ANNA UNIVERSITY COIMBATORE

CURRICULUM AND SYLLABI 2007

FULL TIME MODE

M.E.ENGINEERING DESIGN

SEMESTER – I

Code No.	Course Title	L	T	P	M
THEORY					
	ADVANCED MATHEMATICS	3	1	0	100
	COMPUTER APPLICATIONS IN DESIGN	3	0	0	100
	FINITE ELEMENT ANALYSIS	3	0	0	100
	CONCEPTS OF ENGINEERING DESIGN	3	0	0	100
	MICRO ELECTRO MECHANICAL SYSTEMS DESIGN	3	0	0	100
	ELECTIVE-I	3	0	0	100
PRACTICAL					
	CAD LAB	0	0	3	100

SEMESTER – II

Code No.	Course Title	L	T	P	M
THEORY					
	MECHANICAL VIBRATIONS	3	1	0	100
	INTEGRATED PRODUCT AND PROCESSES DEVELOPMENT	3	0	0	100
	ADVANCED MECHANISMS DESIGN AND SIMULATION	3	1	0	100
	DESIGN FOR MANUFACTURE AND ASSEMBLY	3	0	0	100
	ELECTIVE-II	3	0	0	100
	ELECTIVE-III	3	0	0	100
PRACTICAL					
	ANALYSIS AND SIMULATION LAB	0	0	3	100

SEMESTER – III

Code No.	Course Title	L	T	P	M
THEORY					
	ELECTIVE – IV	3	0	0	100
	ELECTIVE – V	3	0	0	100
	ELECTIVE – VI	3	0	0	100
PRACTICAL					
	PROJECT WORK PHASE I	0	0	12	200

SEMESTER – IV

Code No.	Course Title	L	T	P	M
PRACTICAL					
	PROJECT WOK PHASE II	0	0	24	400

LIST OF ELECTIVES

M.E. ENGINEERING DESIGN

Course Code	Course Title	L	T	P	M
	OPTIMIZATION TECHNIQUES IN DESIGN	3	1	0	100
	TRIBOLOGY IN DESIGN	3	1	0	100
	ADVANCED STRENGTH OF MATERIALS	3	1	0	100
	DESIGN OF MATERIAL HANDLING EQUIPMENT	3	0	0	100
	MECHANICS OF COMPOSITE MATERIALS	3	0	0	100
	DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEM	3	0	0	100
	EXPERIMENTAL STRESS ANALYSIS	3	0	0	100
	ADVANCED FINITE ELEMENT ANALYSIS	3	1	0	100
	APPLIED ENGINEERING ACOUSTICS	3	0	0	100
	THEORY OF PLATES AND SHELLS	3	0	0	100
	VIBRATION CONTROL AND CONDITION MONITORING	3	0	0	100
	MECHANICS OF FRACTURE	3	0	0	100
	DESIGN OF HEAT EXCHANGERS	3	0	0	100
	COMPUTATIONAL FLUID DYNAMICS	3	0	0	100
	MODELING OF DYNAMIC SYSTEM	3	0	0	100
	DESIGN OF AUTOMOTIVE SYSTEMS	3	0	0	100
	DESIGN AND ANALYSIS OF THERMAL SYSTEMS	3	0	0	100
	DESIGN OF PLASTIC PARTS	3	0	0	100
	INDUSTRIAL ROBOTICS AND EXPERT SYSTEMS	3	0	0	100
	MECHATRONICS SYSTEM DESIGN	3	0	0	100
	ADVANCED TOOL DESIGN	3	0	0	100
	PRODUCTIVITY MANAGEMENT AND RE-ENGINEERING	3	0	0	100
	PRODUCT DATA MANAGEMENT	3	0	0	100
	RAPID PROTOTYPING AND TOOLING	3	0	0	100

ED: Engineering Design, **CD: Computer Aided Design**
CC: CAD/CAM **PC: Product Design and Commerce**

07ED101 ADVANCED MATHEMATICS 3 1 0 100

1. SIMULTANEOUS EQUATIONS AND NUMERICAL INTEGRATION 10

Solving of set of equations, Gauss elimination method, Choleski method, Iterative methods, Relaxation method, System of non-linear equations- Newton Raphson method -Newton-Cotes integration formulas, Trapezoidal rule, Simpson's rules, Gaussian quadrature, Adaptive integration, Examples.

2. BOUNDARY VALUE AND CHARACTERISTIC VALUE PROBLEMS 8

Shooting method, solution through a set of equations, derivative boundary conditions, Rayleigh-Ritz method, characteristic value problems, solution using Characteristic polynomial method, Jacobi method, Power method and Inverse power method.

3. CALCULUS OF VARIATIONS 6

Variation and its properties –Euler's equation – Functionals dependent on first and higher order derivatives - Functionals dependent on functions of several independent variables – Rayleigh Ritz method- Galerkin method**.**

4. PARTIAL DIFFERENTIAL EQUATIONS - NUMERICAL SOLUTION 7

Laplace's equations, representations as a difference equation, Iterative methods for Laplace's equations, Poisson equation, derivative boundary conditions, irregular and non-rectangular grids, Matrix patterns, Sparseness, ADI method, Applications to heat flow problems.

5. PARABOLIC PARTIAL DIFFERENTIAL EQUATIONS 7

Explicit method, Crank-Nicholson method, derivative boundary condition, stability and convergence criteria, Parabolic equations in two or more dimensions, applications to heat flow problems.

6.HYPERBOLIC PARTIAL DIFFERENTIAL EQUATIONS 7

Solving wave equation by finite differences, stability of numerical method, method of characteristics, Wave equation in two space dimensions, computer programs.

Note: Assignments/Term papers using MATLAB / C / C++ to solve design problems.

TUTORIALS: 15
TOTAL: 60

REFERENCES

1. Curtis F Gerald and Patrick O Wheatley, "Applied Numerical Analysis", Pearson Education, 2002.
2. Rajasekaran S, "Numerical Methods in Science and Engineering – A Practical Approach", Wheeler Publishing, 1999, Second Edition.
3. Douglas J Faires and Riched Burden, "Numerical Methods", Brooks/Cole Publishing Company, 1998, Second Edition.
4. Steven C Chapra and Raymond P Canale, "Numerical Methods for Engineers with Software and Programming Applications", Tata McGraw Hill Edition, 2004.
5. John H Mathews and Kurtis D Fink, "Numerical Methods using MATLAB", Prentice Hall, 1998.
6. Ward Cheney and David Kincaid, "Numerical Mathematics and Computing", Brooks/Cole Publishing Company, 1999, Fourth Edition.

07ED102 COMPUTER APPLICATIONS IN DESIGN

3 0 0100

1. **INTRODUCTION TO COMPUTER APPLICATIONS IN NEW PRODUCT DESIGN** **9**

Concept design – parametric sketching – constraints – computer graphics principles- 2D transformation, scaling, rotation – windowing, view ports – clipping – data exchange formats.

2. **COMPUTERS IN DESIGN** **10**

Solid modeling of Mechanical components – associative features – Sheet metal components, nesting and development – plastic parts with draft and shrinkage allowance – Reverse engineering of components – assembly of parts – tolerance analysis – mass property calculations

3. **COMPUTERS IN TOOLING DESIGN** **9**

Mould design – jigs and fixtures design – check for interferences – mechanism design and analysis – Rapid tooling

4. **COMPUTERS IN DESIGN PRODUCTIVITY** **8**

Customizing various software by using visual basic, pro/program, script, LISP etc to write applications like design of shafts, gears etc.,

5. **MANAGING PRODUCT DESIGN DATA** **9**

Version control – library creation – catalog making – standardization for design – collaborative design among peer groups – Design optimization for geometry - Design check, approval and validation.

Total: 45

REFERENCES

1. William M. Neumann and Robert Sproul " Principles of Computer Graphics" McGraw Hill Book Co. Singapore 1989.
2. Ibrahim Zeid "CAD/CAM – Theory and Practice" – McGraw Hill, International Edition 1998.
3. P N Rao "CAD/CAM :Principles and Applications" Tata McGraw Hill , Second Edition. 2004.
4. Schlechtendahl, E. G, CAD – Data transfer for Solid Models, Springer Verlag, Berlin, 1989.
5. Donald Hearn and M Pauline Baker "Computer Graphics" Prentice Hall Inc 1992.

