NEW CODES

Detailed Syllabi

for

M.Tech Programmes

Computer Aided Design (Full Time)

Applicable to Students admitted in the Academic Session 2019-20 onwards

DEPARTMENT OF MECHANICAL ENGINEERING

HARCOURT BUTLER TECHNICAL UNIVERSITY
KANPUR-208002

NEW CODES

M.TECH. COMPUTER AIDED DESIGN
(FULL TIME PROGRAMME)

SEMESTER - I

EME-551 NUMERICAL METHODS & COMPUTER PROGRAMMING 5(3-2-0)

UNIT-1 Solution of Algebraic and Transcendental Equation: Newton-Raphson method including method of complex roots, Graeffe's root square method (Computer based algorithm and programme for these methods)

UNIT-2 Interpolation and Approximation: Lagrange's and Newton-divided difference formula, Newton interpolation formula for finite differences, Gauss's forward and backward interpolation formulae, Bessel's and Laplace-Everett's formulae, Cubic spline, least squares approximation using Chebyshev polynomial.

UNIT-3 Solution of Linear Simultaneous Equations: Cholesky's (Crout's) method, Gauss-Seidel iteration and relaxation methods, Solution of Eigenvalue problems; Smallest, largest and intermediate Eigen values (Computer based algorithm and programme for these methods)

UNIT-4 Numerical Differentiation and Integration: Numerical differentiation using difference operators, Simpson's 1/3 and 3/8 rules, Boole's rule, Weddle's rule.

UNIT-5 Solution of Differential Equations: Modified Euler's method, Runge-Kutta method of 2^{nd}, 3^{rd} and 4^{th} orders, Predictor-Corrector method, Stability of Ordinary differential equation, Solution of Laplace's and Poisson's equations by Liebmann's method, Relaxation method.

Text Books:

1. M. K. Jain, S.R.K. Iyenger and R.K. Jain, "Numerical Method for Scientific and Engineering Computation", Wiley Eastern Ltd.
2. S. K. Gupta, "Numerical Methods for Engineers", Wiley Eastern Ltd.
3. B. S. Grewal, " Numerical Methods", Khanna Publications.
4. A. D. Booth, "Numerical Methods", Academic Press, NY
5. K.E. Atkinson, "An Introduction to Numerical Analysis", John Wiley & Sons, NY

EME-553 ADVANCED MECHANICS OF SOLIDS 4(3-1-0)

UNIT-1: Analysis of stress and strain, Constitutive relationships, failure theories.

UNIT-2: Torsion of non-circular sections, Plane stress and plain strain problems, Review of fatigue analysis.

UNIT-3: Introduction to fracture mechanics, Inelastic behaviour, Viscoelasticity, Structure and behaviour of polymers

UNIT-4:, Behaviour of unidirectional composites and orthotropic lamina, Failure theories for fibre composites, development of various structures in composites, UNIT-5: Computer based analysis and solutions to problems in mechanics of solids

Text Books:

1. A I Lurie, "Theory of Elasticity - Foundations of Engineering Mechanics"
2. T.L. Anderson, "Fracture Mechanics: Fundamentals and Applications", CRC Press

Reference Books:

1. Norman E Dowling, "Mechanical Behaviour of Materials: Engineering Methods for Deformation, fracture and Fatigue", Prentice Hall.
2. E.P. Popov, "Engineering Mechanics of Solids", Prentice Hall of India
3. AK Singh, "Mechanics of Solids", Prentice Hall of India.
4. Kanninen, Melvin F, Popelar, Carl H and C.H. Popelar, "Advanced Fracture Mechanics", Oxford University
5. Isaac M. Daniel Ori Ishai, "Engg Mechanics of Composite Material", Oxford University

EME-555 COMPUTER GRAPHICS & GEOMETRIC MODELLING 5(3-2-0)

UNIT-1

Introduction to CAD- Computer systems & hardware for CAD-Input & output devices, types of display devices- CRT, principles of raster scan and vector graphics. Plotting: Points, Line drawing, Circle generation algorithms. Scan conversions: Real time conversions Run length encoding and cell encoding, character display, Polygon filling. Computer Graphic & its standards- GKS, IGES.

UNIT-2

Transformations: Homogenous coordinate system, Scaling, Translation, shear, Reflection about axis & line. Viewing 3D on 2D screen: Representation of 3D shapes, rendering of surfaces and solids, hidden lines, edges and surface removals, Shading models, Shadows, Representation scheme for colors and its mixing.

UNIT-3

Curves: Analytical curves, Parametric representation of Curves, Control points, Control polygon & graph, Knots, Continuity of curves & C- & G-types continuity, Effect of knots and control points on continuity, Synthetic curves, Hermite curves, Bezier curves, B-spline curves, rational curves, curve manipulations, NURBS.

UNIT-4

Surface: Introduction, Surface models and entities, surface representation, Parametric representation of analytic and synthetic surfaces, Non-uniform rational B-splines (NURBS), Coon's and Bezier surface patches, ruled, lofted, revolved and swept surfaces.

UNIT-5

Solids: Wire frame models, Solid models and entities, B-representation Constructive Solid geometry-basic elements & basic operations, Sweep representation.

