UNIVERSITY DEPARTMENTS

ANNA UNIVERSITY : : CHENNAI 600 025

REGULATIONS - 2013

M.E. ENGINEERING DESIGN (FT & PT)

I TO IV SEMESTERS CURRICULUM AND SYLLABUS

SEMESTER I

S.NO	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	ED8151	Advanced Mechanics of Materials	3	0	0	3
2.	ED8152	Computer Applications in Design	3	0	2	4
3.	ED8153	Quality Concepts in Design	3	0	0	3
4.	ED8154	Vibration Analysis and Control **	3	0	2	4
5.	MA8155	Advanced Numerical Methods	3	1	0	4
6.		Elective I	3	0	0	3
PRACTICAL						
7.	ED8161	CAD Lab	0	0	2	1
		TOTAL	**18**	**1**	**6**	**22**

SEMESTER II

S.NO	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	ED8201	Behavior of Engineering Materials	3	0	0	3
2.	ED8251	Finite Element Methods in Mechanical Design	3	1	0	4
3.	ED8252	Integrated Mechanical Design	3	1	0	4
4.	ED8253	Mechanisms Design and Simulation	3	0	2	4
5.		Elective II	3	0	0	3
6.		Elective III	3	0	0	3
PRACTICAL						
7.	ED8211	Design Project	0	0	3	2
8.	ED8261	Analysis and Simulation Lab	0	0	2	1
		TOTAL	**18**	**2**	**7**	**24**

SEMESTER III

S.NO	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.		Elective IV	3	0	0	3
2.		Elective V	3	0	0	3
3.		Elective VI	3	0	0	3
4.	ED8311	Project Work Phase I	0	0	12	6
		TOTAL	**9**	**0**	**12**	**15**

SEMESTER IV

S.NO	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	ED8411	Project Work Phase II	0	0	24	12
		TOTAL	**0**	**0**	**24**	**12**
** a Term Project must be given for Assessment – 3 (Compulsory) **(Total number of credits: 22 + 24 + 15 + 12 = 73)**						

ELECTIVES FOR M.E. ENGINEERING DESIGN FOR REGULATIONS 2013

S.NO	COURSE CODE	COURSE TITLE	L	T	P	C
1.	ED8001	Advanced Metal Forming Techniques	3	0	0	3
2.	ED8002	Plates and Shells	3	0	0	3
3.	ED8003	Surface Engineering	3	0	0	3
4.	ED8071	Advanced Finite Element Analysis	3	0	0	3
5.	ED8072	Bearing Design and Rotor Dynamics	3	0	0	3
6.	ED8073	Composite Materials and Mechanics	3	0	0	3
7.	ED8074	Design for Manufacture Assembly and Environments	3	0	0	3
8.	ED8075	Design Of Hydraulic And Pneumatic Systems	3	0	0	3
9.	ED8076	Design of Material Handling Equipments	3	0	0	3
10.	ED8077	Design of Pressure Vessel and Piping	3	0	0	3
11.	ED8078	Engineering Fracture Mechanics	3	0	0	3
12.	ED8079	Modal Analysis of Mechanical Systems	3	0	0	3
13.	ED8080	Optimization Techniques In Design	3	0	0	3
14.	ED8081	Tribology in Design	3	0	0	3
15.	RA8071	Computational Fluid Dynamics	3	0	0	3

UNIVERSITY DEPARTMENTS

ANNA UNIVERSITY : : CHENNAI 600 025

REGULATIONS - 2013

M.E.ENGINEERING DESIGN (PART TIME)

I TO VI SEMESTERS CURRICULUM AND SYLLABUS

SEMESTER I

S.NO	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	MA8155	Advanced Numerical Methods	3	1	0	4
2.	ED8151	Advanced Mechanics of Materials	3	0	0	3
3.	ED8152	Computer Applications in Design	3	0	2	4
PRACTICAL						
4.	ED8161	CAD Lab	0	0	2	1
		TOTAL	**9**	**1**	**4**	**12**

SEMESTER II

S.NO	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	ED8251	Finite Element Methods in Mechanical Design	3	1	0	4
2.	ED8253	Mechanisms Design and Simulation**	3	0	2	4
3.	ED8201	Behavior of Engineering Materials	3	0	0	3
PRACTICAL						
4.	ED8261	Analysis and Simulation Lab	0	0	2	1
		TOTAL	**9**	**1**	**4**	**12**

SEMESTER III

S.NO	COURSE CODE	COURSE TITLE	L	T	P	C
1.	ED8153	Quality Concepts in Design	3	0	0	3
2.	ED8154	Vibration Analysis and Control**	3	0	2	4
3.		Elective I	3	0	0	3
		TOTAL	**9**	**0**	**2**	**10**

SEMESTER IV

S.NO	COURSE CODE	COURSE TITLE	L	T	P	C
1.	ED8252	Integrated Mechanical Design**	3	1	0	4
2.		Elective II	3	0	0	3
3.		Elective III	3	0	0	3
PRACTICAL						
4.	ED8211	Design Project	0	0	3	2
		TOTAL	**9**	**1**	**3**	**12**

Attested

DIRECTOR
Centre For Academic Courses
Anna University, Chennai-600 025.

SEMESTER V

S.NO	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.		Elective IV	3	0	0	3
2.		Elective V	3	0	0	3
3.		Elective VI	3	0	0	3
4.	ED8311	Project Work Phase I	0	0	12	6
		TOTAL	**9**	**0**	**12**	**15**

SEMESTER VI

S.NO	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	ED8411	Project Work Phase II	0	0	24	12
		TOTAL	**0**	**0**	**24**	**12**
** a Term Project must be given for Assessment – 3 (Compulsory) **(Total number of credits: 12+12+10+12+ 15 + 12 = 73)**						

ELECTIVES FOR M.E. ENGINEERING DESIGN FOR REGULATIONS 2013

S.NO	COURSE CODE	COURSE TITLE	L	T	P	C
1.	ED8001	Advanced Metal Forming Techniques	3	0	0	3
2.	ED8002	Plates and Shells	3	0	0	3
3.	ED8003	Surface Engineering	3	0	0	3
4.	ED8071	Advanced Finite Element Analysis	3	0	0	3
5.	ED8072	Bearing Design and Rotor Dynamics	3	0	0	3
6.	ED8073	Composite Materials and Mechanics	3	0	0	3
7.	ED8074	Design for Manufacture Assembly and Environments	3	0	0	3
8.	ED8075	Design of Hydraulic and Pneumatic systems	3	0	0	3
9.	ED8076	Design of Material Handling Equipments	3	0	0	3
10.	ED8077	Design of Pressure Vessel and Piping	3	0	0	3
11.	ED8078	Engineering Fracture Mechanics	3	0	0	3
12.	ED8079	Modal Analysis of Mechanical Systems	3	0	0	3
13.	ED8080	Optimization Techniques In Design	3	0	0	3
14.	ED8081	Tribology in Design	3	0	0	3
15.	RA8071	Computational Fluid Dynamics	3	0	0	3

Attested

DIRECTOR
Centre For Academic Courses
Anna University, Chennai-600 025.

