

**AFFILIATED INSTITUTIONS  
ANNA UNIVERSITY, CHENNAI  
REGULATIONS - 2009  
M.E. ENGINEERING DESIGN**

**II TO IV SEMESTERS (FULL TIME) CURRICULUM AND SYLLABUS**

**SEMESTER II**

<b>COURSE CODE</b>	<b>COURSE TITLE</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>THEORY</b>					
ED 9221	Finite Element Methods in Mechanical Design	3	1	0	4
ED 9222	<u>Vibration Analysis and Control</u> *	<b>3</b>	<b>0</b>	<b>2</b>	<b>4</b>
ED 9223	<u>Mechanisms Design and Simulation</u> *	3	0	2	4
ED 9224	<u>Mechanical Behavior of Materials</u>	3	0	0	3
E3	Elective III	3	0	0	3
E4	Elective IV	3	0	0	3
<b>PRACTICAL</b>					
ED 9225	<u>Analysis and Simulation Lab</u>	0	0	2	1
ED 9226	Seminar	0	0	2	1
<b>TOTAL</b>		<b>18</b>	<b>1</b>	<b>8</b>	<b>23</b>

**SEMESTER III**

<b>COURSE CODE</b>	<b>COURSE TITLE</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>THEORY</b>					
E5	Elective V	3	0	0	3
E6	Elective VI	3	0	0	3
E7	Elective VII	3	0	0	3
ED 9231	Project Work (Phase I)	0	0	12	6
<b>Total</b>		<b>9</b>	<b>0</b>	<b>12</b>	<b>15</b>

**SEMESTER IV**

<b>COURSE CODE</b>	<b>COURSE TITLE</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>THEORY</b>					
ED 9241	Project Work (Phase II)	0	0	24	12
<b>Total</b>		<b>0</b>	<b>0</b>	<b>24</b>	<b>12</b>

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

**TOTAL NUMBER OF CREDIT: 21 + 23 + 15 + 12 = 71**

**LIST OF ELECTIVES FOR M.E. ENGINEERING DESIGN**

<b>COURSE CODE</b>	<b><u>COURSE TITLE</u></b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
CC 9221	<u>Design for Manufacture, Assembly &amp; Environments</u>	3	0	0	3
CC 9222	<u>Integrated Manufacturing Systems</u>	3	0	0	3
CI 9222	<u>Mechatronics in Manufacturing</u>	3	0	0	3
ED 9250	<u>Optimization Techniques In Design</u>	3	0	0	3
ED 9251	<u>Engineering Fracture Mechanics</u>	3	0	0	3
ED 9252	<u>Tribology in Design</u>	3	0	0	3
ED 9253	<u>Advanced Mechanics of Materials</u>	3	0	0	3
ED 9254	<u>Composite Materials and Mechanics</u>	3	0	0	3
ED 9255	<u>Applied Engineering Acoustics</u>	3	0	0	3
ED 9256	<u>Advanced Tool Design</u>	3	0	0	3
ED 9257	Productivity Management and Re-Engineering	3	0	0	3
ED 9258	Industrial Robotics and Expert systems	3	0	0	3
ED 9259	<u>Design of Material Handling Equipments</u>	3	0	0	3
ED 9260	<u>Plasticity and Metal Forming</u>	3	0	0	3
ED 9261	<b><u>Theory of Plates and Shells</u></b>	3	0	0	3
ED 9262	<u>Design of Pressure Vessel and Piping</u>	3	0	0	3
ED 9263	<u>Modal Analysis of Mechanical Systems</u>	3	0	0	3
<b>ED 9264</b>	<b><u>Design of Hydraulic and Pneumatic systems</u></b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
ED 9265	<u>Experimental Stress Analysis</u>	3	0	0	3
ED 9266	<u>Maintenance Engineering</u>	3	0	0	3
ED 9267	<u>Bearing Design and Rotor Dynamics</u>	3	0	0	3
ED 9268	Mini Project	3	0	0	3
ED 9271	<u>Rapid Prototyping and Tooling</u>	3	0	0	3
EY 9256	<u>Design of Heat Exchangers</u>	3	0	0	3
IC 9262	<u>Computational Fluid Dynamics</u>	3	0	0	3
<b>IE 9224</b>	<u>Supply Chain Management</u>	3	0	0	3
PD 9250	<u>Design Paradigm</u>	3	0	0	3
PD 9251	<u>Micro Electro Mechanical Systems</u>	3	0	0	3
PD 9252	<u>Creativity in Design</u>	3	0	0	3
PD 9253	<u>Reverse Engineering</u>	3	0	0	3
PD 9254	<u>Enterprise Resource Planning</u>	3	0	0	3



