FIRST SEMESTER WITH EFFECT FROM 2019-20
MTMD 101 THEORY OF ELASTICITY AND PLASTICITY

Periods per week : 4   Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs.   Credits : 3

Elasticity: Two dimensional stress analysis - Plane stress - Plane strain - Equations of compatibility - Stress function - Boundary conditions.
Problem in rectangular coordinates - Solution by polynomials - Saint Venent's principles - Determination of displacement - Simple beam problems.
Problems in polar coordinates - General equations in polar coordinates - Stress distribution symmetrical about axis - Strain components in polar coordinates - Simple and symmetric problems.
Analysis of stress and strain in three dimensions - Principle stresses - Homogeneous deformations - Strain spherical and deviatoric stress - Hydrostatic strain.
General theorems: Differential equations of equilibrium and compatibility - Displacement - Uniqueness of solution - Reciprocal theorem.
Bending of prismatic bars - Stress function - Bending of cantilever beam - Beam of rectangular cross-section - Beams of circular cross-section.
Plasticity: Plastic deformation of metals - Structure of metals - Deformation - Creep stress relaxation of deformation - Strain rate condition of constant maximum shear stress - Condition of constant strain energy - Approximate equation of plasticity.
Methods of solving practical problems - The characteristic method - Engineering method - Compression of metal under press - Theoretical and experimental data drawing.

References:
1. Theory of Elasticity by Timoshenko, S.P. and Goodier, J.N./Koakusha Publishers
2. An Engineering Theory of Plasticity by E.P. Unksov/Butterworths
3. Applied Elasticity by W.T. Wang.
4. Theory of Plasticity by Hoffman and Sacks.
5. Theory of Elasticity and Plasticity/Sadhu Singh/ Khanna Publishers
   6. Theory of Elasticity and Plasticity/Harold Malcolm Westergaard/Harvard University Press

FIRST SEMESTER WITH EFFECT FROM 2019-20
MTMD 102 ADVANCED MECHANICS OF SOLIDS

Periods per week : 4   Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs.   Credits : 3

Flat plates: Introduction - Stress resultants in a flat plate - Kinematics: Strain - Displacement relations for plates - Equilibrium equations for small displacement theory of flat plates - stressstrain- temperature relations for isotropic elastic plates - Strain energy of a plate - Boundary conditions for plates - Solutions of rectangular and circular plate problems.
Torsion: Torsion of cylindrical bar of circular cross-section Saint-Venant's semi-inverse method - Linear elastic solution - The Prandtl elastic - Membrane (soap-film) analogy - Narrow rectangular cross-section - Hollow thin-wall torsion members: Multiply connected cross-section - Thin-wall torsion members with restrained ends - Fully plastic torsion.
Beams on elastic foundation: General theory - Infinite beam subjected to concentrated load: Boundary conditions - Infinite beam subjected to a distributed load segment - Semi-infinite beam subjected to loads of its end - Semi-infinite beam with concentrated load near its end - Short beams - Thin-wall circular cylinders.
Stress concentrations: Basic concepts - Nature of a stress concentration problem. Stress concentration factor - Stress concentration factor. Theory of elasticity - Stress concentration factors. Experimental techniques - Stress gradients due to concentrated load - The stationary crack - Crack propagation. Stress intensity factor. Effective stress concentration factor: Applications - Stress concentration factor. Combined loads - Effective stress concentration factors - Effective stress concentration factors. Repeated loads - Effective stress concentration factors - Other influences - Effective stress concentration factors - In-elastic strains.
Contact stresses: Introduction - The problem of determining contact stresses - Assumptions on which a solution for contact stresses is based - Notation and meaning of terms - Expressions for principal stresses - Method of computing contact stresses - Deflection of bodies in point contact - Stress for two bodies in contact over narrow rectangular area (line contact). Loads normal to area - Stresses for two bodies in line contact. Loads normal and tangent to contact area.

References:
1. Advanced Mechanics of Materials by Boresi, A.P. and Sidebottm, O.M.
2. Advanced Mechanics of Materials by Seely and Smith.
3. Advanced Strength of Materials by Den Hartog.
4. Advanced Strength of Materials by Timoshenko S.P.
5. Advanced strength of materials / Den Hortog J.P./Torrent
6. Theory of Plates /Timoshenko
7. Strength of materials / Sadhu singh/ Khanna Publishers
8. Mechanics of Materials / Beer & Jhonson / McGraw Hill
9. Theory of Plates & Shells / Timoshenko/ McGraw Hill/ 2nd Edition

MTMD 103 ADVANCED MECHANICS OF MACHINERY

Periods per week : 4   Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs.   Credits : 3

Kinematics of complex mechanisms - Complex mechanisms, Low and high degree of complexity, Goodman's indirect acceleration analysis, Method of normal accelerations, Hall and Ault's auxiliary point method, Carter's method and comparison of methods.
Advanced kinematics of plane motion - The inflexion circle - Euler-Savary equation, Analytical and graphical determination of diameter of inflection circle - Bobbileier's construction, Collineation axis - Hartman's construction, Application of inflection circle to kinematic analysis - Polode curvature - General case and special case, Polode curvature in the four-bar mechanism - Coupler motion, Relative motion of the output and input links, Freudenstein's collineation axis theorem - Carter Hall circle, Circling-point curve (general case).
Introduction to synthesis (graphical methods) guiding a point through two, three and four distinct positions - Burmaster's curve, Function generation - Overlay's method, Path generation - Robert's theorem.
Introduction to synthesis (analytical methods) - Freudenstein's equation - Precision point approximation - Precision derivative approximation - Method of components - Block synthesis and Reven's method.
Forces in mechanisms - Free body diagrams - Friction in link connections - Forces in linkages.
Cam dynamics - Forces in rigid systems, Mathematical models, Response of a uniform - Motion undamped cam mechanism - Analytical method, Follower response by phase - Plane method - Position error, Jump, Crossover shock - Johnson's numerical analysis.

References:
1. Kinematics and Dynamics of Plane Mechanisms by J. Hirschhorn, McGraw Hill Book Co., 1962.
2. Theory of Machines and Mechanisms/ J.E Shigley and J.J . Uicker Jr./ McGraw-Hill, 1995
3. Theory of Mechanisms and Machines/ Amitabh Ghosh and Ashok Kumar Mallik/ E.W.P.Publishers.
4. Kinematics and Linkage Design/ Allen S.Hall Jr./ PHI,1964.
5. Kinematics and Dynamics of Machinery/Charles E Wilson/Pearson/3rd Edition

MTMD 104 MECHANICAL VIBRATIONS

Periods per week : 4   Examination : 70 ; Sessionals : 30

Fundamentals and Basic Concepts of Mechanical Vibrations: Introduction to Mechanical Vibrations-Definitions-Main Causes of Vibration-Elements of Vibratory System-Mathematical Models-Simple Harmonic Motion-Phenomena of Beats-Equivalent Springs and Dashpots when it is in series and parallel.

Free Vibrations of Single degree freedom systems -Introduction - Single degree freedom systems –Derivation of Differential Equation of Motion for Undamped free vibrations – Rayleigh's energy method-Different types of Damping- Derivation of Differential Equation of Motion for damped free vibrations- Logarithmic decrement-Viscous Dampers-Dry friction or Coulomb Damping.

Forced Vibrations of Single degree freedom systems -Introduction to forced vibration-Derivation of Differential Equation of Motion for Undamped and Damped vibrations –Force vibration with rotating and Reciprocating unbalance- Force vibration due to excitation of the support-Energy Dissipated by Damping- Vibration Isolation and transmissibility –Vibration Measuring Instruments.

Two degree freedom systems – Introduction-Principal modes of Vibration-Simple two degree freedom systems- Combined rectilinear angular modes-systems with damping-Vibration absorbers-Vibration isolation.

Multi degree freedom systems exact Analysis: Introduction- Free Vibrations Equations of motions-Influence coefficients-Generalized coordinates and coordinate coupling-Natural frequencies and mode shapes-Orthogonal properties of normal modes-Modal Analysis -Forced Vibration by matrix inversion-Torsional vibrations of multi rotor system-Continuous systems.

Multi degree freedom systems Numeral Methods: Introduction-Rayleigh's method-Dunkerley's method-Stodool's method- Rayleigh-Ritz method- Method of Matrix iteration-Holzers method.

