M.TECH. MACHINE DESIGN
Choice Based Credit System (CBCS)
SEMESTER – I

Advanced Engineering Mathematics (4:0:0) 4
(Effective from the academic year 2021-22)

Course Code	21MMD11	CIE Marks	50
Teaching Hours/Week (L:T:P)	4:0:0	SEE Marks	50
Total Number of Contact Hours	52	Exam Hours	3

Course Objectives:
This course will enable students to:
1. Identify and explain the basics of linear systems through matrix algebra and use the same to formulate and solve a linear system of equations.
2. Apply the important numerical tools to solve ordinary and partial differential equations arising in engineering applications.
3. Understand probability concepts to test the hypothesis of random physical phenomena.
4. Analyze the physical problem to establish mathematical model and use appropriate method to solve the problems.

Module – 1

Introduction: Understanding the importance of the study of Numerical methods and its applications to solve problems in the field of Engineering.
Errors and Simple Mathematical Modelling: Significant figures, accuracy and precision, Error definitions, round off errors and truncation errors, Mathematical modelling and Engineering problem solving, Conservation Laws of Engineering, Engineering Applications on Deflection of Beams Whirling of shafts and Terminal velocity of a freely falling body.
(12 Hours)

Module – 2

System of Linear Algebraic Equations and Eigen Value Problems: Gauss-Jordan Method, Cholesky Method, Partition method, Givens method for symmetric matrices.
(10 hours)

Module – 3

Roots of Equations: Muller's method, Graeffe's roots squaring method.
Numerical Solutions of Ordinary Differential Equations: Introduction, Picard`s method of successive approximation, solution of first order simultaneous equations by Picard`s & Runge Kutta methods, solution of second order equations by Picard`s & Runge Kutta methods.
(10 hours)

Module – 4

Partial Differential Equations: Numerical solution of one-dimensional wave equation, Heat equation, (Schmidt`s explicit formula) & Laplace equation (Gauss-Seidel process) by finite difference schemes. Illustrative examples on each method
(10 hours)

Module – 5

Sampling theory: Testing of hypothesis: Chi square test and F-test. Analysis of Variance (ANOVA): one-way classification, Design of experiments, Randomized Block Diagram.
Summary: The student will be able to analyse and apply various concepts related to

numerical methods and sampling theory.
Recap/Summary of the Course

(10 hours)

Course Outcomes: The students will be able to:

CO1: Acquire the idea of significant figures, and types of errors that occur during numerical computation

CO2: Understand various numerical methods to solve system of linear equations and solve the roots of algebraic/transcendental equations and PDE's arising in engineering applications.

CO3: Understand statistical and probabilistic concepts required to test the hypothesis and designing the experiments using RBD.

CO4: Creating a model of various simple physical and engineering phenomena.

Question paper pattern:

- **SEE** will be conducted for 100 marks.
- **Part A:** First question with 20 MCQs carrying 1 mark each.
- **Part B:** Each full question is for 16 marks. (Answer five full questions out of 10 questions with intra modular choice). In every question, there will be a maximum of three sub-questions.
- **CIE** will be announced prior to the commencement of the course.
- 25 marks for test. Average of three test will be taken.
- 25 marks for Alternate Assessment Method.

Reference Books:

1. Steven C Chapra, Raymond P Canale, "Numerical Methods for Engineers", 7th Edition, Tata McGraw-Hill, 2015.
2. R. E. Walpole, R. H. Myres, S. L. Myres, Keying Ye, "Probability and Statistics for Engineers and Scientists", 9th Edition, Pearson, 2012.
3. M K Jain, S.R.K Iyengar, R K. Jain, "Numerical Methods for Scientific and Engineering Computation", 6th Edition, New Age International Publishers, 2007.
4. David. C. Lay, "Linear Algebra and its applications", 3rd Edition, Pearson Education, 2002
5. B. S. Grewal, "Numerical Methods in Engineering and Science", 11th Edition, Khanna Publishers, 2017.
6. K. Sankara Rao, "Introduction to Partial Differential Equations", 3rd Edition, Prentice - Hall of India Private Limited, 2011.

M.Tech Machine Design
Choice Based Credit System (CBCS)
SEMESTER – I

Research Methodology and IPR (2:0:0) 2
(Effective from the academic year 2021-22)

Course Code	21MMD12	CIE Marks	50
Teaching Hours/Week (L: T:P)	2:0:0	SEE Marks	50
Total Number of Contact Hours	26	Exam Hours	3

Course Objectives:
This course will enable students to:

5. Give an overview of the research methodology and explain the technique of defining a research problem.
6. Explain the functions of the literature review in research and develop theoretical and conceptual frameworks by carrying out a literature search
7. Appreciate various research designs, sampling designs, and also different methods of data collections.
8. Understand hypothesis and chi- square test.
9. Develop the art of interpretation and writing different research reports.
10. Explain various forms of the intellectual property, its relevance and impact in the changing global business environment.

Module – 1

Research: Objectives, Types, Approaches, Significance, Research Methods versus Methodology, Research and scientific method, Importance of knowing how research is done
Research Process: criteria of good research and Problems Encountered by Researchers in India.
Research Problem: Research problem, Necessity and Techniques involved in defining a research problem, An Illustration.
Self-study: Problems encountered by researchers in India **(5 Hours)**

Module – 2

Literature Review: Place of the literature review in research, how to search and review the existing literature, writing about the literature reviewed.
Research Design: Research Design, Need, features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs
Self-study: searching the existing literature **(5 Hours)**

Module – 3

Design of Sampling: Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs.
Measurement and Scaling: Qualitative and Quantitative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, Sources of Error in Measurement Tools, Scaling, Scale Classification Bases, Scaling Technics, Multidimensional Scaling, Deciding the Scale.
Data Collection: Experimental and Surveys, Collection of Primary Data and Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method.
Self-study: Case study method **(5 hours)**

Module – 4

Hypothesis Testing: Hypothesis, Basic Concepts, Testing the Hypothesis, Test Statistic and Critical Region, Critical Value and Decision Rule, Hypothesis Testing procedure, Hypothesis

Testing for mean, proportion, variance, difference of two mean, difference of two proportions, difference of two variances.
Chi-square Test: Test of Difference of more than Two Proportions, Test of Independence of Attributes, Test of Goodness of Fit, Cautions in Using Chi Square Tests.
Interpretation and Report Writing: Interpretation, Techniques, Precautions in Interpretation, Report writing, Significance, Different Steps, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports
Self-study: Significance of report writing and types of reports (5 hours)

Module – 5

Intellectual Property: Intellectual Properties, Intellectual Property System in India, Patents, Copyrights, Trademarks, Industrial Designs, The Geographical Indications, The Protection of Plant Varieties, The Semi-Conductor Integrated Circuits Layout Designs, The Acts regulating the Intellectual Properties in India, Enforcement of Intellectual Properties,
Leading International Instruments Concerning IPR: Paris Convention for the protection of Industrial Property, TRIPS, PCT, Berne Convention- Basic Principles and Features. Role of WIPO and WTO in governing Intellectual Property system worldwide.
Self-study: Intellectual Property System in India **(6 hours)**

Course Outcomes: The students will be able to:
CO1: Examine research methodology, research problem and literature review.
CO2: Categorise various research designs, sampling designs, measurement and scaling techniques and data collection methods.
CO3: Appraise several parametric tests of hypotheses and Chi-square test.
CO4: Develop the art of interpretation and writing research reports.
CO5: Interpret various forms of the intellectual property, its relevance and business impact in the changing global business environment and leading International Instruments concerning IPR

Question paper pattern:
- **SEE** will be conducted for 100 marks.
- **Part A:** First question with 20 MCQs carrying 1 mark each.
- **Part B:** Each full question is for 16 marks. (Answer five full questions out of 10 questions with intra modular choice). In every question, there will be a maximum of three sub-questions.
- **CIE** will be announced prior to the commencement of the course.
- 25 marks for test. Average of three test will be taken.
- 25 marks for Alternate Assessment Method.

Reference Books:

1. C.R. Kothari, Gaurav Garg, Research Methodology: Methods and Techniques, 4th Edition, New Age International, 2018.
2. Ranjit Kumar, Research Methodology, 4th Edition, SAGE Publications Ltd. 2014.
3. Study Material (For the topic Intellectual Property under module 5), Professional Programme Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament, September 2013.
4. M. K. Trochim William, Research Methods: the concise knowledge base, Atomic Dog Publishing Inc, 2005.
5. G. Fink Arlene, Conducting Research Literature Reviews: From the Internet to Paper, Sage Publications Inc, 2009.
6. R Panneerselvam, Research Methodology,2nd Edition, New Delhi, Prentice Hall of India, 2014.

M. TECH. MACHINE DESIGN
Choice Based Credit System (CBCS)
SEMESTER -I

Fracture Mechanics (4:0:0) 4
(Effective from the academic year 2021-22)

Course Code	21MMD13	CIE Marks	50
Teaching Hours/Week (L:T:P)	4:0:0	SEE Marks	50
Total Number of Contact Hours	52	Exam Hours	3

Course Objectives:
This course will enable students to:
1. To understand the design principle of materials and structures using fracture mechanics approaches.
2. To introduce the mathematical and physical principles of fracture mechanics and their applications to engineering design.
3. To develop the ability in students to compute the stress intensity factor, strain energy release rate and the stress and strain fields around a crack tip for linear and nonlinear materials.
4. To prepare the students for broader applications of fracture mechanics in material testing, evaluation, characterization, and material selection.

Module – 1

Fracture mechanics principles: Sources of micro and macro cracks. stress concentration due to elliptical hole, strength ideal materials, Griffith's energy balance approach. Fracture mechanics approach to design. NDT and Various NDT methods used in fracture mechanics, numerical problems. The Airy stress function, complex stress function, solution to crack problems, effect of finite size, special cases, elliptical cracks, numerical problems.

(12 Hours)

Module – 2

Plasticity effects: Plastic zone, effective crack length, Irwin plastic zone correction. Dugdale approach, size and shape of the plastic zone for plane stress and plane strain cases, Thickness effect, numerical problems.
Energy release rate: Griffith's criteria, Energy release rate, compliance approach, crack resistance, R-curve, Compliance, stable and unstable crack growth, equivalence.