Text Books:

1. D Hearn & M P Baker, "Computer Graphics", Prentice Hall.
2. IIbrahim Zeid & R Sivasubramanian, "CAD/CAM Theory and Practice" Tata McGraw-Hill.

Reference Books:

1. A Saxena and B Sahay, "Computer Aided Engineering Design", Anamya Publications
2. D F Rogers and J A Adams, "Mathematical Elements for Computer Graphics", McGraw-Hill International
3. H P Grover and E W Zimmers, "CAD/CAM", Prentice Hall

EME-557 COMPUTER AIDED DESIGN OF MECHANICAL SYSTEMS 4(3-1-0)

UNIT-1: SOLID MECHANICS BASED SYSTEMS-STATIC

Advanced Fundamentals of FEM, Geometry based design, Topological optimization. Adaptive analysis & Mesh control, Truss, Frames, Beams, Torsion-shafts-hybrid approach & mixed approach, Thick & Thin Plate analysis, Cracks analysis,

UNIT-2: SOLID MECHANICS BASED SYSTEMS- DYNAMIC ANALSIS

Flexural vibration bar beam, Impact problems, Linear Buckling analysis of column, Vehicle design problems, Dynamic analysis of machine tools, Composites materials based system

UNIT-3: HEAT TRANSFER SYSTEMS
Fins design-engine application, Heat transfer through composite walls, Heat exchangers, Pressure vessels,

UNIT-4: FLUID FLOW SYSTEMS
Computational Fluid dynamics, Flow through pipes, pipe design, Flow over aerodynamic structures

UNIT-5 ADDITIONAL APPLICATIONS
Mechanical Systems for Bio-medical application, Machine tool design, Meshless based design.

Text Books:

1. Mikell P. Groover and E. W. Zimmers, "CAD/CAM", Prentice hall India Ltd
2. Ibrahim Zeid & R Sivasubramanian, "CAD/CAM Theory and Practice", Tata McGraw-Hill.
3. Tai-Ram Hsu & Dipendra K Sinha, "Computer Aided Design", West publishing company.
4. Y.M. Desai, T.I. Eldho, A.H. Shah, "Finite Element Method with applications in Engineering", PEARSON.
5. R Dhanraj & K Prabhakaran, "Finite Element Method", OXFORD (Higher Education)
6. Singiresu S. Rao, "Finite Element in Engineering", ELSEVIER

SEMESTER - II

EME-552 OPTIMIZATION METHODS FOR ENGINEERING DESIGN 4(3-1-0)

UNIT-1: Introduction: Historical Developments, Engineering applications of Optimization, Classical Optimization Techniques: Introduction, Review of single and multivariable optimization methods with and without constraints, Non-linear one-dimensional minimization problems, Examples.

UNIT-2: Constrained Optimization Techniques: Introduction, Direct methods - Cutting plane method and Method of Feasible directions, Indirect methods - Convex programming problems, Exterior penalty function method, Examples and problems
UNIT-3: Unconstrained Optimization Techniques: Introduction, Direct search method - Random, Univariate and Pattern search methods, Rosenbrock's method of rotating co-ordinates, Descent methods - Steepest Decent methods-Quasi-Newton's and Variable metric method, Examples.

UNIT-4: Geometric Programming: Introduction, Unconstrained minimization problems, solution of unconstrained problem from arithmetic-geometric inequality point of view, Constrained minimization problems, Generalized polynomial optimization, Applications of geometric problems, Introduction to stochastic optimization.

UNIT-5: Novel methods for Optimization: Introduction to simulated annealing, selection of simulated annealing parameters, simulated annealing algorithm; Genetic Algorithm (GA), Design of GA, Key concepts of GA, Neural Networks, A frame work for Neural Network models, Construction of Neural Network algorithm, Examples of simulated algorithm, genetic annealing and Neural Network method.

Text Books:

1. S.S. Rao, "Engineering Optimization" New Age International
2. E.J. Haug and J.S. Arora, "Applied Optimal Design", Wiley, New York
3. Kalyanmoy Deb, "Optimization for Engg Design", Prentice Hall of India
4. G.V. Reklaites, A Ravindran and K.M.Rogsdeth, "Optimization", Wiley, New York

EME-554 FINITE ELEMENT METHOD 4(3-1-0)

UNIT-1: Numerical methods for Integration & Differential equations, Geometrical aspects of Integration, Differential equations, Interpolation & Approximation functions. Mathematical background: Exact methods and Approximate methods, Classical Methods- Variational approach with application in axial bar and beams, Rayleigh Ritz method for axial bar and beam, Weighted residual methods, Galerkin methods-Bubnov & Petrov. Finite Difference Methods.

UNIT-2: Finite Element Formulations: Nodes & types of elements, Selection of approximation functions & role of degree, Shape functions & its derivation. Direct approach, Variational approach, Energy approach, Weighted approach. Derivation of stiffness matrix for 1D stress & strain applications. Finite Element Procedure-pre-processing-processing-post processing, Boundary conditions, Solution Techniques: direct method-Gauss & iterative methods, Penalty Approach.

UNIT-3: 1-D FEM applications with one degree approximation function: Deriving stiffness matrix, load vector, assembly of element matrices, implementing boundary conditions with Elimination and Penalty approach. Stress & strain, Heat conduction and convections, fluid flow problems. FEM for Truss,1-D with 2 degree of freedom applications.