ED8151 ADVANCED MECHANICS OF MATERIALS L T P C
3 0 0 3

OBJECTIVE:

- 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

Stress-Strain relations and general equations of elasticity in Cartesian, Polar and curvilinear coordinates, differential equations of equilibrium-compatibility-boundary conditions-representation of three-dimensional stress of a tension generalized hook's law - St. Venant's principle - plane stress - Airy's stress function. Energy methods.

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.

TOTAL : 45 PERIODS

REFERENCES:

1. Arthur P Boresi, Richard J. Schmidt, "Advanced mechanics of materials",John Wiley, 2002.
2. Timoshenko and Goodier, "Theory of Elasticity", McGraw Hill.
3. Robert D. Cook, Warren C. Young, "Advanced Mechanics of Materials", Mc- millan pub. Co., 1985.
4. Srinath. L.S., "Advanced Mechanics of solids", Tata McGraw Hill, 1992.
5. G H Ryder Strength of Materials Macmillan, India Ltd, 2007.
6. Allan F. Bower, "Applied Mechanics of Solids", CRC press – Special Indian Edition -2012, 2010
7. K. Baskar and T.K. Varadan, "Theory of Isotropic/Orthotropic Elasticity", Ane Books Pvt. Ltd., New Delhi, 2009

ED8152 COMPUTER APPLICATIONS IN DESIGN L T P C
3 0 2 4

OBJECTIVE:

- 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.

Introduction to surfaces - Analytical surfaces: Plane surface, ruled surface , surface of revolution and tabulated cylinder – synthetic surfaces: Hermite bicubic surface- Bezier surface and B-Spline surface- surface manipulations.

UNIT III NURBS AND SOLID MODELING 9

NURBS- Basics- curves , lines, arcs, circle and bi linear surface. Regularized Boolean set operations - primitive instancing - sweep representations - boundary representations - constructive solid Geometry - comparison of representations - user interface for solid modeling.

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.

NOTE: LAB PRACTICE OF 30 HRS. TOTAL 45 + 30 = 75 HOURS

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.

REFERENCES:

1. William M Neumann and Robert F.Sproul "Principles of Computer Graphics", Mc Graw Hill Book Co. Singapore, 1989.
2. Donald Hearn and M. Pauline Baker "Computer Graphics", Prentice Hall, Inc., 1992.
3. Ibrahim Zeid Mastering CAD/CAM – McGraw Hill, International Edition, 2007.
4. Foley, Wan Dam, Feiner and Hughes – Computer graphics principles & practices, Pearson Education – 2003.
5. David F. Rogers, James Alan Adams "Mathematical elements for computer graphics" second edition, Tata McGraw-Hill edition.

Attested

DIRECTOR
Centre For Academic Courses
Anna University, Chennai-600 025.

ED8153 QUALITY CONCEPTS IN DESIGN L T P C
3 0 0 3

OBJECTIVE:

- 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

Morphology of Design – The Design Process – Computer Aided Engineering – Concurrent Engineering – Competition Bench Marking – Creativity – Theory of Problem solving (TRIZ) – Value Analysis - Design for Manufacture, Design for Assembly – Design for casting, Forging, Metal Forming, Machining and Welding

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, 2^K 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:

1. Dieter, George E., "Engineering Design - A Materials and Processing Approach", McGraw Hill, International Editions, Singapore, 2000.
2. Product Design Techniques in Reverse Engineering and New Product Development, KEVIN OTTO & KRISTIN WOOD, Pearson Education (LPE), 2001.
3. Product Design And Development, KARL T. ULRICH, STEVEN D. EPPINGER, TATA McGRAW-HILL- 3rd Edition, 2003.
4. The Management and control of Quality-6th edition-James R. Evens, William M Lindsay Pub:son south-western(www.swlearning.com)
5. Fundamentals of Quality control and improvement 2nd edition, AMITAVA MITRA, Pearson Education Asia, 2002.

6. Montgomery, D.C., Design and Analysis of experiments, John Wiley and Sons, 2003.
7. Phillip J.Rose, Taguchi techniques for quality engineering, McGraw Hill, 1996.

ED8154 VIBRATION ANALYSIS AND CONTROL [**] **L T P C**
3 0 2 4

OBJECTIVE:

- 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

Introduction -Sources Of Vibration-Mathematical Models- Displacement, velocity and Acceleration-Review Of Single Degree Freedom Systems -Vibration isolation Vibrometers and accelerometers - . Response To Arbitrary and non- harmonic Excitations – Transient Vibration –Impulse loads-Critical Speed Of Shaft-Rotor systems.

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

Specification of Vibration Limits –Vibration severity standards- Vibration as condition Monitoring tool-Vibration Isolation methods- -Dynamic Vibration Absorber, Torsional and Pendulum Type Absorber- Damped Vibration absorbers-Static and Dynamic Balancing-Balancing machines-Field balancing – Vibration Control by Design Modification- - Active Vibration Control

UNIT V EXPERIMENTAL METHODS IN VIBRATION ANALYSIS 10

Vibration Analysis Overview - Experimental Methods in Vibration Analysis.-Vibration Measuring Instruments - Selection of Sensors- Accelerometer Mountings. -Vibration Exciters-Mechanical, Hydraulic, Electromagnetic And Electrodynamics –Frequency Measuring Instruments-. System Identification from Frequency Response -Testing for resonance and mode shapes

TOTAL 45 + 30 = 75 PERIODS

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

REFERENCES:

1. Rao, S.S.," Mechanical Vibrations," Addison Wesley Longman, 1995.
2. Thomson, W.T. – "Theory of Vibration with Applications", CBS Publishers and Distributors, New Delhi, 1990
3. Ramamurti. V, "Mechanical Vibration Practice with Basic Theory", Narosa, New Delhi, 2000.
4. S. Graham Kelly & Shashidar K. Kudari, "Mechanical Vibrations", Tata McGraw –Hill Publishing Com. Ltd New Delhi,2007

MA8155 ADVANCED NUMERICAL METHODS L T P C
3 1 0 4

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 (9+3)

Systems of linear equations: Gauss Elimination method, pivoting techniques, Thomas algorithm for tridiagonal system – Jacobi, Gauss Seidel, SOR iteration methods - Systems of nonlinear equations: Fixed point iterations, Newton Method, Eigenvalue problems: power method, inverse power method, Faddeev – Leverrier Method.