07ED103 FINITE ELEMENT ANALYSIS

3 0 0 100

1. INTRODUCTION & ONE-DIMENSIONAL PROBLEMS 10

Relevance of finite element analysis in design - Variational principles and methods – Weighted-Integral statements – Weak formulations – Ritz method – Method of weighted residuals – Applications of FEA - Finite element modeling – Co-ordinates and shape functions - Potential energy approach – Galerkin's approach – One dimensional finite element models in Solid mechanics and Heat transfer – Finite element model for beams

2. TWO-DIMENSIONAL PROBLEMS 10

Poisson equation – Laplace equation – Weak form – Element matrices for triangular and rectangular elements – Evaluation of integrals – Assembly – Axi-symmetric problems – Applications – Conduction and convection heat transfer - Torsional cylindrical member – Transient analysis - Theory of elasticity – Plane strain – Plane stress – Axi-symmetric problems – Principle of virtual displacement

3. ISOPARAMETRIC ELEMENTS 8

Introduction – Bilinear quadrilateral elements – Quadratic quadrilaterals – Hexahedral elements - Numerical integration – Gauss quadrature – Static condensation – Load considerations – Stress calculations – Examples of 2D and 3D applications

4. STRUCTURAL DYNAMICS APPLICATIONS 9

Dynamic equations – Mass and damping matrices – Natural frequencies and modes – Reduction of number of DOF-response history – Model methods – Ritz vectors – Component mode synthesis – Harmonic response – Direct integration techniques – Explicit and implicit methods – Analysis by response spectra – Example problems

5. NON-LINEAR PROBLEMS & ERROR ESTIMATES 8

Introduction – Material non-linearity – Elasto Plasticity – Plasticity – Visco plasticity – Geometric non-linearity – Large displacement – Error norms and convergence rates – H-refinement with adaptivity – adaptive refinement

Total : 45

REFERENCES

1. Reddy J.N., "An Introduction to the Finite Element Method", McGraw Hill, International Edition, 1993.
2. Logan D.L, "A First Course in the Finite Element Method", Third Edition, Thomson Learning, 2002.
3. Cook, Robert Davis et al "Concepts and Applications of Finite Element Analysis", Wiley, John & Sons, 1999.
4. Segerlind L.J., "Applied Finite Element Analysis", John Wiley, 1984.
5. S.S.Rao, "Finite Element Analysis", 2002 Edition.
6. Zienkiewicz, O.C. and Taylor, R.L., "The Finite Element Method", Fourth Edition, Volumes 1 & 2, McGraw Hill International Edition, Physics Services, 1991.
7. Bathe K.J., "Finite Element Procedures in Engineering Analysis", Prentice Hall, 1990.

07ED104 CONCEPTS OF ENGINEERING DESIGN

3 0 0 100

1. THE DESIGN PROCESS **8**

The Design Process - need identification – Design requirements – Product Life Cycle – Morphology of Design steps of Product Design – Conceptual Design, Embodiment Design, detailed Design – Concurrent Engineering – CAD & CAM, Human factors in Design.

2. TOOLS IN ENGINEERING DESIGN **9**

Creativity and problem solving, Decision Theory, Modeling – Role of models in Engineering Design, Mathematical modeling, Geometric modeling, finite element modeling, Rapid Prototyping – Simulation Finite Difference method, Monte Carlo method – Optimization – Search methods, Geometric programming, Structural and shape optimization.

3 MATERIAL SELECTION AND MATERIALS IN DESIGN **9**

The Classification and properties of Engineering materials, material standards and specifications – Methods of material selection – Ashby Chart and method of weight factors, Derivation of material indices, Use of material selection Chart, Pugh selection method, selection with computed aided databases – Design for brittle fracture, Design for fatigue failure, Design for corrosion resistance, Designing with plastics.

4. MATERIAL PROCESSING AND DESIGN **9**

Classification of manufacturing processes and their role in design, Factors determining the process selection, use of process selection chart and computerized database – Design for manufacturing, Design for forging and sheet metal forming, Design for casting, Design for machining, welding and assembly, design for residual stresses and heat – treatment.

5. Legal, ethical environmental and safety issues in design and Quality Engineering **10**

The origin of laws, Contracts, - Liability – Tort Law- Product Liability – Design aspects of product liability, Codes of ethics, solving ethical conflicts. Design for environment – Life Cycle assessment – Material recycling and remanufacture, Design for safety – Potential Dangers and Guidelines for design for safety, Design for reliability failure mode effect analysis, robust Design.

Total: 45

REFERENCES

1. Dieter, George E, Engineering Design –"A materials and processing Approach,". Mc Graw Hill, International Edition, Singapore 2000.
2. Karl T. Vlrich and Steven D. Eppinger "Product design and Development", Mc Graw Hill, International Edition, 2000.
3. Pahlgand Beitz W "Engineering Design" Springr – Verlag NY- 1984.
4. Ray M.S. "Elements of Engineering Design", Printice Hall Inc. 1985
5. Suh. N. P. "The principles of design",. Oxford University, Press NY 1990.

07ED105 MICRO ELECTRO MECHANICAL SYSTEMS DESIGN

3 0 0 100

1. INTRODUCTION 9

Overview-Microsystems and microelectronics - Working principle of Microsystems -micro actuation techniques-micro sensors-types-microactuators-types-micropump-micromotors-micro-valves-microgrippers-scaling laws-scaling in geomentry-scaling in rigid body dynamics- scaling in electrostatic forces- scaling in electricity- scaling in fluid mechanics-scaling in heat transfer.

2. MATERIALS AND FABRICATION PROCESS 9

Substrates and wafer-single crystal silicon wafer formation-ideal substrates-mechanical properties-silicon compounds - Sio_2, SiC, Si_3N_4 and polycrystalline silicon - Silicon piezoresistors - Gallium aresenside, Quartz-piezoelectric crystals-polymers for MEMS - conductive polymers – Photolithography - Ion implantation - Diffusion – Oxidation –CVD - Physical vapor deposition - Deposition by epitaxy - etching process

3. MICROMECHANICS 9

Introduction-static bending of thin plates-circular plates with edge fixed - rectangular plate with all edges fixed and square plate with all edges fixed – Mechanical vibration-resonant vibration- micro accelerometers-design theory and damping coefficients- thermo mechanics-thermal stresses-fracture mechanics-stress intensity factors, fracture toughness and interfacial fracture mechanics.

4. MICRO SYSTEM MANUFACTURING 9

Clean room technology-Bulk Micro manufacturing- surface micro machining –LIGA-SLIGA-Micro system packaging-materials-die level-device level-system level-packaging techniques-die preparation-surface bonding-wire bonding-sealing

5. MICRO SYSTEM DESIGN 9

Design considerations-process design-mask layout design- mechanical design-applications of micro system in -automotive industry-bio medical –aero space-telecommunications.

Total: 45

REFERENCES

1. Mohamed Gad-el-Hak, The MEMS Hand book, CRC press 2002.
2. Julian W.Gardner,Vijay K.Varadan,Osama O.Awadel Karim,Microsensors MEMS and Smart Devices, John Wiby & sons Ltd.,2001.
3. S.Fatikow,U.Rembold,Microsystem Technology and Microrobotics,Springer-Verlag Berlin Heidelberg ,1997.
4. Tai-Ran Hsu,MEMS & Microsystems Design and Manufacture,Tata McGraw-Hill,2006.
5. Francis E.H Tay and W.O Choong, Microfludics and BioMEMS Applications, Springer, 2002.

07ED1L1 CAD Laboratory

0 0 3 100

Exercises in Sketching, Solid Modeling, Surface modeling, Sheet metal and mechanism design of Mechanical Components and assembly using Parametric and Feature Based Packages like **PRO-E / SOLID WORKS /SOLID EDGE/CATIA / NX / ANSYS / NASTRAN** etc.

Total: 45

07ED201 MECHANICAL VIBRATIONS 3 1 0 100

1. FUNDAMENTALS OF VIBRATION 8

Introduction – Single degree freedom free vibration systems – Damped vibrations – Single degree freedom forced vibration with elastically coupled viscous dampers, System Identification from frequency response, Support motion, Duhamel's Integral – Impulse Response function – Virtual work – Lagrange's equation-– Transient Vibration

2. TWO DEGREE FREEDOM SYSTEM 8

Free vibration of spring-coupled system – mass coupled system – Vibration of two degree freedom system – Forced vibration – Vibration Absorber – Vibration isolation.

3. MULTI-DEGREE FREEDOM SYSTEM 12

Normal mode of vibration – Flexibility Matrix and Stiffness matrix – Eigen values and eigen vectors – orthogonal properties – Modal matrix-Modal Analysis – Forced Vibration by matrix inversion – Modal damping in forced vibration – Numerical methods for fundamental frequencies.

