DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY

CIRCULAR NO. ACAD / NP /M.E./M.Tech./97/2012

It is hereby notified for the information of all concerned that, the Academic Council at its meeting held on 06-07-2012 **has accepted the following New Syllabi** under the Faculty of Engineering & Technology **as appended herewith** :-

Sr. No.	Syllabi.
[1]	M.E. Mechanical,
[2]	M.E. Mechanical [Design Engineering],
[3]	M.E. [Thermal],
[4]	M.E. [Biotechnology],
[5]	M. Tech. [Computer Science and Technology],
[6]	M.Tech. [Food Processing Tech.].

This is effective from the academic year 2012-2013 and onwards.

All concerned are requested to note the contents of this circular for their information and necessary action.

University Campus,
Aurangabad-431 004.
REF.NO.ACAD/ NP/ M.TECH./
2012/20668-72

A.C.S.S. I.No.84

Date:- 03-08-2012.

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Director,
Board of College and
University Development.

Copy forwarded with compliments to :-

1] The Principals, affiliated concerned Colleges,
Dr. Babasaheb Ambedkar Marathwada University.

Copy to :-

1] The Controller of Examinations,
2] The Superintendent, [Engineering Unit],
3] The Superintendent, [Eligibility Unit],
4] The Record Keeper,
Dr. Babasaheb Ambedkar Marathwada University.

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S/030812/-*

Dr BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, AURANGABAD

New Structure and Syllabus of

M.E.

MECHANICAL [DESIGN ENGNEERING]

EFECTIVE FROM - 2012-13 & ONWARDS

DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, AURANGABAD

Teaching / Evaluation Scheme for

M.E. MECHANICAL (Design Engineering)

w. e. f. Year 2012–13

Semester - I

Course Code	Name of Subject	Teaching Scheme hr/wk			Examination Scheme Marks			
		L	T	Total Hrs	Theory	Term Work	Viva Voce	Total
	Computational Techniques in Design Engineering	3	1	4	100	25	---	125
	Machine Stress Analysis	3	1	4	100	25	---	125
	Finite Element Methods	3	1	4	100	25	---	125
	Design of Experiments & Research Methodology	3	1	4	100	---	---	100
	Elective – I	3	1	4	100	---	---	100
	Lab – I	---	2	2	---	---	25	25
	Seminar – I	---	2	2	---	---	50	50
	Total	**15**	**9**	**24**	**500**	**75**	**75**	**650**

Semester – II

Course Code	Name of Subject	Teaching Scheme hr/wk			Examination Scheme Marks			
		L	T	Total Hrs	Theory	Term Work	Viva Voce	Total
	Design Engineering	3	1	4	100	25	---	125
	Mechanical Vibration Analysis	3	1	4	100	25	---	125
	Analysis and Synthesis of Mechanisms	3	1	4	100	25	---	125
	Industrial Product Design	3	1	4	100	---	---	100
	Elective – II	3	1	4	100	---	---	100
	Lab – II	---	2	2	---	---	25	25
	Seminar – II	---	2	2	---	---	50	50
	Total	**15**	**9**	**24**	**500**	**75**	**75**	**650**

Semester - III

Course Code	Name of Subject	Teaching Scheme hr/wk			Examination Scheme Marks			
		L	T	Total Hrs	Theory	Term Work	Viva Voce	Total
	Dissertation Part – I	---	24	24	---	50	50	100
	Total	---	**24**	**24**	---	**50**	**50**	**100**

Semester - IV

Course Code	Name of Subject	Teaching Scheme hr/wk			Examination Scheme Marks			
		L	T	Total Hrs	Theory	Term Work	Viva Voce	Total
	Dissertation Part – II	---	24	24	---	50	150	200
	Total	---	**24**	**24**	---	**50**	**150**	**200**
	Grand Total							**1600**

L – Lectures T – Tutorial / Seminar / Project

Elective – I

1) Tribology
2) Reliability Engineering
3) Advanced Material Science
4) Experimental Stress Analysis

Elective – II

1) Advanced Optimization Techniques
2) Simulation and Mathematical Modeling
3) Machine Tool Design
4) Industrial Instrumentation

Computational Techniques in Design Engineering

Teaching Scheme :
Lecturers : 03 hrs/week
Tutorials : 01 hr/week

Examination Scheme
Theory Paper : 100 marks (3 hrs)
Term Work : 25 marks

1. **Data Analysis :** Errors in numerical calculations, Interpolations by Central Differences, Sterling, Bessel and Events Formulas, Interpolation Formula for Unequal Intervals, Spline Interpolation, Cubic Splines. (6)

2. **Curve Fitting :** Least Square Method for Linear and Non – linear functions, Weighted Least Square Methods. (4)

3. **Solution Of Linear System of Equations :** Gauss Elimination with Pivoting, LU Decomposition Method, Derivative Methods, Eigen Vectors-Jacobi Method. (5)

4. **Numerical Differentiation and Integration :** Numerical Differentiation and Integration by Newton-Cotes Formula and Gauss Quadrature. (3)

5. **Solution of Ordinary Differential Equation :** Picard's Method, Euler's Method, and Modified Euler's Method, Runge-Kutta Method (up to forth order). Predictor-Corrector Methods, Milne Sompson, Adams Bashforth, Moulten Methods. (6)

6. **Solution of Partial Differential Equation :** Numerical methods to solve Partial Differential Equations, Hyperbolic Equations, Elliptic Equations, Solution of Laplace Equations, Solution of Poisson's Equations, Solution of Elliptical Equations by Relaxation Method. (8)

7. **Finite Difference Methods:** Formation of Difference Equation, Linear Difference Equation, Rules for finding out Complementary Function, Rules for finding out particular integral, difference equations reducible to linear form, Simultaneous Difference Equation with Constant Coefficients. Application to deflection of a loaded string, loaded simply supported beams or cantilevers. (8)

Term Work :

The term work shall consist of seven assignments based on above topics.

