## ANNA UNIVERSITY, CHENNAI
### AFFILIATED INSTITUTIONS
#### REGULATIONS 2013
##### M.E. ENGINEERING DESIGN
###### I TO IV SEMESTERS (FULL TIME) CURRICULUM AND SYLLABUS

### SEMESTER I

<table>
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<tr>
<th>SL. NO</th>
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TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE = 73

LIST OF ELECTIVES FOR M.E. ENGINEERING DESIGN

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MA7169 ADVANCED NUMERICAL METHODS

OBJECTIVE:

- To impart knowledge on numerical methods that will come in handy to solve numerically the problems that arise in engineering and technology. This will also serve as a precursor for future research.

OUTCOME:

- It helps the students to get familiarized with the numerical methods which are necessary to solve numerically the problems that arise in engineering.

UNIT I ALGEBRAIC EQUATIONS


UNIT II ORDINARY DIFFERENTIAL EQUATIONS

Runge Kutta Methods for system of IVPs, numerical stability, Adams-Bashforth multistep method, solution of stiff ODEs, shooting method, BVP: Finite difference method, orthogonal collocation method, orthogonal collocation with finite element method, Galerkin finite element method.

UNIT III FINITE DIFFERENCE METHOD FOR TIME DEPENDENT PARTIAL DIFFERENTIAL EQUATION


UNIT IV FINITE DIFFERENCE METHODS FOR ELLIPTIC EQUATIONS

Laplace and Poisson’s equations in a rectangular region: Five point finite difference schemes, Leibmann’s iterative methods, Dirichlet and Neumann conditions – Laplace equation in polar coordinates: finite difference schemes – approximation of derivatives near a curved boundary while using a square mesh.

UNIT V FINITE ELEMENT METHOD


TOTAL: 60 PERIODS

REFERENCES

OBJECTIVES:
- To know the fundamentals of mechanics of materials under various loading conditions.

OUTCOME:
- It helps the students to be familiarized with the stresses under different loading conditions.

UNIT I ELASTICITY
9

UNIT II SHEAR CENTER AND UNSYMMETRICAL BENDING
10
Location of shear center for various thin sections - shear flows. Stresses and Deflections in beams subjected to unsymmetrical loading-kern of a section.

UNIT III STRESSES IN FLAT PLATES AND CURVED MEMBERS
10
Circumference and radial stresses – deflections - curved beam with restrained ends - closed ring subjected to concentrated load and uniform load - chain links and crane hooks. Solution of rectangular plates – pure bending of plates – deflection – uniformly distributed load – various end conditions

UNIT IV TORSION OF NON-CIRCULAR SECTIONS
7
Torsion of rectangular cross section - St.Venants theory - elastic membrane analogy - Prandtl’s stress function - torsional stress in hollow thin walled tubes.

UNIT V STRESSES IN ROTATING MEMBERS AND CONTACT STRESSES
9
Radial and tangential stresses in solid disc and ring of uniform thickness and varying thickness allowable speeds. Methods of computing contact stress- deflection of bodies in point and line contact applications.

REFERENCES

OBJECTIVES:
- To impart knowledge on computer graphics which are used routinely in diverse areas as science, engineering, medicine, etc.
OUTCOME:

- With laboratory classes in conjunction, it helps the students to get familiarized with the computer graphics application in design. This understanding reinforces the knowledge being learned and shortens the overall learning curves which are necessary to solve CAE problems that arise in engineering.

UNIT I

INTRODUCTION TO COMPUTER GRAPHICS FUNDAMENTALS

8

Output primitives (points, lines, curves etc.), 2-D & 3-D transformation (Translation, scaling, rotators) windowing - view ports - clipping transformation.

UNIT II

CURVES AND SURFACES MODELLING

10

Introduction to curves - Analytical curves: line, circle and conics – synthetic curves: Hermite cubic spline- Bezier curve and B-Spline curve – curve manipulations.


UNIT III

NURBS AND SOLID MODELING

9

NURBS- Basics- curves , lines, arcs, circle and bi linear surface.


UNIT IV

VISUAL REALISM

9

Hidden – Line – Surface – solid removal algorithms shading – coloring. Introduction to parametric and variational geometry based software’s and their principles creation of prismatic and lofted parts using these packages.

UNIT V

ASSEMBLY OF PARTS AND PRODUCT DATA EXCHANGE

9

Assembly modeling - interferences of positions and orientation - tolerances analysis - mass property calculations - mechanism simulation.

Graphics and computing standards- Open GL Data Exchange standards – IGES, STEP etc- Communication standards.

Laboratory session: Writing interactive programs generate graphics and to solve design problems - using any languages like Auto LISP/ C / FORTRAN etc. Each assessment should contain a component of Laboratory session.

T=30, TOTAL : 75 PERIODS

REFERENCES

OBJECTIVES:
- To impart knowledge on various concepts in engineering design and principles of implementing quality in a product or service through tools such as quality houses, control charts, statistical process control method, failure mode effect analysis and various strategies of designing experiments, methods to uphold the status of six sigma and improve the reliability of a product.

