Robotic Engineering -an Integrated Approach", PHI
v) Spyros G. Tzafestas, "Intelligent Robotic Systems"
vi) Ramamurthy, "Computer Aided Design in Mechanical Engineering"

Course Outcomes

At the end of course, students will be able to

CO-No.	Course Outcome	Module Covered
1	Learning about robots types and application in industry.	1, 2
2	To study the economics and social issues in robot applications.	3
3	To study the end effectors and sensors of robots, robot visions.	4, 5, 8
4	To study the robot manipulator's kinematics and dynamics.	6, 7
	To study the manufacturing cell, a step towards production.	6
	Designing of pathways and programing of robots.	7, 9
	Learning about robots types and application in industry.	1, 2

CO-PO Mapping (Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO - 1	PSO - 2
CO-1	1	3	2	3	1	3	1	1
CO-2	3	3	3	3	2	3	3	3
CO-3	3	3	3	3	3	3	3	2
CO-4	3	2	3	3	3	2	3	3
CO-5	2	3	2	3	*2*	3	3	3
CO-6	3	2	3	2	3	3	3	3

TRIBOLOGICAL SYSTEM DESIGN

Semester: 2nd	Credit: 4					
Course Name: Tribological System Design	**L**	**T**	**P**	3	1	0

Course Objectives:

1) To of Tribology in Design of machine components.
2) To select proper grade lubricant for specific application.
3) To adequate knowledge to understand the principles of lubrication, lubrication regimes.
4) To provide the concept of surface engineering and its importance in tribology.

Syllabus Contents

Module 1:

Friction, theories of friction, Friction control, contact of surfaces, stick-slip phenomenon.

Module 2:

Wear, types of wear, theories of wear, wear prevention.

Module 3:

Surface Texture and Interactions, Geometric characterization of surfaces, Surface parameters, Measurement of surface texture, Measurement of surface flatness, Statistical descriptions, Contact between surfaces, Lubrication regime relation to surface roughness, Bearing Materials, Distinctive selection factors, Oil-film bearing materials, Dry and semi-lubricated bearing materials, Air bearing materials, High-temperature materials, Rolling bearing materials.

Module 4:

Lubricants and Lubrication, Mineral oils, Synthetic oils, Viscosity, Density and compressibility, Thermal Properties, Oil life, Greases, Solid lubricants, Lubricant supply methods.

Module 5:

Reynolds's equation and its limitations, idealized bearings, infinitely long pivoted and fixed slider shoe bearings, Infinitely long, short (narrow) and finite journal bearings, lightly loaded infinitely long journal bearing (Petroff's solution), Design of hydrodynamic journal and slider-shoe bearings, Air lubricated bearings,, Squeeze film Circular and rectangular flat plates,

Module 6:

Hydrostatic Bearings, Types and configurations, Circular step thrust bearings, Design procedure for compensated bearings, Hydraulic lift, Rolling Element Bearings, Ball bearing types, Roller bearing types, Thrust bearing types, Load–life relations, Adjusted rating life, Static load capacity.

Text Book:

i) Engineering Tribology– Prasanta Sahoo – Prentice Hall of India Pvt. Ltd., New Delhi, 2005.

ii) Fundamentals of Tribology – S.K. Basu, S.N. Sengupta, B.B. Ahuja – PHI Learning Pvt. Ltd., 2010.

iii) Tribology in Industries – S.K. Shrivastava – S. Chand & Company Ltd., New Delhi, 2001

iv) Bearing Design in Machinery, Engineering Tribology and Lubrication - A. Harnoy-Marcel Dekker Inc., 2003

References Books:

i) Principles in Tribology, Edited by J. Halling, 1975

ii) Fundamentals of Fluid Film Lubrication – B. J. Hamrock, McGraw Hill International,1994

iii) Cameron, "Basic Lubrication Theory", Ellis Horwood Ltd, 1981.

iv) D.D. Fuller, "Theory and Practice of Lubrication for Engineers", John Wiley and Sons, 1984.

v) "Fundamentals of Friction and wear of Materials" American Society of Metals.

vi) Introduction to Tribology of Bearings –B. C. Majumdar, A. H. Wheeler & co. pvt. ltd 1985.

vii) T.A. Stolarski, "Tribology in Machine Design".

