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**SHIVAJI UNIVERSITY,  
KOLHAPUR.**

**Syllabus of**

**M. E. Mechanical (Machine Design)**

**(Semester –I to Semester-IV)**

**To be introduced from the academic year 2012-13**

**(i.e. from June 2012 Onwards)**

(Subject to the modifications will be made from time to time)

**SHIVAJI UNIVERSITY, KOLHAPUR**

**M. E. Mechanical (Machine Design)**

(W.e.f. Academic Year-2012-13)

**PART - I (SEMESTER – I)**

Sr. No	Name of the Course	Teaching Scheme		Examination			Total Marks
		L	T/P	TP	TW	ORAL	
1.	Mathematical Modeling and Design Optimization	03	01	100	25	--	125
2	Advanced Mechanics of Solids	03	01	100	25	--	125
3	Advanced Theory of Vibrations	03	01	100	25	--	125
4	Elective – I	03	01	100	25	--	125
5	Elective-II	03	01	100	25	--	125
6	Instrumentation Lab	--	02	--	25	25	50
7	*Seminar – I	--	02	--	25	--	25
<b>Total</b>		15	09	500	175	25	700

L-Lecture, T/P-Tutorial/Practical, TP- Theory Paper, TW-Term Work

Sr. No.	Elective-I	Elective-II
1	Tribology	Vibration Control and Condition Monitoring
2	Process Equipment Design	Product Design and Development
3	Advanced Finite Element Analysis	Material Handling Equipment Design
4	Mechatronics	Robotics

**PART - I (SEMESTER – II)**

Sr. No	Name of the Course	Teaching Scheme		Examination			Total Marks
		L	T/P	TP	TW	ORAL	
1.	Advanced Material Science	03	01	100	25	--	125
2	Advanced Machine Design	03	01	100	25	--	125
3	Mechanics of Machinery	03	01	100	25	--	125
4	Elective-III	03	01	100	25	--	125
5	Elective-IV	03	01	100	25	--	125
6	Computer Aided Analysis Lab	--	02	--	25	25	50
7	*Seminar – II	--	02	--	25	--	25
8	Comprehensive Viva	--	--	--	--	50	50
<b>Total</b>		15	09	500	175	75	750

Sr.No.	Elective-III	Elective-IV
1	Experimental Stress Analysis	Noise and Vibration Harshness (NVH)
2	Composite Materials	Vehicle Dynamics
3	Advanced Machine Tool Design	Engineering Fracture Mechanics
4	** Open Elective	Reliability Engineering

**PART - II (SEMESTER – III)**

Sr. No	Name of the Course	Teaching Scheme		Examination			Total Marks
		L	T/P	TP	TW	ORAL	
1	Inplant Training	---	---	---	50	---	50
2	***Dissertation Phase-I	---	05	---	50	50	100
Total		---	05	---	100	50	150

**PART - II (SEMESTER – IV)**

Sr. No	Name of the Course	Teaching Scheme		Examination			Total Marks
		L	T/P	TP	TW	ORAL	
1	***Dissertation Phase-II	---	05	---	200	100	300
Total		---	05	---	200	100	300

\* For Seminar I and Seminar II work load will be for two students.

\*\* Open Elective-

Students can take any subject from other Discipline, being conducting in the same

Institute and with consent of their guide.

\*\*\* For Dissertation phase I and Dissertation phase II, work load will be for one student.

**M.E. Mechanical (Machine Design) Part – I (Semester – I)**  
**Mathematical Modeling and Design Optimization**

Teaching Scheme:

Lectures : 3 Hours per week

Tutorial : 1 Hour per week

Examination Scheme:

Theory Paper : 100 Marks

Term Work : 25 Marks

**Section I: Mathematical Modeling**

**1. Research Modeling and Simulation:**

The Reality, the experiment and the model, Concept of modeling, Models as Approximations, Types of Modeling, Need and Classification of mathematical modeling, Use of Analogy, Data consideration and Testing of Models, Modeling of dynamic systems with differential equations, Simulation of data in the form of mathematical equations, Linear-Non-linear equations, Determining the Unknowns of Equations using Least Square Criterion, Process of Simulation, Steps and Features of Simulation Experiments and their Validation.

**Section II: Design Optimization**

**2. a. Classical Optimization Techniques:**

Single-variable and Multi-variable Optimization, Hessian Matrix, Saddle Point, Lagrange Multipliers Method and Kuhn-Tucker Conditions.

**b. Single-variable Optimization Techniques:**

Linear and Non-Linear behavior, Unrestricted Search, Solution using Graphical Method and Numerical Methods, Interval-halving Method, Golden-section Method, Newton Method, Secant Method

**c. Multi-variable Optimization Techniques:**

Non-linear Equations, Steepest Descent Method, Conjugate Gradient Method, Davids on- Fletcher-Powell Method

**3. Taguchi Method:**

Introduction, Loss Function and Signal –to-noise ratios, Control Factors and Noise Factors, Orthogonal Design, Design of Experiments, Steps in carrying out experiment, Analysis of variances etc.

**Term Work:**

The Student is expected to understand and study the basic components of the research process so that they should carry out the term work so that it will help/lead to finalize research project.

**Four Assignments based on the Syllabus which includes**

Data Collection, data Processing, data Simulation

Modeling and simulation of Design problem

Optimum Design of Mechanical system using Numerical/Graphical techniques.

**Case studies to be solved by using EXCEL sheet of following nature.**

Case I: For Better Surface Finish (Consider three parameters (factors))

a. Hardness b. Speed c. Feed

Case II: For Better Tool Life (Consider three parameters (factors))

a. Linear Velocity b. Depth of Cut c. Feed

Case III: For Optimum Cutting Force during Turning Operation (Consider three parameters (factors)) a. Speed b. Depth of cut c. feed

Students are to design the experiment based on similar problems given as above.

**Text Books:**

1. Wilkinson K.P.L. Bhandarkar, Formulation of Hypothesis, Himalaya Publishing House
2. Ranjit Kumar, (2006), Research Methodology – A Step-By-Step Guide for Beginners, (Pearson Education, Delhi) ISBN : 81-317-0496-3
3. C.R. Kothari, "Research Methodology", Wiley Eastern Publication.
4. Dr S.S. Rao, "Optimization Theory and Applications", Wiley Eastern Ltd., New Age International, New Delhi, 2<sup>nd</sup> Edition, 1994.
5. Adler and Granovsky, "Optimization of Engineering Experiments", Meer Publications

**Reference Books:**

1. Trochim, William M.K. (2003), 2/e, Research Methods, (Biztantra, Dreamtech Press, New Delhi), ISBN : 81-7722-372-0
2. Montgomery Douglas C., & Tunker, George C. (2007). 3/e, Applied Statistics & Probability for Engineers, (Wiley India).
3. Ross P.J., "Taguchi Techniques for Quality Engineering", TMH, 2005.
4. Jeff Wu, "Experiments: Planning, Analysis and Parameter Design", John Wiley, 2000.
5. Fox R.L., "Optimization Methods for Engineering Design", Addison Wesley, 1971.

**M.E. Mechanical (Machine Design) Part – I (Semester – I)**  
**Advanced Mechanics of Solids**

Teaching Scheme:

Lectures : 3 Hours per week

Tutorial : 1 Hour per week

Examination Scheme:

Theory Paper : 100 Marks

Term Work : 25 Marks

1. Plane stress and plane strain: Differential equations of equilibrium, Boundary conditions, Compatibility, Stress functions and Biharmonic equation. Two dimensional problems in Rectangular coordinates, Applications to polynomials in rectangular coordinates, Saint-Venant's principle.
2. Two dimensional problems in polar coordinates: General equations in polar coordinates, Pure bending of curved bars, Strain components in polar coordinates, Rotating discs, stresses in a circular discs.
3. Shear center: Shear stress, distribution and shear centre for thin walled open sections. Bending of Beams, Energy methods, Introduction to elastic stability, Plasticity.
4. Torsion: Torsion of bars with elliptical square and rectangular cross section, Membrane analogy, Hydro dynamical analogy, Torsion of hollow and thin tubes.
5. Membrane stresses in shell and storage vessels, Shells and vessels of uniform strength.
6. Contact stresses: Problem of determining contact stresses, Assumption Expressions for principal stresses, Examples.

**Term Work:**

10 to 12 study experiments/tutorials based on above topics.