UNIT-4: Beam elements & problems. Sub-parametric, iso-parametric, super-parametric elements. Higher degree approximation function applications: Cartesian & Natural coordinate system, Shape function using Lagrangian methods. 2D elements and applications: Triangular element-Constant strain triangle (CST) problems, Iso-parametric formulation of 2D elements - Jacobian Matrix, 2-D Intergrations by Gauss quadrature methods, Axi-symmetric applications.

UNIT-5 Mesh generation through computer graphics, Meshless methods. FEM for Orthotropic materials & composite materials. Special design problems using FEM in Static / Dynamic: Isotropic materials, Composite materials, Heat transfer, Computational fluid dynamics, Manufacturing applications, Biomedical applications or any relevant area.

Text Books:

1. R Dhanraj & K Prabhakaran, “The Finite Element Method”, OXFORD Higher Education
2. Y.M. Desai, T.I. Eldho, A.H. Shah, “FEM with applications in Engg”, PEARSON

Reference Books:

1. Singiresu S. Rao, “Finite Element in Engineering”, ELSEVIER
2. C.S. Krishnamoorthy, “Finite Element Analysis” TMH
3. T.R. Chandragupta and A.D Belegundu, “Introduction of FE in Engg”, PHI

Elective I (EME-556 to EME-567) 4(3-1-0)

EME-556/557: Theory of Elasticity & Plasticity

EME-558/559: Computational Fluid Dynamics

EME-560/561: Smart Material & Structures

EME-562/563: Industrial Design and Ergonomics

EME-564/565: Rapid Prototyping & Tooling

EME-566/567: Advanced Manufacturing Processes

Please refer to syllabi of electives.

Elective II (EME-580 to 589) 4(3-1-0)

EME-580/581: Advanced Mechanical Vibrations

EME-582/583: Introduction to Robotics

EME-584/585: Flexible Manufacturing System

EME-586/587: Reliability & Maintenance

EME-588/589: Composite Materials

Please refer to syllabi of electives.

SEMESTER - III

EME-651 PRODUCT DESIGN & DEVELOPMENT 4(3-1-0)

Introduction, Sources of new ideas, Development processes, Product planning, Identification for Customer needs and technology potentials, Innovation and intellectual property rights, Product and process Patents, Patents and patenting processes.

Product specifications, Tolerance specifications, Taguchi loss factor concepts, Quality function deployment, Functional specifications of products, Form and function, Development of alternatives. Design for manufacture, Design for Assembly and design for economy, Prototyping and analytical prototyping, Stage-gate process of product development.

Holistic product development approaches-Form product concept to decommissioning, Environment requirements, Life cycle design, Product data management and Product life cycle management systems, Dependency and concurrent engineering in development of products. Internet based approach to product development involving users. Democratization of innovation, Connecting products to services, Experience innovation, Robust design, Patents and Intellectual properties, product Developments.

Text Books:

1. K. K. Ahuja, "Production Management", CBS Publishers
2. A. K. Chitale & A.K. Gupta, "Production Design and Manufacturing", PHI
3. Alan Mumford, " Management Development", Jaico Publishing House

Elective III (EME-653 to EME-664) 4(3-1-0)

EME-653/654: Computer Aided Manufacturing

EME-655/656: Fracture Mechanics

EME-657/658: Neural Network and Fuzzy Systems

EME-659/660: Design of Thermal System

EME-661/662: Advanced Machine Design

EME-663/664: Simulation Modelling & Analysis

Please refer to syllabi of electives.

EME-671 SEMINAR 2(0-0-4)

EME-697 DISSERTATION 4(0-0-8)

NEW CODES

SEMESTER IV

EME-698	**DISSERTATION**	**12(0-0-24)**

SYLLABI OF ELECTIVES

EME-556 to 567 ELECTIVE I 4(3-1-0)

EME-556/557 THEORY OF ELASTICITY & PLASTICITY

Theory of Elasticity: Analysis of stress and strain, equilibrium, Compatibility and constitutive equations, Plane stress and plane strain problems, General equation in Polar co-ordinates, Rotating discs and stresses in circular discs, Stress function in terms of harmonic and complex functions, Equation of equilibrium of a deformed body in curvilinear co-ordinates, Principle of superposition and principle of virtual work, Torsion of thin tubes, Bending of cantilevers, Uniformly and continuous loaded beams, Bending of circular, elliptical and rectangular cross-section bars, Axi-symmetric formulation and deformation of solids of revolution.

Theory of Plasticity: Nature of engineering plasticity, Differential equations of equilibrium, 3D stress analysis, infinitesimal deformation, finite deformation, Von Mises', Tresca's and anisotropic yield criteria, halgh-Westergard stress space representation of yield criteria, experimental verification of yield criteria, Subsequent yield surfaces, Elastic and plastic stress-strain relations and stress strain rate equations, Prandtle-Reuaa equations, Generalized plastic stress strain relations, Anisotropy and instability. Plane plastic flow, Slip-line field theory, Application of slip line field theory to plane strain metal forming processes, Plane plastic stress and pseudo plane stress analysis and its applications, Extremum principle for rigid perfectly plastic material, surfaces of stress and velocity discontinuity, Upper bound and lower bound theorems and applications.

