Department of Mechanical Engineering

SCHEME & SYLLABUS

M.Tech. Mechanical Engineering Design

2024-25

Shri G S Institute of Technology & Science Indore

[Govt. Aided Autonomous Institute Estd. In 1952]

CONTENTS

M. Tech. Mechanical Engineering Design

ME 80001 : Advanced Machine Design

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 80001	Advanced Machine Design	4	-	-	3	-	3	70	30	-	-	100

Course Outcomes: At the end of the course,

- Students will demonstrate the ability to identify needs of the customer and convert them in to technical specifications of a product.
- Students will realize that creativity, manufacturability, assembly, maintainability, reliability are also important aspects of design other than finding dimensions and stresses
- Students will be able to solve problems in unsymmetrical bending and shear center.
- Students will be able to analyse torsion in solid and thin section
- Students will be able to design the components considering strength based reliability.

Syllabus Contents:

Unit 1: Mechanical design process, Phases and interactions of design process, design for sustainability, use of standards and codes in design. Tribological considerations in design, Human factors in design.

Unit 2: Design for manufacturing & assembly: Design consideration and recommendation for machining, casting, extrusion, etc. design consideration and recommendation for assembly processes.

Unit 3: Unsymmetrical Bending and Shear Centre: Concept of shear center in symmetrical and unsymmetrical bending, stress and deflections in beams subjected to unsymmetrical bending, shear center for thin wall beam cross section, open section with one axis of symmetry, general open section, and closed section.

Unit 4. Theory of Torsion: Torsion of prismatic bars of solid section and thin walled section. Analogies for torsion, membrane analogy, fluid flow analogy and electrical analogy. Torsion of conical shaft, bar of variable diameter, thin walled members of open cross section in which some sections are prevented from warping, Torsion of noncircular shaft.

Unit 5: Design based on Reliability: Design for Reliability, strength based reliability, approach to robust design.

Experimental Stress Analysis: Strain gauges, photo elasticity, non-destructive testing, brittle coating.

Course Assessment: The following methods are adopted for the assessment of this course;

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, mid semester tests and class attendance.
2. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

References:

1. Mechanical Design Process, D G Ullman, McGraw Hill Book Company
2. Design of Machine Elements, V B Bhandari McGraw Hill
3. Design for Manufacturing and Assembly, O Molloy, E A Warman, S Tilley, Springer
4. Advance Strength of Materials, Sandhu Singh, Khanna Publishers
5. Strength of Materials, S S Ratan, McGraw Hill
6. Experimental Stress Analysis, J W Dally, W F Riley, McGraw Hill

M. Tech. Mechanical Engineering Design

ME 80002 : Finite Element Analysis

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 80002	Finite Element Analysis	4	-	-	3	-	3	70	30	-	-	100

Course outcomes: At the end of the course, students will be able to-

1. Classify a given problem on the basis of its dimensionality as 1- D, 2-D, or 3-D, time-dependence as Static or Dynamic, Linear or Non-linear. Student will also understand deriving governing differential equations for axial bar problems.
2. Derive the shape functions and element level governing equations for solving axial bar problem. They will also understand criterion to select proper number of elements in finite element analysis.
3. Solve beam problems by finite element method and will also learn to extend bar and beam elements to solve truss and frame problems.
4. Write shape functions for lower and higher order two dimensional and quadrilateral elements and will also learn writing governing differential equations for two dimensional problems.
5. Write equations of motion of dynamic systems using finite element method. They will also learn solving eigenvalue and force vibration problem using finite element method.

Syllabus Contents:

Unit 1: Introduction to approximate methods of solving mathematical models of physical systems. Method of weighted residuals and variational approach for solving differential equations. Galerkin method. Weak form of weighted residual statement.

Unit 2: Basic aspects of the finite element method. Principle of minimum potential energy. Rayleigh-Ritz method. Introduction to finite element modelling of one dimensional problems in statics. Finite element for bar problems, Linear and quadratic shape functions. Convergence criterion.

Unit 3: Finite element formulation for truss and frame problems. Formulation of Beam problems. Numerical integration, Coordinate transformation

Unit 4: Plane stress and plane strain problems, Axisymmetric Formulation, Two dimensional problems using constant strain triangles and higher order elements, iso-parametric formulation.

Unit 5: Dynamic analysis, Equations of motion, Mass Matrices, Free vibration analysis, Natural frequencies of longitudinal, transverse and torsional vibration, Introduction to transient field problems.

Course Assessment: The following methods are adopted for the assessment of this course;

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, mid semester tests and class attendance.
2. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Books-

1. Textbook of Finite Element Analysis, P. Seshu, Eastern Economy Edition
2. Finite Element Analysis, C S Krishnamoorthy, Tata McGraw-Hill
3. Finite Element Method, J. N. Reddy, Tata Mc Graw-Hill
4. Finite Elements in Engineering, Chandrupatla and Belegundu, Prentice Hall India

M. Tech. Mechanical Engineering Design

ME 80003/ ME 87006 : Computer Aided Design

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 80003	Computer Aided Design	4	-	-	3	-	3	70	30	-	-	100

Course Outcomes: At the end of this course the student is expected to learn

1 Student will understand the fundamental of CAD Graphic standards and their modes
2 Student will be able to understand the concept of geometric modelling
3 Student will be able to solve the surface modelling and their engineering application
4 Students will be able to analysis of solid models of engineering applications
5 Students will be get idea of strategic plan f CAD system Design & development

COURSE CONTENTS

Unit 1: Review of basic fundamentals of CAD, CAD data exchange, Graphics standards, modes of graphics operation.

Unit 2: Geometric Modelling: Types of Mathematical representation of curves, parametric representation of analytic and synthetic curves, wire frame modelling. Introduction of transformation of geometric models, visual realism.

Unit 3: Surface Modelling: Parametric representation of analytic and synthetic curves, surface manipulation, Design and engineering applications. Solid Modelling: Boundary representation, constructive solid geometry, Sweep representation, Analytical solid modelling, Design and Engineering applications.

Unit 4: Engineering analysis of solid model.

Unit 5: Strategic plan of CAD system design & development, Graphic exchange, features recovery etc.

Course Assessment: The following methods are adopted for the assessment of this course;

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, mid semester tests and class attendance.
2. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Reference Books:

1. Chris McMohan and Jimmi Browne, “CAD/CAM principles, practice and manufacturing management”, Pearson Education Asia, Ltd., 2000.
2. Donald Hearn and M. Pauline Baker, “Computer Graphics”, Prentice Hall, Inc., 1992.
3. Ibrahim Zeid, “CAD/CAM - Theory and Practice”, McGraw Hill, International Edition, 1998.

M. Tech. Mechanical Engineering Design

ME 84501 : Advanced Vibrations and Acoustics

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 84501	Advanced Vibrations & Acoustics	4	-	-	3	-	3	70	30	-	-	100

Course Outcomes: At the end of the course, students will be able to-

1. Predict response of a SDOF system, damped or undamped, subjected to simple arbitrary base or force excitations. They will be able to obtain Shock Response Spectrum of SDOF systems for such excitations and understand use of the SRS.
2. Write differential equations of motion for MDOF systems, and through the technique of decoupling and orthogonal properties of natural modes, should be able to obtain the Eigen-values and mode shapes of natural vibrations and response to harmonic and arbitrary excitations.
3. Determine Eigen-values and mode shapes of natural vibrations of bar, beams, rods and response to harmonic excitations using orthogonal properties of natural modes.
4. Obtain the natural frequencies and damping factor of any system using measured vibration data by capturing the response using response sensors, exciting the structure using excitation devices using the basic concepts of digital signal processing.
5. Know various terminologies used in acoustics and acoustic wave transmission, understand the basics of psychoacoustics, equal loudness contours, dBA scale, loudness, pitch and timbre, obtain sound pressure level at a given distance from a simple sound source of known strength.