**Reference Books:**

1. S. Timoshenko and J.W. Goodier "Theory of Elasticity" MGH book co Ltd.
2. J.P. Den Hartog, "Advanced strength of materials" MGH book co Ltd.
3. F.B. Seely & Smith "Advanced mechanics of materials" John Wiley & Sons.
4. Irving H. Shames & James M. Pitarresi, "Introduction to Solid Mechanics", 3<sup>rd</sup> ed, PHI, pub.
5. Boresi A.P. and Sidebottom O.M., "Advanced Mechanics of Materials", John Wiley, 1993.
6. Chakrabarty, "Theory of Plasticity", McGraw-Hill Book Company, New York 1990.
7. Popov E.P., "Engineering Mechanics of Solids", 2nd Ed., Prentice Hall India, 1998.
8. Crandall S.H., Dahl N.C. and Lardner T.J., "An Introduction to the Mechanics of Solids", 2nd Ed., McGraw-Hill, 1978.
9. Nash W., "Strength of Materials", Schaum's outline series, McGraw Hill.
10. Timoshenko.S. and Young D.H. – "Elements of strength materials Vol. I and Vol. II". T. Van Nostrand Co-Inc Princeton-N.J. 1990.
11. "Statics and Mechanics of Materials: An Integrated Approach", Riley Sturges and Morris. Wiley, 2nd Edition.
12. Sadhu Singh – Theory of Elasticity, Khanna Publisher

**M.E. Mechanical (Machine Design) Part – I (Semester – I)**  
**Advanced Theory of Vibrations**

Teaching Scheme:

Lectures : 3 Hours per week

Tutorial : 1 Hour per week

Examination Scheme:

Theory Paper : 100 Marks

Term Work : 25 Marks

1. **Fundamentals of Vibration:** Review of Single and Two degree freedom systems subjected to Forced and Motion Excitation. Response to arbitrary periodic and aperiodic excitations, Impulse response - Transient vibration - Laplace transformation formulation. Fourier transforms- definition, Relation to transfer functions, First order systems, applications. Basic Concepts like Passive, Semi-active and Active Parameters.
2. **Two Degree Freedom System:** Optimum design of single, two degree of freedom systems, Vibration Absorber and Vibration isolators.
3. **Multi Degree Freedom System :** Normal mode of vibration - Flexibility matrix and stiffness matrix - Eigen value and Eigen vector – Orthogonal properties - Modal matrix - Modal analysis - Forced vibration by matrix inversion - Modal damping in forced vibration - Numerical methods of determining natural frequencies.
4. **Vibration of Continuous Systems:** Systems governed by wave equations - Vibration of strings - Vibration of rods - Euler's equation for beams - Effect of Rotary inertia and shear deformation - Vibration of plates.
5. **Experimental Methods in Vibration Analysis:** Vibration instruments - Vibration exciters, Measuring Devices - Analysis - Vibration Tests - Free and Forced Vibration tests. Collection of FRF, Experimental modal analysis methods, Examples of vibration tests - Industrial case studies.
6. **Analytical Dynamic Analysis:** Dynamic analysis - Equation of motions - Mass matrices - Free vibration analysis - Natural frequencies of Longitudinal - Transverse and torsional vibrations - Introduction to transient field problem.
7. **Validation of Analytical Models:** Preliminary check, Correlation of analytical model with experimental model, Model updating- fundamentals.
8. **Non-Linear Vibrations:** Introduction, Sources of nonlinearity, Qualitative analysis of nonlinear systems, Phase plane, Conservative systems, Stability of equilibrium, Limit cycles-van der pol oscillator, Perturbation method, Chaos, Method of iteration, Self-excited oscillations, Lindstedt's Method.
9. **Random Vibrations:** Random phenomena, Time averaging and expected value, Frequency response function, Probability distribution, Correlation, Power spectrum and power spectral density, Fourier transforms, FT's and response.

**Term Work:**

Following Experiments/Assignments Comprise the laboratory Practice:-

1. Application of sensors and related instrumentation for time domain and frequency domain.
2. Two assignments on measurement of dynamic test data of machine elements.
3. Modal testing and analysis for natural frequencies and mode shapes for structures.
4. Random vibration and measurement of vehicles on test track.
5. Two assignments on dynamic analysis using FEA software like Nastran, Hyperworks etc.
6. One Assignment on model data correlation for any one model used in Sr. No. 2 and 3.
7. Minimum TWO assignments on solving vibration problems using MATLAB.
8. Sound intensity measurement in interior of vehicle for source location for harshness.

**Text Books:**

1. Thomson W.T., "Theory of Vibration with Applications" CBS Publishers and Distributors, New Delhi ,1990
2. Den Hartog J.P., "Mechanical Vibrations", Dover Publications, 1990.
3. Rao S.S., "Mechanical Vibrations", Addison Wesley Longman, 1995.
4. Mechanical Vibrations - S. Graham Kelly, Schaum's Outlines, Tata McGraw Hill, 2007
5. Elements of Vibration Analysis, Lenord Meirovitch, Mc,Graw Hill Ltd, 2004

**Reference Books:**

1. Rao J.S. & Gupta K., "Ind. Course on Theory and Practice Mechanical Vibration", New Age International (P) Ltd., 1984.
2. D.J. Ewins, Modal Testing: Theory and Practice, Research Press Ltd, Letch worth (Herefordshire, England) (1984).
3. M.I. Friswell & J.E. Mottershead, Finite Element Model Updating in Structural Dynamics (Solid Mechanics & Its Applications.) Kluwer Academic Publishers (1995)
4. Vibration: Fundamental and Practice, Clarence W. de Silva, CRC Press LLC, 2000.
5. Fundamentals of Mechanical Vibration. - S. Graham Kelly. 2 nd edition McGraw Hill.



**M.E. Mechanical (Machine Design) Part – I (Semester – I)**  
**Elective I- Tribology**

Teaching Scheme:

Lectures : 3 Hours per week

Tutorial : 1 Hour per week

Examination Scheme:

Theory Paper : 100 Marks

Term Work : 25 Marks

**1.Introduction:**

Introduction to Tribology-General Tribology considerations in the design of gears, Cams, Reciprocating components, etc. Engine Tribology basics- Tribology aspects of engine components such as bearings, piston assembly, valve train and drive train components etc.

**2.Friction and wear:**

Nature of metal surfaces- surface properties- surface parameters and measurements, Friction-sliding friction-rolling friction characteristics of common metals and nonmetals- friction under extreme environments, Engine friction- Losses and engine design parameters, Economic role of wear-type of wear-wear mechanism-factors affecting wear-selection of materials for different wear situations-measurement of wear-tribometers and Tribometry, Engine wear-mechanisms, Wear resistance material and coatings and failure mode analysis.

**3.Bearings, lubrication and Lubricants:**

Theory of hydrodynamic lubrication-Generalized Reynolds Equation-Slider bearings-Fixed and pivoted shoe bearings-Hydrodynamic journal bearings-short and finite bearing-Thrust bearings-Sintered Bearing-Non Circular bearings and multi side surface bearings.

Lubrication-type of lubricants-Properties and Testing –Service Classification of lubricants-Lubrication of tribological components-Lubrication systems-Lubricant monitoring, SOAP, Ferrography and other rapid testing methods for lubricants contamination.

**4.Hydrostatic (externally-pressurized) & Elasto-Hydrodynamic lubrication:**

Hydrostatic bearing-basic concepts, bearing pad coefficient, Restrictors-Capillary, Orifice and flow control valve-bearing characteristic number and performance coefficients-Flat, Conical and Spherical pad thrust bearing-Multirecess journal and thrust bearings-Air and gas lubricated bearings, Lubrication of Ball and roller bearings, cams and gears, Selection and life estimation, Fatigue and diagnostics.

**5.Rheodynamic (static) lubrication:**

Non-Newtonian fluids, characteristics, Thixotropic, materials and Bingham solids, Grease lubrication and stability, Tribology of components in extreme environments like vacuum, pressure, temperature; tribomonitoring and special applications, Tribology matching and selection, Tribometry, Tribo-testing and standards

**Term-Work:**

Minimum TEN assignments based on the above topics.

**Reference Books:**

1. Bowden F.P. & Tabor D., "Friction and Lubrication of solids", Oxford University Press., 1986.
2. Ernest Rabinoweiez: "Friction and Wear of materials" Interscience Publishers, 1995.
3. Neale M.J., Tribology-: Hand Book", Butterworth, 1995.
4. Fuller D.D.: "Theory and practice of Lubrication for engineers", John Wiley sons, 1984.
5. Gross W. A.: "Gas film lubrication", Wiley, 1980.

**M.E. Mechanical (Machine Design) Part – I (Semester – I)**  
**Elective I-Process Equipment Design**

Teaching Scheme:

Lectures : 3 Hours per week

Tutorial : 1 Hour per week

Examination Scheme:

Theory Paper : 100 Marks

Term Work : 25 Marks

**1. Process Design Parameters:**

Basic concepts in process design, Block diagrams for flow of processes, Material flow balance, Design pressures --temperatures, Design stresses, factory of safety, Minimum shell thickness and corrosion allowance, Weld joints efficiency, Design loading, Stress concentration and thermal stresses, Failure criteria, Optimization technique such as Lagrange's multiplier and golden section method, Cost and profitability estimation. Introduction to design codes like IS-2825, ASME-SECT, EIGHT-DIV-II TEMA.API-650, BS-1500 & 1515.

**2. Design of Cylindrical and Spherical Vessels:**

Thin and thick walled cylinder analysis, Design of end closers, Local stresses due to discontinuity or change of shape of vessel, Vessel opening compensation, Design of standard and non-standard flanges, Design of vessels and pipes under external pressure, Design of supports for process vessels.

**3. Design of Tall Vessels and Large Storage Tanks:**

Determination of equivalent stress under combined loadings including seismic and wind loads, Application of it to vertical equipment like distillation column.

**4. Design of Thick Walled High Pressure Vessels:**

Design by various theories of failure, Construction of these vessels with high strength steel and other special methods.

**5. Process Equipment Design :**

Storage vessels, Reaction vessels, Agitators and Mixers, Heat exchangers, Filters and Driers, Centrifuges, Code practices, selection and specification procedures used in design, Selection of pumps, compressors, electrical equipments and auxiliary services, safety, etc.

**6. Process Piping Design :**

Flow diagrams and pipe work symbols, Design of layout of water, steam and compressed air pipes work, Pipe fitting, Linings and flanged connections. Types of valves used on pipe line, Fabrication of pipe lines, Expansion joints and pipe supports.

**7.Planning, manufacture, inspection and erection of process equipment:**

Planning, manufacture, inspection and erection of process equipment like Pressure vessels, chimneys, ducting, heat exchangers, pulverizing equipment, etc. Protective coatings, Lining of vessels.

**8. Process Control :**

Fundamentals of process measurements and control modern control devices and other controls of major unit operation and processes.

