COURSE SCHEME

EXAMINATION SCHEME &

COURSE CONTENTS

OF

I-II SEMESTER CBCS OF

MASTER OF TECHNOLOGY (M.TECH.)

IN

MECHANICAL ENGINEERING DESIGN (MED)

OF

GONDWANA UNIVERSITY, GADCHIROLI

GONDWANA UNIVERSITY , GADCHIROLI

FACULTY OF ENGINEERING AND TECHNOLOGY

Course and Examination Scheme for

Master of Technology in -Mechanical Engineering Design (MED)

SEMESTER - I

Course Code	Name of Course	Teaching scheme				Examination Scheme								
		Hours per week			No. of Credits	Theory					Practical			
		L	T (Tutorial / Assignment/ Field work)	P		Duration of Paper (Hrs.)	Max. Marks ESE	Max. Marks Sessional MSE	Total Marks	Min. passing marks	Max. Marks TW	Max. Marks PEE	Total Marks	Min. passing marks
MED11	Advanced Engg Mathematics	3	1	---	4	3	70	30	100	50	---	---	---	---
MED12	Advanced Mechanics of solids	3	1	---	4	3	70	30	100	50	---	---	---	---
MED13	Mechanical Vibrations	3	1	---	4	3	70	30	100	50	---	---	---	---
MED14	Computer Aided Mechanical Design	3	1	---	4	3	70	30	100	50	---	---	---	---
MED15	Elective – I	3	1	---	4	3	70	30	100	50	---	---	---	---
MED16	Lab. Practice-I (Mechanical Vibration)	---	---	2	1	---	---	---	---	---	25	25	50	25
MED17	Seminar-I	---	---	2	1	---	---	---	---	---	50	---	50	25
	Total	15	5	4	22		---	---	500		---	---	100	
	I-Semester Total	24			22	600								

Elective–I (MED15) :- (A) Advance Engineering Materials (B) Design for Manufacturing & Assembly (C) Reliability, maintainability & wear

GONDWANA UNIVERSITY, GADCHIROLI

FACULTY OF ENGINEERING AND TECHNOLOGY

Course and Examination Scheme for

Master of Technology in -Mechanical Engineering Design (MED)

SEMESTER- II

Course Code	Name of Course	Teaching scheme				Examination Scheme								
		Hours per week			No. of Credits	Theory					Practical			
		L	T (Tutorial / Assignment/ Field work)	P		Duration of Paper (Hrs.)	Max. Marks ESE	Max. Marks Sessional MSE	Total Marks	Min. passing marks	Max. Marks TW	Max. Marks PEE	Total Marks	Min. passing marks
MED 21	Analysis & Synthesis of Mechanisms	3	1	---	4	3	70	30	100	50	---	---	---	---
MED 22	Finite Element Analysis	3	1	---	4	3	70	30	100	50	---	---	---	---
MED 23	Optimization Techniques in Design	3	1	---	4	3	70	30	100	50	---	---	---	---
MED 24	Elective – II	3	1	---	4	3	70	30	100	50	---	---	---	---
MED 25	Elective – III	3	1	---	4	3	70	30	100	50	---	---	---	---
MED 26	Lab. Practice-II (FEA)	---	---	2	1	---	---	---	---	---	25	25	50	25
MED 27	Seminar-II / Mini Project	---	---	2	1	---	---	---	---	---	50	---	50	25
	Total	15	5	4	22		---	---	500		---	---	100	
	II-Semester Total	24			22	600								

- **Elective–II (MED 24) :-** (A) Tribology & Bearing Design (B) Design of hydraulic & Pneumatic Systems (C) Design of Mechanical Handling System
- **Elective–III (MED 25) :-** (A) Advanced Machine Tool Design (B) Robotics & Automation (C) Fracture Mechanics

FIRST SEMESTER

M.TECH. – MECHANICAL ENGINEERING DESIGN (MED)

M.Tech. – Mechanical Engineering Design (MED)

COURSE: MED 11- ADVANCED ENGINEERING MATHEMATICS

CREDITS: 04

Teaching Scheme:
Lectures: 03 Hrs. /Week
Tutorials: 01 Hr. /Week

Examination Scheme
Duration of paper: 03 Hrs.
University Assessment: 70 Marks
College Assessment: 30 Marks

CONTENTS:

Approximations and round off errors: Significant figures, accuracy and precision, error definitions, round off errors and truncation errors. Mathematical modeling and Engineering problem solving: Simple mathematical model, Conservation Laws of Engineering.

Differential Equation : Series Solution of differential equations, Bessel's and Legendre's differential equations, Mass spring systems of multi degree freedom, Matrix formulation for differential equations in vibration theory, Normal mode solution, Numerical computation of Eigen value.

Numerical Methods for Differential Equations: Numerical solutions to the ordinary differential equations of first and second order with initial and boundary conditions, Picard's Method, Taylor's Method, Euler's Method, modified Euler's Method, Milne's Method and Runge-Kutta Method.

Numerical solutions to the partial differential equations: Finite difference equivalence to partial derivatives, elliptical, parabolic and hyperbolic equations.

Curve Fitting: Least square curve fitting procedures for straight line, Nonlinear curve fitting, weighted least square approximation, Method of least square for continuous function.