Critical speeds of Shafts: Introduction- Critical speeds of a light shaft having a single disc with and without damping- Critical speeds of a shaft having multiple discs-Secondary Critical Speed-Critical speeds of a light cantilever shafts with a large heavy disc at its ends.

Transient Vibration: Introduction-Laplace transformation-Response to an impulsive input, Step input, Pulse input-phase Plane method-Shock spectrum

References:

1. Mechanical Vibrations/G.K.Groover/Nem Chand and Bros
2. Mechanical Vibrations / SS Rao/ Pearson/ 2009, Ed 4
3. Mechanical Vibrations by Den Hartog.
4 Mechanical Vibrations by R.Venkatachalam
5. Elements of Vibration Analysis by Meirovitch, TMH, 2001
6. Mechanical Vibrations/Schaum Series/ McGraw Hill
7. Vibration Problems in Engineering by Timoshenko and Young.
8. Mechanical Vibrations/Debabrata Nag/Wiley
9. Mechanical Vibrations and Noise engineering/ A.G.Ambekar/ PHI
10.Theory and Practice of Mechanical Vibrations/JS Rao & K. Gupta/New Age Intl.
Publishers/Revised 2nd Edition
11. Mechanical Vibrations by A.H. Church.

FIRST SEMESTER WITH EFFECT FROM 2019-20
MTMD 105 ADVANCED OPTIMIZATION TECHNIQUES

Periods per week : 4   Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs.   Credits : 3

Geometric programming (G.P): Solution of an unconstrained geometric programming, differential calculus method and arithmetic method. Primal dual relationship and sufficiency conditions. Solution of a constrained geometric programming problem (G.P.P), Complementary Geometric Programming (C.G.P)

Dynamic programming(D.P): Multistage decision processes. Concepts of sub optimization and Principal of optimality, computational procedure in dynamic programming calculus method and tabular methods. Linear programming as a case of D.P. and continuous D.P.

Integer programming(I.P): Graphical representation. Gomory's cutting plane method. Bala's algorithm for zero-one programming problem. Branch-and-bound method, Sequential linear discrete Programming, Generalized penalty function method.

Stochastic Programming (S.P): Basic Concepts of Probability Theory, Stochastic Linear programming.

Non-traditional optimization techniques: Multi-objective optimization - Lexicographic method, Goal programming method, Genetic algorithms, Simulated annealing, Neural Networks based Optimization.

References:
1. Operations Research- Principles and Practice by Ravindran, Phillips and Solberg, John Wiely
2. Introduction to Operations Research by Hiller and Lieberman, Mc Graw Hill
3. Engineering Optimization - Theory and Practice by Rao, S.S., New Age International (P) Ltd. Publishers.
4. Engineering Optimization By Kalyanmanai Deb, Prentice Hall of India, New Delhi.
5. Genetic Algorithms - In Search, Optimization and Machine Learning by David E. Goldberg, Addison-Wesley Longman (Singapore) Pvt. Ltd.

FIRST SEMESTER WITH EFFECT FROM 2019-20
MTMD 106 Elective Subject - I
A) DESIGN AND ANALYSIS OF EXPERIMENTS

Periods per week : 4   Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs.   Credits : 3

Fundamentals of Experimentation: Role of experimentation in rapid scientific progress, historical perspective of experimental approaches , Steps in experimentation, principles of experimentation

Simple Comparative Experiments: Basic concepts of probability & statistics, comparison of two means and two variances.

Experiments with Single Factor: ANOVA, fixed effects model, model adequacy checking, determining sample size, randomized complete block design(RCBD), Statistical Analysis of RCBD.

Introduction to Factorial Designs: Two factor factorial design, general factorial design, 2^k factorial design, general 2^k design, single replicate of 2^k design, the addition of centre point to 2^k design.

Two-level Fractional Factorial Designs: Blocking and confounding, one half fraction of the 2^k design, one quarter fraction of the 2^k design, resolution III,IV and V designs.

Response Surface Methodology: Concept, linear model, steepest ascent, second order model, regression.

Taguchi's Parameter Design: Concept of robustness, noise factor, objective function & S/N ratios , inner array& outer array design, data analysis.

References:
1. Montgomery DC, Design and Analysis of Experiments, 7th Edition, John Wiley &
Sons, NY, 2008.
2. Ross P J , Taguchi techniques for Quality Engineering, McGraw-Hill Book Company,
NY, 2008
3. Taguchi G, Chowdhury S and Taguchi S, Robust Engineering, TMH, 2000

Periods per week : 4   Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs.   Credits : 3

Introduction: Introduction, Overview, Why Simulate Mechanisms, Kinematics Simulations, Dynamic Simulation of Mechanisms, Summary, Vector Loop and Vector Chain Equations – Introduction, The Planar Vector, Single Loop Equations, Derivatives of Vectors, Other Common Mechanisms, Vector Chains.
Solutions of the position problem: Overview, Numerical Solutions of Nonlinear algebraic Equations, The Position Problem of a Four-Bar Linkage, Mat lab Solution of the position of a Four-Bar Linkage.
Kinematic simulations using SIMULINK: What is a Kinematic Simulation, Velocity Solution via Kinematic Simulation, Acceleration Solution via Kinematic Simulation, The Consistency Check, Kinematic Simulation of a Four-Bar Mechanism.
Introducing dynamics: Simulating the slider on inclined plane, Adding the Pendulum, Assembling the Matrix Equation, Creating a Dynamic Simulation, Setting Initial conditions and Running Simulation
Two-link planar Robot: Overview, Vector Equations, Dynamic Equations, The Simultaneous Constraint matrix, Dynamic Simulation, Robot Coordinate Control.

References:
1. Simulation Of Machines using Mat Lab and Simulink/John F. Gardner/
India Edition (IE)
2. CAD/CAM / Ibrahim zeid/ TMH.
3. Mat Lab / Raj Kumar Bansal / Pearson Education

FIRST SEMESTER WITH EFFECT FROM 2019-20

MTMD 106 Elective Subject - I
C) NON-LINEAR SOLID MECHANICS

Periods per week : 4   Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs.   Credits : 3

Introduction to Vectors and Tensors: Algebra of Vectors, Algebra of Tensors, Higher-order Tensors, Eigenvalues, Eigenvectors of Tensors, Transformation Laws for Basis Vectors and omponents, General Bases, Scalar, Vector, Tensor Functions, Gradients and Related Operators, Integral Theorems.

Kinematics: Configurations and Motions of Continuum Bodies, Displacement, Velocity, Acceleration Fields, Material, Spatial Derivatives, Deformation Gradient, Strain Tensors, Rotation Tensor, Stretch Tensors, Rates of Deformation Tensors, Lie Time Derivatives.

The Concept of Stress: Traction Vectors, and Stress Tensors, Extremal Stress Values, Examples of States of Stress, Alternative Stress Tensors.

Balance Principles: Conservation of Mass, Reynolds' Transport Theorem, Momentum Balance Principles, Balance of Mechanical Energy, Balance of Energy in Continuum Thermodynamics, Entropy Inequality Principle, Master Balance Principle.

Some Aspects of Objectivity: Change of Observer, and Objective Tensor Fields, Superimposed Rigid-body Motions, Objective Rates, Invariance of Elastic Material Response.

Hyperelastic Materials: General Remarks on Constitutive Equations, Isotropic Hyperelastic Materials, Incompressible Hyperelastic Materials, Compressible Hyperelastic Materials, Some Forms of Strain-energy Functions, Elasticity Tensors, Transversely Isotropic Materials, Composite Materials with Two Families of Fibers, Constitutive Models with Internal Variables, Viscoelastic Materials at Large Strains, Hyperelastic Materials with Isotropic Damage. 32

Thermodynamics of Materials: Physical Preliminaries, Thermoelasticity of Macroscopic Networks, Thermodynamic Potentials, Calorimetry, Isothermal, Isentropic Elasticity Tensors, Entropic Elastic Materials, Thermodynamic Extension of Ogden's Material Model, Simple Tension of Entropic Elastic Materials, Thermodynamics with Internal Variables.

Variational Principles: Virtual Displacements, Variations, Principle of Virtual Work, Principle of Stationary Potential Energy, Linearization of the Principle of Virtual Work, Two-field Variational Principles, Three-field Variational Principles.