**9. Applications of CAD to Process Equipment Design:**

**Term Work:**

Following assignments / experiments comprise the laboratory practice :-

1. Design and optimization of tall vessels and large tanks.
2. Design of Heat exchangers used in industries.
3. Design of crystallizers.
4. Design and development of equipment useful to process industries such as Sugar, Cement and Chemical
5. Preparing flow diagrams of processes, piping layout, etc.
6. Report based on visit to industries such as Sugar, Cement and Chemical

**Reference Books:**

1. Process Equipment Design : By Dr. M.V. Joshi, Mc-Millan.
2. Process Equipment Design : By Browell and Young, John Wiley.
3. Plant Design and Economics : Max and Timasulaus Kalus – McGraw Hill.
4. Industrial Instrumentation servicing Hand Book : Cannel Grady & McGraw Hill.
5. Handbook of Instrumentation and Control : Kellen Heward, McGraw Hill.
6. Chemical Engineering Handbook : Perry John, McGraw Hill.
7. Chemical Equipment Design : B.C. Bhattacharya.
8. Industrial Pipe Work : D.N.W. Kentish, McGraw Hill.
9. Chemical Engineering : J.M. Coulson, Richardson, Sinnott Vol. VII, Maxwell, McMillan.
10. Pressure Vessel Design Hand Book : H. Bedna.
11. Dryden's outlines of Chemical Technology for the 2 : By Roa M. Gopala & Sitting M., East West Press Pvt. Ltd., New Delhi.
12. Applied Process Design for Chemical and Petrochemical, Vol. I, II and III : By E.E. Ludwig, Gulf Publication Co., Houston.

13. Chemical Process Control : An Introduction to Theory and Practice : By Stephanopoulos G., Prentice Hall of India, New Delhi.
14. Chemical Process Equipment Selection and Design : By Stanley M.Walas, Butterworth- Heinemann Series in Chemical Engineering.
15. Process System Analysis and Control : By D.R. Coughanowr, McGraw Hill, New York.
16. Engineering Optimization: Theory and Practice : By Rao S.S., New Age Publishing Co., New Delhi.
17. Optimization of Chemical Processes : By Edgar T.F., Himmelblau D.M., McGraw Hill Book Co., New York.
18. Control Devices, Vol. I and II : Liptak
19. Analysis, synthesis and design of Chemical Processes : Richard Turton, Richard C. Bailie, Wallace B. Whiting, Josheph A. Shaewitz, Prentice Hall Int. Series in Physical and Chemical Science.
20. Theory and Design of Pressure Vessels", by Harvey, second edition, CBS publishers and distributors

**M.E. Mechanical (Machine Design) Part – I (Semester – I)**  
**Elective I - Advanced Finite Element Analysis**

Teaching Scheme:

Lectures : 3 Hours per week

Tutorial : 1 Hour per week

Examination Scheme:

Theory Paper : 100 Marks

Term Work : 25 Marks

**1. Introduction to Finite Element Method** : Engineering Analysis, History, Advantages, Classification, Basic steps, Convergence criteria, Role of finite element analysis in computer-aided design, Mathematical Preliminaries, Differential equations formulations, Variational formulations, Weighted residual methods.

**2. One-Dimensional Elements-Analysis of Bars and Trusses:** Basic Equations and Potential Energy Functional, 1-D Bar Element, Trusses, Admissible displacement function, Strain matrix, Stress recovery, Element equations, Stiffness matrix, Consistent nodal force vector: Body force, Initial strain, Assembly Procedure, Boundary and Constraint Conditions, Single point constraint, Multi-point constraint, 2-D Bar Element, Shape Functions for Higher Order Elements.

**3. Two-Dimensional Elements-Analysis of Plane Elasticity Problems:** Three-Noded Triangular Element (TRIA 3), Four-Noded Quadrilateral Element (QUAD 4), Shape functions for Higher Order Elements (TRIA 6, QUAD 8).

**4. Axi-symmetric Solid Elements-**Analysis of Bodies of Revolution under axi-symmetric loading: Axisymmetric Triangular and Quadrilateral Ring Elements. Shape functions for Higher Order Elements.

**5. Three-Dimensional Elements-**Applications to Solid Mechanics Problems: Basic Equations and Potential Energy Functional, Four-Noded Tetrahedral Element (TET 4), Eight-Noded Hexahedral Element (HEXA 8), Tetrahedral elements, Hexahedral elements: Serendipity family, Hexahedral elements: Lagrange family, Shape functions for Higher Order Elements

**6. Beam Elements-**Analysis of Beams and Frames: 1–D Beam Element, 2–D Beam Element Problems, Plate bending and shell elements.

**7. Heat Transfer - Fluid Flow:** Steady state heat transfer, 1 D heat conduction governing equation, Boundary conditions, One dimensional element, Functional approach for heat conduction, Galerkin approach for heat conduction, Heat flux boundary condition, 1 D heat transfer in thin fins. Basic differential equation for fluid flow in pipes, around solid bodies, porous media.

**8. Dynamic Considerations:** Formulation for point mass and distributed masses, Consistent element mass matrix of one dimensional bar element, truss element, axisymmetric triangular element, quadrilateral element, beam element. Lumped mass matrix, Evaluation of Eigen values and Eigen vectors, Applications to bars, stepped bars, and beams. Introduction to FE Software Packages, Algorithmic approach for developing the code by the individuals

**9. Non-linear Analysis** - Sources and types of non-linearity, Incremental approach to solution of nonlinear problems, Iterative solution methodologies, Considerations for simulation of non-linear problems.

**Term Work:**

Tutorials should be given based on the below mentioned topics.

1. 1D & 2D structural analysis.
2. Analysis of plane trusses
3. Stress Analysis of Bracket.
4. Stress Analysis of with circular hole.
5. 1D and 2D heat transfer problems.
6. Computation of shape function.
7. Analysis of 2-D transient heat flow in plate
8. Computer programmes for 3D structural analysis
9. Finite Element Analysis of Fluid Flow Problems.
10. Formulation and solution of dynamic problems using computer programmes.

**Text Books:**

1. Rao S. S. "Finite Elements Method in Engineering"- 4<sup>th</sup> Edition, Elsevier, 2006
2. J.N.Reddy, "Finite Element Method"- McGraw -Hill International Edition.
3. Bathe K. J. Finite Elements Procedures, PHI. Cook R. D., et al. "Concepts and Application of Finite Elements Analysis"- 4<sup>th</sup> Edition, Wiley & Sons, 2003.
4. Chandrupatla T. R., "Finite Elements in engineering"- 2nd Editions, PHI, 2007.2.

**Reference Books:**

1. Frank L. Stasa," Applied finite Element Analysis for Engineers", CBS International Edition, 1985.
2. Zeinkovich, "The Finite Element Method for Solid and Structural Mechanics, 6<sup>th</sup> Ed., Elsevier 2007.

**M.E. Mechanical (Machine Design) Part – I (Semester – I)**  
**Elective I- Mechatronics**

Teaching Scheme:

Lectures : 3 Hours per week

Tutorial : 1 Hour per week

Examination Scheme:

Theory Paper : 100 Marks

Term Work : 25 Marks

**1. Introduction**

What is Mechatronics Systems, Measurement Systems, Control Systems, Microprocessor- based controllers, The Mechatronics Approach.

**2. Sensors & transducers**

Sensors and Transducers, Performance Terminology, (Displacement, Position & Proximity Sensors),(Velocity & Motion, Force, Fluid Pressure, Liquid Flow, Liquid Level, Temperature & Light Sensors), Selection of Sensors.

**3. Electronic fundamentals**

Signal Conditioning Process, Operational Amplifier, Digital Logic, Logic Gates, Boolean Algebra, Data Acquisition Systems, Measurement Systems, Testing and Calibration.

**4. Actuators**

Mechanical Actuation Systems, Hydraulic & Pneumatic Actuation Systems, Electrical Actuation Systems, A.C. Motor, D.C. Motor, Stepper Motor.

**5. System modelling & control**

Mathematical Models, Engineering Systems, Electromechanical & Hydraulic-Mechanical Systems, Modeling Dynamic Systems, Transfer Functions, Introduction to MATLAB & SIMULINK, Control Modes, PID Controller.

**6. Microprocessor & computer**

Computer and Interfacing, Microcomputer Structure, Microcontrollers, Application of Microcontrollers, PLC.

**7. Design & mechatronics**

Designing, Possible Design Solutions, Case Studies of Mechatronic Systems.

**Term Work:**

Minimum Ten assignments based on above topics.

**Text Books:**

1. Mechatronics, W. Bolton, Pearson Education Asia
2. Mechatronics, Dan Neacsulescu, Pearson Education Asia
3. Mechatronics, HMT
4. Measurement Systems, E.O. Doebelin, McGraw Hill
5. Automatic Control Systems, B.C. Kuo, Ogata, PHI



**Reference Books:**

1. Mechatronics System Design by Devdas Shetty and Richard A. Kolk, P.W.S. Publishing Company, 2001.
2. Mechatronics by W. Bolton, Pearson Education, Asia, II-Edition, 2001.
3. Analytical Robotics and Mechatronics, Wolfram Stadler & McGraw Hill
4. Mechatronics, AMT
5. Introduction to Digital Computer Electronics, A.P. Mahind & TMH
6. Understanding Electromechanical Engineering; An Introduction to Mechatronics- Lawrence J K PHI

**M.E. Mechanical (Machine Design) Part – I (Semester – I)**  
**Elective II-Vibration Control and Condition Monitoring**

Teaching Scheme:

Lectures : 3 Hours per week

Tutorial : 1 Hour per week

Examination Scheme:

Theory Paper : 100 Marks

Term Work : 25 Marks

**1.Introduction** - Review of Fundamentals of Single Degree Freedom Systems – Two Degree Freedom Systems, Multi Degree Freedom System, continuous system, Determination of Natural frequencies and mode shapes, Numerical methods in Vibration Analysis.