Reference Books:

1. *"Introductory Methods of Numerical Analysis"*, S. S. Shastri.
2. *"Advanced Engineering Mathematics"*, Kreyszig Erwin.
3. *"Numerical Methods"*, Mathews John. H.,PHI New Delhi.
4. *"Numerical Methods"*, Grewal B.S., Khanna Publication , New Delhi.
5. *"Numerical Methods for Engineers"*, Chapra, Canal.

Machine Stress Analysis

Teaching Scheme :
Lecturers : 03 hrs/week
Tutorials : 01 hr/week

Examination Scheme
Theory Paper : 100 marks (3 hrs)
Term Work : 25 marks

1. **Theory of Elasticity:** Plane stresses and plane strain: plane stress, plane strain, stress and strain at a point, differential equations of equilibrium, boundary conditions, compatibility equations, Airy's stress function. (6)
2. **Two-dimensional Problems in Rectangular Coordinates:** Solutions by polynomials, end effects, Saint Venant's principle. (4)
3. **Two-dimensional Problems in Polar Coordinates:** General equations in polar coordinates, stress distribution symmetrical about axis, strain components in polar coordinates. Pure bending of curves bars, Rotating discs, Stresses in circular disks. (8)
4. **Shear Center and Unsymmetrical Bending:** Shear center for beams of different cross-sections, bending and deflections of beams subjected to unsymmetrical bending. (6)
5. **Theory of Torsion:** Torsion of prismatic bars of non-circular cross sections, Thin walled hollow and rectangular cross sections, Saint Venant's theory, Prandtle's membrane analogy, Kelvin's fluid flow analogy, Warping of the cross sections. (6)
6. **Membrane Stresses:** Membrane stresses in shell and storage vessels, Shells and vessels of uniform strength. (4)
7. **Contact Stresses:** Hertz's contact stresses, expression for principle stresses, deflection of bodies in point contact, stress in bodies in point and line contacts. (6)

Term Work :
The term work shall consist of seven assignments based on above topics.

Reference Books :
1. *"Theory of Elasticity"*, S. Timoshenko & J.W. Goodler, MGH book co Ltd.
2. *"Advanced Strength of Materials"*, J.P. Den Hartog, MGH book co Ltd.
3. *"Advanced Mechanics of Materials"*, F.B. Seely & Smith, John Wiley & Sons.
4. *"Strength of Materials"*, Schaum's Outline Series, McGraw Hill
5. *"Experimental Stress Analysis"*, Dally and Riley.

Finite Element Method

Teaching Scheme :
Lecturers : 03 hrs/week
Tutorials : 01 hr/week

Examination Scheme
Theory Paper : 100 marks (3 hrs)
Term Work : 25 marks

1. **Introduction :** Physical problem, Mathematical Modeling and Finite Element Solutions, FEM as integral part of Computer Aided Design. (5)

2. **General Procedure Used In FEM :** Discretization, Formulation, Solving and Post processing. (5)

3. **Mathematical Formulation :** Types of 2D and 3D Elements and their properties, types of shape functions (Langragian and Hermite), Principal of virtual work and principle of minimum potential energy, concentrated mass and lumped mass formulation, principle of minimization – weighted residual and variational methods, imposing of boundary conditions, formulation for isoperimetric elements. (10)

4. **Applications of FEM for Static Analysis** : Direct stiffness method, Plain stress and strain elements, axis-symmetric elements, non linear analysis, composite materials, time dependant loads, determination of temperature distribution and thermal stresses.(8)

5. **Applications of FEM for Dynamic Analysis** : Spring and dashpot elements, Eigen value analysis, frequency analysis, transient analysis. (4)

6. **Computer Implementation of FE Procedure :** Various interactive methods used in static and dynamic analysis, Inter-elemental continuity, Convergence rate, Refinement of FE solution, Validation of FE solutions, Review of software in FEM. (8)

Term Work :

The term work shall consist of six assignments based on above topics.

Reference Books:

1. *"Finite Element Procedures"* , Klaus Jurgen Bathe.
2. *"Introduction to Finite Element in Engineering"*, S.S. Rao.
3. *"Introduction to Finite Element"*, J.N. Reddy.
4. *"The Finite Element Method"*, O.C. Zienkiewicz.
5. *"Introduction to Finite Element in Engineering"*, T.R. Chandrupatia.
6. *"Finite Element Method"*, Belagundu & Chandrupatla, New Age Int. Pub.
7. *"Text Book of Finite Element Analysis"*, P. Seshu, PHI Publishing

Design of Experiments and Research Methodology

Teaching Scheme :
Lecturers : 03 hrs/week
Tutorials : 01 hr/week

Examination Scheme
Theory Paper : 100 marks (3 hrs)