UNIT II ORDINARY DIFFERENTIAL EQUATIONS (9+3)

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 (9+3)

Parabolic equations: explicit and implicit finite difference methods, weighted average approximation - Dirichlet and Neumann conditions – Two dimensional parabolic equations – ADI method; First order hyperbolic equations – method of characteristics, different explicit and implicit methods; numerical stability analysis, method of lines – Wave equation: Explicit scheme-Stability of above schemes.

UNIT IV FINITE DIFFERENCE METHODS FOR ELLIPTIC EQUATIONS (9+3)

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 (9+3)

Partial differential equations – Finite element method - orthogonal collocation method, orthogonal collocation with finite element method, Galerkin finite element method.

L:45 +T: 15 TOTAL: 60 PERIODS

REFERENCES

1. Saumyen Guha and Rajesh Srivastava, "Numerical methods for Engineering and Science", Oxford Higher Education, New Delhi, 2010.
2. Gupta S.K., "Numerical Methods for Engineers", New Age Publishers, 1995.

3. Burden, R.L., and Faires, J.D., “Numerical Analysis – Theory and Applications”, Cengage Learning, India Edition, New Delhi, 2009
4. Jain M. K., Iyengar S. R., Kanchi M. B., Jain , “Computational Methods for Partial Differential Equations”, New Age Publishers, 1993.
5. Morton K.W. and Mayers D.F., “Numerical solution of partial differential equations”,Cambridge University press, Cambridge, 2002.

ED8161 CAD LAB L T P C
0 0 2 1

OBJECTIVE:
- 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

ED8201 BEHAVIOR OF ENGINEERING MATERIALS L T P C
3 0 0 3

OBJECTIVE:
- 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 12

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 10

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 8

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 8

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 7

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, Al_2O3, SiC, Si_3N_4 CBN and diamond – properties, processing and applications.

TOTAL:45 PERIODS

REFERENCES:

1. George E.Dieter, Mechanical Metallurgy, McGraw Hill, 1988
2. Thomas H. Courtney, Mechanical Behavior of Materials, (2nd edition), McGraw Hill, 2000
3. Charles, J.A., Crane, F.A.A. and Fumess, J.A.G., Selection and use of engineering materials, (34d edition), Butterworth-Heiremann, 1997.
4. Flinn, R.A., and Trojan, P.K., Engineering Materials and their Applications, (4th Edition) Jaico, 1999.
5. Metals Hand book, Vol.10, Failure Analysis and Prevention, (10th Edition), Jaico, 1999.
6. Ashby M.F., materials selection in Mechanical Design 2nd Edition, Butter worth 1999.
7. www.astm.org/labs/pages/131350.htm.

ED8251 FINITE ELEMENT METHODS IN MECHANICAL DESIGN L T P C
3 1 0 4

OBJECTIVE:

- 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

OUTCOMES:

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

Historical Background – Weighted Residual Methods - Basic Concept of FEM – Variational Formulation of B.V.P. – Ritz Method – Finite Element Modelling – Element Equations – Linear and Quadratic Shape functions – Bar, Beam Elements – Bars and beams of arbitrary orientation - Applications to Heat Transfer problems.

Attested

DIRECTOR
Centre For Academic Courses
Anna University, Chennai-600 025.

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

Introduction to Theory of Elasticity – Plane Stress – Plane Strain and Axisymmetric Formulation – Principle of virtual work – Element matrices using energy approach – Examples related to one-dimensional and two-dimensional problems.

UNIT III ISO-PARAMETRIC FORMULATION 8+3

Natural Co-ordinate Systems – Lagrangian Interpolation Polynomials – Isoparametric Elements – Formulation – Numerical Integration – Gauss quadrature – one-, two- and three-dimensional triangular elements formulation – rectangular elements – Serendipity elements - Illustrative Examples.

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

Dynamic Analysis – Equation of Motion – Mass & damping matrices – Free Vibration analysis – Natural frequencies of Longitudinal, Transverse and torsional vibration – Introduction to transient field problems. Non-linear analysis. Use of softwares – h & p elements – special element formulation – Solution techniques – Explicit & Implicit methods

TOTAL 45 + 15 = 60 HOURS

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:

1. *Zienkiewicz.O.C, Taylor.R.L,& Zhu,J.Z "The Finite Element Method: Its Basis & Fundamentals", Butterworth-Heinemann (An imprint of Elsevier), First printed in India 2007, India Reprint ISBN:978-81-312-1118-2, published by Elsevier India Pvt. Ltd., New Delhi.
2. **Cook, R.D., Malkus, D. S., Plesha,M.E., and Witt,R.J " Concepts and Applications of Finite Element Analysis", Wiley Student Edition, 4th Edition, First Reprint 2007, Authorized reprint by Wiley India(P) Ltd., New Delhi, ISBN-13 978-81-265-1336-9
3. *** Zienkiewicz.O.C, Taylor.R.L "The Finite Element Method" McGraw Hill International Editions, Fourth Edition, 1991, Volume 2 (Chapters 7&8)
4. 4. Reddy, J.N., "Introduction to Non-Linear Finite Element Analysis", Oxford Uniiversity Press, 2008
5. Rao,S.S., "The Finite Element Method in Engineering", Butterworth-Heinemann(An imprint of Elsevier), reprinted 2006,2007, Published by Elsevier India Pvt. Ltd., New Delhi, Indian Reprint ISBN: 978-81-8147-885-6
6. Huebner,K.H., Dewhirst,D.L.,Smith,D.E & Byron,T.G., "The Finite Element Method for Engineers", Wiley Student Edition, Fourth Edition 2004,John Wiley&Sons(Asia)Pve.Ltd., ISBN: 9812-53-154-8
7. Ramamurthi, V., "Finite Element Method in Machine Design", Narosa Publishing House, January 2009, ISBN: 978-81-7319-965-3

Attested

DIRECTOR
Centre For Academic Courses
Anna University, Chennai-600 025.