REFERENCES

1. Kreyszig, E. "Advanced Engineering Mathematics", John Wiley & Sons, New Edition.
2. Chandrika Prasad "Advanced Mathematics for Engineers", Prasad Mudranalaya, New Edition,
3. Speigel, M.R. "Advanced Mathematics For Engineers and Scientists", McGraw Hill.,.
4. Higher Engineering Mathematics, B. S. Grewal, Khanna Publishers Delhi
5. Linear Algebra, Jin Ho Kwak and Sungpyo Hong, Springer international edition
6. Applied Numerical Analysis, Curtis F.Gerald and Patrick O. Wheatley, Pearson Education, Inc
7. Essential Mathematical Methods for Physicists, Hans J. Weber and G. B. Arfken, Academic Press.

M.Tech. – Mechanical Engineering Design (MED)

COURSE: MED 12- ADVANCED MECHANICS OF SOLIDS

CREDITS: 04

Teaching Scheme:
Lectures: 03 Hrs. /Week
Tutorials: 01 Hr. /Week

Examination Scheme
Duration of paper: 03 Hrs.
University Assessment: 70 Marks
College Assessment: 30 Marks

CONTENTS:

Shear Centre: Bending axis and shear center-shear center for axis-symmetric and unsymmetrical sections. Unsymmetrical bending: Bending stresses in Beams subjected to Non symmetrical bending; Deflection of straight beams due to non symmetrical bending.

Torsion: Torsion of a cylindrical bar of Circular cross Section; Saint-Venant's semi-inverse methods; Linear elastic solution; Prandtl elastic membrane (Soap-Film) Analogy; Narrow rectangular cross Section; Hallow thin wall torsion members, Multiply connected Cross section, Thin wall torsion members with restrained ends.

Theory of Plates: Introduction; Stress resultants in a flat plate; Kinematics: Strain- Displacement relations for plates; Equilibrium equations for small displacement theory of flat plates; Stress – Strain – Temperature relation for Isotropic plates: Strain energy of a plate; Boundary conditions for plate; Solution of rectangular plate problem; Solution of circular plate problem. General theory Beams on Elastic Foundation.

Contact Stresses: Introduction, problem of determining contact stresses; Assumptions on which a solution for contact stresses is based; Expressions for principal stresses; Methods of computing contact stresses; Deflection of bodies in point contact; Stresses for two bodies in contact over narrow rectangular area (Line contact).

REFERENCES:

1. Advanced Mechanics of materials/Seely and Smith/ John Willey
2. Advanced Mechanics of materials / Boresi & Sidebottom/Wiley international
3. Advanced strength of materials / Den Hortog J.P./Torrent
4. Theory of Plates /Timoshenko/
5. Strength of materials / Sadhu singh/ Khanna Publishers

M.Tech. – Mechanical Engineering Design (MED)

COURSE: MED 13- MECHANICAL VIBRATIONS

CREDITS: 04

Teaching Scheme:
Lectures: 03 Hrs. /Week
Tutorials: 01 Hr. /Week

Examination Scheme
Duration of paper : 03 Hrs.
University Assessment : 70 Marks
College Assessment: 30 Marks

CONTENTS:

Vibration problems in engineering causes and effects of vibration relevance of vibration analysis continuum and discrete modelling lumped parameter systems free vibration and response to damped single degree freedom systems. Frequency response function-amplitude and phase plots mechanical impedance and mobility – vibration isolation.

Response of Systems to Arbitrary Periodic Excitation: Duhamel's integral impulse response function – shock spectra –Laplace and Fourier transform methods.

Multi Degree of Freedom Systems: Matrix formulation Eigen values and Eigen formulation matrix iteration techniques – normal modes and orthgonality transient response of multidegree freedom system mode superposition technique tensional oscillations of malty rotor systems.

Continuous Systems: Longitudinal and transverse vibration of beams-forced response of beams. Vibration of plates –finite element techniques in vibration analysis.

Vibration Instrumentation: Vibration measurements – instrumentation –electrodynamics exciters –impact hammers piezoelectric accelerometers signal conditioning and amplification preamplifiers and power amplifiers real time analysis digital Fourier transforms FFT analysis structural frequency response measurement random sinusoidal and transient test methods model testing of beams.

REFERENCE:

1. J.S. Rao and K. Gupta Advanced theory of vibration. Willey Eastern.
2. P.Srinivasan Mechanical Vibration Analysis, Tata Mc Graw Hill, New Delhi.
3. N. L. Meirovitch , Elements of vibration Analysis, Mc Graw Hill New York.
4. J.P. Den Hartog Mechanical Vibration (4th edition Mc Graw Hill, New York.
5. Timoshenko, Engineering vibration.
6. R.A. Collacott, Vibration Monitoring and diagnosis, John Willey, New York.

M.Tech. – Mechanical Engineering Design (MED)

COURSE: MED 14-COMPUTER AIDED MECHANICAL DESIGN

CREDITS: 04

Teaching Scheme:
Lectures: 03 Hrs. /Week
Tutorials: 01 Hr. /Week

Examination Scheme
Duration of paper: 03 Hrs.
University Assessment: 70 Marks
College Assessment: 30 Marks

CONTENTS:

Introduction to CAD/CAM and Product Cycle: Role of Computers in the design process. Requirement of Hardware & Software in CAD. Representation of Line, Circle, & other analytic curves, Algorithms & Programs. Drafting of machine elements with dimension and tolerances using 2-D drafting packages. Graphic standards GKS [Graphical Kernal System] IGES [Initial Graphic Exchange Specifications].