Course Contents:

Unit 1:

Transient Vibrations, Response of a single degree of freedom system to step and any arbitrary excitation, convolution (Duhamel's) integral, impulse response function.

Unit 2:

Multi degree of freedom systems, Free, damped and forced vibrations of two degree of freedom systems, Eigen values and Eigen vectors, normal modes and their properties, mode summation method, use of Lagrange's equations to derive the equations of motion,

Unit 3:

Continuous Systems. . Longitudinal, transverse and torsional vibrations. Natural Vibrations of beams – Differential equation of motion, solution by the method of separation of variables, frequency parameter, natural frequencies and mode shapes, forced vibration of simply supported beam subjected to concentrated harmonic force at a point, Mode summation method, discretized models of continuous systems and their solutions using Rayleigh – Ritz method

Unit 4:

Vibration measurement, Introduction to response measurement sensors, e.g. accelerometers, eddy current probes etc. Excitation of structures using instrumented impact hammer and hydrodynamic shaker. Concepts of time and frequency resolution of measured signals. Nyquist theorem for sampling. Modal analysis. Orthogonality of mode shapes. Frequency response functions and estimation of eigenvalues.

Unit 5:

Speech, mechanism of hearing, thresholds of the ear, Sound pressure. Inverse square Law of sound, sound pressure, power and sound intensity levels. dB scale. Symmetric Spherical waves, near and far fields. Sound frequency analysis. Sound weighting networks. Loudness, equal loudness levels, pitch, beats, masking by pure tones, masking by noise. Noise Control, noise control standards, Daily Noise dose.

Course Assessment: The following methods are adopted for the assessment of this course;

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, mid semester tests and class attendance.
2. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

References:

1. A G Ambekar, Mechanical Vibrations & Noise Engineering, PHI private limited 2006
2. S.S. Rao, Addison, “Mechanical Vibrations”, Wesley Publishing Co., 1990.
3. Leonard Meirovitch, “Fundamentals of vibrations”, McGraw Hill International Edition.
4. S. Timoshenko, “Vibration problems in Engineering”, Wiley, 1974.
5. Lawrence E. Kinsler and Austin R. Frey, “Fundamentals of acoustics”, Wiley Eastern Ltd., 1987.
6. Michael Rettinger, “Acoustic Design and Noise Control”, Vol. I & II. , Chemical Publishing Co., New York, 1977.
7. Thomson W.T., “Theory of Vibrations with applications”, George Allen and Unwh Ltd. London, 1981.

M. Tech. Mechanical Engineering Design

ME 84502 : Tribology in Design

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 84502	Tribology in Design	4	-	-	3	-	3	70	30	-	-	100

Course Outcomes: At the end of the course, the students will be able to
1. Understand the various surface measurement techniques and effect of surface texture on tribological behavior of a surface
2. Apply theories of friction and wear to various practical situations by analyzing the physics of the process.
3. Design a hydrodynamic bearing using various bearing charts.
4. Select lubrication solution to a particular situation.
5. Understand the recent developments in the field and understand modern research material.

Syllabus Contents:

Unit 1: Introduction to tribo-design, theories of friction, genesis of friction, instabilities and stick-slip motion, Friction control, reduction techniques, Surface texture and measurement. Design consideration of friction in mechanical components

Unit 2: Wear: Types of wear, Mechanism of wear, adhesive, abrasive, erosive, corrosive, fretting etc. wear equations, parameters affecting, wear measurement and prevention techniques. Design consideration of wear in mechanical components

Unit 3: Lubricants: Types of lubricants, properties of lubricants, regimes of lubrications, Petroff's equation, Reynolds's equation- applications to bearings (hydrodynamic, hydrostatic, squeeze film lubrication) and limitations, energy equation, application to journal bearings.

Unit 4: Hydrostatic and Elasto-hydrodynamic lubrication – Pressure-viscosity relation, Hertz' theory, Ertel-Grubin equation, thrust pad bearing, Design of tribo-element - piston ring and pin, gears, cam etc.

Unit 5: Air lubricated bearings, Tilting pad bearings, magneto-rheological bearing, rolling element bearing, Nano materials in lubrications.

Course Assessment: The following methods are adopted for the assessment of this course;
1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, mid semester tests and class attendance.
2. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

References:

1. M M Khonsari, E R Booser, Applied Tribology: Bearing Design and Lubrication, John Wiley
2. Bhushan, Bharat. Modern tribology handbook, two volume set. CRC press, 2000.
3. Cameron "Basic Lubrication Theory", Ellis Horwood Ltd, 1981.
4. Principles in Tribology, Edited by J. Halling, 1975
5. Fundamentals of Fluid Film Lubrication – B. J. Hamrock, McGraw Hill International,1994
6. D.D. Fuller, "Theory and Practice of Lubrication for Engineers", John Wiley and Sons, 1984.
7. "Fundamentals of Friction and wear of Materials" American Society of Metals.
8. Introduction to Tribology of Bearings –B. C. Majumdar, A. H. Wheeler &co. pvt. Ltd 1985.
9. T.A. Stolarski, "Tribology in Machine Design".

M. Tech. Mechanical Engineering Design

ME 84503 : Advanced Stress Analysis

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 84503	Advanced Stress Analysis	4	-	-	3	-	3	70	30	-	-	100

Course Objectives:

To impart knowledge on the basic concepts of theory of elasticity and solve the Engineering problems.

Course Outcomes:

At the end of the course the students will be able to:
1. Use indicial notation and understand Cartesian tensor analysis
2. Analysis of stress and deformation
3. Formulation and solution of plane stress and plane strain problems, compatibility and equilibrium
5. Demonstrate the knowledge of fundamental methods of elasticity for 2-D Cartesian and Polar problems.
5. Analyze concept of material yielding and plastic behavior of structures.

COURSE CONTENTS

Unit 1: Continuum & Tensors, Index notation, Displacement and strains, small deformation theory, strain compatibility relations, principle strain, spherical and deviatoric components, curvilinear coordinates.

Unit 2: Stress and equilibrium: Stress tensor, equilibrium equations, linear elasticity and constitutive relations. Boundary conditions, stress and displacement formulation, principle of superposition, St. Venant's principles

Unit 3: Plane strain, plane stress problems, Compatibility relations, Airy stress function, Two dimensional problems in rectangular coordinates, solution by polynomials, use of Fourier's series cantilever and supported beams problems,

Unit 4: Polar coordinate formulation, stress distribution symmetrical about axis, simple and symmetric problems such as thick cylinder, curved bars. Hole in a plate etc.

Analysis of stress and strain in three dimensions - Principle stresses – Homogeneous deformations spherical and deviatoric stress

Unit 5: Energy Methods: Energy method for analysis of stress, strain and deflection, theorem of virtual work, theorem of least work, Castigliano's theorem, Rayleigh Ritz method, Galerkin's method, Elastic behavior of anisotropic materials like fiber reinforced composites.