1. **Introduction:** Defining Research, Scientific Enquiry, Hypothesis, Scientific Method, Types of Research, Research Process and steps in it. Research Proposals – Types, contents, sponsoring agent's requirements, Ethical, Training, Cooperation and Legal aspects. (5)
2. **Research Design:** Meaning, Need, Concepts related to it, categories; Literature Survey and Review, Dimensions and issues of Research Design, Research Design Process – Selection of type of research, Measurement and measurement techniques, Selection of Sample, Selection of Data Collection Procedures, Selection of Methods of Analysis, Errors in Research. (5)
3. **Research Problem:** Problem Solving – Types, Process and Approaches – Logical, Soft System and Creative; Creative problem solving process, Development of Creativity, Group Problem Solving Techniques for Idea Generation – Brain storming and Delphi Method. (4)
4. **Research Modeling:** (a) Mathematical – Classification of Models, Development of Models, Stages in Model building, Principles of Modeling, Use of Analogy, Models as Approximations, Data consideration and Testing of Models (b) Heuristics and Simulation – Definition, Applications and reasons for using Heuristics, Heuristic Methods and approaches, Meta-Heuristics; Simulation – Meaning, Applications and Classification of Simulation Models, Process of Simulation, Steps and Features of Simulation Experiments and their Validation. (7)
5. **Experimentation:** Objective, Strategies, Factorial Experimental Design, Applications of Experimental Design, Basic Principles – Replication, Randomization and Blocking, Guidelines for designing experiments; Laboratory Experiments, Methods of manipulating Variables, Errors in Experiments, Steps in Design of Experiments, Basis. (6)
6. **Process Optimization:** Factorial Design principles, Two factor Factorial Design, General Factorial Design, Fitting response Curves and Surfaces, Blocking, Taguchi Approach to Parameter Design, Robust Design. (7)
7. **Analysis:** Analysis of Variance and Co-variance, Hypothesis Testing – Parametric and Non-Parametric Tests, Uni-variate and Bi-variate analysis. (3)
8. **Report Writing:** Pre-writing Considerations, Principles of Thesis Writing, Formats of Report Writing & Publication in Research Journals, Oral Presentations (Briefing). (3)

Reference Books:

1. *"Research Methodology"*, C.R. Kothari, New Age Publishers.
2. *"Management Research Methodology-Integration of principles, methods and Techniques"*, K.N. Krishnaswami, Sivakumar, Appa Iyer & Mathirajan M., Pearson Education.
3. *"Design & Analysis of Experiments"*, Montgomery, Douglas C., John Wiley & Sons
4. *"Taguchi Techniques for Quality Engineering"*, Ross, Phillip J., McGraw Hill
5. *"Formulation of Hypothesis"*, Willkinson K.P, L Bhandarkar, Hymalaya Publication.
6. *"Research in Education"*, John W Best and V. Kahn, PHI Publication.
7. *"Research Methodology- A step by step guide for beginners"*, Ranjit Kumar, Pearson Education

EL-I Tribology

Teaching Scheme :
Lecturers : 03 hrs/week
Tutorials : 01 hr/week

Examination Scheme
Theory Paper : 100 marks (3 hrs)

1. **Introduction :** Tribology in design. Tribology in industry, Economic, Ergonomic considerations. (4)

2. **Friction :** Introduction. Laws of friction, Kinds of friction, friction measurement, Theory of friction, variable in friction, friction in stability, characteristics of friction vibrations, analysis of stick slip oscillation and its elimination. (5)

3. **Mechanics of Rolling motion :** Introduction, free rolling, microslip in rolling, type road contacts. (4)

4. **Wear :** Type of wear, various factors affection wear, measurement of wear, wear between solids, between metals and flowing liquids.

   Lubricants and Lubrication: Lubricants properties – physical and chemical. Lubrication – Introduction, basic model of lubrication – thick film, thin film, boundary lubrication, Hydrostatic and hydrodynamic lubrication, squeeze film lubrication. Elastohydrodynamic lubrication, Flow of viscous fluids through various slots, Seal-mechanical and dynamic seals (9)

5. **Hydrodynamic Bearing :** Theory of hydrodynamic lubrication, Mechanism of pressure development in oil film. Reynolds equation, Infinite tapered shoe slider bearing. Sommononorfeld solution for an infinite journal bearing. Practical design consideration.

   Friction And Power Losses In Journal Bearing: Evaluation of friction losses in concentric and eccentric journal bearing and quantity of oil flow, with circumferential grooves and hole, square of heat balance.

   Hydrodynamic Thrust Bearing: Introduction flat plate, thrust bearing, step thrust bearing, Tilting pad thrust bearing, spring mounted thrust bearing, and Hydrodynamic pocket thrust bearing (9)

6. **Lubrication Practice Quality Control and Management :** Characteristics of lubricating methods, lubricating devices and system, organizing plant lubrication program. Typical industrial systems, service application chart.
   Lubrication in Special Conditions: Forging, wire drawings, extrusion, rolling, lubrication used for wire ropes. Recent trends in gear lubrication. General recommendation of lubrications. SAE and other cloud numbers. (9)

Reference Books:

1. *"Theory of Lubrication"*, Mack and Shaw.
2. *"Theory and Practical of Lubrication for Engineers"*, Dudley D. Fuller, John Wiley and Sons.
3. *"Principal of Tribology"*, J. Holling McMillan Press Ltd.
4. *"Tribology"*, B.C. Muzumdar.
5. *"Fundamental of Tribology"* Basu S.K., Sengupta S. N. and Ahuja B.B., PHI,

EL-I Reliability Engineering

Teaching Scheme :
Lecturers : 03 hrs/week
Tutorials : 01 hr/week

Examination Scheme
Theory Paper : 100 marks (3 hrs)

1. **Introduction :** History, Definition, Applications of Reliability, Reliability Function-R(t), Probability Density Distribution Function (PDF)-f(t), Cumulative Probability Distribution Function (CPF)- F(t), Hazard Rate Function –Z(t), Mean Time To Failure –MTTF, Mean Time Between Failure – MTBF. (6)

2. **Brief Revision of Probability Mathematics :** Relations between R(t), f(t), F(t), Z(t), MTTF. Hazard Rate models, life Cycle of Product, Bath Tub Curve, Failure data analysis for discrete data. (6)

3. **Probability distributions used in Reliability :** Exponential, Rayleigh. Normal Poisson, Binominal, Weibull distributions, calculation of R (t), Z (t), MTIF for above distributions, Identifying failure distributions, Probability Plots (Normal, Weibull, Exponential), Least Square Curve Fitting Methods. (8)