4. VIBRATION OF CONTINUOUS SYSTEMS 8

Systems governed by wave equations – Vibration of strings – vibration of rods – Euler Equation for Beams – Effect of Rotary inertia and shear deformation – Vibration of plates.

5. EXPERIMENTAL METHODS IN VIBRATION ANALYSIS 9

Vibration instruments – Vibration exciters Measuring Devices – Analysis – Vibration Tests – Free and Forced Vibration tests. Examples of Vibration tests – Industrial, case studies.

L : 45 T : 15 Total 60

REFERENCES:

1. Benson H.Tongue, Principles of Vibration, 2nd edn., Oxford University Press, NY, 2002
2. Thomson, W.T. – "Theory of Vibration with Applications", CBS Publishers and Distributors, New Delhi, 1990.
3. Rao, J.S., & Gupta, K. – "Ind. Course on Theory and Practice Mechanical Vibration", New Age International (P) Ltd., 1984.
4. Den Hartog, J.P, "Mechanical Vibrations," Dover Publications, 1990.
5. Rao, S.S.," Mechanical Vibrations," Addison Wesley Longman, 1995.

07ED202 INTEGRATED PRODUCT AND PROCESSES DEVELOPMENT 3 0 0 100

1. INTRODUCTION 9

Characteristics of Successful Product Development-Interdisciplinary activity-Duration and Costs of Product Development- Challenges of Product Development -Development Processes and Organizations-A Generic Development Process-Concept Development: The Front-End Process Adapting the Generic Product Development Process- The AMF Development Process-Product Development Organizations-The AMF Organization

2. PRODUCT PLANNING 9

Product Planning Process- Identifying Opportunities- Evaluating and Prioritizing Projects-Allocating Resources and Timing- Pre-Project Planning-Reflect on the Results and the Process-Identifying Customer Needs- Raw Data from Customers- Interpreting Raw Data in Terms of Customer Needs-Organizing the Needs into a Hierarchy-Establishing the Relative Importance of the Needs-Reflecting on the Results and the Process

3. PRODUCT SPECIFICATIONS 9

Specifications - Specifications Established - Establishing Target Specifications-Setting the Final Specifications-Concept Generation-The Activity of Concept Generation-Clarify the Problem- Search Externally-Search Internally-Explore Systematically- Reflect on the Results and the Process.

4. CONCEPT SELECTION 9

Concept Selection- Overview of Methodology-Concept Screening-Concept Testing-Define the Purpose of the Concept Test- Choose a Survey Population- Choose a Survey Format-Communicate the Concept- Measure Customer Response-Interpret the Results- Reflect on the Results and the Process

5. PRODUCT ARCHITECTURE 9

Product Architecture-Implications of the Architecture-Establishing the Architecture-Delayed Differentiation-Platform Planning-Related System-Level Design Issues

Total 45

REFERENCE:

1. Product Design and Development , Karl T. Ulrich and Steven .D Epinger , McGraw-Hill International Edns. 1999.
2. Kevien Otto and Kristin Wood, “Product Design” Pearson Publication, 2004
3. Tool Design – Integrated Methods for successful Product Engineering, Stuart Pugh, Addison Wesley Publishing, Neyourk, NY, 1991, ISBN 0-202-41639-5
4. Effective Product Design and Development, Stephen Rosenthal, Business One Orwin, Homewood, 1992,ISBN, 1-55623-603-4
5. Concurrent Engg. /Integrated Product Development. Kemnneth Crow, DRM Associates, 26/3,Via Olivera, Palos Verdes, CA 90274(310) 377-569,Workshop Book

07ED203 ADVANCED MECHANISMS DESIGN AND SIMULATION 3 1 0 100

1. INTRODUCTION 5

Review of fundamentals of kinematics – mobility analysis – formation of one D.O.F. multi loop kinematic chains, Network formula – Gross motion concepts.

2. KINEMATIC ANALYSIS 5

Displacement , Velocity and acceleration analysis of simple mechanisms, instant centres kinematic analysis of complex mechanisms , Goodman analysis , auxiliary point method.

3. PATH CURVATURE THEORY 6

Inflection point and inflection circles. Euler – Savary equation, Bobilliers constructions , Hartmann's construction, the cubic of stationary curvature or Burmester's circle point and center point curves for four infinitesimally close positions of the moving plane.

4. SYNTHESIS OF MECHANISMS 15

Type synthesis – Number synthesis – Associated Linkage Concept. Dimensional synthesis – function generation, path generation, motion generation. Graphical methods. Cognate linkages -Coupler curve synthesis, design of six-bar mechanisms. Algebraic methods. Application of instant center in linkage design. Cam Mechanisms – determination of optimum size of Cams.

5. DYNAMICS OF MECHANISMS AND SPATIAL MECHANISMS AND ROBOTICS 14

Static force analysis with friction – Inertia force analysis – combined static and inertia force analysis, shaking force, Kinetostatic analysis. Introduction to force and moment balancing of linkages.

Kinematic Analysis of Spatial RSSR mechanism – Denavit – Hartenberg Parameters. Forward and inverse Kinematics of Robotic Manipulators.

Study and use of Mechanism using Simulation Soft-ware packages.

L : 45 T : 15 Total 60

REFERENCES:

1. Uicker, J.J, Pennock G.R. and Shigley, J.E., "Theory of Machines and Mechanisms", Oxford University Press, NY, 2003.
2. Amitabha Ghosh and Asok Kumar Mallik, "Theory of Mechanism and Machines", EWLP, Delhi, 1999.
3. Sandor G.N., and Erdman A.G., "Advanced Mechanism Design Analysis and Synthesis", Prentice Hall, 1984.
4. Nortron R.L., "Design of Machinery", McGraw Hill, 1999.
5. Kenneth J, Waldron, Gary L. Kinzel, "Kinematics, Dynamics and Design of Machinery", John Wiley-sons, 1999.

07ED204 DESIGN FOR MANUFACTURE AND ASSEMBLY 3 0 0 100

1. INTRODUCTION 8

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.

2. FACTORS INFLUENCING FORM DESIGN 10

Influence of materials on form design - form design of grey iron, malleable iron, steel and aluminium castings - form design of welded members, forgings.

3. COMPONENT DESIGN - MACHINING CONSIDERATION 9

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.

4. COMPONENT DESIGN - CASTING CONSIDERATION 9

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

5. 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 remanufacture – Design for energy efficiency – Design to regulations and standards.

Total 45

REFERENCES:

1. Boothroyd, G, Design for Assembly Automation and Product Design, Marcel Dekker, New York., 1980
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.

07ED2L1 ANALYSIS AND SIMULATION LAB

Analysis of Mechanical Components – Use of FEA Packages, like ANSYS NASTRON etc., Excesses shell include FEA analysis of

i) Machine elements under static loads
ii) Heat transfer in mechanical systems
iii) Determination of natural frequency
iv) Axi-Symmetric
v) Non-linear systems

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

Total 45 hrs

07ED001 OPTIMIZATION TECHNIQUES IN DESIGN 3 1 0 100

1. INTRODUCTION 5

General Characteristics of mechanical elements, adequate and optimum design, principles of optimization, formulation of objective function, design constraints – Classification of optimization problem.

2. UNCONSTRAINED OPTIMIZATION 8

Single variable and multivariable optimization, Techniques of unconstrained minimization – Golden section, pattern and gradient search methods – Interpolation methods.

3. CONSTRAINED OPTIMIZATION 12

Optimization with equality and inequality constraints - Indirect methods using penalty functions, Lagrange multipliers; Geometric programming- Constrained, mixed inequality and unconstrained minimization; Genetic algorithms.

4. STATIC APPLICATIONS 10

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

5. DYNAMIC APPLICATIONS 10

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

L : 45 T : 15 Total 60

REFERENCES

1. Singiresu S.Rao., “Engineering Optimization Theory and Practice”, New Age International (P) Limited, Publishers 1996.
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.
5. Saravanan.R, “Manufacturing optimization through intelligent techniques”, Taylor and Francis Publications, CRC Press, 2006.

07ED002 TRIBOLOGY IN DESIGN 3 1 0 100

1. Surfaces, Friction and Wear 9

Topography of surfaces – Surfaces features – Experimental Determinations of surface structure – Chemical analysis of surface – surface effects in Tribology – Analysis of surface roughness – measurement of surface roughness. Friction – Mechanism of friction, measuring friction, equations and models of friction – Friction properties of metallic and non metallic materials, friction in extreme conditions. Wear – Types, mechanism, mapping, measurements, wear resistance materials – surface treatment, surface modifications and surface coatings. Computer Simulations of friction, lubrication and wear.