CAD of Machine Elements: Development of interactive design programs [with drafting] for machine elements, incorporating choice of materials and other parameters, Generation of several alternate designs and evaluation.

Geometric Modeling: Mathematical representation of Hermite cubic, Bezeir & B-spline curves. Introduction to difference type of surfaces and solids generated in surface and solid model respectively. Assembly modeling and interference checking .

REFERENCE:

1. Groover, M. P. and Zimmers ,E.W CAD/CAM, Computer Aided Design and manufacturing, Prentice Hall of India.
2. Ibrahim Zeid, CAD/CAM Theory and Pratice, Mc Graw Hill.
3. Dimarogons, A.D. Computer Aided Machine Design, Prentice Hall.
4. Ranky, P.G. Computer Integrated Manufacturing,Prentice Hall.
5. Radhakrishanan,P. and Kothandaraman, C.P. Computer Graphics & Design, Dhanpat Rai & Sons, Delhi.
6. Software Manuals on GEODRAW, GEOMOD, and SUPERTAB, Structural Dynamics Research Corporation, U.S.A. 1986.

M.Tech. – Mechanical Engineering Design (MED)

ELECTIVE - I

COURSE: MED 15A- ADVANCED ENGINEERING MATERIALS

CREDITS: 04

Teaching Scheme:
Lectures: 03 Hrs. /Week
Tutorials: 01 Hr. /Week

Examination Scheme
Duration of paper: 03 Hrs.
University Assessment: 70 Marks
College Assessment: 30 Marks

CONTENTS:

Introduction to Engineering Materials: Classification of Engineering materials , Material selection in mechanical design, Engineering materials and their properties, Basics of materials selection, the design process, material selection charts, Materials-process selection charts. A material selection criterion for flywheels, elastic hinges, springs, materials for passive solar heating

Ferrous Materials: Introduction to Fe-Fe3C phase equilibrium diagrams with relevant reactions, suitable heat treatment and application, stainless steel, heat resisting steels, high temperature alloys for power plant and nuclear applications, precipitation hardenable steels, HSLA steels, micro-alloyed steels, ball bearing steel, high nitrogen steels,cast iron, alloy cast iron , special types of tool steels

Non-ferrous materials: Mechanical properties, phase diagrams, heat treatment and applications: Copper and copper alloys, Aluminium and aluminium alloy(Al-Mg-Si,Al-Cu,Al-Si, Modified form of Al-Si or LM series alloys) , designated system in Al-alloys, materials

Special Materials: High entropy materials with composition, ternary phase diagrams and applications, Materials for bio-compatibility, Application of reactive materials like Molybdenum, Niobium and Magnesium alloys, Materials for high temperature wear application

Composites: Classification , properties , application of composites, polymer matrix composite, metal matrix composites, ceramic matrix composite, carbon materials , glass materials , fiber reinforcement, , types of fibers and their effects, whiskers, laminar composites, filled composites, particulate reinforced composites. Hybrid composites, angle plied composites, mechanism of composites, unidirectional fiber composites, critical volume fraction, discontinuous fiber composites, rule of mixture, Inverse rule of mixture, critical angle. Analysis and strength of orthotropic lamina, analysis of laminated composites, stress strain. Design and selection criteria for various structures like honeycomb structure, beams and struts.

Organic materials: Classification, properties, application of polymers, plastics and elastomers.

Ceramic materials: Classification, properties, structure of refractories, abrasive materials, ceramics for electronic application, cement and concrete.

REFERENCES:

1. Jastrezebski Z.D., The nature and properties of engineering Materials, Wiley Newyork.
2. Aver S.H, Introduction to Physical Metallurgy, McGraw Hill,Tokyo.
3. Sharma S.C,Composite Material, Narosa Publishing House,New Delhi.
4. DeGarmo E.P.,Black J.T,Kosher R.A,Materials and processes in
5. Manufacturing, Prentice Hall.
6. Rajput R. K., Materials Science and Engineering,Kataria and sons.
7. Chawla K.K., Composite Materials, Springer.
8. Michael Ashby, Design & Selection of Materials

M.Tech. – Mechanical Engineering Design (MED)

ELECTIVE - I

COURSE: MED 15B-DESIGN FOR MANUFACTURING AND ASSEMBLY

CREDITS : 04

Teaching Scheme:
Lectures: 03 Hrs./Week
Tutorials: 01 Hr./Week

Examination Scheme
Duration of paper : 03 Hrs.
University Assessment : 70 Marks
College Assessment: 30 Marks

CONTENTS:

Introduction – Definition, History, Advantages and Impact. Selection of materials and processes – General requirements, process capabilities, Systematic selection of processes and materials, design examples.

Product design for manual assembly – General guidelines, systematic design for assembly, effect of various design features on manufacturing, design examples.
Design for high speed automatic and robotic assembly – Design for high speed feeding and orientating, High speed inspection, Analysis of assembly, design examples.

Design for machining – Design for single point / multi point / abrasive machining, assembly of components, accuracy and surface finish, cost estimating, design examples.
Design for injection moulding – Injection moulding materials, moulding cycles, estmation of optimum number of cavities, design examples.

Design for sheet metal working – Dies and Press working, Press selection, Design rules Design for sand casting, die casting, investment casting – Materials, Basic characteristics of process and mould features, cost estimating, design rules for different castings.
Design for forging – characteristics, cost estimation and design rules.