References:
1. Nonlinear Solid Mechanics: A Continuum Approach for Engineering by G. A.
Holzapfel, John-Wiley & Sons.
2. Nonlinear Solid Mechanics: Theoretical formulations and finite element solutions by
A. Ibrahimbegovic, Springer publications.

FIRST SEMESTER WITH EFFECT FROM 2019-20
MTMD 106 Elective Subject - I
D) STRUCTURAL HEALTH MONITORING

Periods per week : 4   Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs.   Credits : 3

Introduction: Definition, Principles, Significance of SHM, Potential Applications in Civil, Naval, Aerospace and Manufacturing Engineering.
Operational evaluation: Sensor technology, Piezoelectric wafer active sensors, Data acquisition and cleansing procedures, Elastic waves in solid structures, Guided waves.
Feature extraction methods: Identify damage sensitive properties, Signal Processing, Fourier and short term Fourier transform, Wavelet analysis.
Pattern recognition: State –of –Art damage identification and pattern recognition Methods, Neural networks, Feature extraction algorithm.
Case studies: SHM based Flaw detection in mechanical structures - Integrity and damage recognition in plates and pipes, defect identification in weld joints, Wear monitoring in cutting tools.

READING:
1. Daniel Balageas, Claus-Peter Fritzen and Alfredo Guemes, Structural Health Monitoring, John Wiley &Sons, 2006.
2. Victor Giurgiutiu,Structural Health Monitoring with Piezoelectric Wafer Active Sensors, Academic Press,2008.
3. A Review of Structural Health Monitoring Literature: 1996-2001/ Hoon Sohn/ Chales R.Farrar/Francois M.Hemez/Devin D.Shunk/Daniel W.Stinemates/Brett R. Nadler/Jerry J.Czarnecki*/Los Alamos National Laboratory
4. Damage Identification and Helath Monitoring of Structural and Mechanical Systems from Changes in Their Vibration Characteristics: A Literature Review/ Scott W. Doebling/Charles R. Farrar/Michael B.Prime/Daniel W.Shevitz

Periods per week : 4   Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs.   Credits : 3

Bending of long rectangular plates to a cylindrical surface: Differential equation for cylindrical bending of plates - Cylindrical bending of uniformly loaded rectangular plates with simply supported edges - Cylindrical bending of uniformly loaded rectangular plates with builtin edges
Pure bending of plates: Slope and curvature of slightly bent plates - Relations between bending moments and curvature in pure bending of plates - Particular cases of pure bending - Strain energy in pure bending of plates.
Symmetrical bending of circular plates: Differential equation for symmetrical bending of laterally loaded circular plates - Uniformly loaded circular plates - Circular plate with a circular hole at the center - Circular plate concentrically loaded - Circular plate loaded at the center.
Small deflections of laterally loaded plates: The differential equation of the deflection surface - Boundary conditions - Alternate method of derivation of the boundary condition - Reduction of the problem of bending of a plate to that of deflection of a membrane
Simply supported rectangular plates: Simply supported rectangular plates under sinusoidal load - Navier solution for simply supported rectangular plates. Rectangular plates with various edge conditions: Bending of rectangular plates by moments distributed along the edges - ectangular plates with two opposite edges simply supported and the other two edges clamped.
Continuous rectangular plates: Simply supported continuous plates - Approximate design of continuous plates with equal spans - Bending symmetrical with respect to a center.
Deformation of shells without bending: Definition and notation - Shells in the form of a surface of revolution and loaded symmetrically with respect to their axis - Particular cases of shells in the form of surfaces of revolution - Shells of constant strength.
General theory of cylindrical shells: A circular cylindrical shell loaded symmetrically with respect to its axis - Particular cases of symmetrical deformation of circular cylindrical shells - Pressure vessels.

Reference:
1. Theory of Plates and Shells by Timoshenko, S. and Woinowsky-Krieger, S.

MTMD 107 COMPUTER AIDED DESIGN, MODELLING AND SIMULATION LAB

Periods per week : 3   Examination: 50 Sessionals : 50
Examination (Practicals): 3hrs   Credits : 1.5

List of Experiments:

1. 2D and 3D modeling and assembly modeling using any one modeling packages like AutoCAD/ Auto Desk Mechanical desktop/CREO/IDEAS/CATIA/Unigraphics/Solid Works.
2. 1D, 2D and 3D Meshing, Linear and non-linear static and dynamic analysis using any one FEA packages like ANSYS/CAEFEM/NASTRAN/NISA.
3. 1D, 2D and 3D Steady State Thermal Analysis, Transient Thermal Analysis Couple Field (Thermal/Structural) Analysis using any one FEA packages like ANSYS/CAEFEM/ NASTRAN/NISA

MTMD 108 MECHANICAL VIBRATIONS LAB - I

Periods per week : 3   Examination: 50 Sessionals : 50
Examination (Practicals): 3hrs   Credits : 1.5

List of Experiments:

1. To determine the radius of gyration of given bar by using bifilar and Trifiller suspension.
2. Find the CG of a connecting rod using free vibration techniques.
3. To determine natural frequency of free torsional vibrations of single rotor system.
4. Determine the moment of inertia of the given flywheel.
5. To determine the modulus of rigidity of a given wire by torsional vibration.
6. Find the Natural frequency of the forced damped vibrations of equivalent spring mass system.
7. Find the Natural frequency of the forced un-damped vibrations of equivalent spring mass system.
8. Find the Natural frequency of the free damped vibrations of equivalent spring mass system.
9. Find the Natural frequency of the free un-damped vibrations of equivalent spring mass system.

SECOND SEMESTER WITH EFFECT FROM 2019-20
MTMD 201 INSTRUMENTATION AND EXPERIMENTAL STRESS ANALYSIS

Periods per week : 4   Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs.   Credits : 3

PART - A (Instrumentation)
Basic concepts: Calibration - Standards - Basic concepts in dynamic measurements - System response - Distortion.
Sensing devices: Bridge circuits - Amplifiers - Filter circuits - Oscilloscope - Oscillograph - Transducers - variable resistance transducers, LVDT - Capacitive and piezoelectric transducers.
Pressure measurement: Mechanical pressure measurement devices - Bourdon tube pressure gauge - Diaphragm and bellow gauges - Low pressure measurement - Mcland gauge - Pirani gauge - Ionization gauge.
Flow measurement: Positive displacement methods - Flow obstruction methods - Flow measurement by drag effect - Hot wire anemometer.
Temperature measurement: Temperature measurements by mechanical effects, Electrical effects and by Radiation - Thermocouples; Force and torque measurement - Motion and vibration measurement.
PART - B (Stress Analysis)
Brittle lacquer method of stress analysis: Application of lacquer - Stress determination - Dynamic stresses.
Strain gauges: Mechanical resistance wire gauges - Types of resistance gauges - Cements and cementing of gauges - Wheatstone bridge - Balanced and unbalanced gauge factor - Calibration of gauges - Strain gauge rosette - Evaluation and principal stresses static and dynamic instrumentation
Photo elasticity: Polariscope plane and circularly polarized light - Photo elastic materials - Calibration - Isochromatic fringes - Isoclines stress determination
Grid methods.

Note: Equal numbers of questions are to be answered from each section.

References:
1. Experimental Methods for Engineers by Holman, J.P., McGraw Hill Book
Company.
2. Stress Analysis and Experimental Techniques/ An Introdution by J.Srinivas/ Narosa
publications
3. A Course In Mechanical Measurements And Instrumentation_A. K. Sawhney And P. Sawhney
4. A treatise on Mathematical theory of elasticity / LOVE A.H./ Dover Publications
5. Photo Elasticity / Frocht/ Wiley / 3rd Edition
6. Experimental Stress Analysis / Sadhu singh / Khanna Publications.
7. Experimental Stress Analysis and Motion Measurement by Dove and Adams.
8. Experimental Stress analysis/ Dally and Riley, Mc Graw-Hill

SECOND SEMESTER WITH EFFECT FROM 2019-20
MTMD 202 SIGNAL ANALYSIS AND CONDITION MONITORING

Periods per week : 4   Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs.   Credits : 3

Introduction: Basic concepts. Fourier analysis. Bandwidth. Signal types. Convolution.
Signal analysis: Filter response time. Detectors. Recorders. Analog analyzer types.
Practical analysis of stationary signals: Stepped filter analysis. Swept filter analysis. High speed analysis. Real-time analysis.
Practical analysis of continuous non-stationary signals: Choice of window type. Choice of window length. Choice of incremental step. Practical details. Scaling of the results.
Practical analysis of transients: Analysis as a periodic signal. Analysis by repeated playback (constant bandwidth). Analysis by repeated playback (variable bandwidth).
Condition monitoring techniques: Visual monitoring, Thermography, Vibration monitoring, Shock pulse monitoring, Wear debris monitoring, Motor current and signature analysis, Acoustic emission, Ultrasound monitoring, ISO standards, Fault detection sensors, Structural Health M0nitoring (SHM), integrated Vehicle Health Monitoring (IVHM).
Condition monitoring in real systems: Diagnostic tools. Condition monitoring of two stage compressor. Cement mill foundation. I.D. fan. Sugar centrifugal. Cooling tower fan. Air separator. Preheater fan. Field balancing of rotors. ISO standards on vibrations.