Plasticity: Yield criteria, Yield surface, Flow rule, Elastic-perfect-plastic analysis of big bending, torsion, pressurized cylinders.

Course Assessment: The following methods are adopted for the assessment of this course;
1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, mid semester tests and class attendance.
2. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

References:

1. Sadd, Martin H., Elasticity: Theory, applications and Numeric, Academic Press.
2. Boresi, A.P. and K. P. Chong, Elasticity in Engineering Mechanics, 2nd Ed., John Wiley.
3. Budynas, R. G. Advance strength and Applied Stress Analysis, 2nd Ed. McGraw Hill 1999
4. Dally, J. W. and W.F. Riley, Experimental Stress Analysis, McGraw Hill Int. 3rd Ed. 1991
5. Timoshenko S., and Goodier, J.N., Theory of Elasticity, Mc Graw Hill, 2010
6. Advanced Strength of Materials, Vol. 1, 2, Timoshenko, S., CBS
7. J. Chakrabarty: Theory of plasticity, Butterworth-Heinemann

M. Tech. Mechanical Engineering Design

MA 84201 : Advanced Mathematical method in Engineering

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
MA 84201	Adv. Mathematical method in Engineering	4	-	-	3	-	3	70	30	-	-	100

Course Outcome:

1. Students will able to analyse and develop the mathematical model of mechanical system.
2. Students should able to analyse the reliability and maintainability of the series and parallel system.
3. Students will able to solve differential equation using numerical techniques.

Syllabus Contents:

Unit 1: Ordinary Differential Equation: First-order equation (Linear, Equi-dimensional, Separable, Exact, Homogeneous); Second-order linear differential equation with constant coefficients (homogeneous and non-homogeneous); Solution methods such as undetermined coefficients and variation of parameters.

Unit 2: Partial Differential Equation: First order Partial Differential Equation - Lagrange's and Charpit's Method; Second order linear homogeneous Partial Differential Equation with constant coefficients; Classification of PDE, Canonical form.

Unit 3: Variable separable method – derivations and problems, Second order Parabolic, Elliptic and hyperbolic equations in rectangular coordinate system (Steady state method); Solution of PDE by Fourier transform method.

Unit 4: Random Variables, Distribution Function and Density Function, Standard Discrete distribution (Binomial distribution, Poisson distribution, Geometric distribution) and Continuous distribution (Uniform distribution, Exponential distribution, Gamma distribution, Weibull distribution, Normal distribution), Central Limit Theorem and its significance.

Unit 5: Relevant topics required for ANOVA (Sample Estimates and Test hypothesis) ANOVA : One- way, Two-way with/ without interactions, latin squares ANOVA techniques.

Course Assessment: The following methods are adopted for the assessment of this course;

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, mid semester tests and class attendance.
2. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

References:

1. K. Sankara Rao, "Introduction to Partial Differential Equations," Third edition, PHI Pvt Ltd, 2019.
2. J.B Doshi, "Differential Equation for Scientist and Engineers", Narosa, 2010.
3. Peter O'neil, "Advanced Engineering Mathematics", 7th ed. Cengage learning, 2012 (Indian Edition).
4. Michael Greenberg, "Advanced Engineering Mathematics", 2nd ed. Pearson Education, 2002 (Indian Ed.).
5. Jennings.A., Matrix Computation for Engineers and Scientists. John Wiley and Sons, 1992.
6. Prem. K. Kythe, Pratap Puri , Michael R. Schaferkotter, Introduction to Partial Differential Equation and Boundary Value problems with Mathematics, CRC Press, 2002.
7. Kreyszig, Erwin, I.S., Advanced Engineering Mathematics , Wiley,1999.
8. Ramamurthy. V., Computer Aided Design in Mechanical Engineering., Tata McGraw Hill Publishing Co.,
9. Fundamental Concept in the Design of Experiments, 5th Ed., by Hicks and Turner.
10. Devore, Jay L., Probability and Statistics for Engineering and the Science, 5th edition, Brooks-cole (1999).

M. Tech. Mechanical Engineering Design

ME 84202 : Advance Engineering Materials

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 84202	Advance Engineering Materials	4	-	-	3	-	3	70	30	-	-	100

Course Outcomes: At the end of the course the student will to-

1. Demonstrate an understanding of mechanics, physical and chemical properties of materials including metals, ceramics, polymers and composites
2. Understand existence of imperfections and their effects on mechanical properties of materials and cause of failure
3. Demonstrate understanding of phase diagrams and their use in predicting phase transformation and microstructure
4. Understand and predict various types of failures using concept of fracture mechanics, creep and effect of impact
5. Know Electrical, Thermal, Optical and Magnetic Properties of metals, ceramics, polymers and composites
6. Understand the economic considerations in usage and recycling of materials in human use

Syllabus Contents

Unit 1. Introduction, Classification of materials. Advanced Materials, Future materials, Modern materials needs, Atomic structure and bonding in solids, Crystal structures, Miller indices. Anisotropy, Elastic behavior of composites. Polymers and Ceramics- Properties and Structure.

Unit 2: Imperfections in Solids: Point defects, Line defects and dislocations, Interfacial defects, Bulk or volume defects. Mechanical Properties: Elastic and Plastic deformation, stress-strain curves, Yield criteria and macroscopic aspects of plastic deformation. Property variability and design factors,

Diffusion mechanisms. Steady and non-steady state diffusion. Factors that influence diffusion. Non-equilibrium transformation and microstructure, Dislocation and plastic deformation. Mechanisms of strengthening. Recovery, recrystallization and grain growth. Strengthening by second phase particles.

Unit 3: Phase Diagrams: Equilibrium phase diagrams. Particle strengthening by precipitation. Precipitation reactions. Kinetics of nucleation and growth. The iron-carbon system. Phase transformations. Transformation rate effects and TTT diagrams. Microstructure and property changes in iron carbon system

Unit 4: Failure: Fracture. Ductile and brittle fracture. Fracture mechanics. Impact fracture. Ductile brittle transition. Fatigue. Crack initiation and propagation. Crack propagation rate. Creep. Generalized creep behaviour. Stress and temperature effects

Unit 5: Applications and Processing of Metals and Alloys, Polymers, Ceramics and composites:

Metals and alloys: types, fabrication, thermal processing, heat treatment, precipitation hardening. Ceramics: types and applications, fabrication and processing, Mechanical behaviour of polymers. Mechanisms of deformation and strengthening of polymers. Crystallization, melting and glass transition. Polymer types. Polymer synthesis and processing, Particle reinforced and Fibre reinforced composites. Structural composites. Recycling issues. Life cycle analysis and its use in Design

Course Assessment: The following methods are adopted for the assessment of this course;

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, mid semester tests and class attendance.
2. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

References:

1. Materials Science and Engineering, William D. Callister, Jr, John Wiley & sons.
2. Modern Physical Metallurgy and Material Engineering, Science, Process, application, Smallman R.E., Bishop R J, Butterworth Heinemann, Sixth Ed., 1999.

ME 84203 : Machine Tool Design

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 84203	Machine Tool Design	4	-	-	3	-	3	70	30	-	-	100

Syllabus Contents

Unit 1: Introduction, working and auxiliary motion in machine tools, parameters defining working motions of a machine tool, machine tool drives, hydraulic transmission and its elements, mechanical transmission and its elements, general requirements of machine tool design, machine tools design process, layout of machine tool.