REFERENCE:

1. Boothroyd, G., Dewhurst, P., Knight, W. A. “Product Design for Manufacturing and Assembly”, Third Edition, CRC Press, 2011.
2. Allen, C. W., “Simultaneous Engineering -Integrating Manufacturing and Design”, Society of Manufacturing Engineers, Nov. 1990.
3. James Bralla, “Design for Manufacturability Handbook” McGraw Hill, 2004.
4. Anderson, D.M., "Design for manufacturability & concurrent engineering: how to design for low cost, design in high quality, design for lean manufacture, and design quickly for fast production," CIM press, 2nd Edition, 2010.

M.Tech. – Mechanical Engineering Design (MED)

ELECTIVE - I

COURSE: MED 15C-RELIABILITY, MAINTAINABILITY & WEAR

CREDITS : 04

Teaching Scheme:
Lectures: 03 Hrs. /Week
Tutorials: 01 Hr. /Week

Examination Scheme
Duration of paper : 03 Hrs.
University Assessment : 70 Marks
College Assessment: 30 Marks

CONTENTS:

Introduction to reliability availability and maintainability failure distributions, Weibull distribution and its applications to industries.

Design and manufacturing for reliability, reliability assessment of mechanical systems FMES and FTA techniques.

Monte carlo simulation method, markov chains in reliability. Maintenance policies and philosophies conditions based antennae , Vibration monitoring non destruction testing.
Correlation between tribology and wear .Industrial importance of wear and abrasive wear behavior of engineering materials. Classification and mechanism of various wear processes. Erosive wear and slurry abrasive wear of engineering materials and wear testing. Sliding wear behavior of metallic and non metallic materials Signification of friction coefficient and Archards equation , Laws of friction and frictional behavior of metals, polymers and composites, Frictional behavior of ceramic materials, fundamentals of lubrication and wear characterization.

REFERENCES:

1. Reliability & Maintainability Engineering Charles E. Ebeling – Tata Mc Graw Hill
2. Reliability Methods Engineering and its application – G.P. Chhalotra –Khanna
3. Introduction to Reliability in Design –Charles O. Smith – Mc. Graw Hill
4. Reliability Engineering –E. Bala guruswamy –Tata Mc. Graw Hill
5. Reliability Engineering –D.J. Smith- Pitman Publishing
6. Reliability Engineering –L.S. Srinath –Affiliated East West Press Pvt. Ltd.
7. Mechanical Reliability – A.D.S. Carter- Mc Millan
8. Friction and Waer of Material –Ernest Rabinowicz-John Wiley & Sons
9. Kapur K. C. , Lamberson L.R. Reliability in engineering Design.
10. Thomson A. Reliability Based Mechanical Design
11. Hull B. , Jhon V. , Non Destructive testing.

M.Tech. – Mechanical Engineering Design (MED)

COURSE: MED 16- LAB 1 – MECHANICAL VIBRATIONS

CREDITS: 01

Teaching Scheme:
Practicals: 02 Hrs. /Week

Examination Scheme
University Assessment: 25 Marks
College Assessment: 25 Marks

List of Experiments

Term work shall consists of the following

1. Simulation study using mathematical simulation software or any programming language on
    a. Single DOF system
    b. Multi DOF system
2. Simulation study of the followings on any simulation platform
    a. Modal analysis
    b. Transient analysis
    c. Harmonic analysis
    d. Active vibration control
3. Experimentation
    a. Acquiring time domain vibration data by using sensors (displacement / velocity / acceleration)
    b. Demonstration of condition based maintenance tool using vibration techniques

M.Tech. – Mechanical Engineering Design (MED)

COURSE: MED 17- SEMINAR-I

CREDITS : 01

Teaching Scheme :	**Examination Scheme**
Tutorials: 02 Hrs./Week	University Assessment : -------
	College Assessment : 50 Marks

CONTENTS:

Seminar shall consists of the in depth study of a topic, related to the field of Design engineering and should have research orientation. The student should know recent developments and applications in the chosen field of study. The topic of study/research is mutually decided by the student and the supervisor and a detailed technical report will be prepared, report shall consist of about 20-25 pages of 'A4' size sheets in either comb or hard bound.

The candidate will have to deliver a seminar presentation in front of the examiners, one of them will be guide and other will be the examiner appointed by University. The performance of the student will be evaluated by both examiners jointly based on the content of the seminar, delivery of seminar and answers to the queries of the examiners.

SECOND SEMESTER

M.TECH. – MECHANICAL ENGINEERING DESIGN (MED)

M.Tech. – Mechanical Engineering Design (MED)

COURSE: MED 21: ANALYSIS AND SYNTHESIS OF MECHANISMS

CREDITS: 04

Teaching Scheme:
Lectures: 03 Hrs. /Week
Tutorials: 01 Hr. /Week

Examination Scheme
Duration of paper: 03 Hrs.
University Assessment: 70 Marks
College Assessment: 30 Marks

CONTENTS:

Basic concepts related to kinematic analysis of mechanisms, degree of freedom, Grashoff's and Grubler's criteria, Transmission and deviation angles, mechanical advantage, Review of graphical and analytical methods of velocity and acceleration analysis of simple and complex mechanisms.
Curvature theory - Fixed and moving centrodes, inflection circle, Euler-Savary equation, Bobillier constructions, cubic of stationary curvature, Ball's point, applications in dwell mechanisms.
Synthesis of Planar Mechanisms - Types, number and dimensional synthesis, function generation, path generation and rigid body guidance problems, accuracy(precision)points, Chebychev spacing, types of errors, graphical synthesis for function generation and rigid body guidance using Relative pole method & Inversion method, center point and circle point curves, Bermester points, branch and order defects, synthesis for path generation.
Analytical synthesis of Planar Mechanisms- Freudenstein's equation, synthesis for four accuracy points, compatibility condition, Introduction to complex numbers method of synthesis, the dyad, center point and circle point circles, ground pivot specifications, three accuracy point synthesis using dyad method, Robert Chebychev theorem, Cognate linkages.
Introduction to Kinematics of Spatial Mechanisms.