2. Lubrication Theory 9

Lubricants – selection criteria – lubrication regimes – Hydrodynamic, elasto and plasto hydrodynamic lubrication, basic equations, Reynold's equation, energy equation, boundary lubrication, boundary lubricating films and its properties. Hydrostatic lubrication – Gas lubrication

3. Design of Fluid Film Bearings 9

Dynamic analysis of hydrodynamic bearing performance, trust and journal bearings– full, partial, fixed and pivoted – mass flow rate, friction, power loss, heat and temperature difference, dynamic loads, oil film thickness, stiffness of squeeze film and dynamic co-efficient – hydrostatic bearing design.

4. Industrial Components and Systems 9

Slider bearings – self acting finite bearings, failure modes, materials rolling element bearings – Types, contact mechanics, bearing internal load distribution, lubrication – Bearing geometry and kinematics, load ratings and life prediction, torque calculation, temperature analysis, endurance testing and failure analysis.

5. Space and Automotive Tribology 9

Introduction – Mechanism, components, liquid and solid lubricants, accelerated testing and life testing of space mechanism. Principles of Aerospace eccentric bearing test mechanism. Engine Tribology –importance, lubrication regimes, engine bearings, wheel bearings, tire. Mechanics of load transfer – contact area and normal pressure distribution, brakes, effects of service on engine oil properties. Tribology in manufacturing – macro and micro tribology of MEMS materials. Technologies for machinery diagnosis and prognosis.

L : 45 T : 15 Total 60

REFERENCES

1. Cameron, A. "Basic Lubrication Theory", Ellis Herward Ltd., UK, 1981.
2. Hulling, J. (Editor) – " Principles of Tribology", MacMillan, 1984.
3. Williams, J.A. "Engineering Tribology", Oxford University Press, 1994.
4. Neale, M.J. "Tribology Handbook", Butterworth Heinemann, 1995.
5. Bharat Bhushan, "Modern Tribology Handbook" Vol. – I & II.

07ED003 ADVANCED STRENGTH OF MATERIALS 3 0 0 100

UNIT - I ELASTICITY (8)

Stress – Strain relation and General equation of elasticity in cartesian, polar and spherical coordinates- differential equation of equilibrium – compact ability – boundary conditions, representations of three dimensional stress of a tension – generalized Hooke's law – St.Vennant's principle – Plane strain, plane stress – Airy's stress function. hear Centre:Location of shear centre for various sections – shear flow.

UNIT - II UNSYMMETRICAL BENDING (10)

Stresses and deflection in beams subjected to unsymmetrical loading – Kern of a section. Curved flexural members - circumferential and radial stresses – deflection and radial curved beam with re-strained ends – closed ring subjected to concentrated load and uniform load – chain link and crane hooks.

UNIT - III THICK CYLINDERS AND ROTATING DISKS (10)

Thick walled cylinder subjected to internal and external pressures – Shrink fit joints – Stresses due to rotation – Radial and tangential stresses in solid disc and ring of uniform thickness and varying thickness – allowable speed. – Rotating shafts and cylinders.

UNIT - IV TORSION OF NON CIRCULAR SECTIONS (8)

Torsion of rectangular cross section – St.Vennant Theory – elastic membrane analogy – Prandtl's stress function – Torsional stresses in hollow thin walled tubes.

UNIT - V STRESSES IN FLAT PLATES (9)

Stresses in circular and rectangular plates due to various types of loading and end conditions – Buckling of plates. Theory of contact stresses – methods of computing contact stresses – deflection of bodies in point and line contact – applications.

L : 45 T : 15 Total 60

Reference Books

1. Arthur P.Boresi and Richard J.Schmidt, "Advanced Mechanics of Materials",John, Willey & Sons, Inc., 2003.
2. Arthur P.Boresi and Omar M.Siseborttom, "Advanced Mechanics of Materials",John, Willey International Education, 1985.
3. Robert,D.Cook, Wareen.C.Yound, "Advanced Mechanics of Materials", Macmillon Publishers Company, 1985.
4. Srinath.L.S., Advanced Mechanics of Solids, Tata McGraw Hill PublishingCompany Limited, 2003
5. KrishnaRaju, N., Gururaja,D.R., Advanced Mechanics of Solids and Structures,Narosa Publishing House, 1997.
6. U.C.Jindal, "Advanced Topics of Strength of materials", Galgotia Publications, First edition, 1997.

07ED004 DESIGN OF MATERIAL HANDLING EQUIPMENT 3 0 0 100

(Use of approved data book is permitted)

1. FLEXIBLE HOISTING APPLIANCES 9

Type, selection and applications of material handling equipments, choice of material handling equipment – hoisting equipment – components and theory of hoisting equipment – chain and ropes – selection of ropes, pulleys, pulley systems, sprockets and drums.

2. LOAD HANDLING EQUIPMENTS AND BRAKES 9

Forged standard hooks – forged Ramshorn hooks – solid triangular eye hooks – crane grabs, electric lifting magnetic – grabbing attachments for loose materials. arresting gear – brakes: shoe, band and cone types – elements of shoe brakes – thermal calculation in shoe brakes.

3. SURFACE AND OVERHEAD TRANSPORTATION EQUIPMENTS 9

Hand operated trucks – powered trucks – tractors – electronically controlled tractors - hand truck on rails – industrial railroad equipments: locomotives - winches – capstans – turntables – monorail conveyors –pipe rail systems – flat bar monorails. Rail traveling mechanism, cantilever and monorail cranes, cogwheel drive, monocable tramways- reversible tramways.

4. ELEVATING EQUIPMENTS 9

Continuous-motion vertical conveyors – reciprocating-motion vertical conveyors – stackers – work levelers and tail gates – industrial lifts – passenger lifts – freight elevators – mast type elevators – vertical skip hoist elevators,
bucket elevators: design, loading and bucket arrangements.

5. CONVEYING EQUIPMENTS 9

Belt conveyors - chain conveyors – apron conveyors – escalators – flight conveyors – roller conveyors - oscillating conveyors. design of belt conveyors, screw conveyors and pneumatic conveyors.

Total: 45

REFERENCES

1. Rudenko. N., Materials Handling Equipment – MIR Publishers, 1969
2. Spivakovsky. A.O and Dyachkov. V.K., Conveying Machines, Volume 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, 2003
6. Lingaiah. K. and Narayana Iyengar, Machine Design Data Hand Book, Vol. 1 & 2, Suma Publishers, 1983
7. Chowdary.R.B and Tagore.G.R.N.– Materials Handling Equipment –Khanna Publishers, 1996

07ED005 MECHANICS OF COMPOSITE MATERIALS 3 0 0 100

1. INTRODUCTION 8

Definition – Need – General Characteristics, Applications. Fibers – Glass, Carbon, Ceramic and Aramid fibers. Matrices – Polymer, Graphite, Ceramic and Metal Matrices – Characteristics of fibers and matrices. Fiber surface treatments, Fillers and additives, Fiber content, density and void content.

2. MECHANICS 12

Rule of mixture -volume and mass fractions – density - void content, Evaluation of four elastic moduli based on strength of materials approach and Semi-Empirical model-Longitudinal Young's modulus-transverse Young's modulus–major Poisson's ratio-In-plane shear modulus, Ultimate strengths of a unidirectional lamina. Characteristics of Fiber-reinforced lamina–laminates–lamination theory, Interlaminar stresses

3. PERFORMANCE 5

Static Mechanical Properties – Fatigue and Impact Properties – Environmental effects – Long term properties, Fracture Behavior and Damage Tolerance.

4. MANUFACTURING 8

Bag Moulding – Compression Moulding – Pultrusion – Filament Winding – Other Manufacturing Processes – Quality Inspection methods. Processing of MMC –diffusion bonding – stir casting – squeeze casting.

5. DESIGN 12

Failure Predictions, Laminate Design Consideration-design criteria-design allowables -design guidelines, Joint design-Bolted and Bonded Joints, Design Examples-Design of a tension member – design of a compression member – design of a beam-design of a torsional member, Application of FEM for design and analysis of laminated composites.