Unit 2: Design of feed box, multi-speed motors drive, gearbox design, determining the number of teeth of gears, classification of speed and feed boxes, step-less regulation of speed and feed rates.

Unit 3: Design of machine tool structures, design criteria for machine tool structures, material selection, static and dynamic stiffness, profiles of machine tool structures, design procedure, design of beds columns, housings, and boss of tables, model techniques in design.

Unit 4: Design of guide ways and slideways power screw, design of rails, arms, saddles and carriage, design of rams. Design of spindle supports.

Unit 5: Dynamics of machines tool, Stability analysis, Forced Vibration analysis, motion conversion systems.

Course Assessment: The following methods are adopted for the assessment of this course;

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, mid semester tests and class attendance.
2. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

References:

1. N.K. Metha, Machine tool design and Numerical Controls, Tata McGraw Hill.
2. Sen, Bharracharya, Principles of Machine tools. New Control Book Agency (P) Ltd. Kolkata.
3. P. H. Joshi, Machine Tools Hand Book Design and Operation, TMH.

M. Tech. Mechanical Engineering Design

ME 84204 : Analysis and Synthesis of Mechanism

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 84204	Analysis and Synthesis of Mechanism	4	-	-	3	-	3	70	30	-	-	100

Course Outcomes: At the end of the course, students will be able-

1. To develop analytical equations of relative position, velocity and acceleration of moving links.
2. To select, configure, and synthesize mechanical components into complete systems.
3. To use kinematic geometry to formulate and solve constraint equations to design linkages for specified tasks.
4. To formulate and solve four position synthesis problems for planar and spherical four-bar linkages by graphical and analytical methods.
5. To analyze and animate the movement of planar and spherical four-bar linkages.

Syllabus Contents:

Unit 1: Basic Concepts; Definitions and assumptions; planar and spatial mechanisms; kinematic pairs; degree of freedom; equivalent mechanisms; Kinematic Analysis of Planar Mechanisms. Review of graphical and analytical methods of velocity and acceleration analysis of kinematically simple mechanisms, velocity-acceleration, analysis of complex mechanisms by the normal acceleration and auxiliary-point methods.
Unit 2 : Curvature Theory: Fixed and moving centrodes, inflection circle, Euler-Savary equation, Bobillier constructions, cubic of stationary curvature, Ball's point, Applications in dwell mechanisms.
Unit 3: Kinematic Synthesis of planar mechanisms, accuracy (precision) points, Chebesychev spacing, types of errors, Graphical synthesis for function generation and rigid body guidance with two, three and four accuracy points using pole method, centre and circle point curves, Analytical synthesis of four-bar and slider-crank mechanisms.
Unit 4: Freudenstein's equation, synthesis for four and five accuracy points, compatibility condition, synthesis of four-bar for prescribed angular velocities and accelerations using complex numbers, three accuracy point synthesis using complex numbers.
Unit 5: Coupler Curves: Equation of coupler curve, Robert-Chebychev theorem, double points and symmetry. Kinematic Analysis of Spatial Mechanisms, Denavit-Hartenberg parameters, matrix method of analysis of spatial mechanisms

Course Assessment: The following methods are adopted for the assessment of this course;
1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, mid semester tests and class attendance.
2. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

References:

1. R.S. Hartenberg and J. Denavit, "Kinematic Synthesis of Linkages", McGraw-Hill, New York, 1980.
2. Robert L. Nortan ,"Design of Machinery', Tata McGraw Hill Edition
3. Hamilton H.Mabie,"Mechanisms and Dynamics of Machinery", John Wiley and sons New York
4. S.B. Tuttle, "Mechanisms for Engineering Design" John Wiley and sons New York
5. A. Ghosh and A.K. Mallik, "Theory of Machines and Mechanisms", Affiliated East-West Press, New Delhi, 1988.
6. A.G. Erdman and G.N. Sandor, "Mechanism Design – Analysis and Synthesis", (Vol. 1 and 2), Prentice Hall India, 1988.
7. A.S. Hall, "Kinematics and Linkage Design", Prentice Hall of India.
8. J.E. Shigley and J.J. Uicker, "Theory of Machines and Mechanisms", 2nd Edition, McGraw-Hill, 1995.

M. Tech. Mechanical Engineering Design

ME 84301 : Design for Manufacturing and Assembly

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 84301	Design for Manufacturing and Assembly	4	-	-	3	-	3	70	30	-	-	100

Course Outcomes:

At the end of the course, the student should be able to
1. Understand the product development cycle
2. Know the manufacturing issues that must be considered in the mechanical engineering design process
3. Know the principles of assembly to minimize the assembly time
4. Know the effect of manufacturing process and assembly operations on the cost of product
5. Understand various tools and methods to facilitate development of component for quality and reliability.

Syllabus Contents:

Unit 1: Introduction: Need Identification and Problem Definition, Concept Generation and Evaluation, Embodiment Design.

Unit 2: Materials and Shape: Properties of Engineering Materials, Selection of Materials, Selection of Shapes.

Unit 3: Manufacturing Processes: Review of Manufacturing Processes, Design for Casting and Machining, Design for Sheet Metal Forming Processes, Design for Powder metallurgy, Design for Polymer Processing.

Unit 4: Design for Assembly, Design for Welding, Brazing and Soldering, Design for Adhesive Bonding, Design for Joining of Polymers, Design for Heat Treatment.

Unit 5: Design for Quality and Reliability, Failure Mode and Effect Analysis, Approach to Robust Design, Design for Optimization, Rapid Prototyping & Reverse Engineering, their applications

Course Assessment: The following methods are adopted for the assessment of this course;
1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, mid semester tests and class attendance.
2. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

References:
1. G Dieter, Engineering Design - A materials and processing approach, McGraw Hill, NY, 00.
2. M F Ashby, Material Selection in Mechanical Design, Butterworth-Heinemann, 1999.
3. T H Courtney, Mechanical Behavior of Materials, McGraw Hill, NY, 00.
4. K G Swift and J D Booker, Process selection: from design to manufacture, London: Arnold, 1997.
5. S S Rao, Engineering Optimization: Theory and practice, John Wiley, NY, 1996.
6. G Boothroyd, P Dewhurst and W Knight, Product design for manufacture and assembly, John Wiley, NY: Marcel Dekkar, 1994.
7. J G Bralla, Handbook for Product Design for Manufacture, McGraw Hill, NY, 1998.

M. Tech. Mechanical Engineering Design

ME 84302 : Robotics

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 84302	Robotics	4	-	-	3	-	3	70	30	-	-	100

Course Outcomes: At the end of the course students will be able to

1 Understand basic terminologies and concepts associated with Robotics and Automation.
2 Explain the Design aspect for gripper and sensor applications in robotics.
3 Understand the concept of drives and control system in automation control technology.
4 understand robot kinematics and dynamics to explain motion and force analysis in robotics
5 Application of vision system and modern tool ANN, AI

Syllabus Contents

Unit 1 Introduction: Basic Concepts such as Definition, three laws, DOF, Misunderstood devices etc., Elements of Robotic Systems i.e. Robot anatomy, Classification, Associated parameters i.e. resolution, accuracy, repeatability, dexterity, compliance, RCC device, etc. Automation - Concept, Need, Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations, introduction to automation productivity.

Unit 2 Robot Grippers: Types of Grippers, Design aspect for gripper, Force analysis for various basic gripper system.