ED8252 **INTEGRATED MECHANICAL DESIGN**** **L T P C**
(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 8

Phases of design – Standardization and interchangeability of machine elements - Process and Function Tolerances – Individual and group tolerances – Selection of fits for different design situations – Design for assembly and modular constructions – Concepts of integration –BIS, ISO, DIN, BS, ASTM Standards.

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 12

Principles of gear tooth action – Gear correction – Gear tooth failure modes – Stresses and loads – Component design of spur, helical, bevel and worm gears – Design for sub assembly – Integrated design of speed reducers and multi-speed gear boxes – application of software packages.

UNIT III BRAKES & CLUTCHES 7

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 18

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

TOTAL: 45+15=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:

1. Norton L. R., “Machine Design – An Integrated Approach” Pearson Education, 2005
2. Newcomb, T.P. and Spur, R.T., “Automobile Brakes and Braking Systems”, Chapman and Hall, 2nd Edition, 1975.
3. Maitra G.M., “Hand Book of Gear Design”, Tata McGraw Hill, 1985.
4. Shigley, J.E., “Mechanical Engineering Design”, McGraw Hill, 1986.
5. Prasad. L. V., “Machine Design”, Tata McGraw Hill, New Delhi, 1992.
8. Alexandrov, M., Materials Handling Equipments, MIR Publishers, 1981.
9. Boltzharol, A., Materials Handling Handbook, The Ronald Press Company, 1958.

APPROVED DATA BOOKS

1. P.S.G. Tech., “Design Data Book”, Kalaikathir Achchagam, Coimbatore, 2003.
2. Lingaiah. K. and Narayana Iyengar, “Machine Design Data Hand Book”, Vol. 1 & 2, Suma Publishers, Bangalore, 1983

ED8253 MECHANISMS DESIGN AND SIMULATION **L T P C**
3 0 2 4

OBJECTIVE:

- 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**

Review of fundamentals of kinematics-classifications of mechanisms-components of mechanisms – mobility analysis – formation of one D.O.F. multi loop kinematic chains, Network formula – Gross motion concepts-Basic kinematic structures of serial and parallel robot manipulators-Compliant mechanisms-Equivalent mechanisms.

UNIT II KINEMATIC ANALYSIS **9**

Position Analysis – Vector loop equations for four bar, slider crank, inverted slider crank, geared five bar and six bar linkages. Analytical methods for velocity and acceleration Analysis– four bar linkage jerk analysis. Plane complex mechanisms-auxiliary point method. Spatial RSSR mechanism-Denavit-Hartenberg Parameters – Forward and inverse kinematics of robot manipulators.

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**

Type synthesis – Number synthesis – Associated Linkage Concept. Dimensional synthesis – function generation, path generation, motion generation. Graphical methods-Pole technique-inversion technique-point position reduction-two, three and four position synthesis of four- bar mechanisms. Analytical methods- Freudenstein's Equation-Bloch's Synthesis.

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

Cognate Lingages-parallel motion Linkages. Design of six bar mechanisms-single dwell-double dwell-double stroke. Geared five bar mechanism-multi-dwell. Cam Mechanisms- determination of optimum size of cams. Mechanism defects.

Study and use of Mechanism using Simulation Soft-ware packages. Students should design and fabricate a mechanism model as term project.

Note: Tutorial/Practice: 30 Hrs TOTAL 45 + 30 = 75 PERIODS

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

REFERENCES:

1. Robert L.Norton., "Design of Machinery",Tata McGraw Hill, 2005.
2. Sandor G.N., and Erdman A.G., "Advanced Mechanism Design Analysis and Synthesis", Prentice Hall, 1984.
3. Uicker, J.J., Pennock, G. R. and Shigley, J.E., "Theory of Machines and Mechanisms", Oxford University Press, 2005.
4. Amitabha Ghosh and Asok Kumar Mallik, "Theory of Mechanism and Machines", EWLP, Delhi, 1999.
5. Kenneth J, Waldron, Gary L. Kinzel, "Kinematics, Dynamics and Design of Machinery", John Wiley-sons, 1999.
6. Ramamurti, V., "Mechanics of Machines", Narosa, 2005.

ED8211 **DESIGN PROJECT** **L T P C**
0 0 3 2

OBJECTIVE:

- It is proposed to carryout detailed design calculations and analysis of any mechanical component or mechanical system. This helps the students to get familiar with respect to the design methodologies applied to any component or mechanical system subjected to static, dynamic and thermo-mechanical loads.

OUTCOME:

- It helps the students to get familiarized with respect to design standards, design calculations and analysis in designing any mechanical component or system.

  Each student is required to select any new component or an integrated mechanical system that involves various sub components which are to be designed as per design standards and further required to be analyzed for optimum dimensions with respect to the strength and stiffness.

TOTAL: 45 PERIODS

ED8261 **ANALYSIS AND SIMULATION LAB** **L T P C**
0 0 2 1

OBJECTIVE:

- 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

ED8001 **ADVANCED METAL FORMING TECHNIQUES** **L T P C**
3 0 0 3

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 9

Theory of plastic deformation – Yield criteria – Tresca and Von-mises – Distortion energy – Stress-strain relation – Mohr's circle representation of a state of stress – cylindrical and spherical co-ordinate system – upper and lower bound solution methods – thermo elastic Elasto plasticity – elasto visco plasticity

UNIT II THEORY AND PRACTICE OF BULK FORMING PROCESSES 9

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 9

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 9

Overview of P/M technique – Advantages – applications – Powder preform forging – powder rolling – Tooling, process parameters and applications. - Orbital forging – Isothermal forging – Hot and cold isostatic pressing – High speed extrusion – Rubber pad forming – Fine blanking – LASER beam forming

UNIT V ELECTROMAGNETIC FORMING AND ITS APPLICATIONS 9

Electromagnetic Forming Process – Electro – Magnetic Forming Machines – Process Variables – Coils and Dies – Effect of Resistivity and Geometry – EM tube and sheet forming, stamping, shearing and welding – Applications – Finite Element Analysis of EM forming.