OUTCOME:
It helps the design cum quality engineer to get familiarized with various concepts in design, quality and reliability principles in the design of an engineering product or a service.

UNIT I  DESIGN FUNDAMENTALS, METHODS AND MATERIAL SELECTION  9

UNIT II  DESIGN FOR QUALITY  9
Quality Function Deployment -House of Quality-Objectives and functions-Targets-Stakeholders-Measures and Matrices-Design of Experiments –design process-Identification of control factors, noise factors, and performance metrics - developing the experimental plan- experimental design – testing noise factors- Running the experiments –Conducting the analysis-Selecting and conforming factor-Set points-reflecting and repeating.

UNIT III  FAILURE MODE EFFECT ANALYSIS AND DESIGN FOR SIX SIGMA  9
Basic methods: Refining geometry and layout, general process of product embodiment - Embodiment checklist- Advanced methods: systems modeling, mechanical embodiment principles-FMEA method- linking fault states to systems modeling - Basis of SIX SIGMA –Project selection for SIX SIGMA- SIX SIGMA problem solving- SIX SIGMA in service and small organizations - SIX SIGMA and lean production –Lean SIX SIGMA and services

UNIT IV  DESIGN OF EXPERIMENTS  9
Importance of Experiments, Experimental Strategies, Basic principles of Design, Terminology, ANOVA, Steps in Experimentation, Sample size, Single Factor experiments - Completely Randomized design, Randomized Block design, Statistical Analysis, Multifactor experiments - Two and three factor full Factorial experiments, 2K factorial Experiments, Confounding and Blocking designs, Fractional factorial design, Taguchi’s approach - Steps in experimentation, Design using Orthogonal Arrays, Data Analysis, Robust Design- Control and Noise factors, S/N ratios

UNIT V  STATISTICAL CONSIDERATION AND RELIABILITY  9
Frequency distributions and Histograms- Run charts –stem and leaf plots- Pareto diagrams-Cause and Effect diagrams-Box plots- Probability distribution-Statistical Process control–Scatter diagrams –Multivariable charts –Matrix plots and 3-D plots.-Reliability-Survival and Failure-Series and parallel systems-Mean time between failure-Weibull distribution

TOTAL : 45 PERIODS

REFERENCES
ED7104 VIBRATION ANALYSIS AND CONTROL ** L T P C 3 0 2 4

OBJECTIVES:
- To understand the Fundamentals of Vibration and its practical applications
- To understand the working principle and operations of various vibration measuring instruments
- To understand the various Vibration control strategies

OUTCOME:
To make the students understand the basics of vibration, its importance in engineering field. Since vibration is a critical problem today in engineering industries, the students are equipped with the working operations of various vibration measuring instruments, vibration control and analysis techniques in the engineering field.

UNIT I FUNDAMENTALS OF VIBRATION 10

UNIT II TWO DEGREE FREEDOM SYSTEM 7
Introduction-Free Vibration Of Undamped And Damped - Forced Vibration With Harmonic Excitation System- Coordinate Couplings And Principal Coordinates

UNIT III MULTI-DEGREE FREEDOM SYSTEM AND CONTINUOUS SYSTEM 9
Multi Degree Freedom System – Influence Coefficients and stiffness coefficients- Flexibility Matrix and Stiffness Matrix – Eigen Values and Eigen Vectors-Matrix Iteration Method – Approximate Methods: Dunkerley, Rayleigh’s, and Holzer Method - Geared Systems-Eigen Values & Eigen vectors for large system of equations using sub space, Lanczos method - Continuous System: Vibration of String, Shafts and Beams

UNIT IV VIBRATION CONTROL 9

UNIT V EXPERIMENTAL METHODS IN VIBRATION ANALYSIS 10

T= 30, TOTAL = 75 PERIODS

" a Term Project must be given for Assessment – 3 (Compulsory)

REFERENCES
ED7111 CAD LABORATORY

OBJECTIVES:
• To impart knowledge on how to prepare drawings for various mechanical components using any commercially available 3D modeling software’s

OUTCOME:
• With laboratory classes, it helps the students to get familiarized with the computer applications in design and preparing drawings for various mechanical components.
• CAD Introduction.
• Sketcher
• Solid modeling –Extrude, Revolve, Sweep, etc and Variational sweep, Loft ,etc
• Surface modeling –Extrude, Sweep, Trim ..etc and Mesh of curves, Free form etc
• Feature manipulation – Copy, Edit, Pattern, Suppress, History operations etc.
• Assembly-Constraints, Exploded Views, Interference check
• Drafting-LAYOUTS, STANDARD & SECTIONAL VIEWS, DETAILING & PLOTTING.