4. **Failure Mode Analysis :** Fault three & Success three methods, symbols used, tie sets , cut sets. Failure Mode Effectiveness & Criticality Analysis. (5)

5. **System Reliability :** Series, parallel and redundancy (active, standby), r out of n systems, mixed, complex system. (5)

6. **Introduction to Maintainability:** MTTR, Availability. Reliability Design of elements, strength & duty Distribution, factor of safety, simple example of Design of elements with reliability-such as tension element, I beam, shaft subjected to torsion etc.
Reliability Testing: Product testing, life testing, bum-in testing, acceptance testing, accelerated life testing, reliability growth. (10)

Reference Books:

1. *"Introduction to Reliability Maintainability Engineering"*, Charles E. Ebiting 1997, Edition, Tata McGraw Hills.
2. *"Reliability in Engineering Design"*, K.C. Kapur, L.R. Laimberson, 1997 Edition, John Wiley & sons.
3. *"Reliability in Design"* L.S. Srinath, East West Press.
4. *"Reliability Based Design"*, S.S. Rao, 1992 Edition, Tata McGraw Hills.
5. *"Engineering Maintainability"*, B.S. Dhllon, 1999 Edition, Prentice Hall of India.

EL-I Advanced Material Science

Teaching Scheme :
Lecturers : 03 hrs/week
Tutorials : 01 hr/week

Examination Scheme
Theory Paper : 100 marks (3 hrs)

1. **Ferrous Materials:** Mechanical properties, heat treatments and applications; stainless steel and heat resisting steels, precipitation hardenable steels, valve steels, high strength low alloy steel (HSLA), micro alloyed steels, ball bearing steel, tool steels, high nitrogen steels, alloy cast iron. (8)
2. **Nonferrous Materials:** Mechanical properties, heat treatments and applications; copper alloys (Brasses and Bronzes), Al alloys (Al-Mg-Si, Al-Cu, Al-Si), designation system in Al-alloys. (6)
3. **Composites:** Classifications, properties, application of composites, polymer matrix materials, metal matrix materials, ceramic matrix materials, carbon materials, glass materials, fiber reinforcements, types of fibers, whiskers, laminar composites, filled composites, particulate reinforced composites. (9)
4. **Design of composites materials:** Hybrid composites, angle plied composites, mechanism of composites, calculation of properties, unidirectional fiber composites, critical volume fraction, discontinuous fiber composites, rule of mixtures equation, critical angle. Analysis of an Orthotropic Lamina, strengths of orthotropic lamina, analysis of Laminated Composites, stress strain variations in laminates. (9)
5. **Organic Materials:** Classification, properties, application of polymers, plastics and elastomers.
   Ceramics: Classification, properties, structures of refractories, abrasive materials, electronic ceramics, cement and concrete. (8)

Reference Books:

1. "The Nature and Properties of Engineering Materials", Jastrezebski Z. D.
2. "Introduction to Physical Metallurgy", Avner S. H.
3. "Composite Materials", Sharma S. C.
4. "Materials & Processes in Manufacturing", DeGarmo E. P., Black J. T., Kosher R. A.
5. "Materials Science and Engineering", Rajput R. K.
6. "Composite Materials", Chawla K. K.
7. "The Metals Data Book", Nayar Alok
8. "Polymer Science and Technology", Fried Joel R.
9. "Analysis and Performance of Fiber Composites", Agrawal B. D., Broutman L. J.

EL-I Experimental Stress Analysis

Teaching Scheme :
Lecturers : 03 hrs/week
Tutorials : 01 hr/week

Examination Scheme
Theory Paper : 100 marks (3 hrs)

1. **Photoelasticity :**
   a. Theory of photo elasticity, Light optics as related to photo electricity, Arrangement of optical elements in a polariscope, stress optic law, plain polariscope, circular polariscope, Isoclinics and Isochromatics.
   b. Photoelastic Materials : Properties, Selection.
   c. Fringe sharpening, Fringe Multiplication.
   d. Analysis techniques : Determination of direction of Principal stresses at given point, Determination of exact fringe order N and principal stress difference $(\sigma_1 - \sigma_2)$ at given point, Principal Stress separation techniques : Shear difference method, Oblique incidence method, Electrical analogy method, Method based on Hooke's Law.
   e. Compensation techniques, Scaling Model to Prototype stresses, Calibration techniques.
   f. Applications of photoelasticity for two dimensional models. (14)

2. **Three dimensional Photoelasticity :**
   a. Stress locking-in models, Casting technique for models, Slicing methods
   b. Analysis techniques (6)

3. **Introductory Treatment to following**
   a. Birefringent coating method
   b. Brittle coating method
   c. Scattered light photoelasticity
   d. Grid method
   e. Moire's fringe method
   f. Holography in stress analysis
   g. Model analysis
   h. Dynamic photoelasticity (8)

4. **Stress Analysis by Strain Gauges**
   a. Electrical Resistance Strain Gauges: types, gauge factor, sensitivity, applications.
   b. Materials, Bonding of strain gauge surface preparation, Moisture proofing etc, types of bounds, Testing of gauge installations
   c. Balancing of Wheatstone bridge circuit
   d. Strain Measuring Circuits, Commercial strain inductors
   e. Rosette Analysis
   f. Strain Gauge Transducers
   g. Cross Sensitivity, Temperature compensation
   h. Introduction to Semi-Conductor strain Gauges (12)

Reference Books:

1. *"Experimental Stress Analysis"*, Dally and Riley, McGraw Hill
2. *"Experimental Stress Analysis"*, Dr. Sadhu Singh., Khanna Publications.
3. *"Experimental Stress Analysis"*, L.S.Srinath., McGraw Hill
4. *"Hand Book of Experimental Stress Analysis"*, Hyteneyi
5. *"Photo Mechanics"*, Dureil and others
6. *"Experimental Stress Analysis"*, Dove R.C., P.H. Adams, P.H.I.