Course Outcomes

At the end of course, students will be able to

CO-No.	Course Outcome	Module Covered
1	Apply different theories of friction and wear to various practical applications	1,2
2	Understand the various surface measurement techniques and effect of surface roughness on Tribology.	3
3	Select lubricants suitable for particular materials and to suggest a tribological solution to a particular situation	4,5
4	Design different types of bearing	5,6
5	Up-to-date with the recent developments and understand modern research material.	5,6

CO – PO mapping (Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO - 1	PSO - 2
CO-1	**2**	**2**	**1**	**1**	2	**1**	2	2
CO-2	**2**	**2**	**2**	**2**	2	**2**	**2**	**2**
CO-3	**3**	2	**3**	**3**	2	**1**	**3**	**2**
CO-4	**3**	2	**3**	**3**	2	**1**	**3**	**2**
CO-5	**1**	**2**	**1**	**1**	2	**1**	**1**	**1**
CO-6	**2**	**2**	**2**	**2**	2	**2**	**2**	**2**

ROBOTICS AND AUTOMATION

Semester: 2nd Sem	Credit: 4					
Course Name: Robotics and Automation	**L**	**T**	**P**	3	1	0

Syllabus content

Module I

Robotics Foundations: Kinematics , Dynamics , Mechanisms and Actuation , Sensing and Estimation , Motion Planning , Motion Control , Force Control , Robotic Systems Architectures and Programming , AI Reasoning Methods for Robotics.

Module II

Robot Structures: Performance Evaluation and Design Criteria , Redundant Manipulators Parallel Mechanisms and Robots , Robots with Flexible Elements , Model Identification , Robot Hands , Legged Robots , Wheeled Robots , Micro/Nano Robots.

Module III

Sensing and Perception: Force and Tactile Sensors , Inertial Sensors, GPS and Odometry, Sonar Sensing , Range Sensors , 3D Vision and Recognition , Visual Servoing and Visual Tracking , Sensor Fusion.

Module IV

Manipulation and Interfaces: Motion for Manipulation Tasks , Modelling and Manipulation , Grasping , Cooperative Manipulators, Haptics, Telerobotics, Networked Teleoperation, Exoskeletons for Human Performance Augmentation.

Module V

Mobile and Distributed Robotics: Motion Control of Wheeled Mobile Robots , Motion Planning and Obstacle Avoidance , World Modeling , Simultaneous Localization and Mapping , Behavior Based Systems , Distributed and Cellular Robots , Multiple Mobile Robot Systems , Networked Robots.

Module VI

Field and Service Robotics: Industrial Robotics, Underwater Robotics, Aerial Robotics, Space Robots and Systems, Robotics in Agriculture and Forestry, Robotics in Construction, Robotics in Hazardous Applications, Mining Robotics , Search and Rescue Robotics, Intelligent Vehicles, Medical Robots and Systems, Rehabilitation and Health Care Robotics , Domestic Robots, Robots for Education.

Module VII

Human-Centered and Life Like Robotics: Humanoids , Safety for Physical Human Robot Interaction , Social Robots that Interact with People , Robot Programming by Demonstration

, Biologically, Inspired Robots , Evolutionary Robotics, Neurorobotics: From Vision to Action Perceptual Robotics, Roboethics: Social and Ethical Implications.

Text Books:

i) Introduction to Robotics: Mechanics & Control, 3ed, J. Craig, Prentice Hall, 2004.
ii) Robot Modeling and Control, M. Spong, S. Hutchinson, M. Vidyasagar, Wiley, 2005.

References Books:

i) Fundamentals of Robotics: Analysis and Control, Robert J. Schilling, Prentice Hall, 1990.
ii) Theory of Applied Robotics 2nd Ed., R. Jazar, Springer, 2010.