Exercises in Modeling and drafting of Mechanical Components - Assembly using Parametric and feature based Packages like PRO-E / SOLID WORKS /CATIA / NX etc

TOTAL = 30 PERIODS

ED7201 FINITE ELEMENT METHODS IN MECHANICAL DESIGN

OBJECTIVES:
• To develop a thorough understanding of the basic principles of the finite element analysis techniques with an ability to effectively use the tools of the analysis for solving practical problems arising in engineering design

OUTCOME:
Upon understanding this course the students will be able to
• Understand how to mathematically model physical systems and solve using numerical techniques.
• Select appropriate element and boundary conditions for various 1D, 2D Boundary problems.
• Apply various solution techniques to solve Boundary value problems and Eigen value problems

UNIT I FINITE ELEMENT ANALYSIS OF ONE DIMENSIONAL PROBLEMS 11+3

UNIT II FINITE ELEMENT ANALYSIS OF TWO DIMENSIONAL PROBLEMS 10+3
Basic Boundary Value Problems in two-dimensions – Triangular, quadrilateral, higher order elements – Poisson’s and Laplace’s Equation – Weak Formulation – Element Matrices and Vectors – Application to scalar variable problem
UNIT III  ISO-PARAMETRIC FORMULATION  8+3

UNIT IV  SOLUTION TECHNIQUES  8+3
Inversion Method, Decomposition Method, Banded Solver method, Skyline procedure method, Band width reduction Techniques, Front width Methods, Free meshing and Mapped Meshing

UNIT V  SPECIAL TOPICS  8+3

TOTAL: 60 PERIODS

NOTE
At the post-graduate level of instruction the contact hours are to be supplemented by self study by students. As for the examination, modelling considerations, choice of elements, boundary conditions, loading conditions, and basic procedures only need to be emphasized without expecting a complete numerical solution to practical problems.

REFERENCES

ED7202  MECHANISMS DESIGN AND SIMULATION  L  T  P  C
3  0  2  4

OBJECTIVES:
• To develop a thorough understanding of the various mechanisms and its design and simulation with an ability to effectively use the various mechanisms in real life problems.

OUTCOME:
• It helps the students to get familiarized with the advanced mechanisms which are necessary to design and simulate mechanisms.
UNIT I INTRODUCTION 9

UNIT II KINEMATIC ANALYSIS 9

UNIT III PATH CURVATURE THEORY, COUPLER CURVE 9
Fixed and moving centrodes, inflection points and inflection circle. Euler Savary equation, graphical constructions – cubic of stationary curvature. Four bar coupler curve-cusp-crunode-coupler driven six-bar mechanisms-straight line mechanisms

UNIT IV SYNTHESIS OF FOUR BAR MECHANISMS 9

UNIT V SYNTHESIS OF COUPLER CURVE BASED MECHANISMS & CAM MECHANISMS 9

" a Term Project must be given for Assessment – 3 (Compulsory)

T =30, TOTAL: 75 PERIODS

REFERENCES

ED7203 MECHANICAL BEHAVIOR OF MATERIALS T P C
L 3 0 0 3

OBJECTIVES:
• To know the mechanical behaviour of both metallic and non-metallic materials under different loading and temperature conditions.

OUTCOME:
• To familiarize the researchers in the area of material behaviour under different loading and selection of materials for the design of engineering structures.
UNIT I BASIC CONCEPTS OF MATERIAL BEHAVIOR
Elasticity in metals and polymers—Strengthening mechanisms, work hardening, solid solutioning, grain boundary strengthening, poly phase mixture, precipitation, particle, fibre and dispersion strengthening. Effect of temperature, strain and strain rate on plastic behaviour — Super plasticity —. Griffith’s theory—. Ductile, brittle transition in steel — High temperature fracture, creep — Larson Miller parameter — Deformation and fracture mechanism maps.

UNIT II BEHAVIOUR UNDER DYNAMIC LOADS AND DESIGN APPROACHES
Stress intensity factor and fracture toughness — Fatigue, low and high cycle fatigue test, crack initiation and propagation mechanisms and Paris law.— Safe life, Stress-life, strain-life and fail-safe design approaches — Effect of surface and metallurgical parameters on fatigue — Fracture of non metallic materials — Failure analysis, sources of failure, procedure of failure analysis.

UNIT III SELECTION OF MATERIALS
Motivation for selection, cost basis and service requirements — Selection for mechanical properties, strength, toughness, fatigue and creep — Selection for surface durability corrosion and wear resistance — Relationship between materials selection and processing — Case studies in materials selection with relevance to aero, auto, marine, machinery and nuclear applications — Computer aided materials selection.

UNIT IV MODERN METALLIC MATERIALS
Dual phase steels, High strength low alloy (HSLA) steel, Transformation induced plasticity (TRIP) Steel, Maraging steel, Nitrogen steel — Intermetallics, Ni and Ti aluminides — smart materials, shape memory alloys — Metallic glass and nano crystalline materials.

UNIT V NON METALLIC MATERIALS
Polymeric materials — Formation of polymer structure — Production techniques of fibers, foams, adhesives and coating — structure, properties and applications of engineering polymers — Advanced structural ceramics, WC, TiC, TaC, Al₂O₃, SiC, Si₃N₄ CBN and diamond — properties, processing and applications.

REFERENCES

ED7204 INTEGRATED MECHANICAL DESIGN (Use of Approved Data Book Is Permitted) 3 1 0 4

OBJECTIVE:
• To know the integrated design procedure of different machine elements for mechanical applications.