Text Books:

1. A I Lurie, Theory of Elasticity (Foundations of Engineering Mechanics)
2. Gladwell G M, "Contact Problems in the Classical Theory of Elasticity", Kluwer Aca
3. Chakrabarty, "Applied Plasticity", J,pringer-Verlog
4. R Hill, "The Mathematical Theory of Plasticity" Oxford University

EME-558/559 COMPUTATIONAL FLUID DYNAMICS

Introduction, Conservation equation, Mass Momentum and Energy equations, Convective form of the equation and general description. Clarification into various types of equation, Parabolic, Elliptic, Boundary and initial conditions, Overview of numerical methods. Finite difference methods; Different means for formulating finite difference equations, Taylor series expansion, Integration over element, Local function method; Finite volume methods; Central, upwind and hybrid formulations and comparison for convection-diffusion problem, Treatment of boundary conditions; Boundary layer treatment; Variable property, Interface and free surface treatment, Accuracy of F.D. method. Solution of finite difference equations; Iterative methods; Matrix inversion methods, ADI method, Operator splitting, Fast Fourier Transform applications. Phase change problems, Rayleigh-Ritz, Galerkin and Least square methods; Interpolation functions, One and two dimensional elements, Applications.
Phase change problems; Different approaches for moving boundary; Variable time step method, Enthalpy method

Text Books:

1. Ferziger Joel H, "Computational Methods for Fluid Dynamics", Springer-Verlog
2. Kaviany M, "Principles of Heat Transfer", Wiley-International
3. Modest Michael, "Radiative Heat Transfer", Academic Press
4. Middleman Stanley, "An Introduction to Mass and Heat Transfer" John Wiley

EME-560/561 SMART MATERIALS AND STRUCTURES

UNIT-1: Introduction to Smart Materials, Principles of Piezoelectricty, Perovskyte Piezoceramic Materials, Single Crystals vs Polycrystalline Systems, Piezoelectric Polymers, Principles of Magnetostriction, Rare earth Magnetostrictive materials, Giant Magnetostriction and Magneto-resistance Effect, Introduction to Electro-active Materials, Electronic Materials, Electro-active Polymers, Ionic Polymer Matrix Composite (IPMC), Shape Memory Effect, Shape Memory Alloys, Shape Memory Polymers, Electro-rheological Fluids, Magneto Rhelological Fluids

UNIT-2: HIGH-BAND WIDTH, LOW STRAIN SMART SENSORS Piezeoelctric Strain Sensors, In-plane and Out-of Plane Sensing, Shear Sensing, Accelerometers, Effect of Electrode Pattern, Active Fibre Sensing, Magnetostrictive Sensing, Villari Effect, Matteuci Effect and Nagoka-Honda Effect, Magnetic Delay Line Sensing, Application of Smart Sensors for Structural Health Monitoring (SHM), System Identification using Smart Sensors

UNIT-3: SMART ACTUATORS Modelling Piezoelectric Actuators, Amplified Piezo Actuation – Internal and External Amplifications, Magnetostrictive Actuation, Joule Effect, Wiedemann Effect, Magnetovolume Effect, Magnetostrictive Mini Actuators, IPMC and Polymeric Actuators, Shape Memory Actuators, Active Vibration Control, Active Shape Control, Passive Vibration Control, Hybrid Vibration Control

UNIT-4: SMART COMPOSITES Review of Composite Materials, Micro and Macro-mechanics, Modelling Laminated Composites based on Classical Laminated Plate Theory, Effect of Shear Deformation, Dynamics of Smart Composite Beam, Governing Equation of Motion, Finite Element Modelling of Smart Composite Beams

UNIT-5: ADVANCES IN SMART STRUCTURES & MATERIALS Self-Sensing Piezoelectric Transducers, Energy Harvesting Materials, Autophagous Materials, Self- Healing Polymers, Intelligent System Design, Emergent System Design

Text Books:

1. Brian Culshaw, Smart Structures and Materials, Artech House, 2000
2. Gauenzi, P., Smart Structures, Wiley, 2009 (c) Cady,
3. W. G., “Piezoelectricity”, Dover Publication.

EME-562/563 INDUSTRIAL DESIGN & ERGONOMICS

Introduction to Ergonomics and Industrial Design: An approach to industrial design- elements of design, Structure for industrial design in engineering; Application in modern manufacturing systems; General approach to the man-machine relationship, Work station design, Working position.

Control and Displays: Shapes and sizes of various controls and displays- Multiple displays and control situations; design of major controls in automobiles, machine tools etc.; Design of furniture; Redesign of instruments.

Ergonomics and Production: Ergonomics and product design, ergonomics in automated systems; Expert systems for ergonomic design; Anthropometrics data and its applications in ergonomic design; Limitations of anthropometric data, Use of computerized database; Case study.

Visual Effects of Line and Colour: The mechanics of seeing; Psychology of seeing; General influence of line and form; Colour and light; Colour and objects; Colour and the eye; Colour consistency; Colour terms; Reaction to colour and colour continuation; Colour on engineering equipments.