REFERENCES:

1. Theory of Machines and Mechanisms, J. E. Shigley and J. J. Uicker,2nd Ed. McGraw-Hill.
2. Theory of Machines and Mechanisms, A. Ghosh and A.K. Mallik, Affiliated East - West Press.
3. Kinematic Synthesis of Linkages, R.S. Hartenberg and J. Denavit, McGraw-Hill.
4. Design of Machinery: An Introduction to the Synthesis and Analysis of Mechanisms and Machines, Robert L. Norton, Tata McGraw-Hill,3rd Edition.
5. S.B.Tuttle,"Mechanisms for Engineering Design" John Wiley and Sons New York
6. Theory of machines – S. S. Rattan McGraw-Hill Publications.
7. Mechanism Design- Analysis and Synthesis (Vol.1and 2), A.G. Erdman and G.N. Sandor, Prentice Hall.

M.Tech. – Mechanical Engineering Design (MED)

COURSE: MED 22: FINITE ELEMENT ANALYSIS

CREDITS : 04

Teaching Scheme :
Lectures: 03 Hrs./Week
Tutorial : 01 Hrs./Week

Examination Scheme
Duration of paper : 03 Hrs.
University Assessment : 70 Marks
College Assessment : 30 Marks

CONTENTS:

Introduction to Engineering Analysis tool FEA and its application in Linear static Analysis and 2D problems, Study of Finite Element modeling and simulation Techniques, Use of FEA in structural vibration and thermal Analysis, Basics of FEM – Review of finite difference method, Initial value and boundary value problems Solution of Boundary Value problems: - weighted residual, Galerkin and Raleigh Ritz methods, Variational Method, Least square Methods. Introduction to meshless FEM, FEA and Linking mechanical design with FEA

Element Matrices: Direct stiffness Method, Properties of global stiffness Matrix, Analysis of simply supported beam

Two Dimensional Elements: Linear Triangular Elements, Rectangular Elements, Two Dimensional Field equations: Coordinate Systems, Isoparametric elements and numerical integration, Integral equations for the element Matrices, Heat transfer by conduction: One dimensional fins, two dimensional fins, and Long and convection Two Dimensional bodies.

FE Applications in Solid Mechanics: The axial force members, potential energy formulations. The Truss Element, Beam element, plane frame element, modeling of bolts for assembly, 3D problems

Two dimensional Elasticity: The displacement functions, Element matrices, Element Shape Functions: Evaluating shape functions

FEM Computations Solution Methods FEM Modeling and Preprocessing FEM Hardware and Post processing Survey of some FE Software Systems

REFERENCES:

1. Reddy, Junuthula Narasimha. An introduction to the finite element method. Vol. 2, no. 2.2. New York: McGraw-Hill, 1993.
2. Chandrupatla, Tirupathi R., Ashok D. Belegundu, T. Ramesh, and Chaitali Ray. Introduction to finite elements in engineering. Vol. 2. Upper Saddle River, NJ: Prentice Hall, 2002.
3. Desai, Chandrakant S., and John Fredrick Abel. Introduction to the finite element method; a numerical method for engineering analysis. Van Nostrand Reinhold, 1971.
4. Zienkiewicz, Olek C., and Robert L. Taylor. The finite element method: Its basis and fundamentals.
5. K.J. Bathe, Finite Element Procedures, Klaus-Jurgen Bathe
6. Singiresu s. Rao . Finite element method in engineering.
7. Cook, R.D, “Concepts and application in Finite Element Analysis”, 3rd Ed, The Wiley & Sons
8. Dixit U.S., “Finite Element Methods for Engineers”, Cengage Learning

M.Tech. – Mechanical Engineering Design (MED)

COURSE: MED 23: OPTIMIZATION TECHNIQUES IN DESIGN

CREDITS: 04

Teaching Scheme:
Lectures: 03 Hrs. /Week
Tutorial: 01 Hrs. /Week

Examination Scheme
Duration of paper: 03 Hrs.
University Assessment: 70 Marks
College Assessment: 30 Marks

CONTENTS:

Introduction, methods, engineering applications of optimization, Statement of an Optimization Problem and Classification of Optimization Problems.

Optimization Techniques: Single-Variable Optimization, Multivariable Optimization with no Constraints, Multivariable Optimization with Equality and Inequality Constraints. Lagrange multipliers method, Kuhn Tucker conditions.

Linear Programming: Simplex Methods, Sensitivity Analysis, Transportation Problem.

Integer Programming: Graphical Representation, Integer Polynomial Programming.

Geometric Programming: Formulation and Solutions of Unconstrained and Constrained geometric programming problem.