OUTCOME:
• This will familiarize the students with the concepts of integration of design of machines and structures.
UNIT I  FUNDAMENTALS AND DESIGN OF SHAFTS
Oblique stresses – Transformation Matrix – Principal stresses – Maximum shear stress - Theories of Failure – Ductile vs. brittle component design -
Analysis and Design of shafts for different applications – integrated design of shaft, bearing and casing – Design for rigidity

UNIT II  DESIGN OF GEARS AND GEAR BOXES

UNIT III  BRAKES & CLUTCHES
Dynamics and thermal aspects of brakes and clutches – Integrated design of brakes and clutches for machine tools, automobiles and mechanical handling equipments.

UNIT IV  INTEGRATED DESIGN
Integrated Design of systems consisting of shaft, bearings, springs, motor, gears, belt, rope, chain, pulleys, Cam & Follower, flywheel etc. Example - Design of Elevators, Escalators, Gear Box, Valve gear Mechanisms, Machine Tools

T=15, TOTAL: 60 PERIODS

The Pattern of Question Paper will consist one Question from Unit – 4 for 50% of total marks.

a Term Project must be given for Assessment – 3 (Compulsory)

REFERENCES

Approved Data Books

ED7211  ANALYSIS AND SIMULATION LABORATORY
L T P C 0 0 2 1

OBJECTIVES:
• At the end of this course the students would have developed a thorough understanding of the Computer Aided Finite Element Analysis packages with an ability to effectively use the tools of the analysis for solving practical problems arising in engineering design

OUTCOME:
• It helps the students to get familiarized with the Computer Aided Finite Element Analysis packages which are necessary to solve the engineering problems numerically.
Analysis of Mechanical Components – Use of FEA Packages like ANSYS/ NASTRAN etc.,
Exercises shall include analysis of
i) Machine elements under Static loads
ii) Thermal Analysis of mechanical systems
iii) Modal Analysis
iv) Machine elements under Dynamic loads
v) Non-linear systems

Use of kinematics and dynamics simulation software like ADAMS, MATLAB. Analysis of velocity
and acceleration for mechanical linkages of different mechanisms.

TOTAL: 30 PERIODS

ED7212 DESIGN PROJECT

OBJECTIVES:
- The main objective is to give an opportunity to the student to achieve integrated
mechanical design of a product through parts design assembly preparation of
manufacturing drawings.

GUIDELINE FOR REVIEW AND EVALUATION
Each student works under a project supervisor. The product system /component(s) to be
designed may be decided in consultation with the supervisor and if possible with an industry.
A project report to be submitted by the student which will be reviewed and evaluated for internal
assessment by a Committee constituted by the Head of the Department. At the end of the
semester examination the project work is evaluated based on oral presentation and the project
report jointly by external and internal examiners

TOTAL : 45 PERIODS

OUTCOMES:
- Use of design principles and develop conceptual and engineering design of any
components.
- Ability to integrate the parts design with assembly and ability to prepare manufacturing
drawings.

ED7001 OPTIMIZATION TECHNIQUES IN DESIGN

OBJECTIVES:
- To impart knowledge on various categories of existing engineering problems and solutions to
such problems through different optimization techniques and approaches.

OUTCOME:
It helps the engineers to get familiarized with the different approaches of optimizing (maximizing
or minimizing) an engineering problem or a function which is essentially required in industries
today.

UNIT I UNCONSTRAINED OPTIMIZATION TECHNIQUES

Introduction to optimum design - General principles of optimization – Problem formulation & their
classifications - Single variable and multivariable optimization, Techniques of unconstrained
minimization – Golden section, Random, pattern and gradient search methods – Interpolation
methods.
UNIT II  CONstrained optimization techniques  10
Optimization with equality and inequality constraints - Direct methods – Indirect methods using penalty functions, Lagrange multipliers - Geometric programming

UNIT III  advanced optimization techniques  10
Multi stage optimization – dynamic programming; stochastic programming; Multi objective optimization, Genetic algorithms and Simulated Annealing techniques; Neural network & Fuzzy logic principles in optimization.

UNIT IV  static applications  8

UNIT V  dynamic applications  7
Dynamic Applications – Optimum design of single, two degree of freedom systems, vibration absorbers. Application in Mechanisms – Optimum design of simple linkage mechanisms.

TOTAL: 45 PERIODS

REFERENCES

ED7003  composite materials and mechanics  L T P C
3 0 0 3

OBJECTIVES:
• To understand the fundamentals of composite material strength and its mechanical behavior
• Understanding the analysis of fiber reinforced Laminate design for different combinations of plies with different orientations of the fiber.
• Thermo-mechanical behavior and study of residual stresses in Laminates during processing.
• Implementation of Classical Laminate Theory (CLT) to study and analysis for residual stresses in an isotropic layered structure such as electronic chips.

OUTCOME:
• At the end of the course the students will be in position to understand the mechanics and design related to layered components such as fiber reinforced polymer composites, isotropic layered structures (example electronic chips) etc and its manufacturing methodologies.