Aesthetic Concepts: Concept of unity; Concept of order with variety; Concept of purpose style and environment; Aesthetic expressions; Style, Components of style; House style; Observation style in capital goods; Case study.

Industrial Design in Practice: General design; Specifying Design equiQMEnts; Rating the importance of industrial design; Industrial design in design process.

Text Books:

1. W.H. Mayall, "Industrial design for Engineers", London Hiffee Books Ltd.
2. R.C. Bridger, "Introduction to Ergonomics", McGraw Hill
3. Sanders & McComlick, "Human Factor Engineering" -

EME-564/565 Rapid Prototyping & Tooling

UNIT-1

Introduction: Historical developments, Fundamentals of RP Systems and its Classification, Rapid prototyping, Process chains, 3D modeling and mesh generation, Data conversion and transmission.

UNIT-2

RP Systems: Liquid polymer based rapid prototyping systems, Teijin Seikis' solid form and other similar commercial RP systems, Solid input materials based rapid prototyping systems, laminated object manufacturing (LOM) and fused deposition modelling (FDM) systems etc.

UNIT-3

Power based rapid prototyping systems, Selective Laser sintering, Soligen Diren's shell production casting (DSPC), Fraunhofer's multiphase jet solidification (MJS) and MIT's 3D printing (3DP) etc.

UNIT-4

RP Database: Rapid prototyping data formats, STL format, STL file problems, STL file repair, Networkbased operations, Digital inspection, Data warehousing and learning from process data.

UNIT-5

RP Applications: Development of dies for moulding, RP applications in developing prototypes of products, application in medical fields, Development of bone replacements and tissues, etc., RP materials and their biological acceptability. Rapid tooling Direct and Indirect Rapid tooling, Tooling applications and Materials.

Books:

1. Kai Chua Chee, "Rapid Prototyping: Principles And Applicatio", World Scie
2. Hamblen James, "Rapid Prototyping Of Digital Systems: A Tutorial Approach", Kluwer Aca.
3. R C Cofer, "Rapid System Prototyping With Fpgas: Accelerating The Design Process", Newnes
4. James O Hamblen, "Rapid Prototyping of Digital Systems" Springer

EME-566/567 ADVANCED MANUFACTURING PROCESSES

UNIT-1

Introduction: Advanced Manufacturing Processes and its Industrial applications Limitations of Conventional machining processes, Need of advanced manufacturing processes and its classification.

UNIT-2

Thermal Type Advance Machining Processes: Classification, General principles and applications of Electro discharge machining, Plasma arc machining, Ion beam machining, Laser beam machining , Electron beam machining, Mechanics of metal removal in EDM, selection of EDM pulse generator dielectric, machining accuracy, surface finish and surface damage in EDM, Generation and control of electron beam for machining applications, advantages and limitations

UNIT-3

Chemical and Electro-chemical Type Metal Removal Processes: Principle, working advantages, disadvantages and applications of Electro-chemical machining, Chemical machining, Economy aspects of ECM, Electro-chemical debarring and honing, ECM and ailed processes.

UNIT-4

Mechanical Type Metal Removal Processes: Ultrasonic machining; Elements of the process; Tool design and economic considerations; Applications and limitations, Abrasive jet and Abrasive water jet machining principles; Mechanics of metal removal; Design of nozzles; applications, Abrasive finishing process, Magnetic abrasive finishing process.

UNIT-5

Advanced Welding Processes Advanced Forming Processes, Hybrid Advanced and Assisted Machining Processes: Introduction to ECDM, ECAM and Abrasive EDM etc.

Books:

1. V.K.Jain,Advance, “Machining Processes”, New Age
2. P.C. Pandey, “Modern Machining Processes”, New Age
3. Degarmo, “Manufacturing Processes”,
4. Kalpakjian, “Manufacturing Processes”, Tata McGraw-Hill International

EME-580 to 589 ELECTIVE II 4(3-1-0)

EME-580/581 ADVANCED MECHANICAL VIBRATIONS

Introduction: Characterization of engineering vibration problems, Review of single degree freedom systems with free, damped and forced vibrations

Two-degree of Freedom Systems: Principal modes of vibration, Spring coupled and mass coupled systems, Forced vibration of an undamped close coupled and far coupled systems, Undamped vibration absorbers, Forced damped vibrations, Vibration isolation.

Multi-degree Freedom systems: Eigen-value problem, Close coupled and far coupled systems, Orthogonality of mode shapes, Modal analysis for free, damped and forced vibration systems, Approximate methods for fundamental frequency-Rayleigh's, Dunkerely, Stodola and Holzer method, Method of matrix iteration, Finite element method for close coupled and far coupled systems.

Continuous systems: Forced vibration of systems governed by wave equation, Free and forced vibrations of beams/ bars

Transient Vibrations: Response to an impulsive, step and pulse input, Shock spectrum

Non-linear Vibrations: Non-linear systems, Undamped and forced vibration with non-linear spring forces,

Self-excited vibrations.