Total: 45

REFERENCES:

1. Mallick, P.K., "Fiber Reinforced Composites: Materials, Manufacturing and Design", Marcel Dekker Inc, 1993.
2. Autar K. Kaw, "Mechanics of Composite Materials" CRC Press, 2006
3. Agarwal, B.D., and Broutman L.J., "Analysis and Performance of Fiber Composites", John Wiley and Sons, New York, 1990.
4. Ronald Gibson, "Principles of Composite Material Mechanics", Tata McGraw Hill, 1994.
5. Chawla K.K., "Composite materials", Springer – Verlag, 1987

07ED006 DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS 3 0 0 100

1. OIL HYDRAULIC SYSTEMS AND HYDRAULIC ACTUATORS 5

Hydraulic Power Generators – Selection and specification of pumps, pump characteristics- Determination of volumetric, mechanical and overall efficiencies of positive displacement pumps. Linear and Rotary Actuators – selection, specification and characteristics.

2. CONTROL AND REGULATION ELEMENTS 12

Pressure - direction and flow control valves - relief valves, non-return and safety valves - actuation systems. Electrical control solenoid valves, relays, Electro hydraulic servo valves.

3. 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.

4. 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.

5. 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

REFERENCES:

1. Bolton. W., “Pneumatic and Hydraulic Systems “, Butterworth –Heinemann, 1997.
2. Antony Espossito, “Fluid Power with Applications”, Prentice Hall, 1980.
3. Dudleyt, A. Pease and John J. Pippenger, Industrial Hydraulics, Tata MGraw Hill Prentice Hall, 1985.
4. Andrew Parr, “Hydraulic and Pneumatics” (HB), Jaico Publishing House, 2004.
5. Majumdar, S.R., Oil Hydraulic Systems, Principles and Maintenance, Tata MGraw Hill Prentice Hall, 2001.

07ED007 EXPERIMENTAL STRESS ANALYSIS 3 0 0 100

1. FORCES AND STRAIN MEASUREMENT 9

Strain gauge, principle, types, performance and uses. Photo elasticity – principle and applications – Moire Fringe - Hydraulic jacks and pressure gauges – Electronic load cells – Proving Rings – Calibration of Testing Machines.

2. VIBRATION MEASUREMENTS 9

Characteristics of Structural Vibrations – Linear Variable Differential Transformer (LVDT) – Transducers for velocity and acceleration measurements.

Vibration meter – Seismographs – Vibration Analyzer – Display and recording of signals – Cathode Ray Oscilloscope – XY Plotter – Chart Plotters – Digital data Acquisition systems.

3. ACOUSTICS AND WIND FLOW MEASURES 9

Principles of Pressure and flow measurements – pressure transducers – sound level meter – Venturimeter and flow meters – wind tunnel and its use in structural analysis – structural modeling – direct and indirect model analysis.

4. DISTRESS MEASUREMENTS 9

Diagnosis of distress in structures – crack observation and measurements – corrosion of reinforcement in concrete – Half-cell, construction and use – damage assessment – controlled blasting for demolition.

5. NON DESTRUCTIVE TESTING METHODS 9

Load testing on structures, buildings, bridges and towers – Rebound Hammer – acoustic emission – ultrasonic testing principles and application – Holography – use of laser for structural testing – Brittle coating

Total 45

REFERENCES:

1. L.S.Srinath et al, Experimental Stress Analysis, Tata McGraw Hill Company, New Delhi, 1984
2. JW Dalley and WF Riley, Experimental Stress Analysis, McGraw Hill Book Company, N.Y. 1991
3. Sadhu Singh – Experimental Stress Analysis, Khanna Publishers, New Delhi, 1996.
4. R.S.Sirohi, HC Radhakrishna, Mechanical Measurements, New Age International (P) Ltd. 1997
5. F.K Garas, J.L. Clarke and GST Armer, Structural assessment, Butterworths, London, 1987
6. D.E. Bray & R. K.Stanley, Non-destructive Evaluation, McGraw Hill Publishing Company, N.Y.1989

07ED008 ADVANCED FINITE ELEMENT ANALYSIS 3 1 0 100

1. 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 – Application and Examples.

2. NON-LINEAR PROBLEMS 10

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

3. DYNAMIC PROBLEM 8

Direct Formulation – Free, Transient and Forced Response – Solution Procedures – Subspace Iterative Technique – Houbolt, Wilson, Newmark – Methods – Examples.

4. FLUID MECHANICS AND HEAT TRANSFER 9

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

5. ERROR ESTIMATES AND ADAPTIVE REFINEMENT 9

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

L : 45 T : 15 Total 60

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.

07ED009 APPLIED ENGINEERING ACOUSTICS 3 0 0 100

1. BASIC CONCEPTS OF ACOUSTICS 9

Scope of Acoustics – Sound pressure – Sound intensity – Sound power level Sound power – Wave motion – Alteration of wave paths –Measurement of sound waves – sound spectra – Sound fields – Interference – Standing waves – Acoustic energy density and intensity – Specific acoustic impedance.

2. CHARACTERISTICS OF SOUND 10

The one dimensional wave equation – Solution of 1D wave equation – Velocity in gaseous medium – Velocity of plane progressive sound wave through a thin solid rod – Velocity of plane wave in a bulk of solid – Transverse wave propagation along a string stretched under tension – Wave equation in two dimension.

3. TRANSMISSION PHENOMENA 6

Changes in media – Transmission from one fluid medium to another, normal incidence, oblique incidence - Reflection at the surface of a solid, normal incidence, oblique incidence – Standing wave pattern – Transmission through three media.

4. AN INTRODUCTION TO THE ASSESSMENT AND MEASUREMENT OF SOUND 10

Introduction – The decibel scale for the measurement of sound power – Sound level meter – Weighted sound pressure level – Equal Loudness contours – Perceived noisiness – Loudness, Loudness level, perceived noise, perceived noise level – Equivalent sound level – Identified level – Frequency and Amplitude measurement.

5. BASIC CONCEPTS OF NOISE CONTROL 10

Noise Control at source, path, receiver – Noise control by acoustical treatment – Machinery noise – Types of machinery involved – Determination of sound power and sound power level – Noise reduction procedures – Acoustic enclosures.

Total 45

REFERENCES:

1. Lawrence E. Kinsler, Austin R. Frey, “Fundamentals of Acoustics “– John Wiley and Sons Inc., 1986.
2. Bies, David, A. and Hansen, Colin H., “Engineering Noise Control – Theory and Practice”, E and FN Spon, Chapman-Hall, Second Edition, 1996.
3. Hansen C.H. and Snyder, S.D., “Active Control of Sound and Vibration”, E and FN Spon, London 1996.

07ED010 THEORY OF PLATES AND SHELLS 3 0 0 100

UNIT – I **8**

Thin Plates with small deflection. Laterally loaded thin plates, governing differential equation, various boundary conditions.

UNIT – II **12**

Rectangular plates. Simply supported rectangular plates, Navier solution and Levy's method, Rectangular plates with various edge conditions, plates on elastic foundation. Symmetrical bending of circular plates.

UNIT – III **6**

Energy methods, Finite difference and Finite element methods.

UNIT – IV **12**

Classification of shells, types of shells, structural action, membrane theory, shells of revolution and shells of translation, examples, limitations of membrane theory.
Folded Plate structures, structural behavior, types, design by ACI - ASCE Task Committee method

UNIT – V **7**

Space frames - configuration - types of nodes - general principles of design Philosophy - Behavior.

Total 45

REFERENCES:

1. Szilard, R., Theory and Analysis of Plates, Prentice Hall Inc., 1995
2. Timoshenko, S. and Krieger S.W. Theory of Plates and Shells, McGraw Hill Book Company, New York 1990.
3. Wilhelm Flügge, stresses in shells, Springer - Verlag
4. Timoshenko, S. Theory of Plates and Shells, McGraw Hill, 1990
5. Ramasamy, G.S., Design and Construction of Concrete Shells Roofs,CBS Publishers, 1986
6. Dr.N.Subramanian, Principles of Space Structures , Wheeler Publishing Co. 1999
7. Proceedings of International Conference on Space Structures, Anna University, November 1997.

07ED011 VIBRATION CONTROL AND CONDITION MONITORING 3 0 0 100

1. INTRODUCTION 11

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

2. VIBRATION CONTROL 12

Introduction – Reduction of Vibration at the Source - Control of Vibration – by Structural design – Material Selection – Localized additions – Artificial damping – Resilient isolation, Vibration isolation, Vibration absorbers.

3. ACTIVE VIBRATION CONTROL 6

Introduction – Concepts and applications, Review of smart materials – Types and Characteristics, Review of smart structures – Characteristics Active vibration control in smart structures.