### **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, 4<sup>th</sup> 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. Reddy, J.N., “Introduction to Non-Linear Finite Element Analysis”, Oxford University 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.

**ED 9222**

**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 vibrations Measuring instruments
- To understand the various Vibration control strategies

### **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 Electrodynamic –Frequency Measuring Instruments-. System Identification from Frequency Response -Testing for resonance and mode shapes

**45 + 15 LAB PERIODS**

**TOTAL : 75 PERIODS**

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

**TEXT BOOKS:**

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

**REFERENCES:**

1. Ramamurti. V, “Mechanical Vibration Practice with Basic Theory”, Narosa, New Delhi, 2000
2. S. Graham Kelly & Shashidar K. Kudari, “Mechanical Vibrations”, Tata McGraw –Hill Publishing Com. Ltd New Delhi,2007.

**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 Linkages-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 PERIODS 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.

**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****10**

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<sub>2</sub>O<sub>3</sub>, SiC, Si<sub>3</sub>N<sub>4</sub> 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, (2<sup>nd</sup> 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, (4<sup>th</sup> Edition) Jaico, 1999.
5. Metals Hand book, Vol.10, Failure Analysis and Prevention, (10<sup>th</sup> Edition), Jaico, 1999.
7. Ashby M.F., materials selection in Mechanical Design 2<sup>nd</sup> Edition, Butter worth 1999.

8. [www.astm.org/labs/pages/131350.htm](http://www.astm.org/labs/pages/131350.htm).

**ED 9225**

**ANALYSIS AND SIMULATION LAB**

**L T P C**  
**0 0 2 1**

Analysis of Mechanical Components – Use of FEA Packages like ANSYS/ NASTRAN etc., Exercises shall include analysis of

- Machine elements under Static loads
- Thermal Analysis of mechanical systems
- Modal Analysis
- Machine elements under Dynamic loads
- 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**

**CC 9221**

**DESIGN FOR MANUFACTURE, ASSEMBLY AND ENVIRONMENTS**

**L T P C**  
**3 0 0 3**

**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 remanufacture – 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, Hartz 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. Keven Otto and Kristin Wood, Product Design. Pearson Publication, 2004.

**CC 9222**

**INTEGRATED MANUFACTURING SYSTEMS**

**LT P C  
3 0 0 3**

**UNIT I INTRODUCTION 5**

Objectives of a manufacturing system-identifying business opportunities and problems classification production systems-linking manufacturing strategy and systems analysis of manufacturing operations

**UNIT II GROUP TECHNOLOGY AND COMPUTER AIDED PROCESS PLANNING 5**

Introduction-part families-parts classification and coding - group technology machine cells-benefits of group technology. Process planning function CAPP - Computer generated time standards.

**UNIT III COMPUTER AIDED PLANNING AND CONTROL 10**

Production planning and control-cost planning and control-inventory management-Material requirements planning (MRP)-shop floor control-Factory data collection system-Automatic identification system-barcode technology- automated data collection system.

**UNIT IV COMPUTER MONITORING 10**

Types of production monitoring systems-structure model of manufacturing process-process control & strategies- direct digital control-supervisory computer control-computer in QC - contact inspection methods non-contact inspection method - computer-aided testing - integration of CAQC with CAD/CAM.

**UNIT V INTEGRATED MANUFACTURING SYSTEM 15**

Definition - application - features - types of manufacturing systems- machine toolsmaterials handling system- computer control system - DNC systems manufacturing cell. Flexible manufacturing systems (FMS) - the FMS concept-transfer systems - head changing FMS - variable mission manufacturing system - CAD/CAM system - human labor in the manufacturing system-computer integrated manufacturing system benefits. Rapid prototyping - Artificial Intelligence and Expert system in CIM.