Sensors for Robots: - Characteristics of sensing devices, Selections of sensors, Classification and applications of sensors. Types of Sensors, Need for sensors and vision system in the working and control of a robot.

Unit 3 Drives and control systems: Types of Drives, Actuators and its selection while designing a robot system. Types of transmission systems, Control Systems - Types of Controllers, Introduction to closed loop control, Control Technologies in Automation:- Industrial Control Systems, Process Industries Verses, Discrete-Manufacturing Industries, Continuous Verses Discrete Control, Computer Process and its Forms. Control System Components such as Sensors, Actuators and others.

Unit 4 Kinematics: Transformation matrices and their arithmetic, link and joint description, Denavit – Hartenberg parameters, frame assignment to links, direct kinematics, kinematics redundancy, kinematics calibration, inverse kinematics, solvability, algebraic and geometrical methods. Velocities and Static forces in manipulators:- Jacobians, singularities, static forces, Jacobian in force domain.

Dynamics:- Introduction to Dynamics, Trajectory generations.

Unit 5 Machine Vision System: Vision System Devices, Image acquisition, Masking, Sampling and quantisation, Image Processing Techniques, Noise reduction methods, Edge detection, Segmentation.

Modern Tools- Artificial neural networks, AI techniques, Need and application of AI.

Course Assessment: The following methods are adopted for the assessment of this course;

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, mid semester tests and class attendance.
2. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Text Books:

1. John J. Craig, Introduction to Robotics (Mechanics and Control), Addison-Wesley, 2nd Edition, 04
2. Mikell P. Groover et. Al., Industrial Robotics: Technology, Programming and Applications, McGraw Hill International, 1986.
3. Shimon Y. Nof , Handbook of Industrial Robotics , John Wiley Co, 2001.
4. Automation, Production Systems and Computer Integrated Manufacturing, M.P. Groover, Pearson Education.
5. Industrial Automation: W.P. David, John Wiley and Sons.

Reference Books:

1. Richard D. Klafter , Thomas A. Chemielewski, Michael Negin, Robotic Engineering : An Integrated Approach, Prentice Hall India, 02.
2. Handbook of design, manufacturing & Automation: R.C. Dorf, John Wiley and Sons.

ME 84303 : Fracture Mechanics

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 84303	Fracture Mechanics	4	-	-	3	-	3	70	30	-	-	100

At the end of the course: Students will be able

1. To use any one of the four parameters for finding out damage tolerance: stress intensity factor, energy release rate, J integral, Crack tip opening displacement.
2. To manage singularity at crack tip using complex variable.
3. To understand important role played by plastic zone at the crack tip.
4. To calculate the fatigue life of a component with or without crack in it.
5. To learn experimental techniques to determine fracture toughness and stress intensity factor.

Syllabus Contents

Unit 1: Modes of fracture failure, Brittle and ductile fracture,

Unit 2: Energy release rate: crack resistance, stable and unstable crack growth.

Unit 3: Stress intensity factor: Stress and displacement fields, edge cracks, embedded cracks.

Unit 4: Crack tip plasticity: Shape and size of plastic zone, effective crack length, effect of plate thickness, J-Integral. Crack tip opening displacement. Test methods.

Unit 5: Fatigue failure: Crack propagation, effect of an overload, crack closure, variable amplitude fatigue load. Environment-assisted cracking. Dynamic mode crack initiation and growth, various crack detection techniques.

Course Assessment: The following methods are adopted for the assessment of this course;

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, mid semester tests and class attendance.
2. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

References:

1. Brook D, “Elementary engineering fracture mechanics”.
2. Liebowitz H., “Fracture” Volume I to VII.
3. A Nadai, W. S. Hemp, “Theory of flow and fracture of solids”, McGraw Hill Book Company, 1950.

M. Tech. Mechanical Engineering Design

ME 84304 : Hydraulic & Pneumatic Control

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 84304	Hydraulic & Pneumatic Control	4	-	-	3	-	3	70	30	-	-	100

Syllabus Contents:

Unit 1: Characteristics of hydraulic components: reservoir, filters & strainers. Hydraulic power generator-classification, selection and specification of pumps. Control and regulation elements-pressure, direction and flow control valves, servo valve. Hydraulic actuators & motors,

Unit 2: Elements of circuit design- reciprocation, quick return, sequencing, regenerative, accumulator circuit, flow control methods.

Unit 3: Pneumatic control systems, conditioning of compressed air, pneumatic regulators, filters. Steady state analysis of pneumatic components, applications for industrial process control, proportional, derivative controllers etc.

Unit 4: Industrial applications of hydraulic and pneumatic circuits such as for machine tools, assembly line etc. Maintenance of hydraulic and Pneumatic system.

Unit 5: Fluidics: basic components and applications, analogue digital amplifiers and sensors Equivalent electric circuits, graphical characteristics, logic gates applications, truth table.

Course Assessment: The following methods are adopted for the assessment of this course;

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, mid semester tests and class attendance.
2. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Books Recommended:

1. Dudley A. Pease, *Basic Fluid Power*
2. Vicker Sparry, *Hand Book -Industrial Hydraulics*
3. S. R. Majumdar *Pneumatic Systems: Principles and Maintenance*
4. A. H. Hehn, *Fluid Power & Trouble shooting*.
5. D. Mccloy, H.R. Martin, *The Control of Fluid Power*

M. Tech. Mechanical Engineering Design

ME 84701 : Advanced Finite Element Methods

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 84701	Advanced Finite Element Methods	4	-	-	3	-	3	70	30	-	-	100

Course Outcomes:

At the end of the course, the students will be able to
1. Demonstrate understanding of FE formulation for linear problems in solid mechanics
2. Understand behaviour of elastic-plastic materials and visco-plasticity
3. Understand flow rules and strain hardening, loading and unloading conditions, Drucker's stability postulates, J2 flow of plasticity
4. Demonstrate use of FE formulation to solve the problems of large deformation
5. Able to solve contact problems using the techniques of non-linear FEM

Syllabus Contents:

Unit 1. **Review of linear FEA**: FE formulation of 1D bar, 3D linear elastic continuum, 2D plane strain, plane stress, and axisymmetric elements; Iso-parametric mapping; numerical integration.

Unit 2. FE formulation for 1D plasticity: Elastic-perfectly plastic material; Isotropic and kinematic hardening; Integration algorithms for 1D plasticity; FE formulation; Newton-Raphson method for solving nonlinear equilibrium equations; 1D visco-plasticity and integration algorithm.

Unit 3. Continuum theories of plasticity: Review of tensor algebra; Yield condition, flow rule and hardening rules; loading and unloading conditions; Drucker's stability postulates; Convexity and normality; J2 flow theory of plasticity and visco-plasticity, Gurson model.

Unit 4. FE procedures for 2D and 3D plasticity: Integration algorithms for rate independent plasticity—explicit forward Euler and implicit backward Euler; Return mapping algorithm; visco-plasticity; FE formulation; Consistent linearization; Algorithmic and consistent tangent modulii; Treatment of incompressible deformation (Locking); B-bar method.

Unit 5. Contact Problems: Condition of impenetrability; Gap elements for modelling contact; Tangent stiffness matrix and force vectors for 2D frictionless contact problems.