(10 Hours)

Module – 3

Elastic Plastic Fracture Mechanics (EPFM): Fracture beyond general yield. The crack-tip opening displacement, the use of CTOD criteria, and experimental determination of CTOD. Parameters affecting the critical CTOD,
J integral, tearing modulus and stability. use of J integral, and limitation of J integral. J_{1c} test method, engineering approach

(10 Hours)

Module – 4

Fatigue crack propagation and applications of fracture mechanics: Crack growth and the stress intensity factor. Factors affecting crack propagation. Variable amplitude service loading, means to provide fail-safety, required information for fracture mechanics approach, mixed mode (combined) loading and design criteria.

(10 hours)

Module – 5
Dynamics and crack arrest: Crack speed and kinetic energy. Dynamic stress intensity and elastic energy release rate. Crack branching. Principles of crack arrest. Crack arrest in practice. Dynamic fracture toughness. **Recap/Summary** of the Course (10 hours)
Course Outcomes: The students will be able to: **CO1:** Apply the principles of failures to study the crack in various structures. **CO2:** Analyse the critical values of parameters at crack tip. **CO3:** Evaluate the critical crack sizes and fatigue crack propagation rates in engineering structures.
Question paper pattern: • **SEE** will be conducted for 100 marks. • **Part A:** First question with 20 MCQs carrying 1 mark each. • **Part B:** Each full question is for 16 marks. (Answer five full questions out of 10 questions with intra modular choice). In every question, there will be a maximum of three sub-questions. • **CIE** will be announced prior to the commencement of the course. • 25 marks for test. Average of three test will be taken. • 25 marks for Alternate Assessment Method.
Reference Books: 1. David Broek, "Elementary Engineering Fracture Mechanics", Springer Netherlands,2011 2. Anderson, "Fracture Mechanics-Fundamental and Application", T.L CRC press1998. 3. Karen Hellan , "Introduction to fracture mechanics", McGraw Hill, 2nd Edition 4. S.A. Meguid , "Engineering fracture mechanics" Elsevier Applied Science, 1989 5. Jayatilaka, "Fracture of Engineering Brittle Materials", Applied Science Publishers, 1979 6. Rolfe and Barsom, "Fracture and Fatigue Control in Structures", Prentice Hall, 1977 7. Knott, "Fundamentals of fracture mechanisms", Butterworths, 1973

M.TECH. MACHINE DESIGN
Choice Based Credit System (CBCS)
SEMESTER – I

Advanced Solid Mechanics (4:0:0) 4
(Effective from the academic year 2021-22)

Course Code	21MMD14	CIE Marks	50
Teaching Hours/Week (L:T:P)	4:0:0	SEE Marks	50
Total Number of Contact Hours	52	Exam Hours	3

Course Objectives:
This course will enable students to:
1. Analyse stress distribution in engineering structures using powerful methods of theory of elasticity
2. Apply stress – strain relations for linearly elastic solids using physical interpretations to obtain results
3. Apply theory of failure or yield criteria.
4. Apply the knowledge of theory of elasticity for applications in bending of beams, asymmetrical bending, shear center, curved beams and deflections of thick curved bars

Module – 1

Analysis of Stress: Body force, surface force, components of stresses, equations of equilibrium, specification of stress at a point. Principal stresses, maximum and minimum shear stress. Boundary conditions. Stress components on an arbitrary plane, stress invariants, octahedral stresses, decomposition of state of stress, deviator and spherical stress tensors, stress transformation.

(10Hours)

Module – 2

Deformation and Strain: Deformation, strain Displacement relations, strain components, The state of strain at a point, , Principal strain, strain invariants, Strain transformation, Compatibility equations, Cubical dilatation, spherical and deviator strains, plane strain, Mohr‟s circle, and compatibility equation Relations and the General Equations of Elasticity: Generalized Hooke's; law in terms of engineering constants. Formulation of elasticity Problems.

(10Hours)

Module – 3

Two Dimensional Problems in Cartesian Co-Ordinates: Airy's stress function, investigation of simple beam problems. Bending of a narrow cantilever beam under end load, simply supported beam with uniform load, Existence and uniqueness of solution, Saint -Venant's principle, Principle of super position and reciprocal theorem.

(10Hours)

Module – 4

Two Dimensional Problems in Polar Co-Ordinates: General equations, stress distribution symmetrical about an axis, strain components in polar co-ordinates, Rotating disk and cylinder, Thermal Stresses: Introduction, Thermo-elastic stress -strain relations, thin circular disc, long circular cylinder.

(10Hours)

Module – 5

Torsion of Prismatic Bars: Introduction, Torsion of circular cross section bars,

Torsion of elliptical cross section bars, Soap film analogy, Membrane analogy,
Viscoelasticity: Linear Viscoelastic behavior. Simple viscoelastic models-generalized models, linear differential operator equation.
Recap/Summary of the Course

(12Hours)

Course Outcomes: The students will be able to:

CO1: Treat general stresses and deformations in continuous materials.

CO2: Formulate and solve specific technical problems of displacement, strain and stress.

CO3: Perform experiments with stresses and deformations.

CO4: Model and analyse the stresses and deformations of simple geometries under an arbitrary load in solids

Question paper pattern:

- **SEE** will be conducted for 100 marks.
- **Part A:** First question with 20 MCQs carrying 1 mark each.
- **Part B:** Each full question is for 16 marks. (Answer five full questions out of 10 questions with intra modular choice).In every question, there will be a maximum of three sub-questions.
- **CIE** will be announced prior to the commencement of the course.
- 25 marks for test. Average of three test will be taken.
- 25 marks for Alternate Assessment Method.

Reference Books:

1. Timoshenko and Goodier, "Theory of Elasticity", Tata McGraw Hill, New Delhi,3rd edition,1970
2. L S Srinath, "Advanced Mechanics of Solids", Tata McGraw Hill, New Delhi, 3rd edition, 2010
3. G ThomasMase, Ronald E Smelser, George E Mase, "Continuum Mechanics for engineers",3rdEdition, CRC Press, Boca Raton, 2010
4. R. C Batra, "Elements of Continuum Mechanics", Reston, 2006.
5. George E. Mase, Schaum's Outline of "Continuum Mechanics", McGraw-Hill,1970
6. Dill, Ellis Harold, "Continuum Mechanics: Elasticity, Plasticity, Viscoelasticity", CRC Press, 2006.
7. Sadhu Singh, "Theory of Elasticity", Khanna publisher, 4th edition, 2013

M.TECH. MACHINE DESIGN
Choice Based Credit System (CBCS)
SEMESTER – I

Composite Materials Technology (4:0:0) 4
(Effective from the academic year 2021-22)

Course Code	21MMD15	CIE Marks	50
Teaching Hours/Week (L:T:P)	4:0:0	SEE Marks	50
Total Number of Contact Hours	52	Exam Hours	3

Course Objectives:
This course will enable students to:

1. To understand the principles, matrix and reinforcement material options, advantages and disadvantages of different manufacturing techniques of composites.
2. To comprehend recent developments in composites, including metal, ceramic and polymer matrix composites.
3. To impart a basic understanding of micro-mechanics of layered composites, analysis and design of composite structures and failure analysis of laminated panels.
4. To know the use of composites in engineering applications.

Module – 1

Composite Materials: Classification of composite materials. Constituent of composite materials: Reinforcements, Matrix, Coupling agents, coatings & fillers. Classification of composite materials: Polymer Matrix Composites, Metal Matrix Composites, Ceramic Matrix Composites, Carbon-Carbon Composites. Reinforcements and Matrix Materials,
Matrix Materials: Polymers, Metals and Ceramic Matrix Materials.
Reinforcements: Introduction, Glass Fibers, Boron Fibers, Carbon Fibers, Organic Fibers, Ceramic Fibers, Whiskers, Other Non-oxide Reinforcements,
Advantages and drawback of composite materials.

(12 Hours)

Module – 2

Metal matrix composites: Reinforcement materials, types, Characteristics & Selection, base Metals selection, applications of Metal matrix composites.
Polymer Matrix Composites (PMC): Processing of PMC's; Processing of Thermoset Matrix Composites, Thermoplastic Matrix Composites, Interfaces in PMC's, Structure & Properties of PMC's

(10 Hours)

Module – 3

Manufacturing Techniques of Composites:
Metal Matrix Composites (MMC's): Powder metallurgy technique, liquid metallurgy technique, special fabrication techniques.
Polymer Matrix Composites (PMC's): Layup and curing, fabricating process, open and closed mould process, Hand layup techniques; structural laminate bag moulding, production procedures for bag moulding; filament winding, pultrusion, polyforming, thermo-forming, injection moulding, blow moulding.

(10 hours)

Module – 4

Micromechanics of Composites: Density, Mechanical Properties; Prediction of Elastic Constants, Micromechanical Approaches, Halpin-Tsai Equations, Transverse Stresses, Thermal properties. Numerical Problems.

Macromechanics of Composites: Introduction, Elastic constants of an isotropic material, elastic constants of a lamina, relationship between engineering constants and reduced stiffnesses and compliances.

(10 hours)

Module – 5

Performance/Characterization of Composites: Static Mechanical Properties; Tensile Properties, Compressive Properties, Flexural Properties, In-Plane Shear Properties, Interlaminar Shear Strength. Fatigue Properties; Tension-Tension Fatigue, Flexural Fatigue. Impact Properties; Charpy, Izod, and Drop-Weight Impact Test.

Application and developments: Aircrafts, missiles, space hardware, automobile, electrical and electronics, marine, recreational and sports equipment - future potential of composites.

Recap/Summary of the Course

(10 hours)

Course Outcomes: The students will be able to:

CO1: Explain the types of composite materials and their characteristic features.
CO2: Explain the methods employed in composite fabrication
CO3: Apply the basic micro-mechanics theories in the design of fibre reinforced composites.
CO4: Analyse the performance of composites in engineering applications.