**TOTAL : 45 PERIODS**

**TEXT BOOK:**

1. Groover, M.P., "Automation, Production System and CIM", Prentice-Hall of India, 1998.

**REFERENCES:**

1. David Bedworth, "Computer Integrated Design and Manufacturing", TMH, New Delhi, 1998.
2. Yorem Koren, "Computer Integrated Manufacturing Systems", McGraw Hill, 1983.
3. Ranky, Paul G., "Computer Integrated Manufacturing", Prentice Hall International 1986.
4. R.W. Yeomamas, A. Choudry and P.J.W. Ten Hagen, "Design rules for a CIM system", North Holland Amsterdam, 1985.

**CI 9222**

**MECHATRONICS IN MANUFACTURING**

**LT PC  
3 0 0 3**

**OBJECTIVE**

This syllabus is formed to create knowledge in Mechatronic systems and impart the source of concepts and techniques, which have recently been applied in practical situation. It gives a framework of knowledge that allows engineers and technicians to develop an interdisciplinary understanding and integrated approach to engineering.

**UNIT I INTRODUCTION**

**5**

Introduction to Mechatronics - Systems- Need for Mechatronics - Emerging area of Mechatronics - Classification of Mechatronics - Measurement Systems - Control Systems.

**UNIT II SENSORS AND TRANSDUCERS**

**12**

Introduction - Performance Terminology – Potentiometers - LVDT - Capacitance sensors - Strain gauges - Eddy current sensor - Hall effect sensor - Temperature sensors - Light sensors - Selection of sensors - Signal processing.

**UNIT III ACTUATORS**

**12**

Actuators – Mechanical - Electrical - Fluid Power - Piezoelectric - Magnetostrictive - Shape memory alloy - applications - selection of actuators.

**UNIT IV PROGRAMMABLE LOGIC CONTROLLERS**

**8**

Introduction - Basic structure - Input and output processing - Programming - Mnemonics- Timers, counters and internal relays - Data handling - Selection of PLC.

**UNIT V DESIGN AND MECHATRONICS CASE STUDIES**

**8**

Designing - Possible design solutions-Traditional and Mechatronics design concepts - Case studies of Mechatronics systems - Pick and place Robot - Conveyor based material handling system - PC based CNC drilling machine - Engine Management system - Automatic car park barrier - Data acquisition Case studies.

**TOTAL: 45PERIODS**

## TEXT BOOKS

1. Bolton.W, "Mechatronics" , Pearson education, second edition, fifth Indian Reprint, 2003
2. Smaili.A and Mrad.F , "Mechatronics integrated technologies for intelligent machines", Oxford university press, 2008

## REFERENCES:

1. Devadas Shetty and Richard A.Kolk, "Mechatronics systems design", PWS Publishing company, 2007.
2. Godfrey C. Onwubolu, "Mechatronics Principles and Applications", Elsevier, 2006.
3. Nitaigour Premchand Mahalik, "Mechatronics Principles, Concepts and Applications" Tata McGraw-Hill Publishing company Limited, 2003.
4. Michael B.Histand and Davis G.Alciatore, " Introduction to Mechatronics and Measurement systems". McGraw Hill International edition, 1999.
5. Bradley D.A, Dawson.D, Buru N.C and Loader A.J, "Mechatronics" Nelson Thornes Ltd, Eswar press, Indian print, 2004.
6. Lawrence J.Kamm, "Understanding Electro-Mechanical Engineering – An Introduction to Mechatronics", Prentice Hall of India Pvt Ltd, 2000.
7. Dan Neculescu, "Mechatronics", Pearson education, 2002.
8. Newton C.Braga, "Mechatronics Sourcebook", Thomson Delmar Learning, Eswar Press, 2003.