Course Assessment: The following methods are adopted for the assessment of this course;
1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, mid semester tests and class attendance.
2. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

References:
1) K. J. Bathe, Finite Element Procedures, Prentice-Hall of India Private Limited, New Delhi, 1996
2) J. C. Simo and T. J. R. Hughes, Computational Inelasticity, Springer-Verlag New York, 1998
3) O. C. Zienkiewicz and R. L. Taylor, Finite Element Method: Volume 2 Solid Mechanics, 5th Ed
4) T. Belytschko and W. K. Liu and B. Moran, Nonlinear Finite Elements for Continua and Structures, John Wiley & Sons Ltd., England.
5) D. R. J. Owen and E. Hinton, Finite Elements in Plasticity: Theory and Practice, Pineridge Press Ltd., Butterworth-Heinemann, Oxford

M. Tech. Mechanical Engineering Design

ME 84702 : Condition Monitoring of Machines

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 84702	Condition Monitoring of Machines	4	-	-	3	-	3	70	30	-	-	100

Course Outcomes: At the end of the course, the students will be able-
1. To understand and be able to explain the aim and the basics of CM
2. To use various methods and procedures applied for general CM;
3. To understand the basic idea behind vibration-based structural health monitoring and condition monitoring, know the general stages of CM;
4. To apply some basic techniques for analysis of random and periodic signals;
5. Know the basics of Vibration of Linear Systems: time and frequency response, resonance;
6. be aware of some basic instrumentation used for machinery and structural vibration-based monitoring;
7. be aware of some basic faults in rotating machinery, their manifestation and methods for detection and recognition: low frequency, medium frequency and high frequency

Syllabus Contents:

Unit 1: The basic idea of health monitoring and condition monitoring of structures and machines.
Some basic techniques.
Unit 2: Basics of signal processing: Study of periodic and random signals, probability distribution, statistical properties, auto and cross correlation and power spectral density functions of commonly found systems, spectral analysis.
Unit 3: Fourier transform: the basic idea of Fourier transform, interpretation and application to real signals. Response of linear systems to stationary random signals: FRFs, resonant frequencies, modes of vibration,
Unit 4: Introduction to vibration-based monitoring, Machinery condition monitoring by vibration analysis: Use and selection of measurements, analysis procedures and instruments,
Unit 5: Typical applications of condition monitoring using vibration analysis to rotating machines. Other health monitoring techniques, acoustic emission, oil debris and temperature analysis, Applications.

Course Assessment: The following methods are adopted for the assessment of this course;
1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, mid semester tests and class attendance.
2. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

References:

1. M.Adams, Rotating machinery analysis - from analysis to troubleshooting, Marcel Dekker, New York.
2. Cornelius Scheffer Paresh Girdhar, Practical Machinery Vibration Analysis and Predictive Maintenance, Newnes, 1st Eds.

M. Tech. Mechanical Engineering Design

ME 84703 : Mechatronics and Automation

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 84703	Mechatronics and Automation	4	-	-	3	-	3	70	30	-	-	100

Course Outcomes:

1. List various control actions and application of Laplace Transform
2. Explain mathematical modelling of mechanical, electrical system and block diagram representation.
3. Discuss stability criteria and method for control system
4. Discuss various frequency response methods for analysis of control system
5. Application of PID controller and state space analysis of control system

Syllabus Contents:

Unit 1: Introduction: Introduction to Control system, Open loop control system and Close loop control system, Examples of control system and their design aspects. Laplace Transforms, Applications of Laplace Transform in solving Linear, Time Invariant Differential Equations.

Unit 2: Mathematical Modelling and Transient Response Analysis: Transfer Function and Impulse Response Function, Block Diagram, Mechanical System, Electrical System, Modelling in State Space. First order system, Second order system, Transient Response Analysis

Unit 3:

(a) Basic Control Action and Response of Control Systems: Basic Control Actions, Effect of Integral and derivative control actions on systems, higher order systems, Routh Stability criterion, Pneumatic, Hydraulic, and Electronic Controller, Steady State Errors.

(b) Root Locus Analysis: Root locus plots, Root locus analysis of control systems, Control system design by Root Locus Method, preliminary design considerations, Lead compensation, Lag compensation, Lag-Lead compensation.

Unit 4: Frequency Response analysis and Design of Control System: Bode Diagrams, Polar Plots, Nyquist Plots, Nyquist Stability Criterion, Stability analysis, closed loop frequency Response. Lead compensation, Lag compensation, Lag-Lead compensation.

Unit 5: PID Controls and Introduction to Robust Control: Tuning Rules for PID Controllers, Modifications of PID Control System, and Design Considerations for robust control. Introduction to Analysis of Control Systems in State Space.

Course Assessment: The following methods are adopted for the assessment of this course;

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, mid semester tests and class attendance.
2. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

References:

1. K. Ogata, Modern Control Theory, PHI, 2004
2. Nakra & Choudhary, Instrumentation, Measurement and Analysis, TMH, 2004
3. Bolton, Mechatronics, Pearson Education India, 2004
4. Norman S. Nice, Control System engineering, John Wiley & Sons, Inc.

M. Tech. Mechanical Engineering Design

ME 84704 : Mechanics of Composite Materials

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 84704	Mechanics of Composite Materials	4	-	-	3	-	3	70	30	-	-	100

Unit 1: Introduction to Composites: General Introduction and Concept, Historical development of composites, Concept of Composite materials, importance of composite material & its engineering applications, Comparison with traditional materials, Advantages & Limitations of Composites. Classification of Composites on the Basis of matrix and reinforcement

Unit 2: Basic constituents of Composites: Types of Reinforcements, Role and Selection of reinforcement materials, Mechanical properties of fibres and whiskers, Manufacturing of various fibers, comparison of reinforcements, Functions of a Matrix, Desired Properties of a Matrix, Types of matrix materials

Unit 3: Manufacturing Processes of composites: Fundamentals of Manufacturing, Manufacturing of Polymer, Metal, Ceramic and Carbon Composites, Manufacturing of Polymer Matrix Composites: Preparation of Moulding compounds and prepregs – hand layup method, Autoclave method, Filament winding method, Compression moulding , Reaction injection moulding . Properties and applications.

Unit 4: Mechanics of composites: Micromechanical analysis of composites, volume and weight fractions, Longitudinal and transverse modulus, Shear modulus, Elastic Properties of Lamina, Stress-Strain relationship of composite materials, Isotropic materials. Orthotropic materials, Compliance and stiffness matrices, Fiber reinforced composites, Transformation of stress-strain.

Unit 5: Strength and failure concept in composites: Strength of laminates, Failure Mechanics of composites, Macro-mechanical failure theories. Maximum stress theory, Maximum strain theory, Tsai-Hill theory, Tsai-Wu theory. Composite codes & standards. Testing of Composites.

Course Assessment: The following methods are adopted for the assessment of this course;

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, mid semester tests and class attendance.
2. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Text Books:

1. Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.
2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.
3. Fiber Reinforced composites, Materials, Manufacturing and Design, P K Mallick, CRC Press
4. Mechanics of composite materials, Auter Jaw

References:

1. Mechanics of composite materials, R. Jones, Taylor & Francis
2. Hand Book of Composite Materials-ed-Lubin.
3. Composite Materials – K.K. Chawla.
4. Composite Materials Science and Applications – Deborah D.L. Chung.
5. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi

M. Tech. Mechanical Engineering Design

IP 84751 : Quantitative Techniques

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
IP 84751	Quantitative Techniques	4	-	-	3	-	3	70	30	-	-	100

COURSE OBJECTIVES:

The course presents basic theory of linear and different quantitative problems to analyzing different situations arises in engineering and management, it gives understanding of getting solution to these problems and some experience in solving them. Also helps to formulate and solve mathematical models in researches.