Question paper pattern:

- **SEE** will be conducted for 100 marks.
- **Part A:** First question with 20 MCQs carrying 1 mark each.
- **Part B:** Each full question is for 16 marks. (Answer five full questions out of 10 questions with intra modular choice). In every question, there will be a maximum of three sub-questions.
- **CIE** will be announced prior to the commencement of the course.
- 25 marks for test. Average of three test will be taken.
- 25 marks for Alternate Assessment Method.

Reference Books:

1. Autar K. Kaw, “Mechanics of Composite materials”, 2nd edition, CRC Press, 2005.
2. Madhijit Mukhopadhay, “Mechanics of Composite Materials & Structures”, 1st edition, Universities Press, 2004.
3. J. N. Reddy, “Mechanics of Laminated Composite Plates & Shells”, 2nd edition, CRD Press, 2004.
4. Mein Schwartz, “Composite Materials handbook”, 1st edition, McGraw Hill, 1984.
5. Robert M. Jones, “Mechanics of Composite Materials”, 1st edition, Taylor & Francis, 1998.
6. Michael W, Hyer, “Stress analysis of fiber Reinforced Composite Materials”, 1st edition, Mc-Graw Hill International, 2009.
7. Krishan K. Chawla, “Composite Material Science and Engineering”, 3rd edition, Springer, 2012.

M.TECH. MACHINE DESIGN Choice Based Credit System (CBCS) SEMESTER – I			
Advanced Finite Element Method (4:0:0) 4 (Effective from the academic year 2021-22)			
Course Code	21MMD16	CIE Marks	50
Teaching Hours/Week (L:T:P)	4:0:0	SEE Marks	50
Total Number of Contact Hours	52	Exam Hours	3

Course Objectives:

This course will enable students to:

1. Illustrate fundamental knowledge on Finite element method.
2. Understand the analysis of structural problems.
3. Solve one dimensional problem using finite element method.
4. Apply finite elements methods for dynamic and axisymmetric problems.
5. Analyse 3-D elements, plates and shells using finite element method.

Module – 1

Introduction to Finite Element Method: Importance of Finite Element Analysis for industries and development of Nation. General description of the finite element method, brief history of finite element methods Description Basic steps in finite element method to solve mechanical engineering problems. Standard Packages and their features: Introduction, commercially available standard packages, structure of a finite element analysis program, processing, output, pre and post processors, desirable features of FEA packages.

One dimensional problem: Coordinates and shape functions, potential energy approach, force terms, Derivation of element stiffness matrix, Properties of stiffness matrix, derivation of shape function using Lagrange interpolation function and natural coordinates for bar. Numerical problems on bars subjected to distributed loads/self-weight and thermal loads.

Torsion of shafts: Torsional equation, derivation of torsional stiffness matrix, finite element analysis of torsion of shafts, determination of twists and stresses in shafts. Numerical problems on torsion.

(11 Hours)

Module – 2

Truss: Plane trusses**,** local coordinate and global coordinate systems**,** direction cosines**,** Derivation of stiffness matrix, element strain and stress. Numerical problems on two element trusses.

2-D elements: Displacement vector, Shape function in natural coordinates for four nodded quadrilateral elements, element force vectors: body force vector, traction force vector triangular and quadrilateral elements. Numerical Problems on quadrilateral element and triangular elements

Dynamic Analysis: Equations of motion, Hamilton's principle, solid body with distributed mass, consistent mass matrix, lumped mass matrix. Element consistent mass matrices for bar and beam element. Evaluation of Eigen values and Eigen vectors, numerical problems on bars, stepped bars

(10 Hours)

Module – 3

Beams: Derivation of load vector for beam element subjected to uniformly distributed loads, Boundary conditions, shear force and bending moment, Beams on elastic support, numerical problems on simply supported/fixed beams uniformly varying load and uniformly distributed loads

Axisymmetric element: Axisymmetric formulation, Finite element modelling of triangular and rectangular axisymmetric element: shape function matrix, displacement vector, displacement functions, body force, surface traction force. Numerical solution of axisymmetric problems.

(10 Hours)

Module – 4

Plates: Bending of thin plates**,** Introduction, Basic relations in thin plate theories, Relations in thin plate theory, displacement model for plate analysis: C^2-continuity elements, C^1 continuity elements, C^0-continuity elements. triangular plate bending element, rectangular plate element with 12 degrees of freedom, Mindlin's plate element. Plate Theory: Mindlin plate theory, Kirchhoff plate.

Linear tetrahedral element: Isoparametric linear triangular element, Displacement function, element strain vector, element stiffness matrix and shape function in natural coordinates for linear Tetrahedral element, Element fraction load vector using natural coordinates

(10 Hours)

Module – 5

Linear Hexahedral Element: Iso-parametric linear Hexahedral element, Displacement function, element strain vector, element stiffness matrix, element traction load vector using natural coordinates

Shells: Analysis of shells, introduction, forces on shell element, Finite elements for shell Analysis: flat shell element, curved shell elements, solid shell elements, degenerated shell elements. Finite element formulation using four noded degenerated quadrilateral shell element, local direction cosines, displacement field, strains and stresses, element stiffness matrices. **Recap/Summary** of the Course

(11Hours)

Course Outcomes: The students will be able to:

CO1: Illustrate the basic concepts involved in Finite Element Method.
CO2: Solve one dimensional structural element using finite element method.
CO3: Analyse 2-D and 3-D elements using finite element method.
CO4: Analyse dynamic and axisymmetric problems using finite element method.
CO5: Evaluate plates and shells using finite element method.

Question paper pattern:

- **SEE** will be conducted for 100 marks.
- **Part A:** First question with 20 MCQs carrying 1 mark each.
- **Part B:** Each full question is for 16 marks. (Answer five full questions out of 10 questions with intra modular choice). In every question, there will be a maximum of three sub-questions.
- **CIE** will be announced prior to the commencement of the course.
- 25 marks for test. Average of three test will be taken.
- 25 marks for Alternate Assessment Method.

Reference Books:

1. Tirupathi R. Chandrupatla, Ashok D. Belegundu, "Introduction to Finite Elements in Engineering", 4th Edition, Pearson, 2015
2. Lakshminarayana H. V, "Finite Elements Analysis– Procedures in Engineering", 3rd Edition, Universities Press (India) Pvt. Ltd. 2017

3. Robert D. Cook Malkus Plesha Witt, "Concepts and Application of Finite Elements Analysis", 4th Edition, Wiley & Sons, 2007
4. Seshu, P, "Text Book of Finite Element Analysis", Prentice-Hall of India Pvt. Ltd., New Delhi, India, 2013
5. K J Bathe, "Finite Element Procedures", Prentice Hall, Indian Edition, 2006

M.TECH. MACHINE DESIGN
Choice Based Credit System (CBCS)
SEMESTER – I

Modelling and Static Analysis Lab (0:0:3) 1.5
(Effective from the academic year 2021-22)

Course Code	21MMD17	CIE Marks	50
Teaching Hours/Week (L:T:P)	0:0:3	SEE Marks	50
Total Number of Contact Hours	40	Exam Hours	3

Course objectives:
This course enables students to:
1. Carryout structural analysis of structural components using FEM
2. Carryout structural analysis of various components using FEA package.
3. Compute and analysis of different materials using FEA package.

List of Experiments

PART A

1. **Analysis of simple and composite bars:**
   Part A: Numerical Analysis using theoretical concept.
   Part B: Analysis using FEA package.

2. **Analysis of Trusses:**
   Part A: Numerical Analysis using theoretical concept
   Part B: Analysis using FEA package.

3. **Analysis of Beams using different loading conditions:**
   Part A: Numerical Analysis using theoretical concept.
   Part B: Analysis using FEA package.

4. **Stress analysis of rectangular plate with circular hole under uniform Tension**
   Part A: Numerical Analysis using theoretical concept.
   Part B: Numerical Analysis using FEA package.

PART B

5. **Structural analysis of composite materials:**
   Part A: Numerical Analysis using theoretical concept.
   Part B: Numerical Analysis using FEA package.

6. **Analysis of Piezo electric materials:**
   Part A: Static analysis to determine the deflection.
   Part B: Electro-magnetic analysis under uniform pressure.

7. **Buckling analysis of arch:**
   Part A: Linear buckling analysis of arch.
   Part B: Non linear buckling analysis of arch.

8. **Analysis of Viscoelastic materials:**
   Part A: Become familiar with input and post processing of viscoelastic materials
   Part B: Analysis of the compression and release of a rubber block to see creep and recovery of elastic strains.

Course outcomes: The students will be able to: **CO1:** Apply the FEM Knowledge to carry out the static and dynamic analysis **CO2:** Analyse the problems to evaluate primary variables under different boundary conditions. **CO3:** Demonstrate skills in use of reputed commercial finite element analysis package. **C04:** Present the results in the form of a technical report.
Examination pattern: • These are independent laboratory exercises. • Student must submit a comprehensive report on the problems solved and give a presentation on the same for Internal Evaluation. • Any one of the experiments from each part done has to be set in the examination for conduction and evaluation.

M.TECH. MACHINE DESIGN
Choice Based Credit System (CBCS)
SEMESTER – I

Composite Materials Lab (0:0:3) 1.5
(Effective from the academic year 2021-22)

Course Code	21MMD18	CIE Marks	50
Teaching Hours/Week (L:T:P)	0:0:3	SEE Marks	50
Total Number of Contact Hours	40	Exam Hours	3

Course objectives:
This course enables students to:
1. Fabricate the composites (PMCs, MMCs) using different manufacturing methods.
2. Carryout the characterization of composite materials.
3. Study the mechanical behaviour of different composite materials.

List of Experiments

PART A

1. Fabrication of Metal Matrix Composites using Stir casting method.
2. Fabrication of Polymer Matrix Composites using Hand layup technique.
3. Fabrication of Polymer Matrix Composites using Open mould technique.

PART B

Mechanical characterization of fabricated composite materials.
1. Tensile test.
2. Compression test.
3. Impact test.
4. Hardness test.
5. Wear test.

Course outcomes:
The students will be able to:
CO1: Understand various technique of composite manufacturing.
CO2: Carryout the composite manufacturing using various techniques.
CO3: Carryout mechanical characterization of composite materials.
C04: Present the results in the form of a technical report

Examination pattern:
- Students has to prepare composites using different fabrication technique (2 or 3students in group).
- Students has to carry out the mechanical characterization tests individually.
- Student has to submit a comprehensive report on the problems solved and give a presentation on the same for Internal Evaluation.
- Any one of the experiments from each part B has to be set in the examination for conduction and evaluation.