4. CONDITION BASED MAINTENANCE PRINCIPLES AND APPLICATIONS 10

Introduction - Condition Monitoring Methods - The Design of Information system, selecting methods of monitoring, Machine condition monitoring and diagnosis – Vibration severity criteria – Machine maintenance techniques – Machine condition monitoring techniques – Vibration monitoring techniques – Instrumentation systems – Choice of monitoring parameter.

5. DYNAMIC BALANCING AND ALIGNMENT OF MACHINERY 6

Introduction, Dynamic Balancing of Rotors, Field Balancing in one Plane, two Planes, and in several Planes, Machinery Alignment, “Rough” Alignment Methods, The Face-Peripheral Dial Indicator Method, Reverse Indicator Method, Shaft-to-coupling spool method.

Total 45

REFERENCES:

1. Rao, J.S.” Vibratory Condition Monitoring of Machines “. CRC Press, 2000.
2. Science Elsevier,” Hand Book of Condition Monitoring”, Elsevier Science, 1996.
3. K.J. Bathe and F.I., Wilson – “Numerical Methods in Finite Element Analysis” – Prentice Hall of India Pvt. Ltd., New Delhi, 1978.
4. J.O. Den Hartog – “Mechanical Vibrations” – McGraw Hill, Newyork, 1985.

07ED012 MECHANICS OF FRACTURE 3 0 0 100

1. ELEMENTS OF SOLID MECHANICS 5

The geometry of stress and strain, elastic deformation, plastic and elasto-plastic deformation - limit analysis.

2. STATIONARY CRACK UNDER STATIC LOADING 10

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

3. ENERGY BALANCE AND CRACK GROWTH 8

Griffith analysis – Linear Fracture Mechanics-Crack Opening displacement – Dynamic energy balance – crack arrest.

4. FATIGUE CRACK GROWTH CURVE 10

Empirical Relation describing crack growth by fatigue – Life calculations for a given load amplitude – effects of changing the load spectrum – Effects of Environment.

5. ELEMENTS OF APPLIED FRACTURE MECHANICS 12

Examples of crack-growth Analysis for cyclic loading - leak before break – crack Initiation under large scale yielding – Thickness as a Design parameter – crack instability in Thermal or Residual – stress fields.

Total 45

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.

07ED013 DESIGN OF HEAT EXCHANGERS 3 0 0 100

1. CONSTRUCTIONAL DETAILS AND HEAT TRANSFER 8

Types - Shell and Tube Heat Exchangers - Regenerators and Recuperators Industrial Applications Temperature Distribution and its Implications - LMTD - Effectiveness

2. FLOW DISTRIBUTION AND STRESS ANALYSIS 7

Effect of Turbulence - Friction Factor - Pressure Loss - Channel Divergence Stresses in Tubes - Heater sheets and Pressure Vessels - Thermal Stresses - Shear Stresses - Types of Failures

3. DESIGN ASPECTS 10

Heat Transfer and Pressure Loss - Flow Configuration - Effect of Baffles - Effect of Deviations from Ideality - Design of Typical Liquid - Gas-Gas-Liquid Heat Exchangers

4. CONDENSERS AND EVAPORATORS DESIGN 10

Design of Surface and Evaporative Condensers - Design of Shell and Tube - Plate Type Evaporators

5. COOLING TOWERS 10

Packings - Spray Design - Selection of Pumps - Fans and Pipes - Testing and Maintenance – Experimental Methods.

Total 45

REFERENCES

1 T. Taborek, G.F. Hewitt and N.Afgan, Heat Exchangers, Theory and Practice, McGraw Hill Book Co., 1980
2 Walker, Industrial Heat Exchangers - A Basic Guide, McGraw Hill Book Co., 1980
3 Nicholas Cheremisioff, Cooling Tower, Ann Arbor Science Pub 1981
4 Arthur P. Fraas, Heat Exchanger Design, John Wiley & Sons, 1988

07CD001 COMPUTATIONAL FLUID DYNAMICS 3 0 0 100

1. 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.

2. CONDUCTION HEAT TRANSFER 10

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

3. INCOMPRESSIBLE FLUID FLOW 10

Governing Equations, Stream Function – Verticity method, Determination of pressure for viscous flow, SIMPLE Procedure of Patankar and spalding, Computation of Boundary layer flow, Finite difference approach.

4. CONVECTION HEAT TRANSFER AND FEM 10

Steady One-Dimensional and Two-Dimensional Convection – Diffusion, Unsteady one-dimensional convection – Diffusion, Unsteady two-dimensional convection – Diffusion – Introduction to finite element method – Solution of steady heat conduction by FEM – Incompressible flow – Simulation by FEM.

5. TURBULENCE MODELS 5

Algebraic Models – One equation model, K - $\in$ Models, Standard and High and Low Reynolds number models, Prediction of fluid flow and heat transfer using standard codes.

Total : 45 hrs

REFERENCES

1 John D. Anderson, Computational Fluid Dynamics, McGraw-Hill International Editions, 1995

2 Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", NarosaPublishing House, New Delhi, 1995.

3 Ghoshdasdidar, P.S., "Computer Simulation of flow and heat transfer" Tata McGraw-Hill Publishing Company Ltd., 1998.

4 Subas, V.Patankar "Numerical heat transfer fluid flow", Hemisphere Publishing Corporation, 1980.

5 Anderson, D.A., Tannehill, J.I., and Pletcher, R.H., "Computational fluid Mechanics and Heat Transfer ", Hemisphere Publishing Corporation, New York, USA, 1984.

6 Fletcher, C.A.J. "Computational Techniques for Fluid Dynamics 1", Fundamental and General Techniques, Springer – Verlag, 1987.

7 Bose, T.X., "Numerical Fluid Dynamics", Narosa Publishing House, 1997

07CD002 MODELING OF DYNAMIC SYSTEM 3 0 0 100

MATHEMATICAL MODELS OF PHYSICAL SYSTEMS (9)

Introduction to control systems, differential equations of physical systems, dynamics of robotic mechanism, transfer functions, block diagram algebra, signal flow graphs.

FEEDBACK CHARACTERISTICS OF CONTROL SYSTEMS AND COMPONENTS (9)

Feed back and non feedback systems, reduction of parameter variations, control over system dynamics, control of the effects of disturbance signals, linearizing effect, regenerative feedback.. Linear approximation on non-linear systems, stepper motors, hydraulic systems, pneumatic systems.

TIME RESPONSE ANALYSIS AND STABILITY IN TIME DOMAIN (9)

Standard test signals, time response of first-order systems, time response of second-order systems, steady-state errors and error constraints, effect of adding a zero to a system, design specifications of second-order systems, design considerations for higher-order system, performance indices, robotic control systems, state variable analysis, approximation of higher-order systems by lower order systems, concept of stability, necessary conditions, Routh stability criterion, relative stability analysis

FREQUENCY RESPONSE ANALYSIS AND STABILITY IN FREQUENCY DOMAIN (9)

Correlation between time and frequency response, polar plots, bode plots, all-pass and minimum-phase systems, experimental determination of transfer functions, log-magnitude versus phase plots, Nyquist stability criterion, assessment of relative stability, closed loop frequency response, sensitivity analysis.

INTRODUCTION TO DESIGN AND STATE VARIABLE ANALYSIS (9)

Preliminary considerations, realization of basic compensators, cascade compensation in time domain and frequency domain, feedback compensation, robust control system design. Concepts of state, state variables and state model, state models for linear-continuous-time systems, state variables and linear discrete-time systems, solutions of state equations, concepts of controllability and observability, pole placement by state feedback.

TOTAL: 45

REFERENCES:

1 Nagrath I J, and Gopal M, “Control Systems Engineering”’ New Age International Publishers, Fourth edition, 2005.

2 Okata K, “Modern Control Engineering”’ Pearson/Prentice hall of India Pvt. Ltd., New Delhi, 1997.

3 Gopal M, “Control Systems-Principles and design”’ Tata McGraw Hill Co. ltd., 2nd Edition, 002.

4 Norman S Nise, “ Control System Engineering”’ John Wiley & Sons Inc., 2001.

5 Sergey Edward Lyshevski, “Control Systems-Theory with Engineering Applications”’ Springer-Verlag, New York Inc., 2002.

6 Stainslaw H Zak, “Systems and Control”’ Oxford University Press Inc., 2003.

07CD003 DESIGN OF AUTOMOTIVE SYSTEMS 3 0 0 100

INTRODUCTION (9)

Fundamentals of designing automobiles-performance of automobiles, general layout of the automobile Design conditions-loading conditions, maximum moments in automobile transmission, forced vibrations of sprung mass with random disturbance, fatigue resistance analysis procedure.