TOTAL: 45 PERIODS

REFERENCES:

1. Dieter G.E., Mechanical Metallurgy (Revised Edition II) McGraw Hill Co., 2004
2. Proceedings of International Workshop on EMFT 2010, Anna University
3. Altan T., Metal forming – Fundamentals and applications – American Society of Metals, Metals park, 2003.
4. ASM Hand book, Forming and Forging, Ninth edition, Vol – 14, 2003
5. SHIRO KOBAYASHI, SOO-IK-oh-ALTAN, T,Metal forming and Finite Element Method, Oxford University Press, 2001.
6. ALTAN.T, SOO-IK-oh, GEGEL, HL – Metal forming, fundamentals and Applications, American Society of Metals, Metals Park, Ohio, 1983.
7. Marciniak,Z., Duncan J.L., Hu S.J., 'Mechanics of Sheet Metal Forming', Butterworth-Heinemann An Imprint of Elesevier, 2006
8. Proc. Of National Seminar on "Advances in Metal Forming" MIT, March 2000
9. SAE Transactions, Journal of Materials and Manufacturing Section 5, 1993-2007

ED8002 PLATES AND SHELLS L T P C
3 0 0 3

OBJECTIVE:

- 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.

Attested

DIRECTOR
Centre For Academic Courses
Anna University, Chennai-600 025.

UNIT I GENERAL INTRODUCTION 7

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 10

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 10

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 9

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 9

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:

1. Reddy,J.N., "Theory and Analysis of Elastic Plates & Shells", C.R.C.Press,NY,USA, 2nd Edition
2. Szilard, R., Theory and Analysis of Plates, Prentice Hall Inc., 1995
3. Timoshenko, S. and Krieger S.W. Theory of Plates and Shells, McGraw Hill Book Company, New York 1990.
4. Wilhelm Flügge, stresses in shells, Springer - Verlag
5. Timoshenko, S. Theory of Plates and Shells, McGraw Hill, 1990
6. Ramasamy, G.S., Design and Construction of Concrete Shells Roofs, CBS Publishers, 1986
7. Dr.N.Subramanian, Principles of Space Structures , Wheeler Publishing Co. 1999
8. K. Baskar and T.K. Varadan, "Plates- Theories and Applications", Ane Books Pvt. Ltd., New Delhi, 2013

ED8003 **SURFACE ENGINEERING** **L T P C**
3 0 0 3

OBJECTIVE:

- 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.

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.

UNIT I FRICTION **7**

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 **6**

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 **10**

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 **12**

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 – New trends in coating technology – DLC – CNC – Thick coatings – Nano-engineered coatings – Other coatings, Corrosion resistant coatings

UNIT V ENGINEERING MATERIALS **10**

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

TOTAL: 45 PERIODS

REFERENCES

1. G.W.Stachowiak & A.W .Batchelor , “Engineering Tribology”, Butterworth-Heinemann, UK, 2005
2. Rabinowicz.E, “Friction and Wear of materials”, John Willey &Sons,UK,1995
3. Halling, J. (Editor) – “Principles of Tribology “, Macmillian – 1984.
4. Williams J.A. “Engineering Tribology”, Oxford Univ. Press, 1994.
5. S.K.Basu, S.N.Sengupta & B.B.Ahuja ,”Fundamentals of Tribology”, Prentice –Hall of India Pvt Ltd , New Delhi, 2005
6. Fontana G., “Corrosion Engineering”, McGraw Hill, 1985

ED8071 ADVANCED FINITE ELEMENT ANALYSIS L T P C
3 0 0 3

OBJECTIVE:

- 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

Review of Elasticity Equations – Bending of Plates and Shells – Finite Element Formulation of Plate and Shell Elements - Conforming and Non Conforming Elements – C_0 and C_1 Continuity Elements –Degenerated shell elements- Application and Examples.

UNIT II NON-LINEAR PROBLEMS 10

Introduction – Iterative Techniques – Material non-linearity – Elasto Plasticity – Plasticity – Visco Plasticity – Geometric Non linearity – large displacement Formulation –Solution procedure-Application in Metal Forming Process and Contact Problems.

UNIT III DYNAMIC PROBLEM 8

Direct Formulation – Free, Transient and Forced Response – Solution Procedures – Eigen solution-Subspace Iterative Technique – Response analysis-Houbolt, Wilson, Newmark – Methods – Explicit &Implict Methods- Lanchzos, Reduced method for large size system equations.

UNIT IV FLUID MECHANICS AND HEAT TRANSFER 9

Governing Equations of Fluid Mechanics – Solid structure interaction - Inviscid and Incompressible Flow – Potential Formulations – Slow Non-Newtonian Flow – Metal and Polymer Forming – Navier Stokes Equation – Steady and Transient Solution.

UNIT V ERROR ESTIMATES AND ADAPTIVE REFINEMENT 9

Error norms and Convergence rates – h-refinement with adaptivity – Adaptive refinement.

TOTAL: 45 PERIODS

REFERENCES:

1. Zienkiewicz, O.C. and Taylor, R.L., “The Finite Element Method”, Fourth Edition, Volumes 1 & 2, McGraw Hill International Edition, Physics Services, 1991.
2. Cook R.D., “Concepts and Applications of Finite Element Analysis”,John Wiley and Sons Inc., Newyork, 1989.
3. Bathe K.J., “Finite Element Procedures in Engineering Analysis”, Prentice Hall, 1990.

ED8072 BEARING DESIGN AND ROTOR DYNAMICS L T P C
3 0 0 3

OBJECTIVE:

- 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 6

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 10

Design and performance analysis of Thrust and Journal bearings – Full, partial, fixed and pivoted journal bearings design procedure-Minimum film thickness – lubricant flow and delivery – power loss, Heat and temperature distribution calculations- Design based on Charts & Tables and Experimental curves-Design of Foil bearings-Air Bearings- Design of Hydrostatic bearings-Thrust and Journal bearings- Stiffness consideration - flow regulators and pump design

UNIT III SELECTION AND DESIGN OF ROLLING BEARINGS 10

Contact Stresses in Rolling bearings- Centrifugal stresses-Elasto hydrodynamic lubrication-Fatique 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 HYDRODYNAMIC BEARINGS 10

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 9

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:

1. Neale, M.J. “Tribology Hand Book”, Butterworth Heinemann, United Kingdom 2001.
2. Cameron, A. “Basic Lubrication Theory”, Ellis Herward Ltd., UK, 1981
3. Halling, J. (Editor) – “Principles of Tribology “, Macmillian – 1984.
4. Williams J.A. “ Engineering Tribology”, Oxford Univ. Press, 1994.
5. S.K.Basu, S.N.Sengupta & B.B.Ahuja ,”Fundamentals of Tribology”, Prentice –Hall of India Pvt Ltd , New Delhi, 2005
6. G.W.Stachowiak & A.W .Batchelor , Engineering Tribology, Butterworth-Heinemann, UK, 2005

ED8073 COMPOSITE MATERIALS AND MECHANICS L T P C
3 0 0 3

OBJECTIVE

- 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

Definition-Matrix materials-polymers-metals-ceramics - Reinforcements: Particles, whiskers, inorganic fibers, metal filaments- ceramic fibers- fiber fabrication- natural composite wood, Jute - Advantages and drawbacks of composites over monolithic materials. Mechanical properties and applications of composites, Particulate-Reinforced composite Materials, Dispersion-Strengthened composite, Fiber-reinforced composites Rule of mixtures-Characteristics of fiber-Reinforced composites, Manufacturing fiber and composites,

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 Mould Composites (SMC) - Manufacturing of Metal Matrix Composites (MMCs) - Solid state, liquid state,vapour state processing, Manufacturing of Ceramic Matrix Composites (CMCs) –hot pressing-reaction bonding process-infiltration technique, direct oxidation- interfaces

UNIT III INTRODUCTION, LAMINA CONSTITUTIVE EQUATIONS 12

Lamina Constitutive Equations: Lamina Assumptions – Macroscopic Viewpoint. Generalized Hooke's Law. Reduction to Homogeneous Orthotropic Lamina – Isotropic limit case, Orthotropic Stiffness matrix (Q_{ij}), Definition of stress and Moment Resultants. Strain Displacement relations. Basic Assumptions of Laminated anisotropic plates. Laminate Constitutive Equations – Coupling Interactions, Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Laminate Structural Moduli. Evaluation of Lamina Properties from Laminate Tests. Quasi-Isotropic Laminates. Determination of Lamina stresses within Laminates.

UNIT IV LAMINA STRENGTH ANALYSIS AND ANALYSIS OF LAMINATED FLAT PLATES 8

Introduction - Maximum Stress and Strain Criteria. Von-Misses Yield criterion for Isotropic Materials. Generalized Hill's Criterion for Anisotropic materials. Tsai-Hill's Failure Criterion for Composites. Tensor Polynomial (Tsai-Wu) Failure criterion. Prediction of laminate Failure
Equilibrium Equations of Motion. Energy Formulations. Static Bending Analysis. Buckling Analysis. Free Vibrations – Natural Frequencies

UNIT V THERMAL ANALYSIS 5

Assumption of Constant Co-efficient of Thermal Expansion (C.T.E.) - Modification of Hooke's Law. Modification of Laminate Constitutive Equations. Orthotropic Lamina C.T.E's. C.T.E's for special Laminate Configurations – Unidirectional, Off-axis, Symmetric Balanced Laminates, Zero C.T.E laminates, Thermally Quasi-Isotropic Laminates

TOTAL: 45 PERIODS

REFERENCES:

1. Gibson, R.F., Principles of Composite Material Mechanics, McGraw-Hill, 1994, Second Edition - CRC press in progress.
2. Hyer, M.W., "Stress Analysis of Fiber – Reinforced Composite Materials", McGraw-Hill, 1998
3. Issac M. Daniel and Ori Ishai, "Engineering Mechanics of Composite Materials", Oxford University Press-2006, First Indian Edition - 2007
4. Mallick, P.K., Fiber –"Reinforced Composites: Materials, Manufacturing and Design", Maneel Dekker Inc, 1993.
5. Halpin, J.C., "Primer on Composite Materials, Analysis", Techomic Publishing Co., 1984.
6. Agarwal, B.D., and Broutman L.J., "Analysis and Performance of Fiber Composites", John Wiley and Sons, New York, 1990.
7. Mallick, P.K. and Newman, S., (edition), "Composite Materials Technology: Processes and Properties", Hansen Publisher, Munish, 1990.
8. Madhujit Mukhopadhyay, "Mechanics of Composite Materials and Structures", University Press (India) Pvt. Ltd., Hyderabad, 2004 (Reprinted 2008)
9. Chung, Deborah D.L., "Composite Materials: Science and Applications", Ane Books Pvt. Ltd./Springer, New Delhi, 1st Indian Reprint, 2009

ED8074 DESIGN FOR MANUFACTURE, ASSEMBLY AND ENVIRONMENTS

L	T	P	C
3	0	0	3

OBJECTIVE:

- 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 **5**

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 **13**

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 **8**

Design features to facilitate machining - drills - milling cutters - keyways - Doweling procedures, counter sunk screws - Reduction of machined area- simplification by separation - simplification by amalgamation - Design for machinability - Design for economy - Design for clampability - Design for accessibility - Design for assembly.

UNIT IV COMPONENT DESIGN – CASTING CONSIDERATION **10**

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 **9**

Introduction – Environmental objectives – Global issues – Regional and local issues – Basic DFE methods – Design guide lines – Example application – Lifecycle assessment – Basic method – AT&T's environmentally responsible product assessment - Weighted sum assessment method – Lifecycle assessment method – Techniques to reduce environmental impact – Design to minimize material usage – Design for disassembly – Design for recyclability – Design for manufacture – Design for energy efficiency – Design to regulations and standards.

TOTAL: 45 PERIODS

REFERENCES:

1. Boothroyd, G, 1980 Design for Assembly Automation and Product Design. New York, Marcel Dekker.
2. Bralla, Design for Manufacture handbook, McGraw hill, 1999.
3. Boothroyd, G, Heartz and Nike, Product Design for Manufacture, Marcel Dekker, 1994.
4. Dickson, John. R, and Corroda Poly, Engineering Design and Design for Manufacture and Structural Approach, Field Stone Publisher, USA, 1995.
5. Fixel, J. Design for the Environment McGraw hill., 1996.
6. Graedel T. Allen By. B, Design for the Environment Angle Wood Cliff, Prentice Hall. Reason Pub., 1996.
7. Kevien Otto and Kristin Wood, Product Design. Pearson Publication, 2004.