M.TECH. MACHINE DESIGN Choice Based Credit System (CBCS) SEMESTER - II			
Advanced Theory of Vibration (4:0:0) 4 (Effective from the academic year 2021-22)			
Course Code	21MMD21	CIE Marks	50
Teaching Hours/Week (L:T:P)	4:0:0	SEE Marks	50
Total Number of Contact Hours	52	Exam Hours	3

Course objectives:

This course will enable students to:

1. Illustrate the basic principles of mechanical vibration and vibrations measurement.
2. Summarise the practical aspect of vibration excitation techniques and vibration control.
3. Examine the machine condition, modal testing and excitation signal.
4. Summarise fundamental aspects of acoustics and noise measurement
5. Analyse acoustic transducer, acoustic exciter and acoustic control.

Module – 1

Introduction to Mechanical Vibrations: Classification of dynamic system models, constraints, generalised co-ordinates, degrees of freedom. Classification of vibration: forced and free vibration, linear and non-linear vibrations, deterministic and random vibration. Example of vibrating motion, Free vibration of undamped translation system, free vibration of undamped torsional system.

Free vibration with viscous damping, free vibration with coulomb damping, free vibration with hysteresis damping.

Vibration Measuring Instruments: Vibration measuring instruments**,** Seismometer: instrument with low natural frequency, Accelerometer: Instruments with high natural frequency, Transducers, acceleration error verses frequency, phase distortion. frequency measuring instruments problems on vibration measurements. Numerical problems on accelerometer, vibrometer, frequency measuring instruments.

(10 hours)

Module – 2

Vibration Excitation Techniques: Vibration excitation, vibration exciters of the contact type: electrodynamic vibration shaker mechanical exciter of the direct drive type, reaction type exciters, electrohydraulic exciter and PZT actuators. non-intrusive/contact excitation techniques: Near-non-intrusive excitation, operational excitation, step relaxation. Impact testing using modal hammers.

Vibration Control: Vibration isolation: disturbing force transmitted through springs and damper, support motion, energy dissipated by damping, equivalent viscous damping, structural damping, sharpness or resonance, Force transmissibility, active vibration control, Vibration absorbers: Undamped dynamic vibration absorber, damped dynamic vibration absorber. Numerical problems on force transmissibility

(12 hours)

Module – 3

Modal analysis: Experimental Modal analysis, introduction, important experimental aspects of modal testing, support conditions of test structure, minimising exciter/test structure interaction Choice of exciters/shakers, impact testing and difficulties, sensing techniques, selection of excitation signals for modal testing: stepped sinusoidal, slow sinusoidal sweep, periodic, true random, pseudo random, transient. applications and features of a signal generator.

Machine Condition Monitoring and Diagnosis: Vibration severity criteria, machine maintenance techniques: breakdown, preventive and condition-based maintenance, machine condition monitoring techniques, vibration monitoring techniques: Time domain analysis: Time waveform, Indices, orbits, statistical methods. Frequency domain analysis, Quefrency domain analysis, instrumentation system, choice of monitoring parameter.

(10 hours)

Module – 4

Fundamentals of Acoustics: Sound pressure level, sound power level, sound intensity level, co and sound propagation in 1-D, amplitude, velocity of sound, relation between sound power level and sound intensity level and relationship between sound intensity level and sound pressure level. Summation of pure tones. Decibel addition, subtraction, and averaging. Sound spectra, types of sound fields, octave band analysis. Sound propagation: point source, line source. Radiation fields of a sound source: near, far, free, reverberant, diffusion and pressure field. Noise measurement, frequency weighting networks, time weighing, practical noise measurement. Recap of the Course.

(12 hours)

Module – 5

Sound Transducer: Sound level meter, microphones, , parameter to be considered in the choice of microphones, various types of microphones, : carbon granule, condenser, electret capacitor, moving coil and piezo electric microphones.

Acoustic Exciter: loudspeaker, Types of loud speaker: Electro-dynamic, electrostatic, electro-pneumatic.

Acoustics Control: Sound absorption, sound isolation, muffing, Use of sound absorption materials, properties of acoustic materials, techniques for noise control. Sound standard and noise legislation, Industrial noise regulation.

(8 hours)

Course outcomes:

The students will be able to

CO1 : Illustrate the basic concept of vibration and vibrations measurement.

CO2 : Summarise the practical aspect of vibration excitation and control.

CO3 : Examine the machine condition and monitoring techniques.

CO4 : Summarise practical aspects of acoustics and noise measurement.

CO5 : Analyse different acoustic transducer, acoustic exciter and acoustic materials.

Question paper pattern:

- **SEE** will be conducted for 100 marks.
- **Part A:** First question with 20 MCQs carrying 1 mark each.
- **Part B:** Each full question is for 16 marks. (Answer five full questions out of 10 questions with intra modular choice). In every question, there will be a maximum of three sub-questions.
- **CIE** will be announced prior to the commencement of the course.
- 25 marks for test. Average of three test will be taken.
- 25 marks for Alternate Assessment Method.

Reference Books:

1. C Sujatha, Vibrations and Acoustics – Measurements and signal analysis, Tata McGraw Hill Education Private Ltd. 2010.

2. S. S. Rao, Mechanical Vibrations, 6th Edition, 2017.
3. A G Ambekar, Mechanical Vibration and Noise Engineering, Eastern Economy Edition, 2006.
4. William T. Thomson, Marie Dillon, Dahleh, Theory of Vibration with Application, 5th Edition, Pearson Education, 1998.
5. V Ramamurthi, Mechanical Vibration Practice and Noise Control, Narosa Publishing House, 2008.
6. Rao V. Dukkipati, Mechanical Vibration, Narosa Publishing House, 2010.

M.TECH. MACHINE DESIGN Choice Based Credit System (CBCS) SEMESTER – II			
Dynamics and Design of Mechanisms (4:0:0) 4 (Effective from the academic year 2021-22)			
Course Code	21MMD22	CIE Marks	50
Teaching Hours/Week (L:T:P)	4:0:0	SEE Marks	50
Total Number of Contact Hours	52	Exam Hours	3

Course Objectives:

This course will enable students to:

1. To provide a theoretical and practical foundation for analysis and design of articulated
2. Mechanical systems for desired applications.
3. Develop skills to analyze the displacement, velocity, and acceleration of mechanisms.
4. Improve understanding of the synthesis of mechanisms for given tasks.
5. To include dynamics considerations in the design of mechanisms for engineering applications.

Module – 1

Introduction: analysis and synthesis, Mechanism terminology, planar, Spherical and spatial mechanisms, mobility, Grashoffs law, Equivalent mechanisms, Unique mechanisms, Inversions of mechanism.

(10 Hours)

Module – 2

Synthesis of Linkages: Type, number, and dimensional synthesis, Function generation, Path generation and Body guidance, Precision positions, Structural error, Chebychev spacing.

Analytical Methods of Dimensional Synthesis: Freudenstein's equation for four bar mechanism and slider crank mechanism, Examples, Bloch's method of synthesis.

(10 Hours)

Module – 3

Graphical Methods of Dimensional Synthesis: Two position synthesis of slider crank mechanisms, two position synthesis of crank and rocker mechanisms, three position synthesis, four position synthesis (point precision reduction) Overlay method, Crank-rocker mechanisms with optimum transmission angle Motion Generation: Poles and relative poles, Location of poles and relative poles, Coupler curve synthesis.

(12 Hours)

Module – 4

Generalized Principles of Dynamics: Fundamental laws of motion, generalized coordinates, Configuration space, Constraints, Virtual work, principle of virtual work, Energy and momentum, Work and kinetic energy, Equilibrium and stability, Kinetic energy of a system, Angular momentum, Generalized momentum.

Lagrange's Equation: Lagrange's equation from D'Alembert's principles, Examples, Hamiltons equations, Hamiltons principle, Lagrange's, equation from Hamiltons principle, Derivation of Hamiltons equations, Examples.

(10 hours)

Module – 5
System Dynamics: Gyroscopic action in machines, Euler's equation of motion, Phase Plane representation, Phase plane Analysis, Response of Linear Systems to transient disturbances. **Recap/Summary** of the Course (10 hours)
Course Outcomes: The students will be able to: CO1: Understand the design and analysis mechanisms for desired applications. CO2: Synthesize mechanisms using graphical and analytical method. CO3: Apply the tools of analytical dynamics with the main goal of developing mathematical models that describe the dynamics of systems of rigid bodies.
Question paper pattern: • **SEE** will be conducted for 100 marks. • **Part A:** First question with 20 MCQs carrying 1 mark each. • **Part B:** Each full question is for 16 marks. (Answer five full questions out of 10 questions with intra modular choice). In every question, there will be a maximum of three sub-questions. • **CIE** will be announced prior to the commencement of the course. • 25 marks for test. Average of three test will be taken. • 25 marks for Alternate Assessment Method.
Reference Books 1. K.J.Waldron&G.L.Kinzel , "Kinematics, Dynamics and Design of Machinery", Wiley India, 2007. 2. Greenwood, "Classical Dynamics", Prentice Hall of India, 1988. 3. J E Shigley, "Theory of Machines and Mechanism" -McGraw-Hill, 1995 4. A.G.Ambekar , "Mechanism and Machine Theory", PHI, 2007. 5. Ghosh and Mallick, "Theory of Mechanism and Mechanism", East West press 2007. 6. David H. Myszka, "Machines and Mechanisms", Pearson Education, 2005.