Dynamic Programming: Multistage Decision Processes.

One-Dimensional Minimization Methods: Elimination methods: Fibonacci Method, Golden Section Method, Interpolation methods: Quadratic Interpolation Method, Cubic Interpolation Method.

Unconstrained Optimization Techniques: Univariate, Conjugate Gradient Method and Variable Metric Method.

Constrained Optimization Techniques: Characteristics of a constrained problem; Direct Method of feasible directions; Indirect Method of interior and exterior penalty functions.

REFERENCES:

1. Rao, S. S., Optimization Theory and Applications, Wiley Eastern Ltd., 2nd Edition, 2004.
2. Fox, R. L., Optimization Methods for Engineering Design, Addison Wesley, 2001.
3. Kalyanmoy Deb, Optimization for Engineering Design: Algorithms and Examples, PHI Learning Pvt. Ltd., 2012.
4. Wilhelm Forst, Dieter Hoffmann, Optimization - Theory and Practice, Springer, 2010.
5. A. Ravindran, G. V. Reklaitis, K. M. Ragsdell, Engineering Optimization: Methods and Applications, John Wiley & Sons, 2006.

ELECTIVE-II

M.Tech. – Mechanical Engineering Design (MED)

COURSE: MED 24A: TRIBOLOGY & BEARING DESIGN

CREDITS: 04

Teaching Scheme:
Lectures: 03 Hrs./Week
Tutorials: 01 Hr./Week

Examination Scheme
Duration of paper : 03 Hrs.
University Assessment : 70 Marks
College Assessment: 30 Marks

CONTENTS:

Introduction to Tribology: Introduction, Friction, Wear, Wear Characterization, Regimes of lubrication, Classification of contacts, lubrication theories, tribological properties of bearing materials and lubricants, theories of friction and wear, instabilities and stick-slip motion .

Newton's Law of viscous forces, Flow through stationary parallel plates. Hagen's Poiseuille's theory, viscometers, Concept of lightly loaded bearings, Petroff's equation, Numerical problems. finite bearings - hydrostatic, hydrodynamic and thrust oil bearings, heat in bearings Hydrostatic squeeze film Circular and rectangular flat plates, variable and alternating loads, piston pin lubrications, application to journal bearings.

Elasto-hydrodynamic lubrication Pressure-viscosity term in Reynold's equation, hertz theory, Ertel-Grubin equation, lubrication of spheres Air lubricated bearings Tilting pad bearings, hydrostatic, hydrodynamic and thrust bearings with air lubrication Tribological aspects of rolling motion Mechanics of tire-road interaction, road grip and rolling resistance.

REFERENCES:

1. Mujamdar.B.C "Introduction to Tribology of Bearing", S. Chand & Co., New Delhi 2010.
2. Radzimovsky, "Lubrication of Bearings - Theoretical principles and design" Oxford press Company, 2000
3. Dudley D.Fulier " Theory and practice of Lubrication for Engineers", New York Company. 1998
4. Moore "Principles and applications of Tribology" Pergamon press, 1975
5. Oscar Pinkus, BenoSternlicht, "Theory of hydrodynamic lubrication", McGraw-Hill, 1961
6. G W Stachowiak, A W Bat chelor , "Engineering Tribology", Elsevier publication 1993.
7. Hydrostatic and hybrid bearings, Butterworth 1983.
8. F. M. Stansfield, Hydrostatic bearings for machine tools and similar applications, Machinery Publishing, 1970
9. Principles of Lubrication, Camaron, Longman's Green Co. Ltd.
10. Tribology in Machine Design, T. A. Stolarski

Elective-II

M.Tech. – Mechanical Engineering Design (MED)

COURSE: MED 24(B) : DESIGN OF HYDRAULIC & PNEUMATIC SYSTEMS

CREDITS: 04

Teaching Scheme:
Lectures: 03 Hrs. /Week
Tutorial: 01 Hrs./Week

Examination Scheme
Duration of paper: 03 Hrs.
University Assessment : 70 Marks
College Assessment: 30 Marks

CONTENTS:

I Oil Hydraulic Systems: Hydraulic Power Generator, selection and specification of pumps, pump characteristics.

II Hydraulic Actuators: Linear & Rotary Actuators, Selection, Specification and characteristics.

III Control & Regulation Elements: Pressure, direction and flow control valves, relief valves, non return and safety valves actuation systems.

IV Hydraulic Circuits : Reciprocating quick return, sequencing synchronizing circuits, accumulator circuits, industrial circuits, press circuits, hydraulic milling machine, grinding ,planning copying, forklift earthmover circuits, design and selection of components, safety and emergency modules.

V Pneumatic System, and Circuits : Pneumatic fundamentals ,control elements, position and pressure sensing, logic circuits, switching circuits, fringe condition modules and their integration, sequential circuits , cascade methods, mapping methods, step counter method, compound circuit design, combination circuit design .

VI Installation, Maintenance and Special Circuits: Pneumatic equipments, selection of components, design calculations, application, fault finding, hydro pneumatic automation, robotic circuits.

REFERENCES:

1. Peter Rohner, ―Fluid piower logic circuits design‖ the Macmillan Press Limited, 1979.
2. Stewart,H.L., ―Hydraulic and pneumatic power for production‖, Industrial press, New York 1955.
3. Walter Ernest, ―Oil hydraulic power and industrial applications‖, Mc Graw Hill Book,Co 1962.
4. Pease ,D.A. ―Basic fluid power‖, Prentice Hall ,1987.