Course Outcomes

At the end of course, students will be able to

CO-No.	Course Outcome	Module Covered
1	Introduction to kinematics and basic construction of Robotics concept.	I
2	Learners will know about structural and design criteria of robot construction with ethical application.	II
3	An introduction to Perception - actuator sequence with environmental variation and haptic manipulation.	III
4	Introduction to mobile robot with AGV and UGV.	IV,V
5	Field application of robotics including agricultural and service sector.	V
6	Human robot interaction and visual perception for surround localization and mapping.	V,VI

CO-PO Mapping (Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO - 1	PSO - 2
CO-1	1	2	1	1	2	1	2	1
CO-2	2	2	2	2	2	2	2	2
CO-3	3	3	2	1	1	1	1	2
CO-4	3	3	3	1	1	1	1	2
CO-5	2	2	3	1	1	1	1	2
CO-6	2	2	3	2	2	3	2	3

APPLIED COMPUTATIONAL METHOD

Semester: 2nd Semester	Credit: 4					
Course Name: Applied Computational Method	**L**	**T**	**P**	3	1	0

Course Objectives:

1) Students will learn the theory underlying the derivation of standard numerical techniques and the development of algorithm
2) Students will demonstrate aptitude in standard numerical techniques for solving various classes of problems.

Syllabus Content

Module1:

Introduction to numerical methods applied to engineering problems: Examples, solving sets of equations – Matrix notation – Determinants and inversion – Iterative methods – Relaxation methods – System of linear algebraic equations and Eigen value problems: elimination method, Gauss method, Gauss-Jordan method; Eigen values and Eigen vectors, System of non-linear equations – computer programs.

Module2:

Numerical differentiation and integration: differentiation of continuous functions, forward difference quotient, central difference quotient, error analysis; derivatives from differences table, higher-order derivatives, Richardson extrapolation techniques, Newton-Cotes method, trapezoidal rule, Simpson's rule, higher order rules, Romberg integration. Numerical solution of ordinary differential equations: Taylor's series method, Euler and modified Euler method, Runge-Kutta methods.

Module3:

Numerical solutions of partial differential equations: Laplace's equations – Representations as a difference equation – Iterative methods for Laplace's equations – poisson equation – Examples – Derivative boundary conditions – Irregular and non – rectangular grids – Matrix patterns, sparseness – ADI method – Finite element method

Module4:

Parabolic partial differential equations: Explicit method – Crank-Nickelson method – Derivative boundary condition – Stability and convergence criteria – Finite element for heat flow – computer programs. **Hyperbolic partial differential equations**: Solving wave equation by finite differences stability of numerical method –method of characteristics-wave equation in two space dimensions-computer programs.

Module5:

Optimization: basic concept of optimization, classification of optimization, optimization techniques, engineering applications of optimization. Classical optimization techniques: unconstrained optimization single-variable optimization, multivariable optimization,

multivariable optimization, multivariable optimization with equality constraints: solution by direct search method, solution by Lagrange-multipliers method, multivariable optimization with inequality constraints

Module6:

Boundary value problems and characteristic value problems: Shooting method – Solution through a set of equations – Derivative boundary conditions – Rayleigh – Ritz method – Characteristic value problems. **Curve fitting and approximation of functions**: Least square approximation fitting of non-linear curves by least squares –regression analysis-multiple linear regressions, non linear regression - computer programs.

Text Books:

i) "Numerical Methods for Engineers", Steven C.Chapra, Raymond P.Canale Tata McGraw hill

ii) "Applied numerical analysis", Curtis F.Gerald, partick.O.WheatlyAddison-wesley,1989

Reference Books:

i) "Numerical methods", Douglas J..Faires, Riched Burden Brooks/cole publishing company, 1998.Second edition.

ii) "Numerical mathematics and computing", Ward cheney &David Kincaid Brooks/Cole publishing company1999,fourth edition.

iii) "Mathematical methods for physics and engineering"Riley K.F.M.P.Hobson.&.Bence S. J. Cambridge university press,1999.

iv) "Engineering Optimization", by SS Rao; New Age International Ltd.

v) "Numerical Method", by E. Balaguruswamy; Tata McGraw Hill.

vi) "Numerical methods for Scientific & Engineering Computation", by MK Jain, SRK Iyengar and RK Jain; New Age International Ltd.