COURSE OUTCOMES:

1. Analyze any real life system with limited constraints and depict it in a model form and convert the problem into a mathematical model using linear programing.
2. Understand variety of problems such as assignment, transportation, Game theory, Dynamic programming etc.
3. Understand different queuing situations and find the optimal solutions using models for different situations
4. Analyze and Simulate different real life probabilistic situations using Monte Carlo simulation technique

COURSE ASSESSMENT: Students will be assessed as following:
Theory paper:
(1) End Semester Exam: 70 Marks
(2) Continuous assessment: 30 Marks (Two mid-term tests:15 Marks, Assignment:5 Marks, Quiz: 5 Marks, and Regularity: 5 Marks)

COURSE CONTENTS:

Unit 1. Introduction: History and Development of O.R & Linear Programming. Present Trend.
(i) Assignment models
(ii) Transportation: Optimality Test, Degeneracy unbalanced Problems, Transshipment.

Unit 2. Linear Programming: Formulation, Graphical Method, Simplex Method, and Big - M Method, Two-phase Method, Degeneracy, and Unrestricted variables. Revised Simplex, Duality, Sensitivity analysis. Introduction to Integer programming. Branch and Bound Method,

Unit 3. Waiting model: Introduction, Classification, States in queue, Probability distribution of arrival and service times Birth and Death Process, Single Server Model (M/M/1). Multiple Server Model (M/M/S), Single Server Model with finite capacity.

Unit 4. Game Theory: Rectangular, Two persons, Zero Sum Games, Maximum and Minimax Principles. Saddle Point. Dominance. Graphical and Algebraic Methods of solution, transforming into Linear Programming Problem. Bidding Problems. Dynamic Programming: Characteristic of Dynamics Optimization Model, Applications of Dynamic Programming, Continuous state DP. Multiple state variables.

Unit 5. Simulation: Building a Simulation Model. Monte-Carlo Simulation and Applications. Random No. And mapping to probability distributions. Simulation Software. Nonlinear Programming: Introduction application. Decision under uncertainty. Tree diagram, probability trees. Decision tree. Markovian Chain. Computer Application in O.R. and Case Study.

Text Books Recommended:

Sr. No.	Books	Unit
1	Philip, Ravindran, Operation Research, John Wiley.	1-5
2	Heera and Gupta, Operation Research, s. Chand.	1-5
3	Sharma S.D. Operation Research	1-5

References Recommended

1	Vohra N.D., Operation Research, TMH	1-5
2	Taha H. Operation Research, PHI	1-5

M. Tech. Mechanical Engineering Design

ME 84752 : Experimental Stress Analysis

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 84752	Experimental Stress Analysis	4	-	-	3	-	3	70	30	-	-	100

Unit 1: Introduction: Principles of measurements, Accuracy, Sensitivity and range of measurements, Extensometer: mechanical, electrical, optical, acoustical etc. displacement sensors, applications.

Unit 2: Photo-elasticity: Wave theory of light, optical interference, Stress optic law, photelastic effect, effect of stressed model in plane and circular polariscopes, Isoclinics & Isochromatics, Fringe order determination, Fringe multiplication techniques, Calibration photoelastic model materials, transmission photoelasticity

Unit 3: 2-D and 3-D Photo-elasticity: Separation methods, Shear difference method, Analytical separation methods, Materials for 2D photo-elasticity, and their properties.

Stress freezing method, Scattered light photo-elasticity, Scattered light polariscope

Unit 4: Electrical Resistance Strain Gages: Gage construction, mounting techniques, Strain sensitivity Strain Gage circuits Potentiometer Wheatstone's bridges, Constant current circuits Calibration and temperature compensation Gage sensitivity and gage factor Two element, three element rectangular and delta rosettes, Stress intensity factor gage.

Unit 5: Brittle Coating: Types of brittle coatings, Coatings stresses, Calibration of coating, Crack patterns, Crack detection methods, Load relaxation techniques.

Moire Methods: Mechanical interference, Geometrical approach, Displacement field approach to Moire fringe analysis, Applications and advantages

Course Assessment: The following methods are adopted for the assessment of this course;

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, mid semester tests and class attendance.
2. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

References:

1. J.W. Dally and W.F. Riley, Experimental Stress Analysis, McGraw-Hill, 1991.
2. K. Ramesh, Digital Photoelasticity – Advanced Techniques and Applications, Springer, 2000.
3. W.N.Sharpe (Ed.), Springer Handbook of Experimental Solid Mechanics, Springer, 2008.
4. L.S. Srinath, M.R. Raghavan, K. Lingaiah, G. Gargesa, B. Pant, and K. Ramachandra, Experimental Stress Analysis, Tata Mc Graw Hill, 1984.

M. Tech. Mechanical Engineering Design

ME 84753 : Optimization Techniques in Design

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 84753	Optimization Techniques in Design	4	-	-	3	-	3	70	30	-	-	100

Course Outcomes: At the end of this course the student is expected to-

1 Understand basic technology and applying classical optimization technique to a given problem.
2 Solve optimization problem using linear programming techniques.
3 Apply single variable optimization search technique to given problem.
4 Understand and apply various methods for non-linear programming problem.
5 Understand and application of geometric programming and some other techniques of optimization like genetic algorithms, artificial neural network, etc.

COURSE CONTENTS

Unit I: Introduction: Optimization, Classical Optimization Techniques, Statement of an Optimization Problem, Basic Terminology. Classification of Optimization Problems.

Classification of Optimization Techniques: Single-Variable Optimization, Multivariable Optimization without Constraints, Multivariable Optimization with Equality Constraints: Solution by the Method of Lagrange Multipliers. Multivariable Optimization with Inequality Constraints: Kuhn–Tucker Conditions, Constraint Qualification.

Unit II: Introduction to Linear Programming, Standard Form of a Linear Programming Problem, Formulation of Problems, Solution of a System of Linear Simultaneous Equations, Algebraic method, Graphical Method, Simplex Algorithm, Big-M Method, Two Phases of the Simplex Method, Revised Simplex Method. Sensitivity or post-optimality analysis, Karmarkar's methods.

Unit III: Nonlinear Programming of Single variable One-Dimensional: Unimodal Function, Elimination Methods: Unrestricted Search with Fixed Step Size and Accelerated Step Size, Exhaustive Search, Dichotomous Search, Interval Halving Method, Fibonacci Method, Golden Section Method, Comparison of Elimination Methods.

Interpolation Methods: Quadratic Interpolation Method, Cubic Interpolation Method, Direct Root Methods, Newton Method, Quasi-Newton Method, Secant Method.

Unit IV: Nonlinear Unconstrained Optimization Techniques: Introduction, Standard form of problems and basic terminology, Direct Search Method: Random Search Methods, Univariate Method, Pattern Directions Method, Simplex Method. Indirect Search (Descent) Methods: Steepest Descent (Cauchy) Method, Conjugate Gradient Method, Newton's Method, Application to engineering Problems.

Nonlinear Constrained Optimization Techniques: Introduction, Standard form of problems and basic terminology, Direct Search Method: Sequential Linear Programming, Basic Approach in the Methods of Feasible Directions, Generalized Reduced Gradient Method. Indirect Methods: Basic Approach of the Penalty Function Method, Interior Penalty Function Method, Convex Programming Problem, Exterior Penalty Function Method.