ED8075 DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS L T P C
3 0 0 3

OBJECTIVE:

- 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

Reciprocation, quick return, sequencing, synchronizing circuits - accumulator circuits - industrial circuits - press circuits - hydraulic milling machine - grinding, planning, copying, - forklift, earth mover circuits- design and selection of components - safety and emergency mandrels.

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.

TOTAL : 45 PERIODS

REFERENCES:

1. Antony Espossito, “Fluid Power with Applications”, Prentice Hall, 1980.
2. Dudleyt, A. Pease and John J. Pippenger, “Basic fluid power”, Prentice Hall, 1987.
3. Andrew Parr, “Hydraulic and Pneumatics” (HB), Jaico Publishing House, 1999.
4. Bolton. W., “Pneumatic and Hydraulic Systems “, Butterworth –Heinemann, 1997.
5. K.Shanmuga Sundaram, “Hydraulic and Pneumatic Controls: Understanding made Easy" S.Chand & Co Book publishers, New Delhi, 2006 (Reprint 2009)

ED8076 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 5

Types, selection and applications

UNIT II DESIGN OF HOISTS 10

Design of hoisting elements: Welded and roller chains - Hemp and wire ropes - Design of ropes, pulleys, pulley systems, sprockets and drums, Load handling attachments. Design of forged hooks and eye hooks – crane grabs - lifting magnets - Grabbing attachments - Design of arresting gear - Brakes: shoe, band and cone types.

UNIT III DRIVES OF HOISTING GEAR 10

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 10

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

UNIT V ELEVATORS 10

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

1. Rudenko, N., Materials handling equipment, ELnvee Publishers, 1970.
2. Spivakovsy, A.O. and Dyachkov, V.K., Conveying Machines, Volumes I and II, MIR Publishers, 1985.
3. Alexandrov, M., Materials Handling Equipments, MIR Publishers, 1981.
4. Boltzharol, A., Materials Handling Handbook, The Ronald Press Company, 1958.
5. P.S.G. Tech., “Design Data Book”, Kalaikathir Achchagam, Coimbatore, 2003.
6. Lingaiah. K. and Narayana Iyengar, “Machine Design Data Hand Book”, Vol. 1 & 2, Suma Publishers, Bangalore, 1983

ED8077 DESIGN OF PRESSURE VESSELS AND PIPING L T P C

3 0 0 3

OBJECTIVE

- 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

Methods for determining stresses – Terminology and Ligament Efficiency – Applications.

UNIT II STRESSES IN PRESSURE VESSELS 15

Introduction – Stresses in a circular ring, cylinder – Membrane stress Analysis of Vessel Shell components – Cylindrical shells, spherical Heads, conical heads – Thermal Stresses – Discontinuity stresses in pressure vessels.

UNIT III DESIGN OF VESSELS 15

Design of Tall cylindrical self supporting process columns – Supports for short, vertical and horizontal vessels – stress concentration – at a variable Thickness transition section in a cylindrical vessel, about a circular hole, elliptical openings. Theory of Reinforcement – pressure vessel Design. Introduction to ASME pressure vessel codes

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

Introduction – Flow diagram – piping layout and piping stress Analysis.

TOTAL: 45 PERIODS

REFERENCES

1. John F. Harvey, Theory and Design of Pressure Vessels, CBS Publishers and Distributors, 1987.
2. Henry H. Bedner, "Pressure Vessels, Design Hand Book, CBS publishers and Distributors, 1987.
3. Stanley, M. Wales, "Chemical process equipment, selection and Design. Buterworths series in Chemical Engineering, 1988.
4. William. J., Bees, "Approximate Methods in the Design and Analysis of Pressure Vessels and Piping", Pre ASME Pressure Vessels and Piping Conference, 1997.

ED8078 ENGINEERING FRACTURE MECHANICS L T P C
3 0 0 3

OBJECTIVE:

- 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

Two dimensional elastic fields – Analytical solutions yielding near a crack front – Irwin's approximation - plastic zone size – Dugdaale model – determination of J integral and its relation to crack opening displacement.

UNIT III ENERGY BALANCE AND CRACK GROWTH 9

Griffith analysis – stable and unstable crack growth –Dynamic energy balance – crack arrest mechanism –K1c test methods - R curves - determination of collapse load.

Attested

DIRECTOR
Centre For Academic Courses
Anna University, Chennai-600 025.

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:

1. David Broek, "Elementary Engineering Fracture Mechanics ", Fifthoff and Noerdhoff International Publisher, 1978.
2. Kare Hellan, "Introduction of Fracture Mechanics", McGraw-Hill Book Company, 1985.
3. Preshant Kumar, "Elements of Fracture Mechanics", Wheeler Publishing, 1999.
4. John M.Barson and Stanely T.Rolfe Fatigue and fracture control in structures Prentice hall Inc. Englewood cliffs. 1977
5. Tribikram Kundu, "Fundamentals of Fracture Mechanics", Ane Books Pvt. Ltd. New Delhi/ CRC Press, 1st Indian Reprint, 2012

ED8079 MODAL ANALYSIS OF MECHANICAL SYSTEMS L T P C

3 0 0 3

OBJECTIVE:

- 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 6

Introduction to Modal Testing – Applications of Modal Testing – Philosophy of Modal Testing – Summary of Theory – Summary of Measurement Methods – Summary of Analysis – Review of Test Procedure.

UNIT II THEORETICAL BASIS 12

Introduction – Single Degree of Freedom (SDOF) System Theory – Presentation and Properties of FRF Data for SDOP System – Undamped Multi-degree of freedom (MDOF) system – Proportional Damping – Hysteretic Damping – General Case – Viscous Damping – General Case – Characteristics and presentation of MDOF – FRF Data – Complete and incomplete models - Non-sinusoidal vibration and FRF Properties – Analysis of Weakly Nonlinear Structures.

UNIT III MOBILITY MEASUREMENT TECHNIQUES 10

Introduction – Basic Measurement System – Structure preparation – Excitation of the Structure – Transducers and Amplifiers – Analyzers – Digital Signal Processing – Use of Different Excitation types – Calibration – Mass Cancellation – Rotational Mobility Measurement – Measurement on Non linear structures – Multi point excitation methods.

UNIT IV MODAL PARAMETER EXTRACTION METHODS 11

Introduction – Preliminary checks of FRF Data – SDOF Modal Analysis-I – Peak-amplitude – SDOF Modal Analysis-II – Circle Fit Method – SDOF Modal Analysis III – Inverse Method – Residuals – MDOF curve-fitting procedures – MDOF curve fitting in the Time Domain – Global or Multi-Curve fitting – Non linear systems.