**2.Vibration Control** – Reduction of Vibration at the Source – Control of Vibration – by Structural design – Material Selection – Localized additions – Artificial damping – Resilient isolation, Vibration isolation, Vibration absorbers, Active vibration control – review of smart materials – types and characteristics – smart structures.

**3.Selecting methods of condition monitoring** – Machine condition monitoring and diagnosis Vibration severity criteria – Machine maintenance techniques – Machine condition monitoring techniques – Vibration monitoring techniques – Instrumentation systems – Choice of monitoring parameter.

**4.Predictive Maintenance and Signature Analysis** – Observational and estimation techniques, Online techniques specially dealing with instrumentation system, Offline technique like visual inspection, non destructive testing and destructive testing for materials, fluids and general mechanical and electrical components, Predictive analysis of potential failures and end of useful life. Diagnostic maintenance, Applications to specific industrial machinery and plants.

**5.Dynamic balancing and alignment of machinery:** Dynamic Balancing of Rotors, Field Balancing in one plane, two planes, and in several Planes, Machinery Alignment, “Rough” Alignment Methods, the Face – Peripheral Dial Indicator Method, Reverse Indicator Method, Shaft-to-coupling spool method.

**Term Work:**

Minimum Ten assignments based on above topics.

**Text Books:**

1. Singiresu S.Rao, “Mechanical Vibrations”, Addison-Wesley Publishing Company, 1995.
2. J.O.Den Hartog, “Mechanical Vibrations”, McGraw Hill, New York, 1985.
3. R.A.Collacott, “Vibration monitoring and diagnosis”, Wiley, 1979.

**Reference Books:**

1. R.A.Collacott, “Mechanical Fault diagnosis and condition monitoring”, Wiley, 1977.
2. First course on “Condition monitoring in the process industries”, Manchester, edited by M.J.Neale, Nov.1979.
3. Newman, “Management of Industrial Maintenance”, Butterworth, 1978.
4. “Condition Monitoring manual”, National Productivity Council, New Delhi.
5. “Terotechnology”, Institute of mechanical Engineers, 1975.
6. Rao J.S., “Vibratory Condition Monitoring of Machines”, CRC Press, 2000.
7. “Hand Book of Condition Monitoring”, Els

**M.E. Mechanical (Machine Design) Part – I (Semester – I)**  
**Elective II-Product Design and Development**

Teaching Scheme:

Lectures : 3 Hours per week

Tutorial : 1 Hour per week

Examination Scheme:

Theory Paper : 100 Marks

Term Work : 25 Marks

**1. Introduction to product design:** Approach industrial product based on idea generation and innovativeness (and inventiveness) to meet the needs of the developing society, Design and development process of industrial products, Various steps such as creative process involved in idea of marketing, The Designer- his role, myth and reality, the industrial design organization, Basic design considerations, Role of Aesthetics in product design, Functional design practice. Use of modeling technique, prototype designs, conceptual (conceptual) design.

**2. Design for Production:** Producibility Requirements in the design of machine components, Forging design, Pressed component design, Casting design for economical molding, eliminating defects and features to aid handling, Design for machining ease, The role of process Engineer, Ease of location and Clamping, Some additional aspects of production design, Design of powder metallurgical parts.

**3.a) Industrial Product Design:** General design situations, sailing specifications, requirements and ratings, their importance in the design., Study of market requirements and manufacturing aspects of industrial designs. Aspects of ergonomic design of machine tools, testing equipments, instruments, automobiles, process equipments etc. Convention of style, form and color of industrial design.

b) **Design of Consumer Product:** Design concepts of consumer products, Specification requirements and rating of their importance in design, functions and use, standard and legal requirements, body/dimensions. Ergonomic Considerations, interpretation of information, conversions for style, forms, colors.

**4.Economics Considerations:** Selection of material, Design for production, Use of standardization, Value analysis and cost reduction, Maintenance aspects of product design. Economic Factors Influencing Design: Product value, Design for safety, Reliability and Environmental considerations, Manufacturing operations in relation to design, Economic analysis, Profit and competitiveness, Break even analysis, Economics of a new product design (Samuel Eilon Model).

**5.Value Engineering and Product Design:** Introduction, Historical perspective, Value, Nature and measurement of value, Maximum value, Normal degree of value, Importance of value, The value Analysis Job Plan, Creativity, Steps to problem solving and value analysis, Value Engg. Idea generation check list, Cost reduction, Materials and process selection in value engineering.

**6.Design Organization** : Organization structure, Designers position, Drawing office procedure, Standardization, Record keeping, Legal product of design patents.

**Term Work:**

Minimum Ten assignments based on above topics.

**Text Books:**

1. Product Design and Development by Kail T Ulrich and Steven D Eppinger
2. Product Design and Development by AK Chitale and Gupta
3. Design of Systems and Devices by Middendorf Marcel Dekker
4. Problems of product design and development – Hearn Buck, Pergamon Press.

**Reference Books:**

1. Industrial design for engineers – W. H. Mayall, London Ilifle books, Ltd.
2. Industrial designs in engineering – Charles H. Flurschein design council.
3. The generation of idea for new products – Trevor sowecy, Kogan page
4. The science of Engineering design – Percy II, Hill
5. Engineering design conceptual stage – M. J. French, Heinman Education Books.
6. Material of Inension – Ezia Manzim.

**M.E. Mechanical (Machine Design) Part – I (Semester – I)**  
**Elective II- Material Handling Equipment Design**

Teaching Scheme:

Lectures : 3 Hours per week

Tutorial : 1 Hour per week

Examination Scheme:

Theory Paper : 100 Marks

Term Work : 25 Marks

**1. Elements of Material Handling System:**

Importance, Terminology, Objectives and benefits of better Material Handling, Principles and features of Material Handling System, Interrelationships between material handling and plant layout, physical facilities and other organizational functions, Classification of Material Handling Equipments.

**2. Selection of Material Handling Equipments:**

Factors affecting for selection, Material Handling Equation, Choices of Material Handling Equipment, General analysis Procedures, Basic Analytical techniques, The unit load concept, Selection of suitable types of systems for applications, Activity cost data and economic analysis for design of components of Material Handling Systems, Functions and parameters affecting service, Packing and storage of materials.

**3. Design of Mechanical Handling Equipments:**

**[A] Design of Hoists:-**

Drives for hoisting, Components, and hoisting mechanisms, Rail traveling components and mechanism, Hoisting gear operation during transient motion, Selecting the motor rating and determining breaking torque for hoisting mechanisms.

**[B] Design of Cranes:-**

Hand-propelled and electrically driven E.O.T. Overhead Traveling Cranes, Traveling mechanisms of cantilever and monorail cranes, Design considerations for structures of rotary cranes with fixed radius, Fixed post and overhead traveling cranes, Stability of stationary, rotary and traveling rotary cranes.

**4. Design of load lifting attachments:**

Load chains and types of ropes used in Material Handling System, Forged, Standard and Ramshorn Hooks, Crane Grabs and Clamps; Grab Buckets, Electromagnet, Design consideration for conveyor belts, Application of attachments.

**5. Study of systems and Equipments used for Material Storage:**

Objectives of storage, Bulk material handling, Gravity flow of solids through slides and chutes, Storage in bins and hoppers, Belt conveyors, Bucket-elevators, Screw conveyors, Vibratory Conveyors, Cabin conveyors, Mobile racks etc.

**6. Material Handling / Warehouse Automation and Safety considerations:**

[A] Storage and warehouse planning and design, computerized warehouse planning, Need, Factors and Indicators for consideration in warehouse automation, which function, When and How to automate, Levels and Means of Mechanizations.

[B] Safety and Design, Safety regulations and discipline.

**Term Work:**

Following assignments comprise the laboratory practice:

1. Design and development of Material Handling Equipments applicable to various process industries such as Sugar Industry, Power plants, Automobile manufacturing, Harbor, Foundries etc.
2. Report based on visits to industries Manufacturing or using various Material Handling Equipments.

**Reference Books:**

1. N. Rudenko, 'Material Handling Equipments', Peace Publishers, Moscow.
2. James M. Apple, 'Material Handling System Design', John-Willlwy and Sons Publication, NewYork.
3. John R. Immer, 'Material Handling' McGrawHill Co. Ltd., New York.
4. Colin Hardi, 'Material Handling in Machine Shops'. Machinery Publication Co. Ltd.,Landon.
5. M .P. Nexandrn, 'Material Handling Equipment', MIR Publication, Moscow.
6. C. R. Cock and J. Mason, 'Bulk Solid Handling', Leonard Hill Publication Co. Ltd.,U.S.A.
7. Spivakovsy A.O. and Dyachkov V.K., 'Conveying Machines', Volumes I and II, MIR Publishers, 1985.
8. Kulwiac R. A., 'Material Handling Hand Book', 2nd edition, JohnWilly Publication,NewYork.

**M.E. Mechanical (Machine Design) Part – I (Semester – I)**  
**Elective II: Robotics**

Teaching Scheme:

Lectures : 3 Hours per week

Tutorial : 1 Hour per week

Examination Scheme:

Theory Paper : 100 Marks

Term Work : 25 Marks

**1. Robot Fundamentals**

Definitions, History of robots, Present and future trends in robotics, Robot classifications, Robot configurations, Point to Point robots, Continuous Path robots, Work volume, Issues in design and controlling robots, Repeatability, Control resolution, spatial resolution, Precision, Accuracy, Robot configurations, Point to Point robots, Continuous Path robots, Work volume, Applications of robots. Drives used in robots- Hydraulic, Pneumatic and Electric drives, Comparison of drive systems and their relative merits and demerits.