Lab – I

Teaching Scheme :
Tutorials : 02 hrs/week

Examination Scheme
Viva-voce : 25 marks

Lab – I consist of Performing/Studying any three of the following experiments. The candidate shall submit the report of these experiments/assignments.

1. Preparation of solid models for minimum two assemblies of any industrial product using solid modeling software like CATIA, Solid works, UNIGRAPHICS etc.
2. Solution of two problems in statics for using FEA software like ANSYS, Hypermesh, Nastran etc.
3. Simulation of any mechanical system using simulation software.
4. Minimum four computer programmes based on C.T.D.E. should be developed.
5. Study of practical on photo elasticity.
6. Determination of strain by attaching strain gauges to minimum two stressed members subjected to tension, bending, torsion or combined.

Seminar – I

Teaching Scheme :
Tutorials : 02 hrs/week

Examination Scheme
Viva-voce : 50 marks

Seminar–I shall be based on the literature survey on one of the advanced topics chosen in consultation with the guide, which will lead to dissertation in that area. The concepts must be clearly understood and presented by the student. All modern methods of presentation should be used by the student. A hard copy of the report should be submitted to the Department before delivering the seminar. A PDF copy of the report in soft form must be submitted to the guide along with other details if any.

The candidate will have to deliver a seminar presentation before the examiners, one of them will be guide and the other will be examiner appointed by the university.

Design Engineering

Teaching Scheme :
Lecturers : 03 hrs/week
Tutorials : 01 hr/week

Examination Scheme
Theory Paper : 100 marks (3 hrs)
Term Work : 25 marks

1. **Design of High Speed Cams :** Types of cams, Kinetic design, Standard Contours, Combined motion and polynomial approaches, CEP and CPM cams and Importance of SVAJ diagrams, Dynamic Design of Cams - Rigid body Analysis, Elastic body analysis, Polydyne Cams. (8)

2. **Design Based on Thermal Stress :** Definition of thermal stress, Application, Form Constraint and Continuity Constraint, Thermal Stress in flat walls and Cylindrical Shells, Additional of thermal and working stress, Methods of heat removal and decreasing thermal stress. (8)

3. **Pressure Vessel Design:** Discontinuity stresses, Theory of beams, on elastic foundation infinite and semi-infinite beams, Concentrated loads and moment, Design based on discontinuity stress for cylinder with spherical head and cylinder with flat head. (6)

4. **Fracture Mechanics :** Types, concepts, fracture criterion, strain energy release, fracture mechanics, stress analysis of cracks, stress around cracks, Irwin's approach, crack displacement, crack closure, Griffith theory of brittle fracture, Metallographic aspects of brittle fracture, ductile fracture, Notch effect in fracture, plastic zone correction, crack opening displacement, J-contour integral, R-curves, fracture toughness testing, fracture under combined stresses. (8)

5. **Fatigue of Metals :** Fatigue phenomena, statistical nature, structural features, micro mechanisms: initiation and propagation, fatigue changes in different metals, fracture mechanism for fatigue, influential factors, effect of stress concentration, size effect, fatigue dislocation structure, fatigue crack growth, surface effects, corrosion fatigue, effect of mean stress on fatigue under multi-axial cyclic stresses, effect of metallurgical variables and temperature, fatigue of plastic and composites. (8)

6. **Creep:** Mechanism of creep of material at high temperature, exponential creep law and hyperbolic sine creep law, true stress and true strain. (2)

Term Work :

The term work shall consist of six assignments based on above topics.

Reference Books:

1. *"Mechanical Design Analysis"*, M.S. Spotts Prentice Hall Inc.
2. *"Engineering Design"*, Mashek.
3. *"Dynamics of Machinery"*, Norton.
4. *"Pressure Vessel Design"*, J.F. Harvey.
5. *"Fatigue Failure of Metal"*, Kocanda, Sijthoff & Noordhoff International Publications.
6. *"Metals Fatigue"*, Frost N.E., Oxford University Press London.

Mechanical Vibration Analysis

Teaching Scheme :
Lecturers : 03 hrs/week
Tutorials : 01 hr/week

Examination Scheme
Theory Paper : 100 marks (3 hrs)
Term Work : 25 marks

1. **Two Degree of Freedom System :** Revision of single degree of freedom systems, Analysis of free, damped and forced vibrations.
   Examples of 2 D.O.F. systems, Free and Forced vibrations, un-damped and damp-free vibration of 2 D.O.F. system, Coordinate coupling, Principal coordinate, Application such as double pendulum etc., Dynamic vibration absorbers- tuned and untuned types. Vibration dampers, Vibration isolators. (12)

2. **Many Degree of Freedom of System :** Method of determination of natural frequencies of many DOF System-Rayleigh's Method, Holzer Method, Iteration Method. (6)

3. **Vibration of Beam and Shaft :** Free and Forced Vibrations of prismatic bars, Torsional vibration of circular shaft, free lateral vibration of prismatic bar with different end conditions, Effect of axial force on lateral vibrations of bars, vibration of springs, wave equation vibration, vibration of beams with variable cross-section. (6)

4. **Non Linear Vibration :** Definition, types of non linearity, Phase-plan method for single DOF oscillators, Mathews equation, Duffing equation, Jump phenomenon.
   Self Excited And Parametrically Excited Vibration: Introduction to above types of vibration. (5)

5. **Random Vibration :** Introduction, random process, stationary, ergodic random process, frequency response function for single DOF system under random excitation, Mean square value, Spectral Density, White noise and Band – limited white noise. (6)

6. **Vibration Measurement** : FFT analyzer, vibration exciters, signal analysis. Time domain & Frequency domain analysis of signals. Experimental modal analysis, Machine Conditioning and Monitoring, fault diagnosis. (5)

Term Work :

The term work shall consist of six assignments based on above topics.