Books:

1. J.S. Rao and K. Gupta, "Theory and practice of Mechanical Vibrations", New Age International
2. G.K. Groover, "Mechanical Vibrations", Nem Chand & Brothers
3. V. Ramamurti, "Mechanical Vibration Practice", Narosa Publications
4. V.P. Singh, "Mechanical Vibrations" Dhanpat Rai & sons
5. R.V. Dukkipati & J. Srinivas, "Textbook of Mechanical Vibrations", Prentice Hall of India

EME-582/583 INTRODUCTION TO ROBOTICS

Introduction: Definition, Classification of Robots, Geometric classification and control classification. Robot Elements: Drive systems, Control systems, sensors, End effectors, Gripper actuators and gripper design.

Robot Coordinate Systems and Manipulator Kinematics: Robot co-ordinate system representation, Transformation, Homogeneous transforms and its inverse, Relating the robot to its world.

Manipulators Kinematics, Parameters of links and joints, Kinematic chains, Dynamics of kinematic chains, Trajectory planning and control, Advanced techniques of kinematics and dynamics of mechanical systems,

Parallel actuated and closed loop manipulators.

Robot Control: Fundamental principles, Classification, Position, path and speed control systems, adaptive control.

Robot Programming: Level of robot programming, Language based programming, task level programming, Robot programming synthesis, robot programming for foundry, press work and heat treatment, welding, machine tools, material handling, warehousing assembly, etc., automatic storage and retrieval system, Robot economics and safety, Robot integration with CAD/CAM/CIM, Collision free motion planning.

Text Books:

1. Phillipe Collet, "Robotic Technology (Vol. I-V)" , Prentice Hall
2. Coiffet and Chirooza, "An Introduction to Robot Technology", Kogan Page
3. Y. Koren, "Robotics for Engineers, McGraw Hill"

EME-584/585 FLEXIBLE MANUFACTURING SYSTEM

Introduction: FMS definition and classification of manufacturing systems, Automated production cycle, Need of flexibility, Concept of flexibility, Types of flexibilities and its measurement.

FMS Equipment: Why FMS, Factors responsible for the growth of FMS, FMS types and applications, Economic justification for FMS, Functional requirements for FMS equipments, FMS processing and QA equipment, e.g., turning and machining centers, Co-ordinate measuring machines, Cleaning and deburring machines, FMS system support equipment, Automated material handling and storage equipment, cutting tool and tool management, Work holding considerations, Fixture considerations in FMS environment.

Group Technology: GT concepts, Advantages of GT, Part family formation-coding and classification systems; Part-machine group analysis, Methods for cell formation, Use of different algorithms, mathematical programming and graph theoretic model approach for part grouping, Cellular vs FMS production.

FMS related problem and Solution Methodology:

FMS design problems: Part assignment, Machine selection, Storage system selection, Selection of pallets and fixtures, Selection of computer hardware and software, designing for layout integration of machine storage, Material handling System and computer system, Communication networks.

FMS planning problems: Strategic planning, Part type selection, Machine grouping, production ratio and resource allocation, Machine loading problems.

Operational & Control problems: Part scheduling, Machines robots & AGVS, Process monitoring & control. FMS Implementation: Objectives, acceptance testing, Performance goals and expectation maintenance concerns.

Text Books:

1. Groover, "Automation, Production System & Computer Integrated Manufacturing", Englewood
2. Rankey, "Design and Operation of SMS", IFS
3. Wernecks, "Flexible Manufacturing System", Spring-Verlag
4. Bonctto, "FMS in Practice", Northox Ford
5. W.W. Luggen, "Flexible Manufacturing Cells and systems" Prentice Hall India
6. Vishwanathan & Narahari, "Performance Modelling of Automated Manufacturing Systems", PHI

EME-586/587 RELIABILITY & MAINTENANCE

Reliability Engineering: System reliability, series, parallel and mixed configuration, Block diagram, r-out-of-n structure, Solving problems using mathematical models. Reliability improvement and allocation.

Difficulty in achieving reliability, Method of improving reliability during design, different techniques available to improve reliability, Optimization, Reliability: Cost trade off, Prediction and analysis, Problems. Maintainability, Availability & Failure Analysis: Maintainability & Availability: Introduction, formulae, Techniques available to improve maintainability & availability, trade off among reliability, maintainability & availability, simple problems, Defect generation: Types of failures, defects reporting and recording, Defect analysis, Failure analysis, Equipment down time analysis, Breakdown analysis, TA, FMEA, FMECA.

Maintenance Planning and Replacement: Maintenance planning: Overhaul and repair, Meaning and difference, Optimal overhaul/Repair/Replace maintenance policy for equipment subject to breakdown, Replacement decisions: Optimal interval between preventive replacements of equipment subject to breakdown, group replacement.

Maintenance Systems: Fixed time maintenance, Condition based maintenance, Operate to failure, Opportunity maintenance, design out maintenance, Total productive maintenance, Inspection decision: Optimal inspection frequency, non-destructive inspection, PERT & CPM in maintenance, Concept of terrotechnology.

Condition Monitoring: Techniques: visual monitoring, temperature monitoring, vibration monitoring, lubricant monitoring, Crack monitoring, Thickness monitoring, Noise and sound monitoring, Condition monitoring of hydraulic system, Machine diagnostics: Objectives, Monitoring strategies, Examples of monitoring and diagnosis, Control structure for machine diagnosis.