**2. Manipulator Kinematics:**

Matrix Algebra, Inverse of matrices, Rotational groups, Matrix representations of coordinate transformation, Transformation about reference frame and moving frame Forward & Inverse Kinematics examples of 2R, 3R & 3P manipulators, Specifying position and orientation of rigid bodies, Euler's angle and fixed rotation for specifying position and orientation, Homogeneous coordinate transformation and examples D-H representation of kinematics linkages, Forward kinematics of 6R manipulators using D-H representations, Inverse kinematics of 6R manipulators using D-H representations, Inverse Kinematics geometric and algebraic methods.

**3. Robotics Dynamics :**

Velocity Kinematics, Acceleration of rigid body, Mass distribution, Newton's equation, Euler's equation, Iterative Newton –Euler's dynamic formulation, Closed dynamic, Lagrangian formulation of manipulator dynamics, Dynamic simulation, Computational consideration.

**4. Trajectory planning:**

Introduction, General considerations in path description and generation, Joint space schemes, Cartesian space schemes, path generation in runtime, planning path using dynamic model point to point and continuous trajectory , 4-3-4 & trapezoidal velocity strategy for robots.

**5. Robot Sensors:**

Internal and external sensors, position- potentiometric, optical sensors ,encoders - absolute, incremental ,touch and slip sensors velocity and acceleration sensors, proximity sensors, force & torque sensors, Laser range finder, Camera. Micro-controllers, DSP, centralized controllers, Real time operating systems.

**6. Robot Controllers:**

Essential components-Drive for Hydraulic and Pneumatic actuators, H-bridge drives for D.C. motor Overload over current and stall detection methods, Example of a micro-controller/ microprocessor based robot Controller.

**7. Robot Vision:-**

Introduction, Image acquisition, Illumination Techniques, Image conversion, Cameras, Sensors, Camera and system interface, Frame buffers and Grabbers, Image processing, Lowlevel & high level machine vision systems.

**8. Robot Programming languages:**

Introduction the three level of robot programming, requirements of a robot programming language, problems peculiar to robot programming languages.

**9. Futuristic topics in Robotics:**

Micro-robotics and MEMS ( Micro electro mechanical systems ), Fabrication technology for Micro-robotics, Stability issue in legged robots, Under-actuated manipulators, Telecheirs.

**Term Work:**

Minimum Ten assignments based on above topics.

**Reference Books:**

1. S.R.Deb, "Robotics Technology and Flexible Automation ", Tata Mc Graw Hill 1994.
2. M.P.Groover, M. Weiss R.N. Nagel, N.G. Odrey " Industrial Robotics (Technology , Programming and application s) , McGraw, Hill 1996
3. K.S.Fu, R.C.Gonzalez and C.S.G.Lee, "Robotics: Control , sensors , vision and inintlligence ", MCGraw-Hill.1987.
4. J.J.Craig , introduction to Robotics , Addison-wesely 1989.
5. Klafter , Richard D., et al " Robotics Engineering",PhI,1996.
6. Zuech, Nello,"Applying Machine Vision ",John Wiley and sons, 1988.



**M.E. Mechanical (Machine Design) Part – I (Semester – I)**  
**Instrumentation Lab**

Teaching Scheme:

Tutorial/Practical: 2 Hours per week

Examination Scheme:

Term Work : 25 Marks

Oral : 25 Marks

The following experiments are to be performed in the laboratory:

1. Measurements of mechanical parameters:
  - a) Displacement
  - b) Force
  - c) Torque
2. Measurement of hydraulic parameters:
  - a) Pressure
  - b) vacuum
  - c) Flow
3. Measurement of thermal parameters:

Temperature : Industrial thermo couples, Resistance thermometer, Radiation temperature measurement.
4. Measurement of vibration parameters:
  - a) Displacement - Vibrometer
  - b) Velocity - Velocity pickup.
  - c) Acceleration - Accelerometer
  - d) Frequency – Vibration Analyzer
5. Measurement of Sound parameters (Noise Meter):
  - a) Sound intensity level
  - b) Sound Power level
  - c) Sound Pressure level
6. Signal & system analysis.
7. Condition monitoring & signature analysis applications.

Vibration signature analysis of different existing machines such as Lathe, Grinder, Blower etc.
8. Data acquisition & conversion.
9. Microprocessor & computer application in measurements.

**Reference Books:**

1. B. C. Nakra & K. K. Choudhary, “ Instrumentation, Measurement & Analysis” Tata McGraw Hill Publications Pvt. Ltd., New Delhi.
2. Rangan & Sharma, “Instrument Devices & Systems” ” Tata McGraw Hill Publications Pvt. Ltd., New Delhi.
3. Earnest O Doebelin, “ Measurement Systems : Applications & Design”, McGraw Hill International.

**M.E. Mechanical (Machine Design) Part – I (Semester – I)**  
**Seminar I**

Teaching Scheme:

Practical: 2 Hours per week

Examination Scheme:

Term Work: 25 Marks

Seminar-I should be based on the literature survey on any topic relevant to Machine Design (should be helpful for selecting a probable title of dissertation).

Each student has to prepare a write up of about 25 pages of “A4” size sheets and submit it in duplicate as the term work.

The student has to deliver a seminar talk in front of the faculty members of the department and his classmates. The faculty members, based on the quality of the work and preparation and understanding of the candidate, shall do an assessment of the seminar internally – jointly.

**M.E. Mechanical (Machine Design) Part – I (Semester – II)**  
**Advanced Material Science**

Teaching Scheme:

Lectures : 3 Hours per week

Tutorial : 1 Hour per week

Examination Scheme:

Theory Paper : 100 Marks

Term Work : 25 Marks

**SECTION-I**

Tensile testing, Other tests of plastic behaviour, Strain hardening of metals, Strain rate and temperature dependence, Slip in BCC,FCC,HCP crystals, Hardening mechanisms in metals-Strain hardening, solid solution strengthening, Dynamic strain aging, Ductility and fracture, Fracture mechanics, Griffiths theory, Orowan theory, Theoretical fracture strength, Irwin's fracture analysis, Fracture mechanics in design, Strain energy release in the J-integral, Creep: Creep mechanics, Temperature dependence of creep, Deformation mechanism maps, Fatigue: S-N curves, Effect of mean stress, Stress concentration, Design estimates, Cyclic stress-strain behaviour, and fatigue of polymers. Design consideration. Mechanical behaviour of ceramics and glasses, Polymers, Composites. Material characterization using optical microscopy and SEM.

**SECTION-II**

Introduction, Engineering materials and their properties, Material property charts, Material selection-the basics, Material selection-case studies, Process and process selection, Case studies, Multiple constraints and objectives, case studies, Selection of materials and shape, case studies, Designing of hybrid materials, case studies, Information and knowledge sources for design, Materials and the environment, Materials and identical design, Forces for change.

**Term Work:**

Minimum Eight assignments based on above topics.

**Text Books:**

1. George E. Dieter: Mechanical Metallurgy- McGraw-Hill
2. William F.Hosford: Mechanical Behaviour of Engineering Materials.
3. Michael F. Ashby, Material selection in Mechanical Design, 3<sup>rd</sup> Ed, Elsevier 2005.

**Reference Books:**

1. R.K. Honey Combe, "The Plastic deformation of metals", American Society for Metals.
2. Joseph Marin, "Mechanical Behaviour of Engineering Materials" Printice Hall.
3. J.E. Dorn, "Mechanical behaviour of materials at elevated temperatures", McGraw Hill.
4. Hellan K., "Introduction to Fracture Mechanics", McGraw Hill.
5. A.J. Kennedy : Processes of creep and fatigue in metals- Oliver and Boyd-Edinburgh
6. Knott J. F.: Fundamentals of fracture mechanics- Butterworths, London.
7. Fracture Mechanics-"Metals Hand Book" Vol. 8 ASME

**M.E. Mechanical (Machine Design) Part – I (Semester – II)**  
**Advanced Machine Design**

Teaching Scheme:

Lectures : 3 Hours per week

Tutorial : 1 Hour per week

Examination Scheme:

Theory Paper : 100 Marks

Term Work : 25 Marks

**1. Introduction and fatigue of materials**

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

**2. Stress-life (s-n) approach and strain-life (-n) approach**

S-N curves, Statistical nature of fatigue test data, General S-N behavior, Mean stress effects, Different factors influencing S-N behaviour, S-N curve representation and approximations, Constant life diagrams, Fatigue life estimation using S-N approach.

Monotonic stress-strain behavior, Strain controlled test methods, Cyclic stress-strain behavior, Strain based approach to life estimation, Determination of strain life fatigue properties, mean stress effects, Effect of surface finish, Life estimation by S-N approach.

**3. LEFM approach and statistical aspects of fatigue**

LEFM concepts, Crack tip plastic zone, Fracture toughness, Fatigue crack growth, Mean stress effects, Crack growth life estimation. Definitions and quantification of data scatter, Probability distributions, Tolerance limits, Regression analysis of fatigue data, Reliability analysis, Problems using the Weibull distribution.

**4. Fatigue from variable amplitude loading**

Spectrum loads and cumulative damage, Damage quantification and the concepts of Damage fraction and accumulation, Cumulative damage theories, Load interaction and sequence effects, Cycle counting methods, Life estimation using stress life approach.

**5. Surface failure**

Introduction, Surface geometry, Mating surface, Friction, Adhesive wear, Abrasive wear, Corrosion wear, Surface fatigue spherical contact, Cylindrical contact, General contact, Dynamic contact stresses, Surface fatigue strength.