Reference Books:

1. *"Mechanical Vibrations"* G. K. Groover.
2. *"Mechanical Vibrations and Noise Control"* Sadhu Singh, Khanna Publishers.
3. *"Mechanical Vibration Analysis"*, P. Shrinivasan, Tata McGraw Hill N.D.
4. *"Vibration Problems In Engineering"*, H. Timosheko and D.H. Young, East-west
5. *"Theory of Vibrations and Applications"*, W.T. Thompson, PHI Pvt, Ltd, N.D.
6. *"Mechanical Vibrations"*, S. S. Rao Addison, Wesley Publishing Co.
7. *"Fundamentals of Vibration"*, Leonard Meirovitch, McGraw Hill International Editon.
8. *"Mechanical Vibrations"*, A. H. Church, John Wiley & Sons Inc.

Analysis and Synthesis of Mechanisms

Teaching Scheme :
Lecturers : 03 hrs/week
Tutorials : 01 hr/week

Examination Scheme
Theory Paper : 100 marks (3 hrs)
Term Work : 25 marks

1. **Introduction**: Concepts related to kinematics and synthesis, kinematic pairs, mechanisms, degree of freedom, Grubler's criteria, transmission angles, mechanical advantages. (4)

2. **Dynamics of four-bar mechanism:** Dynamic analysis for static and inertia forces for a four bar mechanism, center of percussion, dynamically equivalent systems. (4)

3. **Curvature theory**: Fixed and moving centrodes, Equation of coupler curves – Robort Chebyshov Theorem, double points and symmetry, inflection points and inflection circle, Euler- Savary equation, Bobillier constructions, cubic of stationary curvature, Ball's point, Applications in dwell Mechanisms. (8)

4. **Graphical Synthesis of Planar Mechanisms**: Type, 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 with two, three and four accuracy points using pole method, center point and circle point curves, Synthesis for five accuracy points, Branch and order defects, Synthesis for path generation. (8)

5. **Analytical Synthesis of Planar Mechanisms**:- Displacement equations of the four bar linkage, Analytical synthesis of four-bar and slider- crank mechanism, Freudenstein's equation, Synthesis with three accuracy points and four accuracy points, compatibility condition, Analysis of mechanical error in linkages. Synthesis by complex numbers. (8)

6. **Synthesis of Spatial Linkages** : Displacement analysis, Denavit-Hartenberg parameters, Matrix method of analysis of spatial mechanisms. Function generation for symmetric function. Eulerian rotation transformation and Eulerian angle, Applications of spatial mechanisms. (8)

Term Work :

The term work shall consist of six assignments based on above topics.

References Books:

1. *"Theory of Machines and Mechanisms"*, A. Ghosh and A.K.Mallik, Affiliated East-West Press.
2. *"Kinematic Synthesis of Linkages"*, R. S. Hartenberg and J. Denavit, McGraw-Hill.
3. *"Mechanism Design - Analysis and Synthesis"* (Vol. 1 and 2), A. G. Erdman and G. N. Sandor, Prentice Hall of India.
4. *"Theory of Machines and Mechanisms"*, J. E. Shigley and J. J. Uicker, 2nd Ed., McGraw-Hill.
5. *"Design of Machinery : An Introduction to the Synthesis and Analysis of Mechanisms and Machines"*, Robert L.Norton, Tata McGraw-Hill, 3rd Edition.
6. *"Kinematics and Linkage Design"*, A.S.Hall, Prentice Hall of India.
7. *"Theory of Machine"*, S. S. Rattan, Tata McGraw-Hill

Industrial Product Design

Teaching Scheme :
Lecturers : 03 hrs/week
Tutorials : 01 hr/week

Examination Scheme
Theory Paper : 100 marks (3 hrs)

1. **Introduction** : Approach to industrial design
   a. Approach to industrial product based on idea generation and innovations to meet the needs of the developing society. Design and development process of industrial products, various steps such as creative process involved in idea marketing, designers, mind-criticism, design process, creation.
   b. Ergonomics and aesthetic requirements of product design, quality and maintainability consideration in product design, Use of modeling technique, prototype designs, conceptual design. (9)

2. **Industrial Product Design :**
   a. General design situations, setting specifications, requirements and ratings, their importance in the design, Study of market requirements and manufacturing aspects of industrial designs.
   b. Aspects of ergonomic design of machine tools, testing equipments, instruments, automobiles, process equipment etc. Convention of style, from and color of industrial design. (9)

3. **Design of Consumer Product**
   a. Functions and use, standard and legal requirements, body dimensions.
   b. Ergonomic considerations, interpretation of information, conversions for style, forms, colors (6)

4. **Aesthetic Concepts**
   a. Concept of unity and order with variety, concept of purpose, style and environment, Aesthetic expressions of symmetry, balance, contrast and continuity , proportion, rhythm, radiation.
   b. From and style of product: visual effect of line and from, mechanics of seeing', psychology of seeing, influence of line and form, Components of style, Basic factors, Effect of color on product appearance, color composition, conversion of colors of engineering products. (6)

5. **Economic Considerations**
   Selection of material, Design for production, use of standardization, value analysis and cost reduction, maintenance aspects in design. (5)

6. **Design Organization**
   Organization Structure, Designer position, Drawing office procedure, Standardization, record keeping, legal procedure of Design patents. (5)

Reference Books:

1. *"Industrial Design for Engineers"*, W.H. Mayall., London.
2. *"Problems of Product Design and Development"*, Hearn Buck.
3. *"Industrial Designs in Engineering"*, Charles H.Fluerichem.
4. *"Material of Invention"*, Ezia Manzim.
5. *"The Science of Engineering Design"*, Percy H. Hill.