UNIT I  introduction to composite materials  10

UNIT II  manufacturing of composites  10
Manufacturing of Polymer Matrix Composites (PMCs)-handlay-up, spray technique, filament winding, Pultrusion, Resin Transfer Moulding (RTM)-, bag moulding, injection moulding, Sandwich
UNIT III INTRODUCTION, LAMINA CONSTITUTIVE EQUATIONS


UNIT IV LAMINA STRENGTH ANALYSIS AND ANALYSIS OF LAMINATED FLAT PLATES


UNIT V THERMAL ANALYSIS


TOTAL: 45 PERIODS

REFERENCES

ED7005 DESIGN OF MATERIAL HANDLING EQUIPMENTS L T P C
(Use of Approved Data Book Is Permitted) 3 0 0 3

OBJECTIVES:
- To impart students on the need, use, application and design of different material handling techniques, equipments and machines used in common use and in industrial sector

OUTCOME:
- The course would familiarize the student on the technique to select suitable material handling equipment and design them based on the need.
UNIT I MATERIALS HANDLING EQUIPMENT
Types, selection and applications

UNIT II DESIGN OF HOISTS

UNIT III DRIVES OF HOISTING GEAR
Hand and power drives - Traveling gear - Rail traveling mechanism - cantilever and monorail cranes - slewing, jib and luffing gear - cogwheel drive - selecting the motor ratings.

UNIT IV CONVEYORS
Types - description - design and applications of Belt conveyors, apron conveyors and escalators Pneumatic conveyors, Screw conveyors and vibratory conveyors.

UNIT V ELEVATORS
Bucket elevators: design - loading and bucket arrangements - Cage elevators - shaft way, guides, counter weights, hoisting machine, safety devices - Design of fork lift trucks.

TOTAL :45 PERIODS

REFERENCES

ED7006 PLATES AND SHELLS

OBJECTIVES:
- To impart knowledge on the behavior of plates and shell elements, their places of utility and of course the design procedure of such elements in practical applications.

OUTCOME:
After undergoing this course, the students would be in a position to understand the behaviour of these commonly occurring structural elements in engineering design and would have developed the capability to design and analyse them in their normal design practice.

UNIT I GENERAL INTRODUCTION
Review of equations of elasticity- kinematics, compatibility equations, stress measures- equations of motions- constitutive relations- transformation of stresses, strains and stiffness-energy principles and variational methods in elasticity- virtual work-external and internal virtual work- variational operator- functionals- Euler Lagrange equations- energy principles- Hamilton’s principle- principle of minimum total potential- applications

UNIT II CLASSICAL THEORY OF PLATES
Plates as structural elements- stress and moment resultants- assumptions made in the classical theory- displacement fields and strains- equations of equilibrium in Cartesian coordinates and in polar coordinates- boundary conditions – bending of rectangular plates with various boundary
conditions and loading- symmetrical and asymmetrical bending of circular plates-limitations of classical theory- finite element analysis(elementary treatment only; discussion of various elements used and their capabilities- not for examination)

UNIT III BUCKLING ANALYSIS OF RECTANGULAR PLATES
Buckling of simply supported plates under compressive forces- governing equations- the Navier solution- biaxial compression of a plate- uniaxial compression of a plate- buckling of plates simply supported on two opposite edges- Levy’s solution- buckling of plates with various boundary conditions- general formulation- finite element analysis(elementary treatment only; discussion of various elements used and their capabilities- not for examination)

UNIT IV VIBRATION OF PLATES
Governing equations for natural flexural vibrations of rectangular plates- natural vibrations of plates simply supported on all edges- vibration of plates with two parallel sides simply supported- Levy’s solution- vibration of plates with different boundary conditions- Rayleigh-Ritz method- Natural vibration of plates with general boundary conditions- transient analysis of rectangular plates- finite element analysis(elementary treatment only; discussion of various elements used and their capabilities- not for examination)

UNIT V ANALYSIS OF THIN ELASTIC SHELLS OF REVOLUTION
Classification of shell surfaces- geometric properties of shells of revolution- general strain displacement relations for shells of revolution- stress resultants- equations of motion of thin shells- analytical solution for thin cylindrical shells- membrane theory- flexure under axisymmetric loads- shells with double curvature- geometric considerations- equations of equilibrium- bending of spherical shells- vibration of cylindrical shells- finite element analysis(elementary treatment only; discussion of various elements used and their capabilities- not for examination)

TOTAL: 45 PERIODS

REFERENCES
4. Wilhelm Flügge, stresses in shells, Springer - Verlag
7. Dr.N.Subramanian, Principles of Space Structures, Wheeler Publishing Co. 1999

ED7007 MODAL ANALYSIS OF MECHANICAL SYSTEMS L T P C
3 0 0 3

OBJECTIVES:
• To impart knowledge on modal testing, modal analysis of single and multi-degree of freedom systems.