References:
1. Condition Monitoring of Mechanical Systems by Colacat.
2. Frequency Analysis by R.B.Randall.
3. Mechanical Vibrations Practice with Basic Theory by V. Ramamurti, Narosa Publishing House.
4. Machinery Condition Monitoring: Principles and Practices *by* A. R. Mohanty (ISBN: 9781466593046, CRC Press, 2014)
5. NPTEL II Video Lectures: Machinery Condition Monitoring and Signal Processing *by* A R MOHANTY (NPTEL, 2013)

SECOND SEMESTER WITH EFFECT FROM 2019-20
MTMD 203 ADVANCED FINITE ELEMENT ANALYSIS

Periods per week : 4   Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs.   Credits : 3

Introduction: Introduction to FEM, basic concepts, historical back ground, applications of FEM, general description, comparison of FEM with other methods, Finite elements of an elastic continuum - displacement approach, basic element shapes, interpolation function, generalization of the finite element concept - weighted residuals and variational approaches, 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. Plane stress and plane strain, Requirements of Convergence, h – refinement and p - refinement

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

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

Analysis of Beams and Frames: Hermite shape functions – stiffness matrix – Load vector – Problems related to Beams and Frames

3-D Problems: Tetrahedran element – Jacobian matrix – Stiffness matrix. Steady-state Scalar field problems – 1D. 2 D Heat conduction, electric and magnetic potentials, field flow. The time domain, semi-descritization of field and dynamic problems and analytical solution procedures.

Dynamic considerations: Dynamic equations – consistent mass matrix – Eigen Values, Eigen vector, natural frequencies – mode shapes – modal analysis.

Analysis of Plates: Introduction, Triangular Membrane element, Quadratic Triangle element, Rectangular plate element (in-plane forces), Bending behavior of plates, finite element analysis of plates in bending, triangular plate bending element.

References:
1. Concepts and Applications of Finite Element Analysis by Cook, R.D.
2. Applied Finite Element Analysis by Segerland, L.J.
3. The Finite Element Methods in Engineering / SS Rao / Pergamon.
4. Finite Element Methods: Basic Concepts and applications, Alavala, PHI
5. Introduction to Finite Elements in Engineering, Chandrupatla,
Ashok and Belegundu, Prentice – Hall
5. Finite Element Method – Zienkiewicz / Mc Graw Hill
6. Introduction to Fininte element analysis- S.Md.Jalaludeen,
Publications, print-2012
7. A First Course in the Finite Element Method/Daryl L Logan/Cengage
Learning/5th Edition
8. Finite Element Method – Krishna Murthy / TMH
9. Finite Element Analysis – Bathe / PHI

Periods per week : 4   Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs.   Credits : 3

Design philosophy: Design process, Problem formation, Introduction to product design, Various design models-Shigley model, Asimov model and Norton model, Need analysis, Strength considerations -standardization. Creativity, Creative techniques, Material selections, Notches and stress concentration, design for safety and Reliability
Failure theories: Static failure theories, Distortion energy theory, Maximum shear stress theory, Coulomb-Mohr's theory, Modified Mohr's theory, Fracture mechanics theory., Fatigue mechanisms, Fatigue failure models, Design for fatigue strength and life, creep: Types of stress variation, design for fluctuating stresses, design for limited cycles, multiple stress cycles, Fatigue failure theories ,cumulative fatigue damage, thermal fatigue and shock, harmful and beneficial residual stresses, Yielding and transformation
Surface failures: Surface geometry, mating surfaces, oil film and their effects, design values and procedures, adhesive wear, abrasive wear, corrosion wear, surface fatigue, different contacts, dynamic contact stresses, surface fatigue failures, surface fatigue strength.
Economic factors influencing design: Economic analysis, Break-even analysis, Human engineering considerations, Ergonomics, Design of controls, Design of displays. Value engineering, Material and process selection in value engineering, Modern approaches in design.
Importance of Fits and Tolerance influencing design: Tolerance from process and function, interchangeability and selective assembly, selection of fits for different design situations, surface finish. Load transmission, load equalization light weigh and rigid constructions.
Team work and Ethics in engineering design: Team formation, functioning, discharge, team dynamics, Ethical issues considered during engineering design process
Product Design: Product strategies, Product value, Product planning, product specifications, concept generation, concept selection, concept testing.
Design for manufacturing: Forging design, Casting design, Design process for non metallic parts, Plastics, Rubber, Ceramic, Wood, Glass parts. Material selection in machine design.

References:
1. Machine Design An Integrated Approach by Robert L. Norton, Prentice-Hall New Jersey, USA.
2. Mechanical Engineering Design by J.E. Shigley and L.D. Mitchell published by McGraw-Hill International Book Company, New Delhi.
3. Fundamentals of machine elements by Hamrock, Schmid and Jacobian, 2nd edition, McGraw- Hill International edition.
4. Product design and development by Karl T. Ulrich and Steven D. Eppinger. 3rd edition, Tata McGraw Hill.
5. Product Design and Manufacturing by A.K. Chitale and R.C. Gupta, Prentice Hall
6. Engineering Design / George E Dieter / McGraw Hill /2008
7. Fundamentals of machine elements/ Hamrock, Schmid and Jacobian/ 2nd edition /McGraw-Hill International edition.

SECOND SEMESTER WITH EFFECT FROM 2019-20
MTMD 205 ELECTIVE SUBJECT- II
A) INTEGRATED COMPUTER AIDED DESIGN

Periods per week : 4   Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs.   Credits : 3

Fundamentals of CAD: Introduction, Design process, Application of computer for design, Creating the manufacturing database, Benefits of CAD, Design work station, CAD hardware. Geometric modeling: Geometric modeling techniques - Multiple view 2D input, Wire frame geometry, Surface models, Geometric entities - Curves and Surfaces, Solid modelers, Feature recognition.
Computer aided drafting: AutoCAD tools, 3D model building using solid primitives and boolean operations, 3D model building using extrusion, Editing tools, Multiple views: Orthogonal, Isometric.
Visual realism: Shading solids, Coloring, Color models, Using interface for shading and coloring.
Graphic aids: Geometric modifiers, Naming scheme, Layers, Grids, Groups, Dragging and rubber banding.
Computer animation: Conventional animation, Computer animation - Entertainment animation, Engineering animation, Animation types, Animation techniques.
Mechanical assembly: Assembly modeling, Part modeling, Mating conditions, Generation of assembling sequences, Precedence diagram, Liaison-sequence analysis.
Mechanical tolerancing: Tolerance concepts, Geometric tolerancing, Types of geometric tolerances, Location tolerances, Drafting practices in dimensioning and tolerancing, Tolerance analysis.
Mass property calculations: Geometrical property formulation - Curve length, Cross-sectional area, Surface area, Mass property formulation - Mass, Centroid, Moments of inertia, Property mapping. Properties of composite objects.

References:
1. CAD/CAM Theory and Practice by Ibrahim Zeid.
2. CAD/CAM Principles and Applications by P.N. Rao, Tata McGraw Hill Publishing Company Ltd.
3. CAD/CAM Computer Aided Design and Manufacturing by Mikell P. Groover and Emory W. Zimmer, Jr.
4. Computer Integrated Design and Manufacturing by David D. Bedworth, Mark R. Henderson, Philip M. Wolfe.