EL-II Advanced Optimization Techniques

Teaching Scheme :
Lecturers : 03 hrs/week
Tutorials : 01 hr/week

Examination Scheme
Theory Paper : 100 marks (3 hrs)

1. **Introduction:** Optimal problem formulation, engineering optimization problems, optimization algorithms. (3)
2. **Single Variable Optimization Algorithms:** Optimality criteria, bracketing methods, region elimination methods, point estimation methods, gradient based methods, root finding using optimization techniques. (5)
3. **Multivariable Optimization Algorithms:** Optimality criteria, unidirectional search, direct search methods, gradient based methods, Computer programs on above methods. (8)
4. **Constrained Optimization Algorithms:** Kuhn-Tucker conditions, transformation methods, sensitivity analysis, direct search for constrained minimization, linearised search techniques, feasible direction method, generalized reduced gradient method, gradient projection method, Computer programs on above methods. (8)
5. **Special Optimization Algorithms:** Integer programming, Geometric programming, Genetic Algorithms, Simulated annealing, global optimization, Computer programs on above methods. (8)
6. **Optimization in Operations Research:** Linear programming problem, simplex method artificial variable techniques, dual phase method, sensitivity analysis. (8)

Reference Books:

1. *"Optimization in Engineering Design"*, Deb Kalyanmoy, PHI, New Delhi
2. *"Engineering Optimization"*, S. S. Rao, John Wiley, New Delhi.
3. *"Multi-objective Algorithms using Evolutionary Algorithms"*, Deb Kalyanmoy, John Wiley, New Delhi.
4. *"Principles of Optimum Design"*, Paplambros, P.Y. and Wilde D.J. Cambridge, UK
5. *"Optimization in Design"*, Chandrupatla, PHI, New Delhi.

EL-II Simulation and Mathematical Modeling

Teaching Scheme :
Lecturers : 03 hrs/week
Tutorials : 01 hr/week

Examination Scheme
Theory Paper : 100 marks (3 hrs)

1. **Introduction to Simulation:** System and system environment, Components of the system, Type of systems, type of models, steps in simulation, study advantages and disadvantages of simulation, concept of discrete simulation, time-advance mechanisms, components and organization of a discrete-event simulation model. (8)

2. **Statistical models in simulation:** Useful statistical models, discrete distribution, continuous distribution, Poisson process, empirical distribution.
   Queuing Models: Characteristics of queuing systems, queuing notations, long run measures of performance of queuing systems, steady state behaviour finite population model. (8)

3. **Random number generation :** Properties of random numbers, generation of pseudo random numbers, techniques for random numbers generation, tests for random numbers.
   Random variate generation : Inverse transform techniques, convolution method, acceptance rejection techniques. (8)

4. **Input Modeling :** Data collection, identifying the distribution of data, parameter estimation, goodness of fit tests, selection of input model without data, multivariate and time series input model.
   Verification and Validation of Simulation Model : length of simulation runs, validation. (8)

5. **Output Analysis for a Single Model :** Types of simulations with respect to output analysis, stochastic nature of output data, measure of performance and their estimation, output analysis of terminating simulators, output analysis for steady state simulation. Case studies in simulation, orientation of simulation software such as GPSS. (8)

Reference Books:

1. *"Simulation Modeling and Analysis"*, Law A. W., Kelton D., Tata McGraw Hill
2. *"System Simulation"*, Gordon Geoffrey, PHI, New Delhi
3. *"System Simulation with Digital Computers"*, Deo Narsingh, PHI, New Delhi
4. *"Theory of Modeling and Simulation"*, Zeigler B., Prachofer H., Kim T. G., Academic Press
5. *"System Analysis and Modeling"*, Body Donald W., Academic Press Harcourt India
6. *"Discrete Event System"*, Banks Jerry, Carson John, Nelson Barry, Nicole David

EL-II Machine Tool Design

Teaching Scheme :
Lecturers : 03 hrs/week
Tutorials : 01 hr/week

Examination Scheme
Theory Paper : 100 marks (3 hrs)

1. **Introduction to Machine Tool Devices and Mechanism :**
   General requirements of machine tool design, Design process as applied to machine tool, layout of machine tool. Various motions introduced in machine tools, parameters defining limits of motion, Requirements of Machine Tool Drives, mechanical and hydraulic transmission used in machine drives and their elements. (8)

2. **Regulation of Speed and Feed Rates :**
   Aim of speed and feed regulation, stepped regulation of speed. Design of speed box. Design of feed box. Machine tool device using multi speed motors, step-less regulation of speed and feed rates. (8)

3. **Design of Machine Tool Structures :**
   Function of machine tool structure and their requirements. Design criteria, materials, static and dynamic stiffness, Basic design procedure, Design items like beam, column, housing, Rams etc. (6)

4. **Design of Guide ways and Power Screws :**
   Function and type of guide ways, Design of slide ways, Design of Antifriction guide ways, Design of power screws. (6)

5. **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. (6)

6. **Dynamics of Machine Tools Machine :**
   Machine tool elastic system, General procedure for ascending Dynamic stability of equivalent elastic system, Forced vibrations in a machine tool. Introduction to machine tool Control. (6)

Reference Books:

1. *"Design of Machine Tools"*, G.S. Sen and A. Bhattacharyya
2. *"Design of Machine Tools"*, S. K. Basu and D. K. Pal
3. *"Machine Tool Design"*, N.K. Mehta, Tata McGraw Hill
4. *"Design Principal of Metal Cutting Machine Tool"*, F. Koenigs Berger
5. *"Principles of Metal Cutting"*, Koenigs Berger