M.TECH. MACHINE DESIGN Choice Based Credit System (CBCS) SEMESTER - II			
Advanced Machine Design (4:0:0) 4 (Effective from the academic year 2021-22)			
Course Code	21MMD23	CIE Marks	50
Teaching Hours/Week (L:T:P)	4:0:0	SEE Marks	50
Total Number of Contact Hours	52	Exam Hours	3

Course objectives:

This course will enable students to:

1. Apply various modes of failure and explain various fatigue testing methods and machines
2. Estimate fatigue life by stress life and strain life approach
3. Apply linear elastic fracture mechanics
4. Apply cumulative damage and describe various cycle counting methods
5. Apply various contacts such as spherical, cylindrical and general contacts

Module – 1

Introduction: Role of failure prevention analysis in mechanical design, Modes of mechanical failure, Review of failure theories for ductile and brittle materials including Mohr‟ s theory and modified Mohr‟ s theory, Numerical examples. Fatigue of Materials: Introductory concepts, High cycle and low cycle fatigue, Fatigue design models, Fatigue design methods, Fatigue design criteria, Fatigue testing, Test methods and standard test specimens, Fatigue fracture surfaces and macroscopic features, Fatigue mechanisms and microscopic features

(10 hours)

Module – 2

Stress-Life(S-N) Approach: S-N curves, Statistical nature of fatigue Test data, General SN behavior, Mean stress effects, Different factors influencing S-N behaviour, S-N curve representation and approximations, Constant life diagrams, Fatigue life estimation using S- N approach. Strain-Life (ε-N)approach: Monotonic stress-strain behavior, Strain controlled test methods, Cyclic stress-strain behavior, Strain based approach to life estimation, Determination of strain life fatigue properties, Mean stress effects, Effect of surface finish, Life estimation by ε-N approach.

(12 hours)

Module – 3

LEFM Approach: LEFM concepts, Crack tip plastic zone, Fracture toughness, Fatigue crack growth, Mean stress effects, Crack growth life estimation.

Notches and their effects: Concentrations and gradients in stress and strain, S-N approach for notched membranes, mean Stress effects and Haigh diagrams, Numerical examples.

(10 hours)

Module – 4

Fatigue from Variable Amplitude Loading: Spectrum loads and cumulative damage, Damage quantification and the concepts of damage fraction and accumulation, Cumulative damage theories, Load interaction and sequence effects, Cycle counting methods, Life Estimation using stress life approach, Numerical examples.

Notch strain analysis: Strain– life approach, Neuber" s rule, Glinka" s rule, applications of Fracture mechanics to crack growth at notches, Numerical examples.

(12 hours)

Module – 5

Surface Failure: Introduction, Surface geometry, Mating surface, Friction, Abrasive wear, Corrosion wear. Surface fatigue: spherical contact, Cylindrical contact, General contact, Dynamic contact stresses, Surface fatigue strength, Surface fatigue failure modes, Design to avoid Surface failures. Recap/Summary of the Course

(8 hours)

Course outcomes:

The students will be able to

CO1 **:** Apply different state of the art design methodology and distinguish different design criteria to carry out design of mechanical components

CO2 **:** Analyse machine components which are subjected to fluctuating loads and using techniques like stress life approach, Strain

CO3 **:** Apply various statistical aspects of fatigue using different probability distribution plots and also explain the contact stresses and implementation of Hertz contact

CO4 **:** Apply surface failure mechanisms.

Question paper pattern:

- **SEE** will be conducted for 100 marks.
- **Part A:** First question with 20 MCQs carrying 1 mark each.
- **Part B:** Each full question is for 16 marks. (Answer five full questions out of 10 questions with intra modular choice).In every question, there will be a maximum of three sub-questions.
- **CIE** will be announced prior to the commencement of the course.
- 25 marks for test. Average of three test will be taken.
- 25 marks for Alternate Assessment Method.

Reference Books:

1. RalphI. Stephens,Ali Fatemi, Robert, Henryo. Fuchs, "Metal Fatigue in engineering", John Wiley New York, Second edition. 2001.
2. Jack.A. Collins, "Failure of Materials in Mechanical Design", John Wiley, New York 1992.
3. Robert.L.Norton , "Machine Design" , Pearson Education India, 2000
4. S.Suresh , " Fatigue of Materials", Cambridge University Press, -1998
5. Julie.A. Benantine, "Fundamentals of Metal Fatigue Analysis" , PrenticeHall,1990
6. ASM Hand Book "Fatigue and Fracture", Vol .19, 2002.

M.TECH. MACHINE DESIGN Choice Based Credit System (CBCS) SEMESTER – II			
Advanced Materials & Characterization (4:0:0) 4 (Effective from the academic year 2021-22)			
Course Code	20MMD24A1	CIE Marks	50
Teaching Hours/Week (L:T:P)	4:0:0	SEE Marks	50
Total Number of Contact Hours	52	Exam Hours	3

Course Objectives:

This course will enable students to:

1. Analyse advanced materials including nanomaterials and their processing with X-ray & morphological techniques
2. Apply the knowledge of electron microprobe analysis & AFM in preparation of samples for electron microscopic studies.
3. Analyse the concepts Fluorescence and Phosphorescence spectroscopy to perform TGA / DSC samples

Module – 1

Preamble: Nano Materials: Types of nanomaterials including carbon nanotubes and nanocomposites, Methods for creating nano structures, Processes for producing ultrafine powders - physical synthesis and chemical synthesis.

Smart Materials: Shape memory alloys, piezoelectric materials, electro rheological fluid, magneto rheological fluids.

Self-study: Physical and mechanical properties, and applications of advanced materials.

(10 Hours)

Module – 2

Diffraction Techniques: X-ray diffraction, Diffraction under non-ideal conditions. Atomic scattering and Geometrical structure factors. Factors influencing the intensities of diffracted beams. Powder X-ray diffractometer. Applications of XRD in ceramic materials

(10 Hours)

Module – 3

Microscopic Techniques: Study of the morphology, aggregation, size and microstructure of ceramic materials using. Optical microscope, quantitative phase analysis. Principle of electron microscopy. Construction and operation of Transmission Electron Microscope and Scanning Electron Microscope. Electron diffraction by crystalline solids; selected area diffraction

(10 Hours)

Module – 4

Spectrophotometric analysis of materials: Basic laws of spectrophotometry and its application in micro analysis in UV/ Visible range, effect of reflectance factor on optical analysis, construction and working principle of spectrophotometer, importance of additive absorbance's in multiple analysis of materials. Infrared spectrophotometry: General aspects of IR spectroscopy and its application in structural analysis of systems, sources of IR radiations, Optical systems and operation of FTIR spectrophotometers.

Self-study: Samples preparation, IR analysis and structural co-relations

(10 hours)

Module – 5

Fluorescence and Phosphorescence spectroscopy: Basic principle, geometrical optics, construction, working principle and use of fluorescence spectrometers in materials analysis. XRF and on-line analysis of ceramic materials. Electron Spin Resonance spectroscopy in ceramic systems. DTA, TGA and DSC with suitable examples of glass and ceramic materials.

Recap/Summary of the Course

(12 hours)

Course Outcomes: The students will be able to:

CO1: Analyse applications of nano, smart and advanced materials.

CO2: Apply the knowledge of surface morphology of the synthesised materials in understanding its characteristics.

CO3: Apply the concepts of fluorescence and phosphorescence spectroscopy in material analysis using DTA / TGA for thermal analysis.

Question paper pattern:

- **SEE** will be conducted for 100 marks.
- **Part A:** First question with 20 MCQs carrying 1 mark each.
- **Part B:** Each full question is for 16 marks. (Answer five full questions out of 10 questions with intra modular choice). In every question, there will be a maximum of three sub-questions.
- **CIE** will be announced prior to the commencement of the course.
- 25 marks for test. Average of three test will be taken.
- 25 marks for Alternate Assessment Method.

Reference Books:

1. D.R. Askeland, P.P.Phule, "The science and engineering of materials", 4th Edition, Thomson Publication, 2005.
2. AK Bandyopadhyay. "Nano Technology ",2nd Edition, New age international publishers.2010.
3. Yang Leng, "Materials Characterization: Introduction to Microscopic and Spectroscopic Methods", 1st Edition, Wiley & Sons ,2008.

1. R. K. Dogra and A. K. Sharma, "Advances in Material Science", S. K. Kataria and sons, 2003.
2. Sam Zhang, Lin Li and Ashok Kumar, "Materials Characterization Techniques", CRC Press, 2008
3. Van Black, "Elements of Materials science" 6th Edition, 2008.
4. Elton N. Kaufmann, Characterization of Materials, Vol.1, Wiley & Sons, 2003.
5. Peter E.J. Flewitt and R.K. Wild, Physical Methods of Materials Characterization, 2nd Edition, Taylor & Francis, 2003

M.TECH. MACHINE DESIGN
Choice Based Credit System (CBCS)
SEMESTER – II

Design Optimization (4:0:0) 4
(Effective from the academic year 2021-22)

Course Code	21MMD24A2	CIE Marks	50
Teaching Hours/Week (L:T:P)	4:0:0	SEE Marks	50
Total Number of Contact Hours	50	Exam Hours	3

Course Objectives:
This course will enable students to:
1. Understand the fundamentals of optimisation methods and their applications to manufacturing process and product design.
2. Learn optimisation models including design objectives, constraints and variables.
3. Learn appropriate optimisation techniques and programs.
4. Understand the limitations of solutions obtained from optimisation, and to use optimal design tools/software.

Module – 1

Engineering Design Practice: The Design Process, Engineering Design versus Engineering Analysis, Conventional versus Optimum Design Process, Optimum Design versus Optimal Control, Basic Terminology and Notation: Sets and Points, Notation for Constraints, Superscripts/Subscripts and Summation Notation, Norm/Length of a Vector, Functions
Applications of Optimization in Engineering Design: Automotive, Aerospace and General Industry Applications, Optimization of Metallic and Composite Structures,
Concept of Multi-Disciplinary Optimization (MDO) and Multi Objective Optimization (MOO)

(11 Hours)

Module – 2

Optimum Design Problem Formulation: Types of Optimization Problems, The Mathematics of Optimization, Design Variables and Design Constraints, Feasible and infeasible designs, Equality and Inequality Constraints, Discrete and Continuous Optimization, Linear and Non -linear Optimization, The Problem Formulation Process, Numerical Problems.
Graphical Optimization: Graphical Solution Process, Use of Mathematica for Graphical Optimization, Use of MATLAB for Graphical Optimization, Design Problem with Multiple Solutions Problem with Unbounded Solution, Infeasible Problem Graphical Solution for Minimum Weight Tubular Column Graphical Solution for a Beam Design Problem.