Course Outcomes

CO-No.	Course Outcome	Module Covered
1	Apply numerical methods to find our solution of algebraic equations using different methods under different conditions, and numerical solution of system of algebraic equations.	**1 to 6**
2	Work out numerical differentiation and integration whenever and wherever routine methods are not applicable	**2**
3	Apply various interpolation methods and finite difference concepts	**1 &2**
4	Work numerically on the ordinary and Partial differential equations using different methods through the theory of finite differences.	**3 & 4**

5	Apply the concepts of optimization, Boundary value problems, Curve fitting and approximation of functions in various engineering problems.	**5 & 6**
6	To develop a practical approach to various critical distinct mathematical problem solving in the field of machine design domain	**1 to 6**

CO-PO Mapping (Rate: scale of 1 to 3)

Course Outcome	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PSO - 1**	**PSO - 2**
CO-1	3	2	3	2	1	2	2	1
CO-2	3	3	2	1	1	3	2	1
CO-3	3	2	3	2	1	2	1	2
CO-4	3	3	2	1	2	2	2	2
CO-5	2	3	3	2	1	1	2	1
CO-6	3	2	3	2	1	2	2	1

DESIGN OPTIMIZATION

Semester: 2nd	Credit: 4					
Course Name: Design Optimization	**L**	**T**	**P**	3	1	0

Course Objectives:

1) To learn Optimal Design Problem Formulation
2) To learn optimization methods and their application for finding optimum solution

Syllabus Content

Module 1:

Introduction- Optimal design problem formulation, design variables, constraints, objective function, variable bounds, Concept of duality, design optimization problems

Module 2:

Single Variable Optimization- Optimality Criteria, Bracketing methods, Direct search methods, Gradient based methods, Applications.

Module 3:

Multivariable Unconstrained Optimization- Optimality Criteria, Direct search methods, Gradient based methods, Applications

Module 4:

Constrained Optimization- Optimality Criteria, Transformation methods, Direct search methods, Gradient based methods, Applications

Module 5:

Linear Programming Problems- Linear programming, simplex method and Duality in linear programming, sensitivity or post-optimality analysis, Applications

Module 6:

Non-traditional methods-Evolutionary Optimization methods, Genetic Algorithm, Simulated Annealing, etc. Introduction to Multi-objective optimization, Applications.

Text Books:

i) Kalyanmoy Deb, "Optimization for Engineering Design", Prentice Hall of India, New Delhi

ii) J. S. Arora, "Introduction to Optimum Design", McGraw Hill, New York

iii) Kalyanmoy Deb,"Evolutionary multi-objective optimization, Willey, New York

Reference Books:

i) L.C.W. Dixon, "Non-Linear Optimization - Theory and Algorithms", Birkhauser, Boston

ii) G.B. Dantzig, "Linear Programming and Extensions Princeton University Press", Princeton, N. J.

iii) R.C. Johnson, "Optimum Design of Mechanical Elements", Willey, New York

Course Outcomes

At the end of course, students will be able to

CO-No.	Course Outcome	Module Covered
1	Formulate an optimum design problem	1
2	Solve single and multivariable optimization problems	2, 3
3	Apply appropriate algorithm for constraint optimization	4
4	Solve linear programming problems	5
5	ind the optimum solution using nontraditional optimization techniques	6

CO-PO Mapping (Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO - 1	PSO - 2
CO-1	3	2	3					
CO-2	3	2	3					
CO-3	3	2	3					
CO-4	3	2	3					
CO-5	3	2	3					
CO-6	3	2	3					

ELECTIVE - IV

FRACTURE MECHANICS

Semester: 2nd	Credit: 4					
Course Name: Fracture Mechanics	**L**	**T**	**P**	3	1	0

Course Objectives:

3) To introduce the concept of failure due the existing flaws.
4) To provide knowledge on fundamental theories of fracture mechanics and their uses in engineering design.
5) To make the students enable for determining the chances of failure due to fracture.