Periods per week : 4   Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs.   Credits : 3

Introduction: Overview, History of mechatronics, Scope and significance of Mechatronics systems, elements of Mechatronic systems, Needs and benefits of Mechatronics in manufacturing.
Sensors: Classification of sensors basic working principles, displacement sensor – linear and rotary potentiometers, LVDT and RVDT, incremental and absolute encoders, Proximity and range sensors – Eddy current sensor, ultrasonic sensor, laser interferometer transducer, hall Effect sensor, inductive Proximity switch, Light sensors – Photodiodes, Phototransistors, Flow Sensors – ultrasonic Sensor, Laser Doppler Anemometer, Tactile Sensors – PVDF tactile sensor, micro-switch and reed switch, Piezoelectric sensors, Vision Sensor.
Actuators: Electrical Actuators: Solenoids, relays, diodes, thyristors, triacs, BJT, FET, DC motor, Servo Motor, BLDC Motor, AC Motor, Stepper Motor, Hydraulic & pneumatic devices – Power supplies, valves, Cylinder sequencing, Design of hydraulic & pneumatic circuits. PiezoElectric Actuators, Shape memory alloys.
Basic System models & Analysis: Modeling of one & two degrees of freedom Mechanical, Electrical, fluid and thermal systems, block diagram representations of these systems. Dynamic Responses of System: Transfer function, modeling dynamic systems, first order systems, second order systems.
Digital Electronics: Number systems, BCD codes and arithmetic, Gray codes, self complimenting codes, Error detection and correction principles. Boolean functions using Karnaugh Map, Design of combinational circuits, design of arithmetic circuits, Design of code converters, encoders and decoders.
Signal Conditioning: Operational amplifiers, inverting amplifier, differential amplifier, Protection, comparator, filters, multiplexer, Pulse width modulation counters, decoders. Data acquisition – Quantizing theory, Analog to digital conversion, digital to analog conversion.
Controllers: Classification of Control systems, Feedback, Closed loop and open loop systems
PLC Programming: PLC Principles of operation, PLC sizes, PLC hardware components, I/O section Analog I/O section, Analog I/O modules, digital I/O modules, CPU processor memory, module programming, Ladder Programming, ladder diagrams, Timers, Internal relays and counters, data handling, analogue input and output. Application on real time industrial automation systems.
Advanced Applications in Mechatronics: Sensors for condition monitoring, mechatronic control in automated manufacturing, Artificial intelligence in Mechatronics, micro sensors in mechatronics, Application of Washing machine as mechatronic device.
References:
1. W. Boton, "Mechatronics", 5th edition, Adison WesleyLongman ltd, 2010.
2. Mehatronics system design by Devdas Shetty and Richard A. Kolk, P.W.S. Publishing company, 2001.
3. Alciatore David G & Histand Michael B, "Introduction to Mechatronics and Measurement systems", 4th edition, Tata McGraw Hill, 2006.
4. Saeed B Niku, "Introduction to Robotics: Analysis, Systems, Applications ", 2nd edition, Pearson Education India, PHI, 2003.

SECOND SEMESTER WITH EFFECT FROM 2019-20
MTMD 205 ELECTIVE SUBJECT- II
C) FUZZY LOGIC & NEURAL NETWORKS

Periods per week : 4   Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs.   Credits : 3

Fuzzy set theory and fuzzy logic control: Basic concepts of fuzzy sets- Operations on fuzzy sets- Fuzzy relation equations- Fuzzy logic control- Fuzzification –Defuzzificatiuon- Knowledge base- Decision making logic- Membership functions – Rule base.
Adaptive fuzzy systems: Performance index- Modification of rule base0- Modification of embership functions- Simultaneous modification of rule base and membership functions- Genetic algorithms-Adaptive fuzzy system- Neuro fuzzy systems.
Artificial neural networks: Introduction- History of neural networks- multilayer perceptions- Back propagation algorithm and its Variants- Different types of learning, examples.
Mapping and recurrent net works: Counter propagation –Self organization Map- Congnitron and Neocognitron- Hopfield Net- Kohonnen Nets- Grossberg Nets- Art-I, Art-II reinforcement learning
Case Studies: Application of fuzzy logic and neural networks to Measurement- Control- Adaptive Neural Controllers – Signal Processing and Image Processing

References:
1. Vallum B.R And Hayagriva V.R C++, Neural networks and Fuzzy logic, BPB
Publications, New Delhi, 1996
2. Neural Networks for control, Millon W.T, Sutton R.S and Werbos P.J, MIT Press 1992
3. Fuzzy sets Fuzzy logic, Klir, G.J anfd Yuan B.B Prentice Hall oif India Pvt. Ltd.,, New
Delhi
4. Neural Networks and Fuzzy systems, Kosko.. Prentice hall of India Pvt. Ltd.,, New Delhi
1994
5. Introduction to Fuzzy control, Dirankov D. Hellendoorn H, Reinfrank M., Narosa
Publications House, New Delhi 1996
6. Introduction to Artificial Neural systems, Zurada J.M Jaico Publishing House, New Delhi
1994

SECOND SEMESTER WITH EFFECT FROM 2019-20
MTMD 205 ELECTIVE SUBJECT- II
D) RELIABILITY ENGINEERING

Periods per week : 4   Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs.   Credits : 3

Introduction: Concepts of quality and reliability, a brief history, terms, definitions, reliability function, MTTF, Hazard rate function, bath tub curve, conditional reliability.

Constant failure rate models: Exponential reliability, failure modes, failure modes with exponential distribution, applications, two parameter exponential distribution, Poisson process.

Time dependent failure models: Weibull distribution, burn-in screening for Weibull, three parameter Weibull distribution, Normal and Lognormal distributions

Reliability of systems: Series, parallel configurations, combined systems, k-out-of-n systems, complex configurations, common failure modes, minimal cuts and minimal paths.

State dependent systems: Markov analysis, load sharing, standby systems, degraded systems

Physical reliability models: Static models- random stress and random strength, dynamic models- periodic models, random loads.

Design for reliability: Reliability specification, Lifecycle costs, reliability allocation, design methods, failure analysis, FTA.

Reliability testing: Life testing, burn-in testing, acceptance testing-binomial acceptance testing.

Reliability growth testing: Reliability growth process, idealized growth curve, Duane growth model.

Text Book:

1. Introduction to Reliability and Maintenance engineering by Charles E Ebeling, Tata McGrawhill, India.

References:

1. Introduction to Reliability Engineering by E.E. Lewis, John Wiley& Sons, NewYork

2. Reliability based design by S.S.Rao, McGraw-Hill, New York

MTMD 205 ELECTIVE SUBJECT- II
E) MECHANICAL BEHAVIOUR OF ENGINEERING MATERIALS

Periods per week : 4   Examination : 70 ; Sessional : 30
Examination (Theory): 3hrs.   Credits : 3

Introduction: Fracture behavior of metals and alloys. The ductile/brittle transition temperatures for notched and un-notched components, Ductile rupture as a failure mechanism Fracture at elevated temperature. Definitions of types of fracture and failure, Introduction to stress intensity factor and strain energy release rate, Equivalence of energy approach and stress intensity approach.
Stress intensity factor and its use in fracture mechanics: Early concepts of stress concentrators and flaws, Ingles solution to stress round an elliptical hole-implications of results. Stress intensity factor for a crack. Westergaard's solution for crack tip stresses. Stresses and displacement in Cartesian and polar coordinates,
Linear elastic fracture mechanics (LEFM): Three loading modes and the state of stress ahead of the crack tip, stress concentration factor, strain energy release rate, fracture energy, R. Modification for ductile materials, loading conditions. Stress intensity factor and the material parameter, the critical stress intensity factor.
Elastic/plastic fracture mechanics: The crack opening displacement and J-integral approaches, R-curve analysis Testing procedures, Measurement of these parameters, RAD, Fail sage and safe life design approaches, Practical applications. Advanced topics in EOFM.
Fatigue: definition of terms used to describe fatigue cycles, High Cycle Fatigue, Low Cycle Fatigue, Fatigue of Welded structures: Factors effecting the fatigue lives of welded joints. Mean stress R ratio, strain and load control. S-N curves. Goodman's rule and Miners rule. Micro mechanisms of fatigue damage, fatigue limits and initiation and propagation control leading to a consideration of factors enhancing fatigue resistance. Total life and damage tolerant approaches to life prediction.
Creep deformation: The evolution of creep damage, primary, secondary and tertiary creep, Micro mechanisms of creep in materials and the role of diffusion, Ashby creep deformation maps. Stress dependence of creep – power law dependence. Comparison of creep performance under different conditions – extrapolation and the use of Larson-Miller parameters, Creep-fatigue interactions, Creep integrals, Examples.