OUTCOME:
It helps the students to get familiarized with the modal testing, modal analysis of single and multi-degree of freedom systems.
UNIT I  
OVERVIEW

UNIT II  
THEORETICAL BASIS

UNIT III  
MOBILITY MEASUREMENT TECHNIQUES

UNIT IV  
MODAL PARAMETER EXTRACTION METHODS

UNIT V  
DERIVATION OF MATHEMATICAL MODELS

TOTAL : 45 PERIODS

REFERENCES

ED7008  
ADVANCED METAL FORMING TECHNIQUES

OBJECTIVES:
- To study the concepts of latest metal forming techniques and their applications in metal forming industry.
- To study the thermo mechanical regimes and its requirements of metal forming

OUTCOME:
- The course would familiarize the students on the latest metal forming techniques and help them decide on the suitable method to form the metals for various industrial applications.

UNIT I  
INTRODUCTION TO THEORY OF PLASTICITY AND FORMING

UNIT II  
THEORY AND PRACTICE OF BULK FORMING PROCESSES
Analysis of plastic deformation in Forging, Rolling, Extrusion, rod/wire drawing and tube drawing – Effect of friction – calculation of forces, work done – Process parameters, equipment used – Defects – applications – Recent advances in Forging, Rolling, Extrusion and Drawing processes –
Design consideration in forming - Formability of laminated sheet - Overview of FEM applications in Metal Forming analysis.

UNIT III SHEET METAL FORMING
Formability studies – Conventional processes – H E R F techniques – Superplastic forming techniques – Hydro forming – Stretch forming – Water hammer forming – Principles and process parameters – Advantage, Limitations and application

UNIT IV POWDER METALLURGY AND SPECIAL FORMING PROCESSES

UNIT V ELECTROMAGNETIC FORMING AND ITS APPLICATIONS

TOTAL: 45 PERIODS

REFERENCES
2. Proceedings of International Workshop on EMFT 2010, Anna University

ED7010 TRIBOLOGY IN DESIGN

OBJECTIVES:
- To impart knowledge in the friction, wear and lubrication aspects of machine components
- To understand the material properties which influence the tribological characteristics of surfaces.
- To understand the analytical behavior of different types bearings and design of bearings based on analytical/theoretical approach

OUTCOME:
- Ability to select material/surface properties based on the tribological requirements
- Methodology for deciding lubricants and lubrication regimes for different operating conditions
- Analysis ability of different types of bearings for given load/speed conditions.

UNIT I SURFACE INTERACTION AND FRICTION
Topography of Surfaces – Surface features-Properties and measurement – Surface interaction – Adhesive Theory of Sliding Friction –Rolling Friction-Friction properties of metallic and non-metallic materials – friction in extreme conditions –Thermal considerations in sliding contact

19
UNIT II WEAR AND SURFACE TREATMENT

UNIT III LUBRICANTS AND LUBRICATION REGIMES

UNIT IV THEORY OF HYDRODYNAMIC AND HYDROSTATIC LUBRICATION
Reynolds Equation, Assumptions and limitations-One and two dimensional Reynolds Equation-Reynolds and Sommerfeld boundary conditions- Pressure wave, flow, load capacity and friction calculations in Hydrodynamic bearings-Long and short bearings-Pad bearings and Journal bearings-Squeeze film effects-Thermal considerations-Hydrostatic lubrication of Pad bearing-Pressure , flow , load and friction calculations-Stiffness considerations- Various types of flow restrictors in hydrostatic bearings

UNIT V HIGH PRESSURE CONTACTS AND ELASTO HYDRODYNAMIC LUBRICATION
Rolling contacts of Elastic solids- contact stresses – Hertzian stress equation- Spherical and cylindrical contacts-Contact Fatigue life- Oil film effects- Elasto Hydrodynamic lubrication Theory- Soft and hard EHL-Reynolds equation for elasto hydrodynamic lubrication- Film shape within and outside contact zones-Film thickness and friction calculation- Rolling bearings- Stresses and deflections-Traction drives

REFERENCES

ED7012 SURFACE ENGINEERING

OBJECTIVES:
- To impart knowledge on surface engineering and surface modification methods that will come in handy to solve the industrial problems. This will also serve as a precursor for future research in the same field.

UNIT I FRICTION
Topography of Surfaces – Surface features – Properties and measurement – Surface interaction – Adhesive Theory of Sliding Friction – Rolling Friction – Friction properties of metallic and non metallic materials – Friction in extreme conditions – Thermal considerations in sliding contact
UNIT II WEAR
Introduction – Abrasive wear, Erosive, Cavitation, Adhesion, Fatigue wear and Fretting Wear-
Laws of wear – Theoretical wear models – Wear of metals and non metals - International
standards in friction and wear measurements

UNIT III CORROSION
Introduction – Principle of corrosion – Classification of corrosion – Types of corrosion – Factors
influencing corrosion – Testing of corrosion – In-service monitoring, Simulated service, Laboratory
testing – Evaluation of corrosion – Prevention of Corrosion – Material selection, Alteration of
environment, Design, Cathodic and Anodic Protection, Corrosion inhibitors

UNIT IV SURFACE TREATMENTS
Introduction – Surface properties, Superficial layer – Changing surface metallurgy – Wear resistant
coatings and Surface treatments – Techniques – PVD – CVD – Physical CVD – Ion implantation –
Surface welding – Thermal spraying – Laser surface hardening and alloying, Applications of
coatings and surface treatments in wear and friction control – Characteristics of Wear resistant
coatings – Other coatings, Corrosion resistant coatings

UNIT V ENGINEERING MATERIALS
Introduction – Advanced alloys – Super alloys, Titanium alloys, Magnesium alloys, Aluminium
alloys, and Nickel based alloys – Ceramics – Polymers – Biomaterials – Applications – Bio
Tribology Nano Tribology.