Syllabus Content

Module 1:

Introduction- A Crack in Structure, Fracture Toughness, Micro and Macro Phenomena of Fracture, Microscopic Aspects: Surface Energy, Theoretical Strength, Microstructure and Defects, Crack Formation, Macroscopic Aspects: Crack Growth, Types of Fracture, Mechanisms of Fracture and Crack Growth, Cleavage Fracture, Ductile Fracture, Fatigue Cracking, Environment Assisted, Cracking, Creep Fracture, Service Failure Analysis

Module 2:

Crack Growth Based on Energy Balance- Energy Balance During Crack Growth, Griffith Theory, Graphical Representation of the Energy Balance Equation, Equivalence between Strain Energy Release Rate and Stress Intensity Factor, Compliance, Crack Stability

Module 3:

Linear Elastic Stress Fields in Cracked Bodies- Crack Deformation Modes and Basic Concepts, Westergaard's Method, Singular Stress and Displacement Fields, Stress Intensity Factor Solutions, Three-Dimensional Cracks

Module 4:

Linear Elastic-Plastic Stress Fields in Cracked Bodies- Approximate Determination of the Crack-Tip Plastic Zone, Irwin's Model, Dugdale's Model

Module 5:

Fracture Criteria- Critical Stress Intensity Factor Fracture Criterion, J-Integral and Crack Opening Displacement Fracture Criteria, Strain Energy Density Failure Criterion: Mixed-Mode Crack Growth

Module 6:

Dynamic Fracture- Mott's Model, Stress Field around a Rapidly Propagating Crack, Strain

Energy Release Rate, Crack Branching, Crack Arrest, Experimental Determination of Crack Velocity and Dynamic Stress Intensity Factor.

Module 7:

Fatigue Fracture and Environment-Assisted Fracture- Fatigue Fracture, Terminology, S-N Curve, Crack Initiation, Crack Propagation, Effect of an overload, Crack Closure, Variable Amplitude Fracture Load, Micromechanisms, Test Methods, Major Factors Influencing Environment-assisted Fracture, Liquid Metal Embrittlement, Design Considerations

Module 8:

Crack Detection Methods- Dye Penetration, Magnetic Particles, Eddy Current, Radiography, Ultrasonics, Acoustic Emission

Text Books:

i) Prashant Kumar, Elements of Fracture Mechanics, Tata McGraw Hill, New Delhi, India.

Reference Books:

i. E.E. Gdoutos, "Fracture Mechanics - An Introduction", Springer
ii. D. Gross and T. Seelig, "Fracture Mechanics - With an Introduction to Micromechanics", Springer
iii. D. Broek, "Elementary Engineering Fracture Mechanics", MartinusNijhoff Publishers
iv. R.W. Hertzberg, "Deformation and Fracture Mechanics of Engineering Materials" John Wiley& Sons, Inc.

Course Outcomes

At the end of course, students will be able to

CO-No.	Course Outcome	Module Covered
1	Understand the theory, concepts and principles of fracture mechanics.	1, 6
2	Analyze crack growth using energy Balance approach	2
3	Determine the stress and displacement fields around the crack tip using the concept of stress intensity factor	3, 4
4	Use of J-Integral for finding stress and strain around the crack tip.	5
5	Understand the cause of fracture failure.	7
6	Use of different nondestructive testing in crack detection.	8

CO-PO Mapping (Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2
CO-1	1	1	2	1	1	1	1	1
CO-2	2	1	3	3	1	1	3	2
CO-3	2	1	3	3	1	1	3	2
CO-4	2	1	3	3	1	1	3	2
CO-5	1	1	2	1	2	3	2	1
CO-6	3	1	2	1	1	2	2	1