EL-II Industrial Instrumentation

Teaching Scheme :
Lecturers : 03 hrs/week
Tutorials : 01 hr/week

Examination Scheme
Theory Paper : 100 marks (3 hrs)

1. **Generalized Measurement System :** Measurement, Methods of measurement, Calibration, Generalized measurement system and its elements. (3)
2. **Performance Characteristics :** Static characteristics, Dynamic Characteristics, Instrument Types: Zero order, first order and second order. Input Types : Step input, ramp input, sinusoidal impulses. Dynamic response of first and second order instrument. Types of errors, accuracy and precision. Statistical analysis of data. (8)
3. **Measurement of Force and Torque :** Mass, weight and force measurement systems, Elastic transducers. Torque measurement, mechanical, electrical and transmission dynamometers.
   Measurement of Speed: Mechanical, electrical, contact less type tachometers, stroboscope.
   Measurement of Pressure: Pressure measuring transducers, strain gauge pressure cells, measurement of high and low pressure. McLeod vacuum gauge. Thermal conductivity gauge. Calibration of pressure gauges. (7)
4. **Measurement of Flow :** Obstruction meters, variable area meter, pressure probes, positive displacement meters. Turbine type flow meters, electromagnetic flow meter. Ultrasonic flow meter, Hot wire anemometer; laser anemometer, flow visualization techniques. Shadowgraph Schlieren techniques and interferometer method.
   Measurement of Temperature: Basic fixed points, expansion thermometers based on expansion of solids, liquids and gases, change of state thermometers. Pyrometric cones, electrical methods, resistance thermisters and thermocouples. Laws of thermocouples. Thermopiles, optical pyrometers, radiation, Pyrometer, Calibration of temperature measuring devices. (9)
5. **Measurement of Head and Level :** Float operated pressure gauge method, diaphragm box method, air-trap method, electrical conductivity method, capacitive level measurement. (3)
6. **Measurement of Vibration and Acoustics :** Vibration and its measurement, measurement of displacement, frequency and mode, seismic instruments, calibration of instruments. Measurement of noise, study of noise meter, signal analysis, condition monitoring and signature analysis. (4)
7. **Data Acquisition and Processing Systems:** Modular system, Compact data loggers, Instrument interconnection systems, Sensor-based computerized data systems.
   Computer Aided Experimentation: Introduction, Functional description of computer system, Sensors, Overall system configuration, Interfacing, Examples of computer algorithms and programmers. (5)

Reference Books:

1. *"Mechanical Measurement"*, Beckwith, Buck.
2. *"Industrial Instrumentation"*, Eckman
3. *"Mechanical Measurements"*, Sirohi, Radhakrishna
4. *"Engineering Measurements and Instrumentation"*, Adam and Dove.
6. *"Measurement Systems"*, E. O. Doebelin, McGraw Hill international.
7. *"Instrumentation, Measurement and Analysis"*, Nakra and Choudhary, McGraw Hill.

Lab – II

Teaching Scheme :
Tutorials : 02 hrs/week

Examination Scheme
Viva-voce : 25 marks

Lab – I consist of Performing/Studying any three of the following experiments. The candidate shall submit the report of these experiments/assignments.

1. Determination of Natural Frequencies & Modal analysis of Machine Components, Equipments to be used: FFT Analyzer, with Impact Hammer or Exciter, Necessary Transducers etc.
2. Condition Monitoring & Fault finding of Machines by using FFT Analyzer, Vibration Meter, Vibration Pickups, Transducers etc.
3. Assignment on solving vibration problems using MATLAB.
4. Synthesis and analysis of a mechanism using softwares such as 'ADAMS' and 'Working Model'.
5. Force measurement and calibration of load cell.

Seminar – II

Teaching Scheme :
Tutorials : 02 hrs/week

Examination Scheme
Viva-voce : 50 marks

Seminar–I shall be based on the literature survey on one of the advanced topics chosen in consultation with the guide, which will lead to dissertation in that area. The concepts must be clearly understood and presented by the student. All modern methods of presentation should be used by the student. A hard copy of the report should be submitted to the Department before delivering the seminar. A PDF copy of the report in soft form must be submitted to the guide along with other details if any.

The candidate will have to deliver a seminar presentation before the examiners, one of them will be guide and the other will be examiner appointed by the university.

Dissertation Part – I

Teaching Scheme:
Tutorials: 24 hrs/week

Examination Scheme
Term Work: 50 marks
Viva-voce: 50 marks

The dissertation–I shall consist of a report on any research work done by the candidate or a comprehensive and critical review of any recent development in the subject or detailed report of the project work consisting of a design and / or development work that the candidate has executed. The report must include comprehensive literature work on the topic selected for dissertation.

Term work:

The dissertation part–I will be in the form of seminar report on the project work being carried out by the candidate and will be assessed by two examiners appointed by the university, one of whom will be the guide and other will be a senior faculty member from the department.

Viva-voce:

The dissertation part–I will be in the form of seminar report on the project work being carried out by the candidate and will be assessed by two examiners appointed by the university, one of whom will be the guide and other will be an external examiner.

Dissertation Part – II

Teaching Scheme:
Tutorials: 24 hrs/week

Examination Scheme
Term Work: 100 marks
Viva-voce: 200 marks

The dissertation part–II will be in continuation of dissertation part–I and shall consist of a report on the research work done by the candidate or a comprehensive and critical review of any recent development in the subject or detailed report of the project work consisting of a design and / or development work that the candidate has executed. Experimentation is necessary for validation of results in research work. The examinee shall submit the dissertation in triplicate to the head of the institution duly certified by the Guide and the concerned Head of department and the Principal certifying that the work has been satisfactorily completed.