**Term Work:**

Minimum Ten assignments based on above topics.

**Text Books:**

1. Metal Fatigue in engineering, Ralph I. Stephens, Ali Fatemi, Robert.R. Stephehs,
2. Henry O.Fuchs, John wiley Newyork, Second edition.2001
3. Failure of Materials in Mechanical Design, Jack.A.Collins, JohnWiley, Newyork1992.
4. Machine Design, Robert L. Norton, Pearson.

**Reference Books:**

1. Fatigue of Materials, S.Suresh, Cambridge University Press, Cambridge, U.K
2. Fundamentals of Metal Fatigue Analysis, Julie.A.Benantine Prentice Hall, 1990.
3. Fatigue and Fracture, ASM Hand Book, Vol 19, 2002.

**M.E. Mechanical (Machine Design) Part – I (Semester – II)**  
**Mechanics of Machinery**

Teaching Scheme:

Lectures : 3 Hours per week

Tutorial : 1 Hour per week

Examination Scheme:

Theory Paper : 100 Marks

Term Work : 25 Marks

**1.Kinematics of complex mechanisms** - Complex mechanisms, Low and high degree of complexity, Goodman's indirect acceleration analysis, Method of normal accelerations, Hall and Ault's auxiliary point method, Carter's method and comparison of methods.

**2.Advanced kinematics of plane motion** - The inflexion circle - Euler-Savary equation, Analytical and graphical determination of diameter of inflection circle - Bobbiler's construction, Collineation axis - Hartman's construction, Application of inflection circle to kinematic analysis - Polode curvature - General case and special case, Polode curvature in the four-bar mechanism - Coupler motion, Relative motion of the output and input links, Freudenstein's collineation axis theorem - Carter Hall circle, Circling-point curve (general case).

**3.Introduction to synthesis (Graphical methods)**- guiding a point through two, three and four distinct positions - Burmaster's curve, Function generation - Overlay's method, Path generation - Robert's theorem.

**4.Introduction to synthesis (Analytical methods)** - Freudenstein's equation - Precision point approximation - Precision derivative approximation - Method of components - Block synthesis and Reven's method.

**5.Forces in mechanisms** - Free body diagrams - Friction in link connections - Forces in linkages.

**6.Cam dynamics** -

Forces in rigid systems, Mathematical models, Response of a uniform -

Motion undamped cam mechanism - Analytical method, Follower response by phase - Plane method - Position error, Jump, Crossover shock - Johnson's numerical analysis.

**Term Work:**

Minimum Ten assignments based on above topics.

**Reference Books:**

1. Kinematics and Dynamics of Plane Mechanisms by J. Hirschhorn, McGraw Hill Book Co., 1962.

2. Theory of Mechanics by J.E. Shigley, McGraw Hill Book Co., 1961 (for Cam Dynamics topic).

**M.E. Mechanical (Machine Design) Part – I (Semester – II)**  
**Elective III-Experimental Stress Analysis**

Teaching Scheme:

Lectures : 3 Hours per week

Tutorial : 1 Hour per week

Examination Scheme:

Theory Paper : 100 Marks

Term Work : 25 Marks

**1. Photo Elasticity :**

- Arrangement of optical elements in a polariscope , Theory of photo elasticity ,Plane & circular polariscope, Isoclinics and isochromatics .
- **Model Materials** : Properties , selection and method of calibration.
- **Different methods of analysis:** Compensation technique, Principle stresses separation technique, Calibration methods, Fringe Multiplication, Scaling model to prototype, Application of photo elasticity for two dimensional models.
- **Three Dimensional Photo elasticity:** Stress locking in model materials, Slicing technique, Shear difference method.
- Scattered light photo elasticity.
- Dynamic photo elasticity.

**2. Strain Gauges:**

- Electrical Resistance strain gauges : types ,gauge factor , sensitivity ,applications.
- Materials ,Bonding of strain gauges : surface preparation ,moisture proofing etc.Types of bonds,
- Testing of gauge installations.
- Strain measuring circuits, Commercial strain indicators.
- Rosette Analysis.
- Strain gauge transducers.
- Cross sensitivity, Temperature compensation.
- Semi –Conductor strain gauges.

**3.Coating Methods for stress analysis:**

Coating stresses, Birefringent coatings (Photoelastic & Brittle coatings),  
Coating sensitivity, Coating materials, Analysis of brittle- coating data.

**4.Holography:**

Equation for plane waves and spherical waves Intensity – Coherence – Spherical radiator as an object (record process), Hurter – Driffeld curve reconstruction process  
General case. Holographic set up

**5. Moire technique :**

Geometrical approach – sensitivity of Moire data - data reduction in plane and out plane Moire methods – Moire photography – Moire grid production.

**Term Work:**

1. Demonstration of preparation of 2D photoelastic model.
2. Demonstration of preparation of 3D photoelastic model.
3. Demonstration of stress freezing technique.
4. Demonstration of calibration technique of photoelastic material.
5. Evaluation of stresses in photoelastic model by using polariscope.
6. Demonstration of stress analysis technique by using brittle coating technique.
7. Demonstration of stress measurement by using strain gauge rosette.

**Text books:**

1. Dally and Riley, “Experimental Stress Analysis”. McGraw Hill.
2. Srinath, Lingaiah, Raghavan, Gargesa, Ramachandra and Pant, “Experimental Stress Analysis”. Tata McGraw Hill.
3. Sadhu Singh “Experimental Stress Analysis”. Hanna publisher.
4. Hand Book of Experimental Stress Analysis by Hyteneyi.

**Reference Books:**

1. M. M. Frocht, “Photo elasticity Vol I and Vol II. John Wiley & sons.
2. Perry and Lissner, “Strain Gauge Primer”.
3. Kuske, Albrecht & Robertson “Photo elastic Stress analysis” John Wiley & Sons.
4. Dave and Adams, “Motion Measurement and Stress Analysis”.
5. Hand Book of Experimental Stress Analysis”. by A. S. Kobayassin (Ed), SEM/VCH,II edition.

**M.E. Mechanical (Machine Design) Part – I (Semester – II)**  
**Elective III- Composite Materials**

Teaching Scheme:

Lectures : 3 Hours per week

Tutorial : 1 Hour per week

Examination Scheme:

Theory Paper : 100 Marks

Term Work : 25 Marks

**1. Introduction**

Definition – Need – General characteristics, Applications – Fibers: Glass, Carbon, Ceramic and Aramid fibers – Matrices: Polymer, Graphite, Ceramic and Metal Matrices – Characteristics of fibers and matrices – Smart materials – Types and Characteristics.

**2. Mechanics and performance**

Characteristics of Fiber-reinforced Lamina-Laminates-Interlaminar stresses-Static Mechanical Properties – Fatigue and impact Properties – Environmental effects – Fracture Behavior and Damage Tolerance.

**3. Manufacturing**

Bag Moulding – Compression Moulding – Pultrusion-Filament, Winding – Other Manufacturing Processes – Quality Inspection methods.

**4. Analysis**

Stress Analysis of Laminated Composites Beams, Plates and Shells – Vibration and Stability

Analysis – Reliability of Composites – Finite Element Method of Analysis – Analysis of Sandwich structures.

**5. Design**

Failure Predictions – Laminate Design Consideration – Bolted and Bonded Joints Design Examples

**Term Work:**

Minimum Ten assignments based on above topics.

**Text Book:**

1. Mallick P.K., “Fiber-Reinforced Composites: Materials, manufacturing and Design”, Maneel Dekker Inc, 1993.

**Reference Books:**

1. Halpin J.C., “Primer on Composite Materials, Analysis”, Techomic Publishing Co., 1984.

2. Agarwal B.D., and Borutman L.J., “Analysis and Performance of Fiber Composites”, John Wiley and Sons, 1990.

3. Mallick P.K. and Newman S., “Composite Materials Technology: Processes and Properties”, Hansen Publisher, 1993



**M.E. Mechanical (Machine Design) Part – I (Semester – II)**  
**Elective III- Advanced Machine Tool Design**

Teaching Scheme:

Lectures : 3 Hours per week

Tutorial : 1 Hour per week

Examination Scheme:

Theory Paper : 100 Marks

Term Work : 25 Marks

- 1. Introduction:** Classification of machine Tools, Elements of machine tools, Selection of speed and feed, Various types of clutch systems, Tool drives and mechanism, General requirements of machine tool design process as applied to machine tools, layout of machine tool, Various motions introduced in machine tools, Parameters defining limits of motions. Requirements of machine, tools drives, Mechanical and hydraulics transmission used in machine drives their elements
  
- 2. Design of machine tool structure:** Function of machine tool structure and their requirements. Design criteria, Materials, Strength and Rigidity consideration, Process capability and compliance, Static and Dynamic stiffness, Basic design procedure, Design items like beam, column, housing, rams, etc.
  
- 3. Design of guide ways and power screws :** Function and types of guide ways, Design of slide ways, Force analysis of Lathe guide ways, Design of antifriction guide ways, Design of power screws
  
- 4. Design of Spindle and spindle support :** Function of spindle unit requirement, Material of spindles, Design calculations, Design of antifriction bearings, Sliding bearing used for spindles
  
- 5. Dynamics of machine Tools :** Vibration of machine tools and dynamic rigidity: Effect of vibrations, Source of vibrations, Self excited vibration, Single degree of freedom chatter, Velocity principle and related models, Regenerative principles, Chatter in lathe, drilling, milling & grinding, Machine tool elastic system, General procedure for assessing dynamic stability of equivalent elastic system.
  