MECHANICS OF COMPOSITE MATERIALS

Semester: 2nd	Credit: **4**					
Course Name: Mechanics of Composite Materials	**L**	**T**	**P**	3	1	0

Course Objectives:

1. Understanding different types of composites, advantages and disadvantages, classifications, and Introduce terminology used for studying mechanics of composites.
2. Developing concepts about about the manufacturing process of different composites. Understanding different material properties of laminated composites.
3. Developing stress-strain relationships, Develop stress-strain relationships for a unidirectional/bidirectional lamina, finding the engineering constants of a unidirectional/bidirectional lamina in terms of the stiffness and compliance parameters of the lamina. Understanding the matrix transformations.
4. Understanding the failure criteria for laminates based on failure of individual lamina in a laminate. Developing concepts about different failure theories.
5. Design laminated structures such as plates and thin pressure vessels subjected to different loads. Understanding different composite plate theories.

Syllabus Content

Module 1:

Geometric and Physical definitions, natural and man-made composites, Aerospace and structural applications. Properties of typical composite materials. Volume and Weight Fractions. Longitudinal Strength and Stiffness. Transverse Modulus. In-plane shear Modulus. Poisson's ratio . Types and classification of composites. Fibres – Glass, Silica, Kevlar, carbon, boron, silicon carbide, and born carbide fibers. Particulate composites, Polymer composites, Thermoplastics, Metal matrix and ceramic composites. Types of Matrix, Fillers and other Additives. Matrices – Polymer, Graphite, Ceramic and Metal Matrices, Characteristics of fibers and matrices.

Module 2:

Unidirectional composites, constituent materials and properties, elastic properties of a lamina, properties of typical composite materials, laminate characteristics and configurations. Manufacturing methods.

Module 3:

Hooke's law for different types of materials, Hooke's law for two dimensional unidirectional lamina, Transformation of stress and strain, Numerical examples of stress strain transformation, Graphic interpretation of stress – strain relations. Off – axis, stiffness modulus, off – axis compliance. Elastic constants of lamina, relationship between engineering constants and reduced stiffness and compliances, analysis of laminated composites, Laminate Constitutive Equations – Coupling Interactions, Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Quasi-Isotropic Laminates. Determination of Lamina stresses within Laminates.

.**Module 4:**

Micro mechanics of failure, Failure mechanisms, strength of an orthotropic lamina, strength of a lamina under tension and shear maximum stress and strain criteria, application to design. The failure envelope, first ply failure. Micros mechanical predictions of elastic constants.

Module 5:

Introduction thin plate theory, specially orthotropic plate, cross and angle ply laminated plates, problems using thin plate theory. Equilibrium Equations of Motion. Energy Formulations. Static Bending Analysis. Buckling Analysis. Free Vibrations – Natural Frequencies

Contents Beyond Syllabus: *Use of software packages or learning codes to design and analyze composites.*

Text Books:

i. Mechanics of Laminated Composite Plates and Shells: Theory and Analysis, J.N. Reddy, CRC Press

Reference Books:

i) Mechanics of Composite Materials/ R. M. Jones/ Mc Graw Hill Company, New York, 1975.

ii) Engineering Mechanics of Composite Materials by Isaac and M Daniel, Oxford University Press, 1994.

iii) Analysis and performance of fibre Composites/ B. D. Agarwal and L. J. Broutman/ Wiley-Interscience, New York, 1980.

iv) Mechanics of Composite Materials/ Second Edition (Mechanical Engineering)/ Autar K. Kaw , CRC

v) Analysis of Laminated Composite Structures/ L. R. Calcote/ Van Nostrand Rainfold, New York, 1969.