Unit V: Geometric programming, Optimum design of mechanical elements like beams, columns, gears, shafts, etc.

Introduction to Non-traditional Methods: Genetic Algorithms: Introduction, Representation of Design Variables, Representation of Objective Function and Constraints, Genetic Operators and Numerical Results. Introduction to Neural-Network-Based Optimization.

Course Assessment: The following methods are adopted for the assessment of this course;
1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, mid semester tests and class attendance.
2. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Text Book:

1. S. S. Rao, "Engineering Optimization (Theory and Practice)" New Age Int. (P) Ltd. 2002.
2. Kalyanmoy Deb, "Optimization for Engineering Design", Prentice Hall of India, New Delhi.

Reference Book:

1. H. A. Taha, "Operations Research: An Introduction", PHI Pvt. Ltd.
2. S. S. Stricker, "Optimising performance of energy systems" Battelle Press, New York, 1985.
3. R.C. Johnson, "Optimum Design of Mechanical Elements", Willey, New York, 1980.
4. J. S. Arora, "Introduction to Optimum Design", McGraw Hill, New York, 1989.
5. L.C.W. Dixon, "Nonlinear Optimisation - Theory and Algorithms", Boston, 1980.
6. R.J. Duffin, E.L. Peterson and C. Zener, Geometric Programming-Theory and Applications, Willey, New York, 1967.
7. G.B. Dantzig, Linear Programming and Extensions, Princeton University Press, Princeton, N. J., 1963.
8. R. Bellman, Dynamic Programming, Princeton University Press, Princeton, N.J. 1957.

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 84754	Bio Mechanics	4	-	-	3	-	3	70	30	-	-	100

Course Outcomes:

CO 1 Understand the mechanical functioning of human body.
CO 2 Discussion of through and expression in the field of biomechanics.
CO 3 Application of biomechanical in biomechanical system of human body.
CO 4 Understand the biomechanical system for human devil development.
CO 5 Understand the application of force, torque etc. to human body.

COURSE CONTENTS

UNIT I

Overview of Biomechanics, Bone structure and composition mechanical properties of bone visco elastic properties, Maxwell and voight models-anisotropy-electrical properties of bone-fracture mechanism and crack propagation, Bone fractures fixators repairing of bones mechanical properties of collagen rich tissues, teeth.

UNIT II

Structure and function of cartilages, tendon, ligaments-biomechanics of joints, Human locomotiongait analysis, foot pressure measurement, Pedobarograph, force platform, Mechanics of foot, Mechanics of plantar ulcer arthritis, biomechanical treatment.

UNIT III

Biomechanics of human heart and its functioning, its mechanical and electric properties. Artificial heart valves, biological mechanical valves development, hetro graft, homograft-testing of valves. Total Hip Prosthesis requirements-different types of components-stress analysis and instrumentation, knee prosthesis.

UNIT IV

Biomechanics of spines, Scoliosis-measurements-biomechanical treatment-instrumentation Muscle mechanic-Exoskeletal system for paraplegics-powered wheel chair-crutches and canes.

UNIT V

Monitoring device, Catheter mathematical model, responses to a sinusoidal input. Tonometry different type’s respiratory sound measurement.

Course Assessment:

The following methods are adopted for the assessment of this course;

1. **Class Work:** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Theory Examination:** (70 Marks) on the basis of end term theory paper examination.

Text Books:

1. Alexander R. Mc Neil, Biomechanics, Chapman & Hall, 1975
2. V. C. Hayes, Basic Orthopedics Biomechanics, Lippincott-raven publ.

Reference Books:

1. D.N. Ghista, Biomechanics of medical devices, Macel Dekker, 1982
2. A. Z. Tohen & C. T. Thomas, Manual of Mechanical Orthopedics
3. D. N. Ghista and Roaf, Orthopedic Mechanics, Academic Press

M. Tech. Mechanical Engineering Design

Research Methodology and IPR

Syllabus for All Branches M.E./ M. Tech. (III Sem) (Credits: 2)

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
MA xxxxx	Research Methodology and IPR	2	-	-	2	-	2	70	30	-	-	100

COURSE OBJECTIVES:

1) Discuss the research types, methodology and formulation.
2) Identify the sources of literature, survey, review and quality journals.
3) Discuss the research design for collection of research data.
4) Analyse the research data and write the research report.
5) To identify and apply appropriate research methodology in order to plan, conduct and evaluate basic research.
6) To compare between the scientific method and common sense knowledge while laying the foundation for research skills at higher levels.

COURSE OUTCOMES: The students will be able to

1) Illustrate the research types and methodology.
2) Collect research data and use various tools and techniques for data analysis
3) Do literature survey using quality journals.
4) Process research data to write research report for grant proposal.
5) Understanding the importance and benefit of IPR protection

COURSE CONTENTS

Unit 1:

Research: Types of research, research process, research proposals and aspects, research methodology, objectives of research, motivation in research, significance of research, selecting the research problem, scope and objective of research problem, Technique involved in defining a problem.

Unit 2:

Statistical Tools: Measures of central tendency, measures of dispersion and measures of relationship: correlation and regression analysis.

Data Sampling, Testing & Research Modelling: Student t-test, F-test, analysis of variance (ANOVA), data graphics and data interpretation.

Unit 3:

Literature Review : National and international scenario of scientific research, effective literature reviewing, reference citation, scientific, engineering and research journals, impact valuation, indexing and abstracting.

Unit 4:

Report Writing: Significance of report writing, types, formats, steps of report writing and publications in research journals. Technique of interpretation, oral presentation. Plagiarism and research ethics.

Unit 5:

Patents, Designs, Trademarks, Geographical Indications and Copyright, Process of patenting and development, International cooperation on Intellectual Property. Scope of patent rights. Licensing and transfer of technology. Patent information and databases, new developments in IPR.

Books & References Recommended:

1) C.R Kothari, “Research Methodology, Methods & Technique”, New Age International Publishers, New Delhi, 2004.
2) R. Ganesan, “Research Methodology for Engineers”, MJP Publishers, Chennai, 2011.
3) R. Khananabis and S. Saha, “Research Methodology”, Universities Press, Hyderabad, 2015.
4) Y.P. Agarwal, “Statistical Methods: Concepts, Application and Computation”, Sterling Publishing Pvt. Ltd., New Delhi, 2004.
5) V Upagade and A Shende, “Research Methodology”, S. Chand & Company Ltd., New Delhi, 2009.
6) G. Nageswara Rao, “Research Methodology and Quantitative methods”, BS Publications, Hyderabad, 2012.
7) R.Panneerselvam, Research Methodology, PHI
8) Ranjit Kumar, Research methodology: a step-by-step guide for beginners, SAGE Publication. Ltd.
9) Montgomery, Douglas C, 5/e, Design and Analysis of Experiments, Wiley India, 2007.
10) Montgomery, Douglas C. & R George C. 3/e, Applied Statistics & Probability for Engineers, Wiley India, 2007.
11) Research Methodology; Integration of Principles, Methods and Techniques, Pearson, New Delhi
12) S. Melville and W. Goddard, “Research methodology: an introduction for science & engineering students’
13) Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction”
14) R. P. Merges, P. S. Menell, M.A. Lemley, “Intellectual Property in New Technological Age”, 2016.
15) T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008