(10 Hours)

Module – 3

Optimization Theory–Fundamental Concepts, Global and Local Minimum, Gradient Vector and Hessian Matrix, Concept of Necessary and Sufficient Conditions, Constrained and Unconstrained Problems, Lagrange Multipliers and Kuhn Tucker Conditions.
Linear Programming Methods for Optimum Design: Definition of a Standard Linear Programming Problem, Basic Ideas and Steps of the Simplex Method, Two-Phase Simplex Method—Artificial Variables, Post-optimality Analysis, Duality in Linear Programming.

(9Hours)

Module – 4

Numerical Methods for Unconstrained Optimum Design, General Concepts Related to Numerical Algorithms, Basic Ideas and Algorithms for Step Size Determination, Steepest

Descent Method, Conjugate Gradient Method, Newton's Method, Modified Newton's Method, Marquardt Modification, Minimization of Total Potential Energy

Numerical Methods for Constrained Optimum Design: Basic Concepts and Ideas, Linearization of Constrained Problem, Sequential Linear Programming Algorithm, Quadratic Programming Subproblem, Constrained Steepest Descent Method

(9 hours)

Module – 5

Numerical Methods for Constrained Optimum Design: Potential Constraint Strategy, Quadratic Programming Problem, Approximate Step Size Determination, Constrained Quasi-Newton Methods, Other Numerical Optimization Methods,

Dynamic Programming: Introduction, Multistage decision processes, Principle of optimality, Computational Procedure in dynamic programming, Initial value problem, Examples.

Recap/Summary of the course (11 hours)

Course Outcomes: The students will be able to:

CO1: Apply decision-making methodologies to evaluate solutions for efficiency, effectiveness and sustainability.

CO2: Identify and apply relevant problem-solving methodologies.

CO3: Design components, systems and/ or processes to meet required specification.

CO4: Optimize an existing design with single or multiple objective functions.

Question paper pattern:

- **SEE** will be conducted for 100 marks.
- **Part A:** First question with 20 MCQs carrying 1 mark each.
- **Part B:** Each full question is for 16 marks. (Answer five full questions out of 10 questions with intra modular choice). In every question, there will be a maximum of three sub-questions.
- **CIE** will be announced prior to the commencement of the course.
- 25 marks for test. Average of three test will be taken.
- 25 marks for Alternate Assessment Method.

Reference Books:

1. Jasbir Arora, Introduction to Optimum Design, McGraw Hill, 2011,
2. S.S.Rao, Engineering Optimization: Theory and Practice, John Wiley, 2009,
3. K. V. Mital and C. Mohan, Optimization methods - New age International Publishers,
4. R.LFox, Optimization methods for Engg. Design - Addison – Wesley, 1971

M.TECH. MACHINE DESIGN
Choice Based Credit System (CBCS)
SEMESTER – II

Design of Robotic System (4:0:0) 4
(Effective from the academic year 2021-22)

Course Code	21MMD24A3	CIE Marks	40
Teaching Hours/Week (L:T:P)	4:0:0	SEE Marks	60
Total Number of Contact Hours	52	Exam Hours	3

Course Objectives:
This course will enable students to:
1. Have a keen knowledge on history of robotic system.
2. Familiarize the importance of automobile mobile robots.
3. Understand the concepts of filed robots & its applications.
4. Apply the knowledge of kinematics, dynamics, modelling to simulated underwater robots.
5. Apply the concepts sensors, actuators and modelling to design aerial robots.

Module – 1

History of Service Robotics: Present status and future trends – Need for service robots – applications examples and Specifications of service and field Robots. Non-conventional Industrial robots. Classification, applications, sensing and perception, social and ethical implications of robotics.

(10 Hours)

Module – 2

Autonomous Mobile Robots: Kinematics, locomotion, perception, motion planning and control, localization and mapping. Road map path planning, intelligent unmanned vehicles. Wheeled and legged, Legged locomotion and balance, Arm movement, Gaze and auditory orientation control, Facial expression, Hands and manipulation, Sound and speech generation, Motion capture/Learning from demonstration, Human activity recognition using vision, touch, sound, Vision, Tactile Sensing, Models of emotion and motivation. Performance, Interaction, Safety and robustness.

(11 Hours)

Module – 3

Field Robots: Collision Avoidance-Robots for agriculture, mining, exploration, underwater, civilian and military applications, nuclear applications, Space applications. Industrial applications like cleaning robots, wall painting robots, wall plastering robots, vehicle equipment and building robots etc Load carrying robots. IDE detection and diffusion robots.

(10 Hours)

Module – 4

Under Water Robots: Kinematics and dynamics, modelling and simulation, navigation, guidance and control. Marine data collection .

Nano Robots: Brief History of nanorobotics, types of nano robotics, Applications of nano robotics, The future of nano robots.

(11 hours)

Module – 5

Aerial Robots: Basics of aerial robots, sensors and actuators, modelling and control of small Unmanned Aerial vehicles, guidance and navigation of small range aerial robots, Autonomous indoor flight control Air defence robots.

Recap/Summary of the Course (10 hours)

Course Outcomes: The students will be able to:

CO1: Demonstrate knowledge of the relationship between mechanical structures of industrial robots and their operational workspace characteristics

CO2: Apply spatial transformation to obtain forward kinematics equation of robot manipulators

CO3: Solve inverse kinematics of simple robot manipulator.

CO4: Analyze robots for underwater application.

CO5: To select type of robot for specific application.

Question paper pattern:

- **SEE** will be conducted for 100 marks.
- **Part A:** First question with 20 MCQs carrying 1 mark each.
- **Part B:** Each full question is for 16 marks. (Answer five full questions out of 10 questions with intra modular choice). In every question, there will be a maximum of three sub-questions.
- **CIE** will be announced prior to the commencement of the course.
- 25 marks for test. Average of three test will be taken.
- 25 marks for Alternate Assessment Method.

Reference Books:

1. Roland Siegwart, Illah Reza Nourbakhsh, DavideScaramuzza, “Introduction to Autonomous Mobile Robots”, Bradford Company Scituate, USA, 2004.
2. RiadhSiaer, “The future of Humanoid Robots”- Research and applications, Intech Publications, 2012.
3. Constantinos Mavroidis, Antoine Ferreira, “Nano Robotics -Current Approaches and Techniques, Springer, New York, NY, 2013.
4. Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Eastern Economy Edition, Prentice Hall of India P Ltd., 2006.
5. Kelly, Alonzo; Iagnemma, Karl; Howard, Andrew, “Field and Service Robotics”, Springer, 2011.

M. TECH. MACHINE DESIGN
Choice Based Credit System (CBCS)
II SEMESTER

Mechatronics System Design (4:0:0) 4
(Effective from the academic year 2021-22)

Course Code	21MMD24A4	CIE Marks	50
Teaching Hours/Week (L:T:P)	4:0:0	SEE Marks	50
Total Number of Contact Hours	50	Exam Hours	3

Course Objectives:
This course will enable students to:
1. Describe the various types of sensors and Transducers.
2. Apply the concept of mathematical models to build various basic system models.
3. Analyse the various signal conditioning devices.
4. Choose the type of actuation devices required for a mechatronics system.

Module – 1

General Introduction: Significance and Scope of the Mechatronics course, Impact of Mechatronics on society and sustainable solutions, Career Perspective, Research in Mechatronics discipline.
Introduction: Mechatronics design process, System, Measurement system, Elements of measurement system, Control system – Open and Closed loop control system, Elements of open loop and closed loop control system, Microprocessor based control systems – Automatic washing machine, Automatic camera.
Study of sensors and transducers: Definition of transducers and Sensors, Differences between Transducers and Sensors, Performance terminologies, Classification of Transducers and Sensors, Hall effect sensors, Proximity sensors, Light sensors, Temperature sensors, Fluid pressure sensors, Fluid flow sensors, Selection of Sensors.
(11 Hours)

Module – 2

Signal Conditioning: Signal conditioning, the operational amplifier, Characteristic features of OpAmps, Pin configuration of OpAmps, Types of operational amplifiers, protection, filtering, Wheatstone bridge.
Digital signals: Analog and Digital signals, Analog to Digital and Digital to Analog converters, Multiplexers, Data Acquisition, Introduction to digital system processing, Pulse-modulation.
(9 Hours)

Module – 3

Mechanical Actuation System: Mechanical systems, Types of Motion, Kinematic chains, Cams, Gears and Gear drives, Belt and Chain drive system, Bearings.
Electrical Actuation System: Electrical systems, DC/AC Motors, Principle of Stepper Motors & servomotors.
Hydraulic and Pneumatic Actuation Systems: Elements of Hydraulic and Pneumatic systems, Valves – Introduction and Classifications, Direction Control Valves, Flow Control Valves, Pressure Control Valves. Single acting cylinders – Operation and Control, Double acting cylinders – Operation and Control.
(10 Hours)

Module – 4

Basic System Models: Mathematical models, Mechanical system building blocks, Electrical system building blocks, Hydraulic system building blocks, Pneumatic system building blocks and Thermal system building blocks. System models – Engineering systems, Rotational – translational systems.

(9 hours)

Module – 5

Fault finding in Mechatronics systems: Fault detection techniques, Faults in microprocessor systems, Fault finding techniques, Systematic fault-location methods, Emulation and simulation.

Advances in Mechatronics system: Case studies - A pick-and-place robot, Car Park barriers, Automotive control systems, Design for manufacturing, User- friendly design.

Recap/Summary of the Course

(11 hours)

Course Outcomes: The students will be able to:

CO1: Illustrate various components of Mechatronics systems

CO2: Interpret various sensors & Transducers to build a mechatronic system

CO3: Analyse the system models considering the Mechanical, Electrical, Thermal, Hydraulic and Pneumatic Actuation systems.

CO4: Design of mechatronics systems using Signal conditioning devices

Question paper pattern:

- **SEE** will be conducted for 100 marks.
- **Part A:** First question with 20 MCQs carrying 1 mark each.
- **Part B:** Each full question is for 16 marks. (Answer five full questions out of 10 questions with intra modular choice). In every question, there will be a maximum of three sub-questions.
- **CIE** will be announced prior to the commencement of the course.
- 25 marks for test. Average of three test will be taken.
- 25 marks for Alternate Assessment Method.