CLUTCH (9)

Introduction-design diagrams of clutch, calculation of critical parameters of clutches, design calculation of standard elements of friction clutches, torsional vibration dampers, clutch control drives.

TRANSMISSION (9)

Determining main parameters of transmission, gear shift mechanisms, main gear, differential, differential housings, axle shafts, fear box, auxiliary gear box, transfer case, planetary gears, kinematics of universal joints, design of universal joint and propeller shaft, location determination of universal joint and propeller shaft.

SUSPENSION AND STEERING SYSTEM (9)

Oscillation and smoothness of ride, elastic characteristics of ride, elastic elements of suspension, shock absorbers. Fundamentals of designing and calculating steering control linkage, steering gears, hydraulic booster.

BRAKES (9)

Pressure distribution along shoe length, determining braking torque, design of drum and disk brakes, fundamentals of designing brake force regulators, antilocking system.

TOTAL: 45

REFERENCES:

1 Lukin P Gasparyants G and Rodionov V, “Automobile Chassis Design and Calculations”, Mir Publishers, 1989.
2 Heinz Heisier, “Vehicle and Engine technology”’ SAE, New York, 1999.
3 Gillespie T D, “Fundamentals of Vehicle Dynamics”’ SAE Inc., New York, 1992
4 Schwaller A E, “Motor Automotive Technology”’ Third Edition, Delman Publishers, New York.

07CD004 DESIGN AND ANALYSIS OF THERMAL SYSTEMS 3 0 0 100

INTRODUCTION (8)

Design Principles, workable systems, optimal systems, matching of system components, economic analysis , depreciation, gradient present worth factor.

MATHEMATICAL MODELING (9)

Equation fitting, nomography, empirical equation, regression analysis, different modes of mathematical models, selection, computer programmes for models.

MODELLING THERMAL EQUIPMENTS (9)

Modelling heat exchangers, evaporators, condensers, absorption and rectification columns, compressor, pumps, simulation studies, information flow diagram, solution procedures.

SYSTEMS OPTIMIZATION (10)

Objective function formulation, constraint equations, mathematical formulation, Calculas method, dynamic programming, geometric programming, linear programming methods, solution procedures.

DYNAMIC BEHAVIOUR OF THERMAL SYSTEM (9)

Steady state simulation, Laplace transformation, feedback control loops, stability analysis, non-linearties.

TOTAL: 45

REFERENCES:

1 Stoecker W F, “Design of Thermal Systems”’ McGraw Hill, 1980.
2 Kapur J N, “Mathematical Modelling”’ Wiley eastern Ltd., New York, 1989.
3 Stoecker W F, “Refrigeration and Air-Conditioning”’ TMH, 1985.
4 Fanger P O, “Thermal Comport”’ McGraw Hill, USA 1972.
5 McQuiston F C and Parker T D, “ Heating, Ventilating and Air conditioning, Analysis and design”’ John Wiley and Sons, USA.

07CD005 DESIGN OF PLASTIC PARTS 3 0 0 100

Selection of Plastics (9)

Mechanical Properties- Material Selection for Strength – Degradation - Wear Resistance and Frictional Properties- Special Properties - Processing - Costs. Mechanical Behavior of Plastics- Short term tests -Long term testing -Design Methods for Plastics using deformation data -Pseudo-Elastic design method for plastics-Thermal stresses and Strains- - Time Temperature Superposition - Fracture behavior - Creep behavior - Impact behavior.

Design of Injection Molded Parts (9)

Manufacturing Considerations -Mold Filling Considerations -Weld line-Shrinkage and Warpage - Cooling and Solidification-Structural design Considerations-Structural Members-Design for Stiffness - Processing Limitations in Product Design.

Introduction to Mould Design (9)

Types of moulds and dies for various processing methods - Mould and Die Design Concept and Materials. Injection Mould Design - Basics of mould construction - Methodical Mould Design - Design of Feed System, Ejection System - Venting - Design of Cooling system -Mould alignment concepts and Demoulding Techniques.

Compression and Transfer Mould Design (9)

Basics of mould construction - Mould design -Positive moulds- Positive moulds with Lands- Multi cavity moulds with individual, common Loading Chamber - Moulds with a slide core - Split cavity moulds, Heat losses and energy requirement.

Blow Mould Design (9)

Materials Selection, Mould Cooling, Clamping Force, Venting, Pinch-off, Head die design, Parison Diameter Calculation, Wall Thickness, Vertical-load strength, Blow ratio, Base pushup, Neck and Shoulder Design, Thread and beads, Bottom Design. Extrusion Die Design - Die geometry, Die Design, Materials and Classification.

TOTAL : 45

REFERENCES

1 P.S.Cracknell and R.W Dyson, Handbook of Thermoplastics - Injection Mould Design, Chapman & Hall, 1993.
2 Laszlo Sors and Imre Balazs, Design of Plastics Moulds and Dies, Elsevier, Amsterdam, 1989.
3 R.G.W.Pye, Injection Mould Design, SPE Publication, 2000.
4 R J Crawford, Plastics Engineering, Butterworth-Heinemann, Oxford, 1999
5 Edward Miller(Ed), Plastics Product Design Handbook Part A –Materials and Components, Marcel Dekker, 1981.
6 R.A Malloy, Plastic Part Design for Injection Molding An Introduction, Hanser, 1997
7 N. Rao, K O'Brien, Design Data for Plastics Engineers, Hanser, New York, 1998

07CC001 INDUSTRIAL ROBOTICS AND EXPERT SYSTEMS 3 0 0 100

1. INTRODUCTION AND ROBOT KINEMATICS 10

Definition need and scope of Industrial robots – Robot anatomy – Work volume – Precision movement – Classifications of Robots.

Robot Kinematics – Direct and inverse kinematics – Robot trajectories – Control of robot manipulators – Robot dynamics – Methods for orientation and location of objects.

2. ROBOT DRIVES AND CONTROL 9

Controlling the Robot motion – Position and velocity sensing devices – Design of drive systems – Hydraulic and Pneumatic drives – Linear and rotary actuators and control valves – Electro hydraulic servo valves, electric drives – Motors – Designing of end effectors – Vacuum, magnetic and air operated grippers.

3. ROBOT SENSORS 9

Transducers and Sensors – Sensors in Robot – Tactile sensor – Proximity and range sensors – Sensing joint forces – Robotic vision system – Image Gribbing – Image processing and analysis – Image segmentation – Pattern recognition – Training of vision system.

4. ROBOT CELL DESIGN AND APPLICATION 9

Robot work cell design and control – Safety in Robotics – Robot cell layouts – Multiple Robots and machine interference – Robot cycle time analysis. Industrial application of robots.

5. ROBOT PROGRAMMING, ARTIFICIAL INTELLIGENCE AND EXPORT SYSTEMS 8

Methods of Robot Programming – Characteristics of task level languages lead through programming methods – Motion interpolation. Artificial intelligence – Basics – Goals of artificial intelligence – AI techniques – problem representation in AI – Problem reduction and solution techniques - Application of Artificial Intelligence in Robots.

Total: 45

REFERENCES:

1. K.S.Fu, R.C. Gonzalez and C.S.G. Lee, "Robotics Control, Sensing, Vision and Intelligence", Mc Graw Hill, 1987.
2. Yoram Koren," Robotics for Engineers' Mc Graw-Hill, 1987.
3. Kozyrey, Yu. "Industrial Robots", MIR Publishers Moscow, 1985.
4. Richard. D, Klafter, Thomas, A, Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Prentice-Hall of India Pvt. Ltd., 1984.
5. Deb, S.R." Robotics Technology and Flexible Automation", Tata Mc Graw-Hill, 1994.
6. Mikell, P. Groover, Mitchell Weis, Roger, N. Nagel, Nicholas G. Odrey," Industrial Robotics Technology, Programming and Applications", Mc Graw-Hill, Int. 1986.
7. Timothy Jordanides et al ,"Expert Systems and Robotics ", Springer –Verlag, New York, May 1991.

07CC002 MECHATRONICS SYSTEM DESIGN 3 0 0 100

1. INTRODUCTION 3

Introduction to Mechatronics - Systems - Mechatronics in Products - Measurement Systems - Control Systems - Traditional design and Mechatronics Design.

2. SENSORS AND TRANSDUCERS 12

Introduction - Performance Terminology - Displacement, Position and Proximity - Velocity and Motion - Fluid pressure - Temperature sensors - Light sensors - Selection of sensors - Signal processing - Servo systems.