- 6. Automation:** Automation drives for machine tools, Degree of automation, Semiautomation, analysis of collect action, design of collect, bar feeding mechanism, tooling layout, single spindle mechanism, analysis, swiss type automatic machine. Loading and unloading. Transfer devices, Modulator- design concept in process gauging.
  
- 7. Introduction to machine tool control:**  
Control system of machine tools: Control, mechanical, electrical, hydraulic, numeric and fluidic. Basic principle of control, hydraulic controls, Fluid controls, Numerical controls, Feedback systems, Primary systems programming.

**Term Work:**

Minimum Ten assignments based on above topics.

**Text Books:**

1. Machine tool design – N. K. Mehta, 1984, Tata McGraw Hill Publishing Co. Ltd.
2. Principles of Machine tool – G. C. Sen and A. Bhattacharyya, New Central book agency, Calcutta.
3. Design of machine tool – S. K. Basu, Allied Publishers Bombay.
4. Machine tools design by Mehta: Tata McGraw Hill
5. Machine Tool Design by Bassu & Pal: Oxford & IBH

**Reference Books:**

1. Design principles of metal cutting machine tools – F. Koeniga Berger
2. Principles of machine tools by Sen et al Central Book Agency
3. Machine tool Design vol. i to iv by Acherken: Mir Publishers
4. Design Principles of Metal cutting machine tools: Koenigsberger: Pergamon

**M.E. Mechanical (Machine Design) Part – I (Semester – II)**  
**Elective IV- Noise and Vibration Harshness**

Teaching Scheme:

Lectures : 3 Hours per week

Tutorial : 1 Hour per week

Examination Scheme:

Theory Paper : 100 Marks

Term Work : 25 Marks

**1. Introduction to NVH:**

Sources of noise and vibration, Design features, Common problems, Marque values, Noise quality, Pass-by Noise requirements, Target vehicles and objective targets, Development stages in a new vehicle programme and the altering role of NVH engineers.

**2. Sound and vibration theory:**

Sound measurement, Human sensitivity and weighting factors, Combining sound sources, Acoustical resonances, Properties of acoustic materials, Transient and steady state response of one degree of freedom system applied to vehicle systems, Transmissibility, Modes of vibration.

**3. Test facilities and instrumentation:**

Laboratory simulation: rolling roads (dynamometers), Road simulators, Semi-anechoic rooms, wind tunnels, etc. Transducers, signal conditioning and recording systems, Binaural head recordings, Sound intensity technique, Acoustic holography, Statistical Energy Analysis.

**4. Signal Processing:**

Sampling, aliasing and resolution, Statistical analysis, Frequency analysis, Campbell's plots, Cascade diagrams, Coherence and correlation functions.

**5. NVH control Strategies & comfort:**

Source ranking, Noise path analysis, Modal analysis, Design of Experiments, Optimization of dynamic characteristics, Vibration absorbers and Helmholtz resonators, Active control techniques.

**Term Work:**

Following Experiments/Assignments comprise the laboratory practice:

1. Application of Sensors and related instruments for time domain and frequency domain.
2. Modal testing and analysis for natural frequencies and mode shapes for structures.
3. Random vibration and measurement on vehicles on road.
4. Internal & External Noise Measurement and spectrum analysis.
5. Sound intensity measurements in interior commercial/ professional vehicles for source location for harshness.
6. Active noise control techniques for passenger comfort.

**Reference Books:**

1. Norton M. P., Fundamental of Noise and vibration, Cambridge University Press, 1989
2. Munjal M. L., Acoustic Ducts and Mufflers, John Wiley, 1987
3. Baxa, Noise Control of Internal Combustion Engine, John Wiley, 1984
4. Ewins D. J., Model Testing: theory and practice, John Wiley, 1995
5. Boris and Kornev, Dynamic Vibration Absorbers, John Wiley, 1993
6. Mcconnell K, "Vibration testing, Theory and practice", John Wiley, 1995.
7. Wong J. Y., "Theory of Ground Vehicles", John Wiley & Sons, New York, 1978.

**M.E. Mechanical (Machine Design) Part – I (Semester – II)**

**Elective IV- Vehicle Dynamics**

Teaching Scheme:

Lectures : 3 Hours per week

Tutorial : 1 Hour per week

Examination Scheme:

Theory Paper : 100 Marks

Term Work : 25 Marks

**1.Introduction:**

Classification of vibration, Definitions, Mechanical vibrating systems, Mechanical vibration and human comfort, Modelling and simulation studies, Model of an automobile, One degree of freedom, Two degree of freedom systems, Free, forced and damped vibrations, Magnification and transmissibility, Vibration absorber, multidegree of freedom systems- closed and far coupled systems, Orthogonality of modal shapes, Modal analysis.

**2.Suspension:**

Requirements, Spring mass frequency, Wheel hop, Wheel shimmy, Choice of suspension spring rate, Calculation of effective spring rate, Vehicle suspension in fore and aft directions, Hydraulic dampers and choice of damper characteristics. Independent, compensated, Rubber and air suspension systems, Roll axis and vehicle under the action of side forces.

**3.Steering systems :** Front axle types, Constructional details, Front wheel geometry, Condition for True rolling, skidding, steering linkages for conventional & independent suspensions, Turning radius, Wheel wobble and shimmy, Power and power assisted steering

**4.Stability of vehicles:**

Load distribution, Stability on a curved track and on a slope, Gyroscopic effects, Weight transfer during acceleration and braking, Overturning and sliding, Rigid vehicle-stability and equations of motion, Cross wind handling.

**5.Tyres:**

Types, Relative merits and demerits, Ride characteristics, Behavior while cornering, slip angle, Cornering force, Power consumed by a tyre, Effect of camber, Camber Thrust.

**6.Vehicle Handling:**

Over steer, under steer, steady state cornering, Effect of braking, driving torques on steering, Effect of camber, Transient effects in cornering, Directional stability of vehicles.

**7.Aerodynamic Drag of Cars:** Cars as a bluff body, Flow field around car, Drag force, Types of drag force, Analysis of aerodynamic drag, Drag coefficient of cars, Strategies for aerodynamic development, Low drag profiles, Scope, historical developments, Fundamentals of fluid mechanics, Flow phenomenon related to vehicles, External and Internal flow problem, Resistance to vehicle motion, Performance, Fuel consumption and performance potential of vehicle aerodynamics

**Term Work:**

(Minimum TEN assignments based on topics mentioned below)

1. Analysis of different Vehicle Models subjected various types of excitations in  
i. Time Domain and ii. Frequency domain using “C” programs or MATLAB
2. Testing of vehicle Ride comfort using FFT analyzer.
3. Testing of Vehicle stability using different models and excitations.
4. Calculation of drag force and its effect on the stability of the vehicle.

**Text Books:**

1. Thomas D. Gillespie, “Fundamentals of Vehicle dynamics”, SAE USA 1992.
2. Thomson W.T., ‘Theory of Vibration with Applications’, CBS Publishers and Distributors, New Delhi. 1990.
3. Maurice Olley, “Chassis Design – Principles and Analysis”, Bentley publishers.

**Reference Books:**

1. Wong J. Y., “Theory of Ground Vehicles”, John Wiley & Sons, New York, 1978.
2. Cole D. E., “Elementary Vehicle Dynamics”, Ann Arbor, Michigan, USA, 1972.
3. J. G. Giles, ‘Steering Suspension and Tyres, Illiffe Books Ltd., 1968.

**M.E. Mechanical (Machine Design) Part – I (Semester – II)**  
**Elective IV- Engineering Fracture Mechanics**

Teaching Scheme:

Lectures : 3 Hours per week

Tutorial : 1 Hour per week

Examination Scheme:

Theory Paper : 100 Marks

Term Work : 25 Marks

Review of - Mechanical properties of solid materials, Theory of elasticity, Stress and strain, Plane stress, Plane strain, Stress function, Theory of plasticity, Yield stress, Yield conditions (Mises & Tresca)

1. **Introduction**:-Macroscopic failure mode, Ideal fracture strength, Energy release rate, Fracture Modes.

2. **Fracture Criteria** :-Griffith criterion, Irwin's Fracture Criterion, Stress Intensity Approach, Stress intensity factor, Crack tip plasticity, Crack opening displacement, Plastic constraint.

3. **Methods for Evaluating Fracture toughness** :-

**Numerical Methods:**

- a. Finite Elements (FE)
- b. Finite Differences (FD)
- c. Boundary Integral Equations (BIE)

**Experimental Methods:**

- a. Compliance Method
- b. Photoelasticity
- c. Interferometry and Holography

4. **Experimental evaluation of Fracture toughness**:-

Plane strain fracture toughness, J – Integral

5. **Fatigue mechanics** :-

S-N diagram, Fatigue limit, Fatigue crack growth rate, Paris law.

6. **Creep mechanics**: -

Creep deformation, Creep strength, Creep-fatigue interaction.

**Special Note**: – No question should be asked on review topic, Derivations

**Term Work:**

Minimum Ten assignments based on above topics.