Reference Books:

1. W.Bolton, "Mechatronics – Electronic Control Systems in Mechanical and Electrical Engineering", 3rd Edition, Pearson Education, 2003.
2. Nitaigour Premchand Mahalik, "Mechatronics-Principles, Concepts and Applications", 1st Edition, Tata McGraw Hill, 2003.
3. Anthony Esposito, "Fluid Power", 6th Edition, Pearson Education, 2011.
4. Shetty and Kolk, "Mechatronics System Design", Cengage Learning, 2010.

M.TECH. MACHINE DESIGN Choice Based Credit System (CBCS) SEMESTER – II			
Experimental Mechanics (4:0:0) 4 (Effective from the academic year 2021-22)			
Course Code	21MMD25B1	CIE Marks	50
Teaching Hours/Week (L:T:P)	4:0:0	SEE Marks	50
Total Number of Contact Hours	52	Exam Hours	3

Course Objectives:

This course will enable students to:

1. Analysing the techniques of Data Acquisition, Signal conditioning and processing.
2. To introduce students to different aspects of measuring deformation, strains, and stresses for developing a mechanistic understanding of both the material and the structure behaviour.
3. Applying the knowledge of experimental techniques employing strain gauges, photo elasticity, Moiré-interferometry, brittle coating, Moiré fringes and holography.

Module – 1

Preamble: Definition of terms, calibration, standards, dimensions, and units, generalized measurement system, Basic concepts in dynamic measurements, system response, distortion, impedance matching, experiment planning. Economical and reliability importance of experimentation.

Analysis of Experimental Data: Cause and types of experimental errors, error analysis. Statistical analysis of experimental data-probability distribution, Gaussian, Normal distribution. Chi-square test, method of least square, correlation coefficient, multivariable regression, general consideration in data analysis.

Self-study: standard deviation of mean, graphical analysis and curve fitting.

(10 Hours)

Module – 2

Data Acquisition and Processing: General data acquisition system, signal conditioning revisited, data transmission, Analog-to-Digital and Digital-to-Analog conversion. Basic components (storage and display) of data acquisition system. Computer program as a substitute for wired logic.

Force, Torque and Strain Measurement: Mass balance measurement, elastic element for Force measurement, torque measurement. Strain gages strain sensitivity of gage metals, Gage construction, gage sensitivity and gage factor, performance characteristics, environmental effects, Strain gage circuits, Potentiometer, Wheat Stone's bridges, Constant current circuits.

Self-study: Strain analysis methods-two element and three element, rectangular and delta rosettes, correction for transverse strains effects, stress gage- plane shear gage, stress intensity factor gage.

(10 Hours)

Module – 3

Stress Analysis: Two-Dimensional Photoelasticity-nature of light, -wave theory of light-optical interference-Polariscopes stress optic law effect of stressed model in plane and circular polariscopes, Isoclinics, Isochromatics fringeorder determination-Fringe multiplication techniques- Calibration photoelastic model materials. Separation methods shear difference method, Analytical separation methods, Model to prototype scaling.

(10 Hours)

Module – 4
Three-Dimensional Photoelasticity: Stress freezing method, General slice, Effective stresses, Stresses separation, Shear deference method, Oblique incidence method, secondary principal stresses, scattered light photoelasticity, Polariscope and stress data analyses. (10 hours)
Module – 5
Coating Methods: a) Photoelastic Coating Method-Birefringence coating techniques, Sensitivity Reinforcing and thickness effects-data reduction-Stress separation techniques, Photoelastic strain gauges. b) Brittle Coatings Method: Brittle coating technique Principle's data analysis coating materials, Coating techniques. c) Moire Technique-Geometrical approach, Displacement approach-sensitivity of Moire data reduction, In plane and out plane Moire methods, Moire photography, Moire grid production. **Holography:** Introduction, Equation for plane waves and spherical waves, Intensity, Coherence, Spherical radiator as an object (record process), Hurter, Driffeld curves, Reconstruction process, Holographic interferometry, Real time and double exposure methods, Displacement measurement, Isopachics. **Recap/Summary** of the Course (12 hours)
Course Outcomes: The students will be able to: CO1: Applying the knowledge of strain gages to take measurements, and analyse the obtained data. CO2: Apply photo elasticity principal for strain measurement viz, stress freezing, and Moirés method. CO3: Apply the principles and techniques of holographic interferometry.
Question paper pattern: • **SEE** will be conducted for 100 marks. • **Part A:** First question with 20 MCQs carrying 1 mark each. • **Part B:** Each full question is for 16 marks. (Answer five full questions out of 10 questions with intra modular choice). In every question, there will be a maximum of three sub-questions. • **CIE** will be announced prior to the commencement of the course. • 25 marks for test. Average of three test will be taken. • 25 marks for Alternate Assessment Method.
Reference Books: 1. Holman, "Experimental Methods for Engineers", 7th Edition, Tata McGraw-Hill Companies, Inc., New York, 2007. 2. R. S. Sirohi, H. C. Radha Krishna, "Mechanical measurements" 1st edition, New Age International Pvt. Ltd., New Delhi, 2004. 3. Srinath, Lingaiah, Raghavan, Gargesa, Ramachandra and Pant, "Experimental Stress Analysis", 1st edition, Tata McGrawHill, 1984. 4. Doeblin E. A., "Measurement Systems Application and Design", 4th (S.I.) Edition, McGraw Hill, NewYork. 1989 5. Montgomery D. C., "Design and Analysis of Experiments", 1st edition, John Wiley & Sons, 1997. 6. Dally and Riley, "Experimental Stress Analysis" 1st edition, McGraw Hill, 1991

M. TECH. MACHINE DESIGN
Choice Based Credit System (CBCS)
II SEMESTER

Theory of Plates and shells (4:0:0) 4
(Effective from the academic year 2021-22)

Course Code	21MMD25B3	CIE Marks	50
Teaching Hours/Week (L:T:P)	4:0:0	SEE Marks	50
Total Number of Contact Hours	52	Exam Hours	3

Course Objectives:
This course will enable students to:
1. Understand the bending of cylindrical surfaces.
2. Describe the various concepts using to analyse the rectangular plates.
3. Develop the pure bending equations for circular and rectangular plates
4. Apply the concept of Navier and Levy approach to analyse the plates

Module – 1

Bending of long rectangular plate into a cylindrical surface: Differential equation - Bending of plates with different boundary conditions - Long plate on elastic foundation.
Pure Bending: Moment and curvature relations problems of simply supported plates-Strain energy impure bending

(10 Hours)

Module – 2

Rectangular Plates: Differential equations - Solution of simply supported plate Various loading conditions, viz, uniformly distributed load, hydrostatic pressure and concentrated load, central as well as non-central, Navier and Levy type solutions with various edge boundary conditions, viz., all edges simply supported, Two opposite edge fixed and two adjacent fixed.

(10 Hours)

Module – 3

Symmetrical Bending of Circular Plates: Differential equation uniformly loaded plates, Plates concentricity loaded plates- loaded at the centre.
Symmetrical Bending of Rectangular Plates: Bending of plate under combined action of lateral and transverse loads derivation of differential equation, simply supported rectangular plate.

(12 Hours)

Module – 4

Introduction to Shell Structures - General description of various types. Membrane Theory of thin shells (Stress Analysis): Cylindrical shells - Spherical Shells- Shells of double curvature, Viz, cooling tower Hyperbolic, Parabolic and elliptic paraboloid.

(10 hours)

Module – 5

Membrane Deformation of Shells: Symmetrical 'loaded shell, symmetrically loaded spherical shell. General Theory of cylindrical shells: Circular; Cylindrical shell loaded symmetrically. **General equation of circular cylindrical shells**. Approximate investigation of: bending of circular cylindrical shell.
Recap/Summary of the Course

(10 hours)

Course Outcomes: The students will be able to:

CO1: Apply the principles of stress to solve the problems plates and structures.

CO2: Analyze the rectangular plates and structures using Navier and Levy approach.

CO3: Develop pure bending equations for plates and structures.

Question paper pattern:

- **SEE** will be conducted for 100 marks.
- **Part A:** First question with 20 MCQs carrying 1 mark each.
- **Part B:** Each full question is for 16 marks. (Answer five full questions out of 10 questions with intra modular choice). In every question, there will be a maximum of three sub-questions.
- **CIE** will be announced prior to the commencement of the course.
- 25 marks for test. Average of three test will be taken.
- 25 marks for Alternate Assessment Method.

Reference Books:

1. Timoshenko, Woinowsky and Krieger," Theory of Plates and Shells", McGraw Hill, Newyork.
2. Ansel C Ugural, "Stresses in Plates and Shells", McGraw Hill, 3rd ed, 1985.
3. Wilhelm Flugge, "Stresses in Shells", Springer Verlag, Berlin, 1990.
4. Goldnvizer, "Theory of Elastic Thin Shells", Pergamon Press, New York.
5. R. Szilard, "Theory and Analysis of Plates", Prentice hall, 2004.

M.TECH. MACHINE DESIGN
Choice Based Credit System (CBCS)
SEMESTER – II

Computer Applications in Design (4:0:0) 4
(Effective from the academic year 2021-22)

Course Code	21MMD25B4	CIE Marks	50
Teaching Hours/Week (L:T:P)	4:0:0	SEE Marks	50
Total Number of Contact Hours	52	Exam Hours	3

Course Objectives:
This course will enable students to:
1. To understand the concepts and tools of computer applications as used in engineering profession.
2. To learn the principles of CAD/CAM/CAE Systems, Graphics programming, Geometric Modeling Systems, CAD, CAM and CAE Integration, and standards for Communicating between Systems.
3. To use technically correct curves that is common to and useful for visualization and problem-solving mechanical engineering.

Module – 1

CAD/CAM/CAE Systems: Integrating the Design and Manufacturing Processes through a Common Database- A Scenario, Using CAD/CAM/CAE Systems for Product Development-A Practical Example.
Components of CAD/CAM/CAE Systems: Hardware Components, Vector-Refresh (Stroke-
Refresh) Graphics Devices, Raster Graphics Devices, Hardware Configuration, Software Components, Windows-Based CAD Systems.