OUTCOME:
• It helps the students to get familiarized with the various theories and practice on surface
  engineering and surface modification methods which are necessary to solve the industrial
  practical problems that arise and also for the research.

REFERENCES
   2005
   Ltd , New Delhi, 2005

ED7002 ENGINEERING FRACTURE MECHANICS

OBJECTIVES:
• To impart knowledge on mechanics of cracked components of different modes by which these
  components fail under static load conditions.
• To impart knowledge on mechanics of cracked components of different modes by which these
  components fail under fatigue load conditions.

OUTCOME:
• It helps the engineers to get familiarized with the design of components that contain crack
  under static load condition.
• It helps the engineers to get familiarized with the design of components that contain crack and
  its growth under fatigue load condition.
UNIT I ELEMENTS OF SOLID MECHANICS 9
The geometry of stress and strain, elastic deformation, plastic and elasto-plastic deformation - limit analysis – Airy's function – field equation for stress intensity factor.

UNIT II STATIONARY CRACK UNDER STATIC LOADING 9

UNIT III ENERGY BALANCE AND CRACK GROWTH 9

UNIT IV FATIGUE CRACK GROWTH CURVE 9
Empirical relation describing crack growth law – life calculations for a given load amplitude – effects of changing the load spectrum -- rain flow method– external factors affecting the K1c values.- leak before break analysis.

UNIT V APPLICATIONS OF FRACTURE MECHANICS 9
Crack Initiation under large scale yielding – thickness as a design parameter – mixed mode fractures - crack instability in thermal and residual stress fields - numerical methods

TOTAL: 45 PERIODS

REFERENCES

ED7004 DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS L T P C
3 0 0 3

OBJECTIVES:
• To impart students on the science, use and application of hydraulics and pneumatics as fluid power in Industry. Also to impart knowledge on the methodology of basic and advanced design of pneumatics and hydraulics systems.

OUTCOME:
• It helps students to get knowledge on the need, use and application of fluid power and make them familiar to industrial design that lead to automation.

UNIT I OIL HYDRAULIC SYSTEMS AND HYDRAULIC ACTUATORS 5
Hydraulic Power Generators – Selection and specification of pumps, pump characteristics. Linear and Rotary Actuators – selection, specification and characteristics.

UNIT II CONTROL AND REGULATION ELEMENTS 12
Pressure - direction and flow control valves - relief valves, non-return and safety valves - actuation systems.

UNIT III HYDRAULIC CIRCUITS 5

UNIT IV PNEUMATIC SYSTEMS AND CIRCUITS 16
Pneumatic fundamentals - control elements, position and pressure sensing - logic circuits - switching circuits - fringe conditions modules and these integration - sequential circuits - cascade methods - mapping methods - step counter method - compound circuit design - combination circuit design.

UNIT V  
INSTALLATION, MAINTENANCE AND SPECIAL CIRCUITS  
7  
Pneumatic equipments - selection of components - design calculations – application - fault finding - hydro pneumatic circuits - use of microprocessors for sequencing - PLC, Low cost automation - Robotic circuits.

REFERENCES  

ED7009  
DESIGN OF PRESSURE VESSEL AND PIPING  
L T P C  
3 0 0 3  

OBJECTIVES  
- The main objective is to present the industrial related problems, procedures and design principles for pressure vessels and enhance the understanding of design procedure of pressure vessel and Design of piping layout.

OUTCOME  
- It helps the student to get familiarized with the various theories and practice on pressure vessel and piping design and procedures which are necessary to solve the industrial practical problems that arise and also for the research in the field of pressure vessel design.

UNIT I  
INTRODUCTION  
3  

UNIT II  
STRESSES IN PRESSURE VESSELS  
15  

UNIT III  
DESIGN OF VESSELS  
15  

UNIT IV  
BUCKLING OF VESSELS  
8  
Buckling phenomenon – Elastic Buckling of circular ring and cylinders under external pressure – collapse of thick walled cylinders or tubes under external pressure – Effect of supports on Elastic Buckling of Cylinders – Buckling under combined External pressure and axial loading.