Safety Aspects: Importance of safety, Factors affecting safety, Safety aspects of site and plant, Hazards of commercial chemical reaction and operation, Instruments for safe operation, Safety education and training, Personnel safety, Disaster planning and measuring safety effectiveness, Future trends in industrial safety.

Text Books:

1. L.S. Srinath Concepts in Reliability Engineering Affiliated East West Press
2. Ireson W.A. and C.F. Coombs, “Maintainability and Reliability Handbook”, McGraw Hill Inc.
3. L.F. Pau, “Failure Diagnosis and Performance Monitoring”, Marcel Dekker
4. S.K. Srivastava, “Industrial Maintenance Management”, S. Chand & Co Ltd.
5. Kelly and M.J. Harris, “Management of Industrial Maintenance”, Butterworth and Co
6. A.K.S. Jardine, “Maintenance, Replacement and Reliability”, Pitman Publishing
7. B.S. Dhillon, “Engineering Maintainability: How to Design for Reliability and Easy Maintenance”, PHI

EME-588/589 COMPOSITE MATERIALS

Introduction: Definition, Characteristics and Classification of Composites, Particulate and fibrous composites.

Fibers and Matrix materials : Glass, Carbon, Graphite, Aramid, Boron and other fibers. Matrix materials.

Fabrication of Composites:

Behavior of Unidirectional Composites : Nomenclatures, Volume and Weight fractions, Longitudinal Strength and Stiffness, Transverse Stiffness and Strength, Prediction of Shear Modulus and Poisson Ratio, Failure modes.

Analysis of an orthotropic Lamina: Hooke's law for orthotropic Materials, Stress- Strain Relations and Engineering Constants, Strengths of an Orthotropic Lamina.

Analysis of Laminated Composites : Strain and Stress Variation in a Laminate, Synthesis of Stiffness Matrix, Construction and Properties of Special Laminates, Determination of Laminae Stress and Strains, Analysis of Laminates after Initial Failure.

Experimental Characterization of Composites: Uniaxial Tension test, Uniaxial Compression Test, Inplane Shear test , Uniaxial Bending Tests, Determination of Interlaminar Shear Strength and Fracture Toughness. Damage Identification using Nondestructive Evaluation Techniques

Books:

1. Analysis and performance of fibre composites by B.D. Agarwal and Broutman
2. Mechanics of composites materials by Jones

EME-653 to 664 ELECTIVE III 4(3-1-0)

EME-653 /654 COMPUTER AIDED MANUFACTURING

UNIT-1
Introduction: Introduction to Automation, Need and future of NC Systems and CAM, Advantages and Disadvantages, Open and Closed loop systems, Historical developments and future trends. Future of NC Machines, Difference between ordinary and NC Machine tools, Methods for improving accuracy and productivity.

UNIT-2
Control of NC Systems: Types of CNC Machine Tools systems devices, e.g. encoders and interpolators, Features of CNC Systems, Direct Numerical Control (DNC), Standard Controllers and General, Programming features available in CNC Systems, Computer Process monitoring and Control. Adaptive control systems.

UNIT-3
NC Part Programming: Manual Programming for simple parts, e.g., turning, milling, drilling, etc., Computer aided NC Programming in APT language, use of canned cycles, Generation of NC Programmes through CAD/CAM systems, Design and implementation of post processors.

UNIT-4
Computer Aided Process Planning: Introduction, Manual process planning vs. Computer aided process planning, Basics of variant and generative process planning methods, Examples of automated process planning systems.

UNIT-5
Computer Integrated Manufacturing: Introduction, features and applications of CIM, key elements, advantages and disadvantages of CIM. Artificial Intelligence in Manufacturing: Introduction, Elements of Expert Systems, Introduction to Neural Networks, Expert Systems application in manufacturing, Case studies.

Text Books:

1. Koren, “Computer Control of Manufacturing Systems”
2. Groover, CAD/CAM”, Prentice Hall
3. S.J. Martin, “NC Machine Tools”
4. P.N. Rao, “CAD/CAM”
5. CAD/CAM, “P Radhakrishnan, S Subramanyam, V”
6. Wysk, Wang, “Computer Aided Manufacturing Chang”

EME-655/656 FRACTURE MECHANICS

Introduction and overview, Concepts of fracture mechanics and strength of materials, Elements of solid mechanics, Elasticity and plasticity, Incremental plasticity and deformation theory.

Elastic crack-tip fields, Basic concepts of linear elastic fracture mechanics, Griffth’s theory, stress intensity factor, Energy release rate, Plastic zone and fracture toughness, path invariant integrals and numerical approach. Plastic crack-tip fields, Mode-I fields and fracture criterion,

Engineering approach to plastic fracture, J-integral approaches and numerical concepts, Tearing modulus, Time dependent fracture, non-linear aspects of fatigue crack growth, Theoretical models, Fatigue cracks in welds, 36 standard tests and testing procedures. Brittle fracture of welded structures, Notch toughness, weld cracks and joint restrains, Weld defects and service behaviour, Application of fracture mechanics concepts and limitations, Weld cracking tests and elimination of joint restraints, Residual stress and its interaction in fracture behaviour, Numerical approaches for estimation of fracture parameters.