(10 Hours)

Module – 2

Basic Concepts of Graphics Programming: Graphics Libraries, Coordinate Systems, Window and Viewport, Output Primitives - Line, Polygon, Marker Text, Graphics Input, Display List, Transformation Matrix, Translation, Rotation, Mapping, Other Transformation Matrices, Hidden-Line and Hidden-Surface Removal, Back-Face Removal Algorithm, Depth-Sorting, or Painters, Algorithm, Hidden-Line Removal Algorithm, z-Buffer Method, Rendering, Shading, Ray Tracing, Graphical User Interface, X Window System.
Standards for communicating Between Systems: Exchange Methods of Product Definition Data, Initial Graphics Exchange Specification, Drawing Interchange Format, Standard for the Exchange of Product Data. Tutorials, Computational exercises involving Geometric Modeling of components and their assemblies.

(10 Hours)

Module – 3

Geometric Modeling Systems: Wireframe Modeling Systems, Surface Modeling Systems, Solid Modeling Systems, Modeling Functions, Data Structure, Euler Operators, Boolean Operations, Calculation of Volumetric Properties, Non manifold Modeling Systems, Assembly Modeling Capabilities, Basic Functions of Assembly Modeling, Browsing an Assembly, Features of Concurrent Design, Use of Assembly models, Simplification of Assemblies, Web-Based Modeling.

(10 Hours)

Module – 4
Representation and Manipulation of Curves: Types of Curve Equations, Conic Sections, Circle or Circular Arc, Ellipse or Elliptic Arc, Hyperbola, Parabola, Hermite Curves, Bezier Curve, Differentiation of a Bezier Curve Equation, Evaluation of a Bezier Curve. B-Spline curve, evaluation of a B-Spline Curve, composition of B-Spline Curves, differentiation of a B-Spline curve, Non uniform Rational B-Spline (NURBS) Curve, evaluation of a NURBS curve, Differentiation of a NURBS curve, interpolation curves, Interpolation using a Hermite curve, Interpolation using a B-Spline curve, intersection of curves. (10 hours)
Module – 5
CAD and CAM Integration: Overview of the Discrete Part Production Cycle, Process Planning, Manual Approach, Variant Approach, Generative Approach, Computer- Aided Process Planning Systems, CAM-ICAPP, MIPLAN and Multi CAPP, Met CAPP, ICEMPART, Group Technology, Classification and Coding, existing Coding Systems, Product Data Management (PDM) Systems. **Summary** of computer applications in design. (12 hours)
Course Outcomes: The students will be able to: **CO 1:** Understand computer-based system, process, component, or program to meet desired needs. **CO 2:** Apply the knowledge of geometric modeling systems and curves to solve CAD and CAM. **CO 3:** Discriminate the generation of various curves used in geometric modeling. **CO 4:** Interpret the given case study material related to the application of cad/cam.
Question paper pattern: • **SEE** will be conducted for 100 marks. • **Part A:** First question with 20 MCQs carrying 1 mark each. • **Part B:** Each full question is for 16 marks. (Answer five full questions out of 10 questions with intra modular choice). In every question, there will be a maximum of three sub-questions. • **CIE** will be announced prior to the commencement of the course. • 25 marks for test. Average of three test will be taken. • 25 marks for Alternate Assessment Method.
Reference Books: 1. Kunwoo Lee, "Principles of CAD/CAM/CAE systems"-Addison Wesley, 1999 2. Radhakrishnan. P., "CAD/CAM/CIM"-New Age International, 2008 3. Bedworth, Mark Henderson & Philip Wolfe, "Computer Integrated Design and Manufacturing" -McGraw hill Inc., 1991. 4. Ibrahim Zeid, "CAD/CAM – Theory & Practice", McGraw Hill, 1998. 5. Pro-Engineer, Part modeling Users Guide, 1998

M.TECH. MACHINE DESIGN
Choice Based Credit System (CBCS)
SEMESTER – II

Vibration and Thermal Analysis Lab (0:0:3) 1.5
(Effective from the academic year 2020-21)

Course Code	20MMD26	CIE Marks	50
Teaching Hours/Week (L:T:P)	0:0:3	SEE Marks	50
Total Number of Contact Hours	40	Exam Hours	3

Course objectives:
This course enables students to:
1. Carryout vibration and thermal analysis of structural components using FEM
2. Carryout vibration analysis of various components using FEA package.
3. Compute and thermal analysis of different materials using FEA package.

List of Experiments

PART A

1. **Modal Analysis**
   Modal analysis of a prestressed structure plate with a hole.

2. **Harmonic Analysis**
   Determine the harmonic response of a steel beam carrying with minimum two members mounted on beam considering damping ratio.

3. **Transient Analysis**
   Determine the transient response of a steel beam considering damping ratio

4. **Random Vibration**
   Determine the displacements and stresses of the plate.

PART B

5. **Thermal analysis**
   Part A: Square Plate with Temperature Prescribed on one edge and opposite edge insulated.
   Part B: A Thick Square Plate with the Top Surface exposed to a Fluid at high temperature, Bottom Surface at room temperature, Lateral Surfaces Insulated.

6. **Thermal Analysis of composite wall**
   Part A: Heat transfer per unit area through composite wall with temperature Prescribed on one edge and opposite edge insulated.
   Part B: A Heat transfer per unit area through composite wall with one surface exposed to a Fluid at high temperature and other Surface at room temperature.

7. **Thermal Stress Analysis**
   Part A: A Thick-Walled Cylinder with specified Temperature at inner and outer Surfaces.
   Part B: A Thick-Walled Cylinder filled with a Fluid at high temperature and Outer Surface exposed to atmosphere.

8. **Thermo-Mechanical Analysis of Bimetallic strip**

Part A: Square Plate with Temperature Prescribed on one edge and Opposite edge insulated.

Part B: A Thick Square Plate with the Top Surface exposed to a Fluid at high temperature, Bottom Surface at room temperature, Lateral Surfaces Insulated.

Course outcomes:

The students will be able to:

CO1: Apply the FEM Knowledge to carry out the vibration and thermal analysis

CO2: Analyse the problems to evaluate primary variables under different boundary conditions.

CO3: Demonstrate skills in use of reputed commercial finite element analysis package.

C04: Present the results in the form of a technical report.

Examination pattern:

- These are independent laboratory exercises.
- Student must submit a comprehensive report on the problems solved and give a presentation on the same for Internal Evaluation.
- Any one of the experiments from each part done has to be set in the examination for conduction and evaluation.

M.TECH. MACHINE DESIGN Choice Based Credit System (CBCS) SEMESTER – II			
Simulation and Failure Analysis Lab (0:0:3) 1.5 (Effective from the academic year 2021-22)			
Course Code	21MMD27	CIE Marks	50
Teaching Hours/Week (L:T:P)	0:0:3	SEE Marks	50
Total Number of Contact Hours	40	Exam Hours	3

Course objectives:

This course enables students to:

1. Correlate the experimental and numerical results.
2. Carryout simulation of various real time Problems using MATLAB.
3. Carryout Vibration analysis of various components using FEA package
4. Solve and simulate real-time problems for stress, vibration and failure in different machine components

List of Experiments

PART A

1. **Numerically Calculation and MATLAB Simulation.**
   Part A: Invariants, Principal stresses and strains with directions
   Part A: Maximum shear stresses and strains and planes, Von-Mises stress
   Part C: Calculate and Plot Stresses in Thick-Walled Cylinder

2. **Torsion of Prismatic bar with Rectangular cross-section.**
   Part A: Elastic solutions, MATLAB Simulation
   Part B: Finite Element Analysis of any chosen geometry.
   Part C: Correlation studies.

3. **Vibration Characteristics of a Spring Mass Damper System.**
   Part A: Analytical Solutions.
   Part B: MATLAB Simulation.
   Part C: Correlation Studies

4. **Modelling and Simulation of Control Systems using MATLAB**.

PART B

4. **Experimental analysis of vibration of machines**
   Part A: Vibration Measurement of any two components
   Part B: Analysis of measured vibration.

5. **Fatigue testing of various materials**
   Part A: Fatigue test of different materials.
   Part B: Correlation of endurance strength with the available data.

Course outcomes:

The students will be able to:

CO1: Apply the knowledge of MATLAB program to simulate different problems.
CO2: Analyse the analyse the vibration problems.
CO3: Evaluate the stress, vibration and failure in different machine components
C04: Present the results in the form of a technical report.

Examination pattern:

- These are independent laboratory exercises.
- Student must submit a comprehensive report on the problems solved and give a presentation on the same for Internal Evaluation.
- Any one of the experiments from each part done has to be set in the examination for conduction and evaluation.

M.TECH. MACHINE DESIGN Choice Based Credit System (CBCS) SEMESTER –II			
Technical Seminar (2:0:0) 2 (Effective from the academic year 2021-22)			
Course Code	21MMD28	CIE Marks	50
Teaching Hours/Week (L:T:P)	0:0:2	SEE Marks	--
Total Number of Contact Hours	--	Exam Hours	--

Course Objectives:

The objective of the seminar is to inculcate self-learning, face audience confidently, enhance communication skill, involve in group discussion and present and exchange ideas. Each student, under the guidance of a faculty, is required to

- Choose, preferably through peer reviewed journals, a recent topic of his/her interest relevant to the Course of Specialization.
- Carryout literature survey, organize the Course topics in a systematic order.
- Prepare the report with own sentences.
- Type the matter to acquaint with the use of Micro-soft equation and drawing tools or any such facilities.
- Present the seminar topic orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of Reference Books.

Marks distribution for CIE of the course: Technical Seminar(21MMD28)

Seminar Report: **10 marks**

Presentation skill: **30 marks**

Question and Answer:**10 marks**

- The CIE marks for the seminar shall be awarded (based on the relevance of the topic, presentation skill, participation in the question-and-answer session and quality of report) by the committee constituted for the purpose by the Head of the Department.
- The committee shall consist of three faculties from the department with the senior most acting as the Chairperson.