Course Outcomes

At the end of course, students will be able to

CO-No.	Course Outcome (4 to 6)	Module Covered
1	Understanding the types of composites, matrices and uses of composites. Understanding the properties of composite materials.	**1**
2	Understanding and establishing the relationships for the properties of composite materials due to its different configurations. Knowing about different methods for developing composite materials.	**1,2**
3	Understanding and developing stress – strain relationships. Understanding the relationship between engineering constants and developing the constitutive equations. Developing relations for cross-ply, angle play laminates.	**2,3**

4	Understanding different failure criteria of composite materials. Developing the relations involved. *Solving related problems.*	**4**
5	Developing concepts about composite plate theories and properties and behaviors of composite plates and their analysis.	**5**

CO-PO Mapping (Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO - 1	PSO - 2
CO-1			3					
CO-2			3		2			
CO-3	3		3					2
CO-4			3	3				2
CO-5			3				2	
CO-6					3	3		2

PRODUCT DESIGN AND DEVELOPMENT

Semester 2nd	Credit:4					
Course Name: Product Design and Development	L	T	P	3	1	0

Course objectives:-

1) To impart basic concepts of product design and development processes
2) To understand the integration of customer requirements in product design.
3) To develop ability to apply structural approach to concept generation, selection and testing.
4) To understand various aspects of design such as product architecture industrial design, design for manufacturing and economic analysis.

Syllabus Content

Module 1:

Introduction- Characteristics of successful product development, Challenges of product development, Structural approach to product development, Adapting generic product development process, Product development process flow.

Module 2:

Product planning and customer needs- Product planning process, identifying opportunities, evaluation and prioritizing projects, resources allocation and plan timing, Pre-project planning, Identifying customer needs, gathering of raw data from customers, Interpreting to customer needs and establishing of relative importance of needs.

Module 3:

Product specifications and concept generation- Processes for establishing target specifications, methods for setting the final specifications, concept generation, screening and evaluation methods.

Module 4:

Product architecture and industrial design- Methods of establishing product architecture, implications of product architecture, introduction to industrial design, study the impact of industrial design, Management of industrial design process and its quality assessment.

Module 5 :

Design for manufacturing and product development economics- Definition, Estimation of Manufacturing cost, reducing the component costs and assembly costs, reducing system complexity - Prototype basics - Principles of prototyping, planning for prototypes, Economic Analysis of product development.

Text Books:

i) Product Design and Development, Karl T.Ulrich and Steven D.Eppinger, Anita Goyal, McGraw –Hill (2008)4th edition (SIE)

Reference Books:

i) Kevin Otto & Kristin Wood Product Design: “Techniques in Reverse Engineering and new Product Development.” 1 / e 2004 , Pearson Education New Delhi

ii) www.mhhe.com/sie-ulrich4e

iii) Clive L.Dym, Patrick Little, "Engineering Design: A Project-based Introduction", Wiley; Fourth edition (1 January 2015)

Course Outcomes

At the end of course, students will be able to

CO No.	Course outcome	Module covered
1	Having the understanding of the processes involved in the product design and development.	1
2	Ability to evaluate customer needs and understand project planning	2
3	Ability to formulate product specifications and generate feasible concepts	3
4	Ability to apply industrial design principles in product development.	4
5	Ability to understand the product development for manufacturability and undertake economic analysis	5

CO-PO Mapping (Rate: scale of 1 to3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO - 1	PSO - 2
CO-1	3	1	1	3	2	2	1	1
CO-2	2	3	1	1	1	2	2	2
CO-3	2	1	2	2	2	1	1	2
CO-4	2	1	2	2	1	1	1	1
CO-5	2	1	2	2	3	3	3	2
CO-6	3	1	1	3	2	2	1	1

DESIGN OF COMBUSTION ENGINE

Semester:2nd	Credit:4					
Course Name: Design Of Combustion Engine	**L**	**T**	**P**	3	1	0

Course Objectives:

1) To understand the basic concepts of S.I. and C. I. engine configuration and working principles.

2) To develop the knowledge of modern day fuel injection systems and cooling and lubricating systems.

3) To understand the basic engine performance parameters and contemporary and pathways to improve the Thermal, Mechanical and Volumetric efficiency.