UNIT V DERIVATION OF MATHEMATICAL MODELS 6

Introduction – Modal Models – Display of Modal Model – Response Models – Spatial Models – Mobility Skeletons and System Models.

TOTAL: 45 PERIODS

REFERENCES:

1. Ewins D J, "Modal Testing: Theory and Practice ", John Wiley & Sons Inc., 1988
2. Nuno Manuel Mendes Maia et al," Theoretical and Experimental Modal Analysis", Wiley John & sons, 1997.

ED8080 OPTIMIZATION TECHNIQUES IN DESIGN L T P C
3 0 0 3

OBJECTIVE:

- 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 10

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

Structural applications – Design of simple truss members - Design applications – Design of simple axial, transverse loaded members for minimum cost, weight – Design of shafts and torsionally loaded members – Design of springs.

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:

1. Rao, Singaresu, S., "Engineering Optimization – Theory & Practice", New Age International (P) Limited, New Delhi, 2000.
2. Johnson Ray, C., "Optimum design of mechanical elements", Wiley, John & Sons, 1990.
3. Kalyanamoy Deb, "Optimization for Engineering design algorithms and Examples", Prentice Hall of India Pvt. 1995.
4. Goldberg, D.E., "Genetic algorithms in search, optimization and machine", Barnen, Addison-Wesley, New York, 1989.

Attested

DIRECTOR
Centre For Academic Courses
Anna University, Chennai-600 025.

ED8081 **TRIBOLOGY IN DESIGN** **L T P C**
3 0 0 3

OBJECTIVE:

- 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 7

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 AND SURFACE TREATMENT 8

Types of wear – Mechanism of various types of wear – Laws of wear –Theoretical wear models-Wear of Metals and Non metals – Surface treatments – Surface modifications – surface coatings methods- Surface Topography measurements –Laser methods – instrumentation - International standards in friction and wear measurements

UNIT III LUBRICANTS AND LUBRICATION REGIMES 8

Lubricants and their physical properties- Viscosity and other properties of oils –Additives-and selection of Lubricants- Lubricants standards ISO,SAE,AGMA, BIS standards – Lubrication Regimes –Solid Lubrication-Dry and marginally lubricated contacts- Boundary Lubrication-Hydrodynamic lubrication — Elasto and plasto hydrodynamic - Magneto hydrodynamic lubrication – Hydro static lubrication – Gas lubrication.

UNIT IV THEORY OF HYDRODYNAMIC AND HYDROSTATIC LUBRICATION 12

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 10

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

TOTAL: 45 PERIODS

REFERENCES:

1. Rabinowicz.E, “Friction and Wear of materials”, John Willey &Sons ,UK,1995
2. Cameron, A. “Basic Lubrication Theory”, Ellis Herward Ltd., UK, 1981
3. Halling, J. (Editor) – “Principles of Tribology “, Macmillian – 1984.
4. Williams J.A. “Engineering Tribology”, Oxford Univ. Press, 1994.
5. S.K.Basu, S.N.Sengupta & B.B.Ahuja ,”Fundamentals of Tribology”, Prentice –Hall of India Pvt Ltd , New Delhi, 2005
6. G.W.Stachowiak & A.W .Batchelor , Engineering Tribology, Butterworth - Heinemann, UK, 2005

RA8071 COMPUTATIONAL FLUID DYNAMICS L T P C
3 0 0 3

OBJECTIVES

- To develop finite difference and finite volume discretized forms of the CFD equations.
- To formulate explicit & implicit algorithms for solving the Euler Equations & Navier Strokes Equations.

OUTCOME

- On successful completion of this course the student will be able to apply concept of CFD to analyse flow in thermal systems.

UNIT I GOVERNING DIFFERENTIAL EQUATIONS 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 BY FINITE DIFFERENCE METHOD AND FINITE VOLUME METHOD 10

Steady one-dimensional conduction, Two and three dimensional steady state problems, Transient one-dimensional problem, Two-dimensional Transient Problems.

UNIT III CONVECTION HEAT TRANSFER BY FINITE DIFFERENCE METHOD AND FINITE VOLUME METHOD 10

Steady One-Dimensional and Two-Dimensional Convection – diffusion, Unsteady one-dimensional convection – diffusion, Unsteady two-dimensional convection – Diffusion.

UNIT IV INCOMPRESSIBLE FLUID FLOW BY FINITE DIFFERENCE METHOD AND FINITE VOLUME METHOD 10

Governing Equations, Stream Function – Vorticity method, Determination of pressure for viscous flow, SIMPLE, Computation of Boundary layer flow - Finite difference approach.

UNIT V FINITE ELEMENT METHOD AND TURBULENCE MODELS 5

Introduction to finite element method – solution of steady heat conduction by FEM. Algebraic Models – One equation model, k – ε models - Standard and High and Low Reynolds number models, Prediction of fluid flow and heat transfer using standard codes – Prediction of flow in a sudden pipe contraction and pipe.

TOTAL: 45 PERIODS

REFERENCES

1. Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 2003.
2. Ghoshdasdidar, P.S.,"Computer Simulation of flow and heat transfer" Tata McGraw-Hill Publishing Company Ltd., 1998.
3. Subas, V.Patankar "Numerical heat transfer fluid flow", Hemisphere Publishing Corporation, 1980.
4. Versteeg and Malalasekera, N, "An Introduction to computational Fluid Dynamics The Finite volume Method," Pearson Education, Ltd., 2007.
5. Taylor, C and Hughes, J.B. "Finite Element Programming of the Navier-Stokes Equation", Pineridge Press Limited, U.K., 1981.
6. Anderson, D.A., Tannehill, J.I., and Pletcher, R.H., "Computational fluid Mechanics and Heat Transfer " Hemisphere Publishing Corporation, New York, USA, 2012.
7. Fletcher, C.A.J. "Computational Techniques for Fluid Dynamics 1" Fundamental and General Techniques, Springer – Verlag, 1991.
8. Fletcher, C.A.J. "Computational Techniques for fluid Dynamics 2" Specific Techniques for Different Flow Categories, Springer – Verlag, 1988.
9. Bose, T.K., "Numerical Fluid Dynamics" Narosa Publishing House, 1997.