References:
1. Mechanical Metallurgy / Dieter / McGraw Hill
2. Fracture Mechanics: Fundamental and Applications /Anderson T.L & Boca Raton/ CRC Press, Florida, 1998.
3. Deformation and Fracture mechanics of Engineering Materials / Richard W Hertz /Wiley
4. Plasticity for structural Engineers / W.F. Chen and D.J,. Ha,
5. Engineering Fracture Mechanics/ D.R.J. Owen and A.J. Fawkes /Pincridge press, Swansea, U.K.
6. Fracture and fatigue control in structures/ S.T. Rolfe and J.M. Barsom/ Printice Hall, Eglewood cliffs, N.J..
7. Fracture of brittle solids/ B.R. Lawn and T.R. Wilshaw/ Cambridge university press.
8. Plastic deformation of Metals/ R.W.K. Honeycombe/ 2nd edition, Edward Arnold
9. Elements of Fracture Mechanics/Prasanth Kumar/TMH

SECOND SEMESTER WITH EFFECT FROM 2019-20
MTMD 206 INSTRUMENTATION AND EXPERIMENTAL STRESS ANALYSIS LAB

Periods per week : 3   Examination: 50 Sessionals : 50
Examination (Practicals): 3hrs   Credits : 1.5

List of Experiments:
1. Measurement of strain by using strain gauges.
2. Calibration of Rotameter.
3. Calibration of Thermocouples.
4. Experiment with constant voltage/current Hot-wire Anemometer.
5. Measurement of Displacement using LVDT
6. Experiments with piezo-electric pick-up, Inductive pick-ups. Determination of characteristics
- Displacement, Velocity and Acceleration.
7. Ultrasonic flaw detector.
8. Experiment on photoelastic bench (Plain polariscope, Circular polariscope).
9. Photoelastic analysis of disc under diametric compression.
10. Photo elastic analysis of Ring under diametric compression.

SECOND SEMESTER WITH EFFECT FROM 2019-20
MTMD 206 MECHANICAL VIBRATIONS LAB-II

Periods per week : 3   Examination: 50 Sessionals : 50
Examination (Practicals): 3hrs   Credits : 1.5

List of Experiments:
1. Finding the damping presence in the structure using half power band width method.
2. Finding the natural frequency of the simply supported beam by sweep sine wave method.
3. Calculation of damping coefficient using Active vibration isolator.
4. Calculation of damping coefficient using Passive vibration isolator.
5. Determination of the Vibration frequency with single Absorber.
6. Determination of the Vibration frequency with Double Absorber.
7.Draw the curve representing the frequency response of the beam with an oil Damper.
8.Modelling and Modal Analysis of Mechanical Component.
9. Modelling and Harmonic Analysis of Mechanical Component.
10.Modelling and Transient Dynamics Analysis of Mechanical Component.

SECOND SEMESTER WITH EFFECT FROM 2019-20
MTMD 208 SEMINAR

Periods per week : 3   Examination: 50 Sessionals : 50
                                                                      Credits : 1

The student has to give at least three seminars on topics related to Machine design.

THIRD SEMESTER WITH EFFECT FROM 2019-20
MTMD 301 ELECTIVE SUBJECT – III
A) VEHICLE DYNAMICS

Periods per week : 4   Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs.   Credits : 3

Introduction to Vehicle Dynamics: Various kinds of vehicles, Motions, Mathematical modelling methods, Multibody system approach, Lagrangian formulations, Methods of investigations, Stability concepts.
Mechanics of pneumatic tyres: Tyre construction, SAE recommended practice, Tyre forces and moments, Rolling resistance of tyres, Tractive effort and longitudinal slip, Cornering properties of tyres, Performance of tyre traction on dry and wet surfaces, Ride properties of tyres.
Performance characteristics of road vehicle: Equation of motion and maximum tractive effort, Aerodynamic forces and moments, Vehicle power plant and transmission characteristics, Prediction of vehicle performance, Operating fuel economy, Braking performance.
Handling and stability characteristics of road vehicles: Steering geometry, Steady state handling characteristics, Steady state response to steering input, Testing of handling characteristics, Transient response characteristics, Directional stability, Effects of tyre factors, Mass distribution and engine location on stability of handling.
Vehicle ride characteristics: Human response to vibration, Vehicle ride models, Introduction to random vibration - 1) Road suirface profile as a random function, 2) Frequency response function, 3) Evaluation of vehicle vertical vibration in relation to ride comfort criteria, 4) Active and semi active systems, 5) Optimum design for ride comfort and road holding.

References:
1. Theory of Ground Vehicles by Wong, J.Y., John Wiley and Sons, NY, 1993.
2. Fundamentals of Vehicle Dynamics by Gillespie, T.D., SAE Publication, Warrendal, USA, 1992.
3. Tyres, Suspension and Handling by Dixon, J.C., SAE Publication, Warrendal, USA and Arnold Publication, London, 1997.

MTMD 301 ELECTIVE SUBJECT – III
B) TRIBOLOGY

Periods per week : 4   Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs.   Credits : 3

Historical background: Viscosity - Viscometry - Effect of temperature on viscosity - Effect of pressure in viscosity - Other physical properties of mineral oils - The generalized Reynolds equation - Flow and shear stress - The energy equation - The equation of state - Mechanism of pressure development.

Circumferential flow: Oil flow through a bearing having a circumferential oil groove - Heat generation and lubricant temperature - Heat balance and effective temperature - Bearing design: Practical considerations - Design of journal bearings - Parallel surface bearing - Step bearing - Some situations under squeeze film lubrication - The mechanism of hydrodynamic instability - Stiffness and damping coefficients - Stability.

Elastohydrodynamic lubrication: Theoretical consideration - Grubin type solution - Accurate solution - Point contact - Dimensionless parameters - Film thickness equations - Different regimes in EHL contact - Deep-groove radial bearings - Angular contact bearings - Thrust ball bearings - Geometry - Kinematics - Stress and deformations - Load capacity.

Surface topography: Surface characterization - Apparent and real area of contact - Derivation of average Reynolds equation for partially lubricated surface - Effect of surface roughness on journal bearings - Laws of friction - Friction theories - Surface contaminants - Frictional heating - Effect of sliding speed on friction - Classification of wear - Mechanisms of wear - Quantitative laws of wear - Wear resistance materials.

Reference:
1. Introduction to Tribology of Bearings by Majumdar, B.C.

C) PRESSURE VESSEL DESIGN

Periods per week : 4   Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs.   Credits : 3

Introduction: Materials- shapes of Vessels –stresses in cylindrical spherical and arbitrary, shaped shells. Cylindrical Vessels subjected to internal pressure, wind load bending and orqueilation of pressure vessels –conical and tetrahedral vessels.

Theory of thick cylinders: Shrink fit stresses in built up cylinders – auto frettage of thick Cylinders Thermal stresses in Pressure Vessels.

Theory of rectangular plates: Pure bending – different edge conditions.

Theory circular plates: Simple support and clamped ends subjected to concentrated and Uniformly distributed loads-stresses from local loads. Design of dome bends, shell connections, flat heads and cone openings.

Discontinuity stresses in pressure vessels: Introduction beam on an elastic Foundation, infinitely long beam semi infinite beam, cylindrical vessel under axially symmetrical Loading, extent and significance of load deformations on pressure vessels, discontinuity stresses in vessels, stresses in a bimetallic joints, deformation and stresses in flanges.

Pressure vessel materials and their environment: Introduction ductile material tensile tests, Structure and strength of steel Leuder's lines determination of stress patterns from plastic flow Observations, behavior of steel beyond the yield point, effect of cold work or strain hardening on The physical properties of pressure vessel steels fracture types in tension. Toughness of Materials, effect of neutron irradiation of steels, fatigue of metals, fatigue crack growth fatigue life.

Fatigue aspects of Pressure vessel: Prediction cumulative fatigue damage stress theory of failure of vessels subject to steady state and fatigue conditions.

Stress concentrations: Influence of surface effects on fatigue, effect of the environment and other factors on fatigue life thermal stress fatigue creep and rupture of metals at elevated Temperatures, hydrogen embitterment of pressure vessel steels brittle fracture effect of Environment on fracture toughness, fracture toughness relationships criteria for design with Defects, significance of fracture mechanics evaluations, effect of warm prestressing on the Ambient temperature toughness of pressure vessel steels.