Books:

1. Anderson, T. L, "Fracture Mechanics: Fundamentals and Applications", CRC Press
2. Dowling, Norman, "Mechanical Behavior of Materials: Engg Methods for Deformation, Fracture & Fatigue.
3. Kanninen, Melvin F Popelar, Carl H, "Advanced Fracture Mechanics", Oxford University Press
4. David J Unger, "Analytical Fracture Mechanics", Dover Publications

EME-657/658 NEURAL NETWORK & FUZZY SYSTEMS

UNIT-1

Introduction to neural network and fuzzy systems; Artificial neural networks and their biological roots; ANN as numerical data/signal processing device, Taxonomy of neural networks. Industrial application of neural network and fuzzy systems.

UNIT-2

Feed forward and recurrent neural networks; Supervised and unsupervised learning; various training methods; Importance of back propagation methods; Adoptive resonance theory.

UNIT-3

Fundamentals of fuzzy logic systems; Operations on fuzzy sets. Complements, intersections and unions etc., Fuzzy arithmetic, Crisp vs fuzzy relations; Fuzzy equivalence; Compatibility and ordering relations; Fuzzy morphisms; Fuzzy relation equations and approximate solutions;

UNIT-4

Fuzzy logic and multi valued logic; Fuzzy propositions; Fuzzy quantifiers; Linguistic hedges; Fuzzy system

Controllers- an operative and examples; Fuzzy dynamic systems such as pattern recognition systems.

UNIT-5

Fuzzy databases and information retrieval systems. Neuro-fuzzy systems; Computational intelligence paradigm and its applications, Hybrid Approaches and Types

Text Books:

1. Anthony Martin, "Neural Network Learning: Theoretical Foundations", M Cambridge University
2. Ean A Pomerlea, "Neural Network Perception for Mobile Robot Guidance"
3. Shigeo Abe, "Neural Networks and Fuzzy Systems"
4. Nadia Nedjah, "Fuzzy Systems Engineering: Theory and Practice", Springer Verlog

EME-659/660 DESIGN OF THERMAL SYSTEMS

Design of Refrigeration systems, design of Air-Conditioning equipments and systems, Design of turbo machines comprising of axial flow turbines and compressors, Centrifugal Compressor. Analysis and Design of Thermal systems using FEM.

Text Books:

1. Robert F Boehm, "Developments In The Design Of Thermal Systems", Cambridge Univ Press
2. Boehm R F, "Design Analysis Of Thermal Systems", John Wiley

EME-661/662 ADVANCED MACHINE DESIGN

UNIT-1: Design considerations for machine elements, Product design & development. Concept of stress and strain, constitutive law, factor of safety and reliability.

UNIT-2: Concepts of 3D stress and strain, Principal Stresses, Plane stress and strain condition, constitutive law, Stress equilibrium equations, concepts of strain compatibility, Contact stresses-Hertz's theory and its application to gears and ball bearings.

UNIT-3: Material selection in design, performance index, effect of shape, size and loading. Importance of non-metallic materials like plastics, ceramics, composite materials for design applications. Case studies.

UNIT-4: Design for fatigue, fatigue strength, factors causing fatigue and its mitigation, statistical analysis, Miner's rule, Paris Law. Design for creep, static and temperature induced creep, creep testing; its mitigation.

UNIT-5: Introduction to fracture, LEFM, EPFM, Griffith's Law, Modes of failures.

Text Books:

1. Shigley, "Machine Design"
2. Juvinall, "Machine Design"
3. Sadhu Singh, "Advanced Machine Design"
4. MF Spotts, "Machine Design"

EME-663/664 SIMULATION MODELING & ANALYSIS

Introduction: A review of basic probability and statistics, random variables and their properties, Estimation of means variances and correlation.

Physical Modelling: Concept of System and environment, Continuous and discrete systems, Linear and non-linear systems, Stochastic activities, Static and Dynamic models, Principles of modeling, Basic Simulation modeling, Role of simulation in model evaluation and studies, advantages of simulation

System Simulation: Techniques of simulation, Monte Carlo method, Experimental nature of simulation, Numerical computation techniques, Continuous system models, Analog and Hybrid simulation, Feedback systems, Computers in simulation studies, Simulation software packages.
System Dynamics: Growth and Decay models, Logistic curves, System dynamics diagrams.

Probability Concepts in Simulation: Stochastic variables, discrete and continuous probability functions, Random numbers, Generation of Random numbers, Variance reduction techniques, Determination of length of simulation runs.

Simulation of Mechanical Systems: Building of Simulation models, Simulation of translational and rotational mechanical systems, Simulation of hydraulic systems.

Simulation of Manufacturing Systems: Simulation of waiting line systems, Job shop with material handling and Flexible manufacturing systems, Simulation software for manufacturing, Case studies.

Text Books:

1. Geoffrey Gordon, "System Simulation", Prentice Hall
2. Robert E. Shannon, "System Simulation: The Art and Science", Prentice Hall

Reference Books:

1. J. Schwarzenbach and K.F. Gill,"System Modelling and Control", Edward Arnold.
2. Charles M close and Dean K.Frederick "Modelling and Analysis of Dynamic Systems", Houghton Mifflin.
3. Allan Carrie, "Simulation of manufacturing", John Wiley & Sons.