3. MICROPROCESSORS IN MECHATRONICS 15

Introduction - Architecture - Pin configuration - Instruction set - Programming of Microprocessors using 8085 instructions - Interfacing input and output devices - Interfacing D/A converters and A/D converters –Applications - Temperature control - Stepper motor control - Traffic light controller.

4. PROGRAMMABLE LOGIC CONTROLLERS 8

Introduction - Basic structure - Input / Output processing - Programming -Mnemonics Timers, Internal relays and counters - Data handling - Analog input / output - Selection of PLC.

5. DESIGN AND MECHATRONICS 7

Designing - Possible design solutions - Case studies of Mechatronics systems.

Total 45

REFERENCE

1. Michael B.Histand and David G. Alciatore, “Introduction to Mechatronics and Measurement Systems", McGraw-Hill International Editions, 1999.
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07CC003 ADVANCED TOOL DESIGN 3 0 0 100

1. TOOL-DESIGN METHODS 5

Introduction – The Design Procedure – Statement of the problem – The Needs Analysis – Research and Ideation – Tentative Design Solutions – The Finished Design – Drafting and Design Techniques in Tooling drawings – Screws and Dowels – Hole location – Jig-boring practice – Installation of Drill Bushings – Punch and Die Manufacture – Electro-discharge machining – Electro-discharge machining for cavity.

2. TOOLING MATERIALS AND HEAT TREATMENT 9

Introduction – Properties of Materials – Ferrous Tooling Materials – Tool steels – Cast Iron – Mild, or low-carbon Steel – Nonmetallic Tooling Materials – Nonferrous Tooling Materials – Metal cutting Tools – Single-point cutting tools – Milling cutters – Drills and Drilling – Reamer classification – Taps – Tap classification- the selection of carbide cutting tools – Determining the insert thickness for carbide tools

3. DESIGN OF DRILL JIGS 9

Introduction – Fixed Gages – Gage Tolerances – The selection of material for Gages – Indicating Gages – Automatic gages – Principles of location – Locating methods and devices – Principles of clamping – Drill jigs – Chip formation in drilling – General considerations in the design of drill jigs – Drill bushings – Methods of construction – Drill jigs and modern manufacturing

4. DESIGN OF FIXTURES AND DIES 14

Introduction – Fixtures and economics – Types of Fixtures – Vise Fixtures – Milling Fixtures – Boring Fixtures – Broaching Fixtures – Lathe Fixtures – Grinding Fixtures – Types of Die construction – Die-design fundamentals – Blanking and Piercing die construction – Pilots – Strippers and pressure pads- Presswork materials – Strip layout – Short-run tooling for Piercing – Bending dies – Forming dies – Drawing operations.

5. TOOL DESIGN FOR NUMERICALLY CONTROLLED MACHINE TOOLS 8

Introduction – The need for numerical control – A basic explanation of numeric control – Numerical control systems in use today – Fixture design for numerically controlled machine tools – Cutting tools for numerical control – Tool holding methods for numerical control – Automatic tool changers and tool positioners – Tool presetting – Introduction – General explanation of the Brown and sharp machine – tooling for Automatic screw machines

Total 45

REFERENCES:

1 Cyrll Donaldson, George H.LeCain, V.C. Goold, “Tool Design”, Tata McGraw Hill Publishing Company Ltd., 2000.

2 Prakash Hiralal Joshi, “Tooling data”, Wheeler Publishing, 2000

07CC004 PRODUCTIVITY MANAGEMENT AND RE-ENGINEERING 3 0 0 100

1. INTRODUCTION 5

Productivity concepts - Macro and Micro factors of productivity, Productivity benefit model, productivity cycle.

2. PRODUCTIVITY MODELS 12

Productivity measurement at International, National and Organizational level, Total productivity models. Productivity management in manufacturing and service sector. Productivity evaluation models, Productivity improvement models and techniques.

3. ORGANIZATIONAL TRANSFORMATION 8

Principles of organizational transformation and re-engineering, fundamentals of process reengineering, preparing the workforce for transformation and reengineering, methodology, guidelines, DSMCQ and PMP model.

4. RE-ENGINEERING PROCESS IMPROVEMENT MODELS 10

PMI models, Edosomwan model, Moen and Nolan strategy for process improvement, LMICIP model, NPRDC model.

5. RE-ENGINEERING TOOLS AND IMPLEMENTATION 10

Analytical and process tools and techniques - Information and communication technology - Enabling role of IT, RE-opportunities, process redesign - cases. Software methods in BPR - specification of BP, case study - Order, processing, user interfaces, maintainability and reusability

Total 45

REFERENCES

1 Sumanth, D.J., " Productivity engineering and management ", TMH, New Delhi, 1990.

2 Edosomwan, J.A., " Organizational transformation and process re-engineering", British Library cataloging in pub. data, 1996.

3 Rastogi, P.N. " Re-Engineering and Re-inventing the enterprise ", Wheeler pub. New Delhi, 1995.

4 Premvrat, Sardana, G.D. and Sahay, B.S, " Productivity Management - A systems approach ", Narosa Pub. New Delhi, 1998.

07PC103 PRODUCT DATA MANAGEMENT 3 0 0 100

1. INTRODUCTION 3

Introduction to PDM-present market constraints-need for collaboration - internet and developments in server-client computing.

2. COMPONENTS OF PDM 9

Components of a typical PDM setup-hardware and software-document management-creation and viewing of documents-creating parts-versions and version control of parts and documents-case studies.

3.CONFIGURATION MANAGEMENT 5

Base lines-product structure-configuration management-case studies.

4. PROJECTS AND ROLES 12

Creation of projects and roles-life cycle of a product- life cycle management-automating information flow-work flows- creation of work flow templates-life cycle-work flow integration-case studies.

5. CHANGE MANAGEMENT 6

Change issue- change request- change investigation- change proposal - change activity - case studies.

6. GENERIC PRODUCTS AND VARIANTS 10

Data Management Systems for FEA data **-** Product configurator - comparison between sales configuration and product configurator-generic product modeling in configuration modeler-use of order generator for variant creation-registering of variants in product register-case studies.

Total: 45

REFERENCES

1. Kevin Otto, Kristin Wood, “Product Design”, Pearson, 2001.
2. Daniel Amor, “The E-Business Revolution”, Prentice-Hall, 2000.
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5. Wind-Chill R5.0Reference Manuals...2000.

07PC104 RAPID PROTOTYPING AND TOOLING 3 0 0 100

1. INTRODUCTION 4

Need for the compression in product development, History of RP systems, Survey of applications, Growth of RP industry, classification of RP systems.

2. STEREOLITHOGRAPHY SYSTEMS 8

Principle, Process parameters, Process details, Data preparation, Data files and Machine details, Applications.

SELECTIVE LASER SINTERING - Types of machines, Principle of operation, Process parameters, Data preparation for SLS, Applications.

3. FUSION DEPOSITION MODELING 6

Principle, Process parameters, Path generation, Applications. SOLID GROUND CURING**:** Principle of operation, Machine details, Applications.

4.LAMINATED OBJECT MANUFACTURING 8

Principle of operation, LOM materials, Process details, Applications. CONCEPT MODELERS - Principle, Thermo jet printer, Sander's model market, 3-D printer, Genisys Xs printer, JP system 5, Object Quadra System. LASER ENGINEERED NET SHAPING (LENS) – principle –applications.

5. RAPID TOOLING 7

Indirect Rapid Tooling - Silicone rubber tooling, Aluminum filled epoxy tooling, Spray metal tooling, etc. Direct Rapid Tooling - Direct AIM, Quick cast process, Copper polyamide, Rapid Tool, DMILS, ProMetal, Sand casting tooling, Laminate tooling, soft tooling vs hard tooling.

6. SOFTWARE FOR RAPID PROTOTYPING 12

STL files, Overview of Solid view, Magics, mimics, magics communicator, etc. Internet based softwares, Collaboration tools.RAPID MANUFACTURING PROCESS OPTIMIZATION **-** Factors influencing accuracy, Data preparation errors, Part building errors, Errors in finishing, Influence of part build orientation. ALLIED PROCESSES **-** Vacuum Casting, Surface Digitizing, Surface Generation from point cloud, Surface modification, data transfer to solid models.

Total: 45

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1. Paul. F. Jacobs, "Stereo lithography and other RP & M Technologies", SME, NY, 1996.
2. Pham. D. T. & Dimov. S. S., "Rapid Manufacturing", Verlag, London, 2001.
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