Elective-II

M.Tech. – Mechanical Engineering Design (MED)

COURSE: MED 24(C): Design of Mechanical Handling System

CREDITS: 04

Teaching Scheme:
Lectures: 03 Hrs. /Week
Tutorial: 01 Hrs./Week

Examination Scheme
Duration of paper: 03 Hrs.
University Assessment : 70 Marks
College Assessment: 30 Marks

CONTENTS:

Constructional features, operation, operational characteristics, advantages, limitations, Design considerations of following conveying machines.

Unit Load conveying: Fork lift Trucks, Trolley, conveyers, Cableways, Rope ways, Cranes, Overhead cranes, Elevators, Drag lines, Robotic Handling, AGV

Bulk solid conveying: Belt conveyers ,chain conveyers, Roller conveyers (Gravity & Powered), Screw conveyers, Tubular screw conveyers, Escalators, Vibrating conveyers (Crank type & spring type), Pneumatic conveying.

REFERENCES:

1. Aleczandow: ―Materials Handling‖, MIR publications
2. Acma, Reference book for Belt conveyers.
3. Conveyaing Machings by CITADINOV, MIR publications

Elective-III

M.Tech. – Mechanical Engineering Design (MED)

COURSE: MED 25(A): ADVANCED MACHINE TOOL DESIGN

CREDITS: 04

Teaching Scheme:
Lectures: 03 Hrs./Week
Tutorial: 01 Hrs./Week

Examination Scheme
Duration of paper : 03 Hrs.
University Assessment : 70 Marks
College Assessment: 30 Marks

CONTENTS:

Mechanics of metal cutting, General requirements of machine tool design, Layout of machine tools, Design of single point tools. Design of multipoint cutting tools like drills, reamers, broaches, taps and milling cutters. Design of tools for joining processes.

Press tool design ,Press working, Types of Presses, Types of dies, Computer aided design of cutting dies like simple die, compound die, progressive die and combination die.

Forming dies like bending die, drawing die, flanging die, coining die, embossing die.

Jigs and fixtures, principles of location and clamping, unconventional clamping systems. Design of various types of jigs for various parts. Design of different types of fixtures.

Taylor's principles of gauge design. Design of limit gauges. Forging in Plane strain, Forging of circular disc, Effect of friction, Forging equipment, defects in forged products: Causes & Remedies. Design of forging dies.

Design of tools for NC, CNC machines.

REFERENCE:

1. Donaldson, "Tool design"
2. ASTME, "Fundamentals of Tool design"
3. Pollock, "Fundamentals of Tool design"
4. Grant, "Unconventional Clamping Systems"
5. Kempster, "Fundamentals of Tool design"
6. Production Engineering - P.C. Sharma S. Chand Publication

Elective-III

M.Tech. – Mechanical Engineering Design (MED)

COURSE: MED 25(B) : ROBOTICS AND AUTOMATION

CREDITS: 04

Teaching Scheme:
Lectures: 03 Hrs./Week
Tutorial: 01 Hrs./Week

Examination Scheme
Duration of paper : 03 Hrs.
University Assessment : 70 Marks
College Assessment: 30 Marks

CONTENTS:

Automation and Robotics: Definition, need of the Robotics, market and future prospects, differentiation of Robots from other automation systems, near relations to robots, robot usages and conditions for its application, Robot Anatomy and Characteristics: Classification, point to point and continuous path system, control loops of robot system, work volume, speed of movement, dynamic performance, Accuracy and repeatability, drive system, sensors used in robotics, letter symbol, coding and kinematics arrangement

Sensors and End Effectors in Robotics: Tactile sensors, proximity and rear sensors, force and torque sensors in Robotics, End effectors: Functions, Types, Design of linkage type end effectors, Vacuum gripper, Magnetic gripper, Special gripper, Engelberger's principles in selection and design of grippers

Robot Programming And Application: Robot Language, Development, Feature of different languages and introduction to robot language softwares, Introduction to artificial intelligence, Robot Cell Design: Function, Types, Man-Machine-Robot system, interlocking Methods of robot programming, Lead through programming methods, A robot program for generating a path space motion, Interpolation wait signal and delay commands, Robot Application: Various applications of Robot in foundry and precision casting, welding, spray coating, Manufacturing by Machining, Assembly and inspection.

CNC Systems And Robotics: Various configurations, CPU, PLC'S, Servo control units, speed position feedback, Other peripheral devices, Tool monitoring controls, Softwares, User interface, PLC programming/DC servo motors, Relays and solenoid stepper motor, Introduction and configuration of the CNC system, Interfacing Monitoring diagnostics, Machine Data, Compensations for machine accuracies, Programming direct numerical control.

Machine Interfacing: Interfacing electro mechanical system to microprocessor, PC and PLC's, Basic flow charts and programming for controlling machine tools and process parameters with the above systems, Study of various mechanical elements used in CNC: Robotics system vizlinear bearings, ball screws couplings.