UNIT V  
PIPING  
4  

TOTAL: 45 PERIODS
REFERENCES

ED7011 BEARING DESIGN AND ROTOR DYNAMICS

OBJECTIVES:
- To know about different types of bearings available for machine design and their operating principles
- To design hydrodynamic/ hydrostatic / rolling bearing for given specifications and analyze the bearings for their performance
- To understand the bearing behavior under dynamic conditions

OUTCOME:
- Acquisition of knowledge in the analysis of all types of bearings.
- Ability to make specifications of all types of bearings
- Skill for conducting dynamic / vibration analysis and trouble shooting of bearings

UNIT I CLASSIFICATION AND SELECTION OF BEARINGS
Selection criteria-Dry and Boundary Lubrication Bearings-Hydrodynamic and Hydrostatic bearings-Electro Magnetic bearings-Dry bearings-Rolling Element bearings- Bearings for Precision Applications-Foil Bearings-Special bearings- Selection of plain Bearing materials –Metallic and Non metallic bearings

UNIT II DESIGN OF FLUID FILM BEARINGS

UNIT III SELECTION AND DESIGN OF ROLLING BEARINGS
Contact Stresses in Rolling bearings- Centrifugal stresses-Elasto hydrodynamic lubrication-Fatigue life calculations- Bearing operating temperature- Lubrication- Selection of lubricants-Internal clearance – Shaft and housing fit- -Mounting arrangements-Materials for rolling bearings-Manufacturing methods- Ceramic bearings-Rolling bearing cages-bearing seals selection

UNIT IV DYNAMICS OF HYDRO_DYNAMIC BEARINGS
Hydrodynamic Lubrication equation for dynamic loadings-Squeeze film effects in journal bearings and thrust bearings -Rotating loads , alternating and impulse loads in journal bearings – Journal centre Trajectory- Analysis of short bearings under dynamic conditions- Finite difference solution for dynamic conditions

UNIT V ROTOR DYNAMICS
Rotor vibration and Rotor critical speeds- support stiffness on critical speeds- Stiffness and damping coefficients of journal bearings-computation and measurements of journal bearing coefficients -Mechanics of Hydro dynamic Instability- Half frequency whirl and Resonance whip- Design configurations of stable journal bearings

TOTAL: 45 PERIODS
REFERENCES

ED7013 ADVANCED FINITE ELEMENT ANALYSIS L T P C 3 0 0 3

OBJECTIVES:
• To develop a thorough understanding of the advanced finite element analysis techniques with an ability to effectively use the tools of the analysis for solving practical problems arising in engineering design

OUTCOME:
It helps the students to get familiarized with the advanced finite element analysis techniques which are necessary to solve the engineering problems.

UNIT I BENDING OF PLATES AND SHELLS 9

UNIT II NON LINEAR PROBLEMS 10

UNIT III DYNAMIC PROBLEM 8

UNIT IV FLUID MECHANICS AND HEAT TRANSFER 9

UNIT V ERROR ESTIMATES AND ADAPTIVE REFINEMENT 9
Error norms and Convergence rates – h-refinement with adaptivity – Adaptive refinement.

TOTAL: 45 PERIODS

REFERENCES
AIM
This course aims to introduce numerical modeling and its role in the field of heat and fluid flow, it will enable the students to understand the various discrimination methods and solving methodologies and to create confidence to solve complex problems in the field of heat transfer and fluid dynamics.

OBJECTIVES:
- To develop finite difference and finite volume discredited forms of the CFD equations.
- To formulate explicit & implicit algorithms for solving the Euler Eqns & Navier Stokes Eqns.

UNIT I GOVERNING DIFFERENTIAL EQUATION AND FINITE DIFFERENCE METHOD 10
Classification, Initial and Boundary conditions, Initial and Boundary value problems. Finite difference method, Central, Forward, Backward difference, Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test.

UNIT II CONDUCTION HEAT TRANSFER 10
Steady one-dimensional conduction, Two and Three dimensional steady state problems, Transient one-dimensional problem, Two-dimensional Transient Problems.

UNIT III INCOMPRESSIBLE FLUID FLOW 10

UNIT IV CONVECTION HEAT Transfer AND FEM 10

UNIT V TURBULENCE MODELS 5
Algebraic Models – One equation model, K - € Models, Standard and High and Low Reynolds number models, Prediction of fluid flow and heat transfer using standard codes.

TOTAL: 45 PERIODS

REFERENCES
CC7201  DESIGN FOR MANUFACTURE, ASSEMBLY AND ENVIRONMENTS  L  T  P  C
3 0 0 3

OBJECTIVES:
- To know the concept of design for manufacturing, assembly and environment.
- To know the computer application in design for manufacturing and assembly.

OUTCOME:
- To make the students get acquainted with the design for manufacturing, assembly and environment.

UNIT I  INTRODUCTION
General design principles for manufacturability - strength and mechanical factors, mechanisms selection, evaluation method, Process capability - Feature tolerances Geometric tolerances - Assembly limits -Datum features - Tolerance stacks.

UNIT II  FACTORS INFLUENCING FORM DESIGN
Working principle, Material, Manufacture, Design- Possible solutions - Materials choice - Influence of materials on form design - form design of welded members, forgings and castings.

UNIT III  COMPONENT DESIGN - MACHINING CONSIDERATION

UNIT IV  COMPONENT DESIGN – CASTING CONSIDERATION
Redesign of castings based on Parting line considerations - Minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design - Modifying the design - group technology - Computer Applications for DFMA

UNIT V  DESIGN FOR THE ENVIRONMENT

TOTAL: 45 PERIODS

REFERENCES