Syllabus Content:

Module 1:

PARAMETERS: Compression ratio, Pressure volume and pressure crank angle diagram, frictional mean effective pressure, engine capacity, calculation of bore and stroke length, velocity and acceleration, gas force, inertia and resultant force at various crank angles–Side thrust on cylinder walls, Optimization criteria for improving Thermal, Mechanical and Volumetric efficiency.

Module 2:

DESIGN OF CRANK TRAIN: Design of Piston, piston rings, piston pin, Design of connecting rod; big end, small end and shank, Material and failures related to Cylinder, piston, connecting rod, design of crankshaft for light and heavy vehicle; Crankshaft, frontend, rear end journals, rank pin, Crank web. Design of flywheel; Speed fluctuation and stress calculations, turning moment diagram, design of hub, rim and arms of the flywheel, Ring gear Material and failures related to Crankshaft and flywheel.

Module 3:

DESIGN OF CYLINDER HEAD AND BLOCK: Functional requirement, Block material like Gray Iron, Aluminum, Compacted Graphite Iron and Magnesium, Cylinder head alloys, Design layout, Basic block, Bulk head design, and Cylinder liner design approach and Thermal loads, Cylinder arrangement.

Module 4:

DESIGN OF VALVE TRAIN: Effect of valve timing on engine performance, Number of Valves, Design of valves, Valve seat, Valve guide and cotter, Time selection of valveCam profile construction, Design of valve spring, Design of camshaft, Single and Double Overhead camshaft design, Design of valve gear train for variable valve timing.

Module 5:

DESIGN OF COOLING, LUBRICATION, INTAKE, EXHAUST AND FUEL INJECTION SYSTEM: Design of cooling system, radiator, water pump, thermostat and fan, Computation of air-cooling system Engine friction and wear, Selection of lubricant, lubricating system, pump and filters, Design of intake and exhaust system, Design of fuel injection system for CI engine, Governor Design, Design of carburetor- electronic carburetor, Design of MPFI, GDI, CRDI system.

Text Books:

i) I. C. Engine & Air Pollution – E. F. Obert, Harper & Row Publishers, New York
ii) Engine Design – Giles J. G., Lliffe Book Ltd.
iii) Engine Design – Crouse, Tata McGraw Publication, Delhi
iv) I.C. Engine - Maleev V. L., McGraw Hill Book, Co.
v) I. C. Engine – L. C. Litchy, International Student Edition
vi) Design of Automotive Engine – A. Kolchin and V. Demidov
vii) I. C. Engine – Heywood

Reference Books:

i) KevinL. Hoag , 'VehicularEngineDesign',SAEinternational,2005.
ii) 2. A. Kolchin and V. Demidov, 'Design of Automotive Engines', MIR Publishers, Moscow,
iii) 1984.
iv) R.K. Jain, 'Machine Design', Khanna Publishers, New Delhi,1997.
v) 'Design Data Book', PSG College of Technology, Coimbatore,2000.
vi) GilesJ. G 'Engine Design'–., Life Book Ltd.2000
vii) Crouse'EngineDesign'Tata McGraw Publication, Delhi 2002

Course Outcomes

At the end of course, students will be able to

CO-No.	Course Outcome	Module Covered
1	Describe the various engine performance parameters	1
2	Construct crank train for the given specifications which includes the design of piston, connecting rod, crankshaft and flywheel	2
3	Calculate thermal loads and select a suitable material to design cylinder head and block	3
4	Select and design suitable valve train for the given specifications	4
5	Describe the design procedure involved in Cooling, Lubrication, Intake, Exhaust and Fuel Injection Systems	5

CO-PO Mapping (Rate: scale of1to3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO - 1	PSO - 2
CO-1	3	3	3	3	2	2	3	3
CO-2	3	3	3	2	2	2	2	2
CO-3	3	3	3	2	2	1	1	2
CO-4	3	3	3	2	1	1	1	1
CO-5	3	3	3	2	3	3	3	2
CO-6	3	3	3	3	2	2	1	1