Design features: Localized stresses and their significance, stress concentration at a Variable thickness transition section in a cylindrical vessel, stress concentration about a circular Hole in a plate subject to tension, elliptical openings, stress concentration, stress concentration Factors for position, dynamic and thermal transient conditions, theory of reinforced openings and Reinforcement, placement and shape fatigue and stress concentration.

References:
1. Theory and design of modern Pressure Vessels / John F. Harvey 'Van/ Nostrand Reihold Company/NY.
2. Pressure Vessel Design and Analysis / Bickell M. B. Ruizes / Macmillan Publishers
3. Process Equipment design / Beowll & Yound Ett.
4. Indian standard code for unfired Pressure vessels IS 2825.
5. Pressure Vessels Design Hand Book Henry H. Bednar PE / CB S Publishers / New Delhi.
6. Theory of plates and shells / Timoshenko& Noinosky / Dover Publications.
7. Stress in Beams, Plates and Shells / Ansel C. Ugural / CRC Press / 3rd Edition

Periods per week : 4   Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs.   Credits : 3

Introduction: Principles of gear tooth action, Generation of Cycloid and Involute gears, Involutometry, gear manufacturing processes and inspection, gear tooth failure modes, stresses, selection of right kind of gears.

Spur Gears : Tooth loads, Principles of Geometry, Design considerations and methodology, Complete design of spur gear teeth considering Lewis beam strength, Buckingham's dynamic load and wear load, Design of gear shaft and bearings.

Helical Gears: Tooth loads, Principles of Geometry, Design considerations and methodology, Complete design of helical gear teeth considering Lewis beam strength, Buckingham's dynamic load and wear load, Design of gear shaft and bearings.

Bevel Gears: Tooth loads, Principles of Geometry, Design considerations and methodology, Complete design of bevel gear teeth considering Lewis beam strength, Buckingham's dynamic load and wear load, Design of gear shaft and bearings.

Worm Gears: Tooth loads, Principles of Geometry, Design considerations and methodology, Complete design of worm gear teeth considering Lewis beam strength, Buckingham's dynamic load and wear load, Heat dissipation considerations. Design of gear shaft and bearings.

Gear failures: Analysis of gear tooth failures, Nomenclature of gear tooth wear and failure, tooth breakage, pitting, scoring, wear, overloading, gear-casing problems, lubrication failures **Gear trains:** Simple, compound and epicyclic gear trains, Ray diagrams, Design of a gear box of an automobile, Design of gear trains from the propeller shafts of airplanes for auxiliary systems.

Optimal Gear design: Optimization of gear design parameters, Weight minimization, Constraints in gear train design-space, interference, strength, dynamic considerations, rigidity etc. Compact design of gear trains, multi objective optimization of gear trains. Application of Traditional and non-traditional optimization techniques

References:
1. Maleev and Hartman, Machine Design, C.B.S. Publishers, India.
2. Henry E.Merrit,Gear engineering ,Wheeler publishing,Allahabad,1992.
3. Practical Gear design by Darle W. Dudley, McGraw-Hill book company
4. Earle Buckingham, Analytical mechanics of gears, Dover publications, New York, 1949.
5. G.M.Maitha, Hand book of gear design, TaTa Mc.Graw Hill publishing company Ltd.,
New Delhi,1994.

THIRD SEMESTER WITH EFFECT FROM 2019-20
MTMD 301 ELECTIVE SUBJECT – III
E) ADVANCED MECHANICS OF COMPOSITE MATERIALS

Periods per week : 4   Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs.   Credits : 3

Basic concepts and characteristics: Geometric and Physical definitions, natural and man-made composites, Aerospace and structural applications, types and classification of composites.
Reinforcements: Fibres – Glass, Silica, Kevlar, carbon, boron, silicon carbide, and born carbide fibres. Particulate composites, Polymer composites, Thermoplastics, Thermosetts, Metal matrix and ceramic composites.
Micromechanics: Unidi rectional composites, constituent materials and properties, elastic properties of a lamina, properties of typical composite materials, laminate characteristics and configurations. Characterization of composite properties.
Coordinate transformation: 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 behavior of unidirectional composites: Elastic constants of lamina, relationship between engineering constants and reduced stiffness and compliances, analysis of laminated composites, constitutive relations.
Strength of unidirectional lamina: 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, free-edge effects. Micros mechanical predictions of elastic constants.
Analysis of laminated composite plates: Introduction thin plate theory, specially orthotropic late, cross and angle ply laminated plates, problems using thin plate theory.

References:
1. Mechanics of Composite Materials/ R. M. Jones/ Mc Graw Hill Company, New York, 1975.
2. Engineering Mechanics of Composite Materials by Isaac and M Daniel, Oxford University Press, 1994.
3. Analysis and performance of fibre Composites/ B. D. Agarwal and L. J. Broutman/ Wiley- Interscience, New York, 1980.
4. Mechanics of Composite Materials/ Second Edition (Mechanical Engineering)/ Autar K. Kaw, Publisher: CRC
5. Analysis of Laminated Composite Structures/ L. R. Calcote/ Van Nostrand Rainfold, New York, 1969.
6. Advanced Mechanics of Composite Materials/ Vasiliev &Morozov/Elsevier/Second Edition

Periods per week : 4   Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs.   Credits : 3

Introduction: Finite difference method, finite volume method, finite element method, governing equations and boundary conditions. Derivation of finite difference equations.

Solution methods: Solution methods of elliptical equations - finite difference formulations, interactive solution methods, direct method with Gaussian elimination. Parabolic equations-explicit schemes and Von Neumann stability analysis, implicit schemes, alternating direction implicit schemes, approximate factorization, fractional step methods, direct method with tridiagonal matrix algorithm.

Hyperbolic equations: explicit schemes and Von Neumann stability analysis, implicit schemes, multi step methods, nonlinear problems, second order one-dimensional wave equations.

Burgers equations: Explicit and implicit schemes, Runge-Kutta method. Formulations of incompressible viscous flows: Formulations of incompressible viscous flows by finite difference methods, pressure correction methods, vortex methods.

Treatment of compressible flows: potential equation, Eluer equations, Navier-stokes system of equations, flowfield-dependent variation methods, boundary conditions, example problems.

Finite volume method: Finite volume method via finite difference method, formulations for two and three-dimensional problems.

Standard variational methods - 1: Linear fluid flow problems, steady state problems,

Standard variational methods - 2: Transient problems.

References:
1. Computational fluid dynamics, T. J.Chung, Cambridge University press,2002.
2. Text book of fluid dynamics, Frank Chorlton, CBS Publishers & distributors, 1985.
3. Numerical heat transfer and fluid flow / Suhas V. Patankar/ Hema shava Publishers corporation & Mc Graw Hill.
4. Computational Fluid Flow and Heat Transfer/ Muralidaran/ Narosa Publications
5. Computational Fluid Dynamics: Basics with applications/John D. Anderson/ Mc Graw Hill.
6. Fundamentals of Computational Fluid Dynamics/Tapan K. Sengupta / Universities Press.
7. Introduction to Theoretical and Computational Fluid Dynamics/C. Pozrikidis /Oxford University Press/2nd Edition

THIRD SEMESTER WITH EFFECT FROM 2019-20
MTMD 302 ELECTIVE SUBJECT – IV
B) ROBOTICS

Periods per week : 4   Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs.   Credits : 3