**Text Books:**

1. Fracture Mechanics, M. Jansen, J Zuidema, K J H Wanhill, Delft Univ Press
2. Analytical Fracture Mechanics, David J Unger, Dover Publications

**Reference Books:**

1. Fatigue of Metals, Subra Suresh, Cambridge University Press
2. Fracture Mechanics, Fundamentals and Applications, Anderson, CRS Press
3. Fatigue of Metals, Pope
4. Hertzberg R. W. *Deformation and Fracture Mechanics of Engineering Materials*. 4<sup>th</sup> ed. John Wiley & Sons, Inc., 1996.
5. ASTM standards



**M.E. Mechanical (Machine Design) Part – I (Semester – II)**  
**Elective IV: Reliability Engineering**

Teaching Scheme:

Lectures : 3 Hours per week

Tutorial : 1 Hour per week

Examination Scheme:

Theory Paper : 100 Marks

Term Work : 25 Marks

1. **Introduction:** Brief history, Concepts, Terms and definitions, applications, The life cycle of a system, Concept of failure, Typical engineering failures and their causes, Theory of probability and reliability, Rules of probability, Random variables, Discrete and continuous probability distributions.
2. **Failure Data Analysis:** Data collection and empirical methods, Estimation of performance measures for ungrouped complete data, Grouped complete data, Analysis of censored data, Fitting probability distributions graphically (Exponential and Weibull) and estimation of distribution parameters.
3. **Reliability Measures:** Reliability function– $R(t)$ , Cumulative distribution function (CDF)– $F(t)$ , Probability density function (PDF) –  $f(t)$ , Hazard rate function– $\lambda(t)$ , Mean time to failure (MTTF) and Mean time between failures (MTBF), Median time to failure ( $t_{med}$ ), mode ( $t_{mode}$ ), Variance ( $\sigma^2$ ) and standard deviation ( $\sigma$ ), Typical forms of hazard rate function, Bathtub curve and conditional reliability.
4. **Basic Reliability Models:** Constant failure rate (CFR) model, Failure modes, Renewal and Poisson process, Two parameter exponential distribution, Redundancy with CFR model, time-dependent failure models, Weibull, Rayleigh, Normal and Lognormal distributions, Burn-in screening for Weibull, Redundancy, Three parameter Weibull, Calculation of  $R(t)$ ,  $F(t)$ ,  $f(t)$ ,  $\lambda(t)$ , MTTF,  $t_{med}$ ,  $t_{mode}$ ,  $\sigma^2$  and  $\sigma$  for above distributions.
5. **Reliability Evaluation of Systems:** Reliability block diagram, Series configuration, Parallel configuration, Mixed configurations, redundant systems, High level versus low level redundancy, k-out-of-n redundancy, Complex configurations, network reduction and decomposition methods, Cut and tie set approach for reliability evaluation.
6. **Maintainability and Availability:** Concept of maintainability, Measures of maintainability, Mean time to repair (MTTR), Analysis of downtime, Repair time distributions, Stochastic point processes, Maintenance concept and procedures, Availability concepts and definitions, Important availability measures.
7. **Design for Reliability and Maintainability:** Reliability design process and design methods, Reliability allocation, Failure modes, effects and criticality analysis (FMECA), Fault tree and success tree methods, Symbols used, Maintainability design process, Quantifiable measures of maintainability, Repair versus replacement.
8. **Reliability Testing:** Product testing, Reliability life testing, Burn-in testing, Acceptance testing, Accelerated life testing and reliability growth testing.

**Term Work:**

Minimum Eight assignments based on above topics with an emphasis on examples of reliability of components and systems.

**Text Books:**

1. Charles E. Ebling, 2004, An Introduction to Reliability and Maintainability Engineering, Tata McGraw Hill Education Private Limited, New Delhi.
2. L. S. Srinath, 1991, “Reliability Engineering”, East West Press, New Delhi.
3. Alessandro Birolini, 2010, “Reliability Engineering: Theory and Practice”, Springer.
4. Roy Billiton and Ronald Norman Allan, 1992, “Reliability evaluation of engineering systems: concepts and techniques”, Springer.
5. Patrick D.T. O’Conner, David Newton, Richard Bromley, 2002, “Practical Reliability Engineering”, John Wiley and Sons.
6. Joel A. Nachlas, 2005, “Reliability Engineering: Probabilistic Models and Maintenance Methods” Taylor and Francis.

**Reference Books:**

1. Guangbin Yang, 2007, “Life cycle reliability engineering”, John Wiley and Sons.
2. W. R. Blischke, D.N.P. Murthy, 2003, “Case studies in Reliability and Maintenance”, John Wiley and Sons.
3. Andrew Kennedy, Skilling Jardine, Albert H. C. Tsang, 2006, “Maintenance, Replacement and Reliability: Theory and Applications”, CRC/Taylor and Francis.
4. B. S. Dhillon, Chanan Singh, 1981, Engineering Reliability – New Techniques and Applications”, John Wiley and Sons.
5. B. S. Dhillon, 1999, “Engineering Maintainability”, Prentice Hall of India.

**M.E. Mechanical (Machine Design) Part – I (Semester – II)**  
**Computer Aided 3D Analysis Laboratory**

Teaching Scheme:

Practical: 2 Hours per week

Examination Scheme:

Term Work : 25 Marks

Oral : 25 Marks

**Laboratory Experiments:**

Students are expected to develop 3D model and analyze the same for loaded configuration. Students will be given on experience on the software packages such as, ANSYS. Various Designs will be analyzed using ANSYS. Various manufacturing processes will be modeled and simulated and the effects of process variables on the quality of product will be analyzed.

1. Study of Finite Element Analysis and its different approaches.
2. Basic procedure of Finite Element Method and Mathematical formulation of problems.
3. Analysis of 1D structural members and verification of the same through manual calculation.
4. Beam analysis problems and their verification
5. Formulation of Dynamic problem and its solution for finding Eigen values and Eigen vectors
6. Problem formulation of 1D & 2D heat transfer problem and verifying solution using software
7. Finite Element Analysis of 2D , 3D problems(**any one**) using FEA
  - Gear tooth analysis
  - Crane Hook analysis
  - Pressure Vessel stress Analysis
  - Connecting Rod, Crank Shaft, Cam Shaft Stress Analysis.
8. Flow Simulation: Flow through pipes, flow over bodies.
9. Programs are to be developed and used in above topics.
10. At least one project and a case study should be carried out based on recent Publications / research papers / technical development.

**Reference Books:**

1. Rao S. S. “Finite Elements Method in Engineering”- 4<sup>th</sup> Edition, Elsevier, 2006
2. Frank L. Stasa,” Applied finite Element Analysis for Engineers”, CBS International Edition, 1985.
3. Bathe K. J., Finite Elements Procedures, PHI. Cook R. D., et al. “Concepts and Application of Finite Elements Analysis”- 4<sup>th</sup> Edition, Wiley & Sons, 2003.
4. Zeinkovich, “The Finite Element Method for Solid and Structural Mechanics, 6<sup>th</sup> Ed., Elsevier 2007.
5. Desai C.S and Abel, J.F., Introduction to the finite element Method, Affiliated East west Press Pvt. Ltd. New Delhi 2000

**M.E. Mechanical (Machine Design) Part – I (Semester – II)**  
**Seminar- II**

Teaching Scheme:

Practical : 2 Hours per week

Examination Scheme:

Term Work : 25 Marks

Seminar II shall be based on tentative topic of dissertation such as review paper on some specific well defined area/ specialized stream of Mechanical Engineering. Each student has to prepare a write up of about 25-30 pages of “A4” size sheets and submit it in IEEE format in duplicate as the term work.

The student has to deliver a seminar talk in front of the teachers of the department and his classmates. The teachers based on the quality of work and preparation and understanding of the candidates, shall do an assessment of the seminar internally. Some marks should be reserved for the attendance of a student in the seminars of other students.

**M.E. Mechanical (Machine Design) Part – I (Semester – II)**  
**Comprehensive Viva**

Examination scheme:  
Oral: 50 Marks

The students have to prepare on all subjects which they have studied In I<sup>st</sup> and II<sup>nd</sup> semesters. The viva will be conducted by the External/Internal Examiner jointly and their appointments will be made by university. The in-depth knowledge, preparation and subjects understanding will be assessed by the Examiners.

**M.E. Mechanical (Machine Design) Part – II (Semester-III)**  
**Inplant Training**

Examination scheme:

Term work: 50 marks

The student has to prepare the report of training undergone in the industry during vacation after semester II. It shall include the brief details of assignment completed by the candidate and general observation and analysis. The identified areas for undertaking the dissertation work shall form part of report. The term work marks be based on report and departmental oral exams. The training should be of minimum two weeks from reputed industries and certificate of the same should be part of report.

**M.E. Mechanical (Machine Design) Part – II (Semester-III)**  
**Dissertation Phase-I**

Teaching scheme:

Tut./Pract.: 5 Hours per week

Examination scheme:

Term work : 50 Marks

Oral : 50 Marks

The term work under this submitted by the student shall include.

- 1) Work diary maintained by the student and countersigned by his guide.
- 2) The content of work diary shall reflect the efforts taken by candidates for (a) Searching the suitable project work. (b) Visits to different factories or organizations. (c) The brief report of feasibility studies carried to come to final conclusion. (d) Rough sketches.(e) Design calculations etc. carried by the student.
- 3) The student has to make a presentation in front of panel of experts in addition to guide as decided by department head.

**M.E. Mechanical (Machine Design) Part – II (Semester-IV)**  
**Dissertation Phase-II**

Teaching scheme:

Tut./Pract.: 5 Hours per week

Examination scheme:

Term work : 200 Marks

Oral : 100 Marks

The dissertation submitted by the student on topic already approved by university authorities on basis of initial synopsis submitted by the candidate, shall be according to following guide lines.

Format of dissertation report:

The dissertation work report shall be typed on A4 size bond paper. The total No. of minimum pages shall not less than 60. Figures, graphs, annexure etc be as per the requirement.

The report should be written in the standard format.

1. Title sheet
2. Certificate
3. Acknowledgement
4. List of figures, Photographs/Graphs/Tables
5. Abbreviations.
6. Abstract
7. Contents.
8. Text with usual scheme of chapters.
9. Discussion of the results and conclusions
10. Bibliography (the source of illustrative matter be acknowledged clearly at appropriate place IEEE/ASME/Elsevier Format)