REFERENCES:

1. Groover M. P., Willis, "Industrial Robotics", McGraw Hill.
2. Aures R. U. and Miller S. M., "Robotics applications and implications", Ballinger Publishing Co., Cambridge
3. Groover M. P. and Zimmer E. W., "Computer Aided Design and Manufacturing", Prentice Hall of India Ltd, New Delhi
4. "Mechatronics", HMT Limited, Tata McGraw Hill Publications, New Delhi
5. David G., "Mechatronics", Tata McGraw Hill Publications, New Delhi
6. Handbook of Industrial Robotics

ELECTIVE-III

M.Tech. – Mechanical Engineering Design (MED)

COURSE: MED 25C: FRACTURE MECHANICS

CREDITS: 04

Teaching Scheme:
Lectures: 03 Hrs. /Week
Tutorials: 01 Hr. /Week

Examination Scheme
Duration of paper: 03 Hrs.
University Assessment: 70 Marks
College Assessment: 30 Marks

CONTENTS:

Fracture mechanics principles: Introduction and historical review, Sources of micro and macro cracks. Modes of fracture failure, Brittle and ductile fracture, NDT and Various NDT methods used in fracture mechanics.
Energy release rate: crack resistance (R curve), stable and unstable crack growth.
Stress intensity factor: Stress and displacement fields, edge cracks, embedded cracks.
Crack tip plasticity: Shape and size of plastic zone, effective crack length, effect of plate thickness, J-Integral. Crack tip opening displacement.
Test methods for determining critical energy release rate, critical stress intensity factor, J-Integral.
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

REFERENCES:

1. Maiti, S. K. Fracture Mechanics: Fundamentals and Applications. Cambridge University Press, 2015.
2. David Broek, “Elementary Engineering Fracture Mechanics”, Springer Netherlands,2011
3. Kumar Prashant. Elements of fracture mechanics. Tata McGraw-Hill Education, 2009
4. Anderson, Ted L. “Fracture Mechanics-Fundamental and Application”, CRC press 2005.
5. S.A. Meguid , “Engineering fracture mechanics” Elsevier Applied Science, 1989
6. Kanninen, Melvin F., and Carl L. Popelar. "Advanced fracture mechanics." (1985).
7. Karen Hellan , “Introduction to fracture mechanics”, McGraw Hill, 2nd Edition
8. Jayatilaka, “Fracture of Engineering Brittle Materials”, Applied Science Publishers, 1979.
9. Rolfe and Barsom , “Fracture and Fatigue Control in Structures” , Prentice Hall, 1977
10. Knott , “Fundamentals of fracture mechanisms”, Butterworths, 1973

M.Tech. – Mechanical Engineering Design (MED)

COURSE: MED 26: LAB 2 – LAB. PRACTICE-II (FEA)

CREDITS: 01

Teaching Scheme:
Practicals: 02 Hrs./Week

Examination Scheme
University Assessment : 25 Marks
College Assessment: 25 Marks

List of Experiments

1. Solution of 1D FE problems (Linear Bar) using commercial / freeware / self developed application programs.
2. Solution of 1D FE problems (Quadratic Bar) using commercial / freeware / self developed application programs
3. Solution of Truss problems using commercial / freeware / self developed application programs
4. Solution of 2D FE problems using commercial / freeware / self developed application programs
5. FE Modeling using advanced software

References:

1. Reddy, Junuthula Narasimha. An introduction to the finite element method. Vol. 2, no. 2.2. New York: McGraw-Hill, 1993.
2. Chandrupatla, Tirupathi R., Ashok D. Belegundu, T. Ramesh, and Chaitali Ray. Introduction to finite elements in engineering. Vol. 2. Upper Saddle River, NJ: Prentice Hall, 2002.
3. Desai, Chandrakant S., and John Fredrick Abel. Introduction to the finite element method; a numerical method for engineering analysis. Van Nostrand Reinhold, 1971.
4. Zienkiewicz, Olek C., and Robert L. Taylor. The finite element method: Its basis and fundamentals
5. K.J. Bathe, Finite Element Procedures, Klaus-Jurgen Bathe
6. Singiresu s. Rao . Finite element method in engineering.
7. Cook, R.D, “Concepts and application in Finite Element Analysis”, 3rd Ed, The Wiley & Sons
8. Dixit U.S., “Finite Element Methods for Engineers”, Cengage Learning

M.Tech. – Mechanical Engineering Design (MED)

COURSE: MED 27- SEMINAR-II / MINI PROJECT

CREDITS: 01

Teaching Scheme:	**Examination Scheme**
Tutorials: 02 Hrs. /Week	University Assessment: --------
	College Assessment: 50 Marks

CONTENTS:

Seminar-II :-

Seminar-II shall consists of the in depth study of a topic, related to the field of Design engineering and should have research orientation. The topic may preferably be in continuation with the Seminar – I. The topic of study/research is mutually decided by the student and the supervisor and a detailed technical report will be prepared, report shall consist of about 20-25 pages of 'A4' size sheets in either comb or hard bound.

The candidate will have to deliver a seminar presentation in front of the examiners, one of them will be guide and other will be the examiner appointed by University. The performance of the student will be evaluated by both examiners jointly based on the content of the seminar, delivery of seminar and answers to the queries of the examiners.

OR

Mini Project:-

The mini project work extends for a single semester and exposes the student to develop and present his/her work related to specific topic. The work at this stage may involve review of literature, laboratory experimental work, design and fabrication of a mechanical system/model, case study, field data collection and analysis etc. On completion of the mini project work the student shall prepare a report of about 25-30 pages of 'A4' size sheets and will deliver a seminar presentation in front of the examiners, one of them will be guide and other will be the examiner appointed by University.