Introduction, Transformations and kinematics: Historical development, A sense of mechanisms, Robotic systems, Classification of robots, Position, orientation and location of a rigid body, Mechanics of robot manipulators. Objectives, Homogeneous coordinates, Homogeneous transformations, Coordinate reference frames, Some properties of transformation matrices, Homogeneous transformations and the manipulator: The position of the manipulator in space, Moving the base of the manipulator via transformations, Moving the tool position and orientation.
Position analysis of serial manipulators: Link parameters and link coordinate systems, Denavit-Hartenberg homogeneous transformation matrices, Loop-closure equations, Other coordinate systems, Denavit-Hartenberg method: Position analysis of a planar 3-DOF manipulator: Direct kinematics, Inverse kinematics, Method of successive screw displacements, Wrist centre position.
Position analysis of parallel manipulators: Structure classification of parallel manipulators, Denavit-Hartenberg method versus geometric method, Position analysis of a planar 3RRR parallel manipulator, Geometry, Inverse kinematics and Direct kinematics, Position analysis of a spatial orientation mechanism.
Jacobian analysis of serial manipulators: Differential kinematics of a rigid body, Differential kinematics of serial manipulators, Screw coordinates and screw systems, Manipulator Jacobian matrix.
Trajectory generation: General considerations in path description and generation, Joint space schemes, Cartesian space schemes, Geometric problems with Cartesian paths, Path generation at run time, Description of paths, Planning paths using the dynamic model, Collision-free path planning.
Robot Programming: Robot languages: AL, AML, RAIL, RPL, VAL, Demonstration of points in space: Continuous path (CP), Via points (VP), Programmed points (PP).
Robot dynamics: Lagrange- Euler Formulation- Newton-Euler Formulations- Problems on Planar two link robot manipulators.
References:
1. Robot Analysis - The Mechanics of Serial and Parallel Manipulators by Lung-Wen Tsai, John Wiley & Sons, Inc.
2. Introduction to Robotics - Mechanics and Control by John J. Craig, Addison-Wesley Longman Inc., 1999.
3. Robotic Engineering - An Integrated Approach by Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, Prentice-Hall of India Private Limited, 1994.
4. Robotics: Fundamental Concepts and Analysis / Ashitava Ghosal / Oxford.
5. Introduction to Robotic Mechanics and Control / J J Craig/ Pearson / 3rd edition.
6. Robotics / Fu K S/ McGraw Hill.
7. Robot Analysis and Intelligence /Asada and Slotine / Wiley Inter-Science.
8. Robotics and Control / Mittal R K & Nagrath I J / TMH
9. Mechanics of Serial and Parallel Manipulators – Lung Wen Tsai

Periods per week : 4   Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs.   Credits : 3

Machine vision: Vision sensors - Comparison with other types of sensors - Image acquisition and recognition - Recognition of 3D objects - Lighting techniques - Machine vision applications.
Image representation: Application of image processing - Image sampling, Digitization and quantization - Image transforms.
Spatial domain techniques: Convolution, Correlation. Frequency domain operations - Fast Fourier transforms, FFT, DFT, Investigation of spectra. Hough transform
Image enhancement: Filtering, Restoration, Histogram equalisation, Segmentation, Region growing.
Image compression: Edge detection - Thresholding - Spatial smoothing - Boundary and Region representation - Shape features - Scene matching and detection - Image classification.

References:
1. Digital Image Processing by Gonzalez, R.C. and Woods, R.E., Addison Wesley Publications.
2 Robot Vision by Prof. Alan Pugh (Editor), IFS Ltd., U.K. 3. Digital Image Processing by A. Rosenfled and A. Kak, Academic Press.
4. The Psychology of Computer Vision by P. Winstan, McGraw-Hill.
5. Algorithms for Graphics and Image Processing by T. Pavidis, Springer Verlag.

MTMD 302 ELECTIVE SUBJECT – IV
D) DESIGN FOR MANUFACTURE AND ASSEMBLY

Periods per week : 4   Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs.   Credits : 3

Introduction: Design philosophy steps in Design process - General Design rules for manufacturability - basic principles of designing for economical production - creativity in design. Materials: Selection of Materials for design Developments in Material technology - criteria for material selection - Material selection interrelationship with process selection, process selection charts.

Machining process: Overview of various machining processes - general design rules for machining - Dimensional tolerance and surface roughness - Design for machining-Ease-Redesigning of components for machining ease with suitable examples. General design recommendations for machined parts.

Metal casting: Appraisal of various casting processes, selection of casting process, - general design considerations for casting - casting tolerances - use of solidification simulation in casting design - product design rules for sand casting.

Metal joining: Appraisal of various welding processes, Factors in design of weldments - general design guidelines - pre and post treatment of welds - effects of thermal stresses in weld joints - design of brazed joints. Forging - Design factors for Forging - Closed dies forging design - parting lines of dies drop forging die design - general design recommendations. Extrusion & Sheet Metal Work: Design guidelines for extruded sections - design principles for Punching, Blanking, Bending, Deep Drawing - Keeler Goodman Forming Line Diagram - Component Design for Blanking.

Assemble advantages: Development of the assemble process, choice of assemble method assemble advantages social effects of automation.

Automatic assembly transfer systems: Continuous transfer, intermittent transfer, indexing mechanisms, and operator - paced free – transfer machine.

Design of manual assembly: Design for assembly fits in the design process, general design guidelines for manual assembly, development of the systematic DFA methodology, assembly efficiency, classification system for manual handling, classification system for manual insertion and fastening, effect of part symmetry on handling time, effect of part thickness and size on handling time, effect of weight on handling time, parts requiring two hands for manipulation, effects of combinations of factors, effect of symmetry effect of chamfer design on insertion operations, estimation of insertion time.

References:

1. Assembly Automation and Product Design/ Geoffrey Boothroyd/ Marcel Dekker Inc., NY, 1992.
2. Engineering Design - Material & Processing Approach/ George E. Deiter/McGraw Hill Intl. 2nd Ed. 2000.
3. Hand Book of Product Design/ Geoffrey Boothroyd/ Marcel and Dekken, N.Y. 1990.
4. Computer Aided Assembly London/ A Delbainbre/.
5. Product Design for Manufacturing and Assembly/ Geoffrey Boothroyd, Peter Dewhurst & Winston Ansthony Knight/CRC Press/2010
6. Design and Manufacturing / Surender Kumar & Goutham Sutradhar / Oxford & IBH

Publishing Co. Pvt .Ltd., New Delhi, 1998.

THIRD SEMESTER WITH EFFECT FROM 2019-20
MTMD 302 ELECTIVE SUBJECT – IV
E) AERODYNAMICS

Periods per week : 4   Examination : 70 ; Sessionals : 30
Examination (Theory): 3hrs.   Credits : 3

Introduction: Lift, drag, moment and related coefficients; Vector operations (review); conservation equations (mass, momentum and energy); Streamlines, streaklines and pathlines; Velocity potential and stream function

Inviscid, Incompressible flow: Bernoulli's equation, low-speed wind tunnel flows; Governing equations and boundary conditions; Elementary flows (uniform, sources, sinks and vortex); ideal lifting flow past a circular cylinder, Kutta-Joukowski theorem and lift generation; source panel method for non-lifting flows; d' Alembert's paradox.

Incompressible flow over airfoils: Introduction; Kutta Condition; Thin airfoil theory (symmetric, cambered); Aerodynamic center; vortex panel method for lifting flows; qualitative picture of viscous flow.

Finite Wing Theory: Introduction; Downwash and induced drag; Biot-Savart Law and Helmholtz's Theorems; Prandtl's lifting line theory; Numerical lifting-line method; Some ractical aspects.

Introduction to Compressible flows (Inviscid): Thermodynamics review; Governing equations; Compressibility.

Normal Shock, Oblique Shock and Expansion Waves: Basic relations; flow over wedges and cones; shock interactions; blunt body flow; Prandtl-Meyer expansion waves; qualitative pitcute of shock wave-boundary layer interaction; quasi-one-dimensional flow through nozzles and diffusers.

Linearized Theory for Subsonic and Supersonic Flows: Introduction; Velocity potential equation and linearized form; Prandtl-Glauert correction; Improved corrections; Critical Mach number; Drag divergence; Supercritical airfoils and area rule.

References:
1. J. D. Anderson, Jr, Fundamentals of Aerodynamics, McGraw Hill, 2005.
2. J. J. Bertin, Aerodynamics for Engineers, Pearson Education, 2002.
3. L. J. Clancy, Aerodynamics, Himalayan Books, 1996.
4. E. L. Houghton, and N. B. Carruthers, Aerodynamics for Engg. Students, Arnold Pub, 1988.
5. M. Kuethe, and C-Y Chow, Foundations of Aerodynamics, Wiley, 1998.

THIRD SEMESTER WITH EFFECT FROM 2019-20
MTMD 303 DISSERTATION (PRELIMINARY)

Periods per week : 3   Viva-Voce: 100
                                                        Credits : 10

A student has to submit his proposal for his Project work, which includes the area of interest coupled with literature survey.

FOURTH SEMESTER WITH EFFECT FROM 2019-20
MTMD 401 DISSERTATION (FINIAL)

Periods per week : 3   Viva-Voce: 100
                                                        Credits : 16

A student has to submit and defend his work in the presence of Expert Committee which includes external Examiner