ED 9250

OPTIMIZATION TECHNIQUES IN DESIGN

L T P C  
3 0 0 3

<b>UNIT I</b>	<b>UNCONSTRAINED OPTIMIZATION TECHNIQUES</b>	<b>10</b>
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.		
<b>UNIT II</b>	<b>CONSTRAINED OPTIMIZATION TECHNIQUES</b>	<b>10</b>
Optimization with equality and inequality constraints - Direct methods – Indirect methods using penalty functions, Lagrange multipliers - Geometric programming		
<b>UNIT III</b>	<b>ADVANCED OPTIMIZATION TECHNIQUES</b>	<b>10</b>
Multi stage optimization – dynamic programming; stochastic programming; Multi objective optimization, Genetic algorithms and Simulated Annealing techniques; Neural network & Fuzzy logic principles in optimization.		
<b>UNITIV</b>	<b>STATIC APPLICATIONS</b>	<b>8</b>
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.		
<b>UNIT V</b>	<b>DYNAMIC APPLICATIONS</b>	<b>7</b>



4. John M. Barson and Stanely T. Rolfe Fatigue and fracture control in structures  
Prentice hall Inc. Englewood cliffs. 1977

**ED 9252**

**TRIBOLOGY IN DESIGN**

**L T P C  
3 0 0 3**

**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.



- 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.

**UNIT I LAMINA CONSTITUTIVE RELATIONS 12**

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

Lamina Constitutive Equations: Lamina Assumptions – Macroscopic Viewpoint. Generalized Hooke's Law. Reduction to Homogeneous Orthotropic Lamina – Isotropic limit case, Orthotropic Stiffness matrix ( $Q_{ij}$ ), Typical Commercial material properties, Rule of Mixtures. Generally Orthotropic Lamina –Transformation Matrix, Transformed Stiffness. Manufacturing: Bag Moulding – Compression Moulding – Pultrusion – Filament Winding – Other Manufacturing Processes.

**UNIT II FLAT PLATE LAMINATE CONSTITUTIVE RELATIONS 10**

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 III LAMINA STRENGTH ANALYSIS 5**

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

**UNIT IV ANALYSIS OF LAMINATED FLAT PLATES 10**

Equilibrium Equations of Motion. Energy Formulations. Static Bending Analysis. Buckling Analysis. Free Vibrations – Natural Frequencies

**UNIT V EFFECT OF THERMAL PROPERTIES 8**

Modification of Hooke's Law due to thermal properties - Modification of Laminate Constitutive Equations. Orthotropic Lamina - special Laminate Configurations – Unidirectional, Off-axis, Symmetric Balanced Laminates - Zero C.T.E laminates, Thermally Quasi-Isotropic Laminates

**TOTAL: 45 PERIODS**

**TEXT BOOKS:**

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

**REFERENCES:**

1. Issac M. Daniel and Ori Ishai, "Engineering Mechanics of Composite Materials", Oxford University Press-2006, First Indian Edition - 2007

2. Mallick, P.K., Fiber –"Reinforced Composites: Materials, Manufacturing and Design", Maneeel Dekker Inc, 1993.
3. Halpin, J.C., "Primer on Composite Materials, Analysis", Techomic Publishing Co., 1984.
4. garwal, B.D., and Broutman L.J., "Analysis and Performance of Fiber Composites", John Wiley and Sons, New York, 1990.
5. Mallick, P.K. and Newman, S., (edition), "Composite Materials Technology: Processes and Properties", Hansen Publisher, Munish, 1990.
6. Madhujit Mukhopadhyay, "Mechanics of Composite Materials and Structures", University Press (India) Pvt. Ltd., Hyderabad, 2004 (Reprinted 2008)

**ED 9255**

**APPLIED ENGINEERING ACOUSTICS**

**L T P C  
3 0 0 3**

**UNIT I 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.

**UNIT II CHARACTERISTICS OF SOUND 10**

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.

**UNIT III 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.

**UNIT IV INTRODUCTION TO THE ASSESSMENT AND MEASUREMENT OF SOUND 10**

Introduction – 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.

**UNIT V BASICS 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 PERIODS**

**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.



- Hansen C.H. and Snyder, S.D., "Active Control of Sound and Vibration", E and FN Spon, London 1996.

**ED 9256** **ADVANCED TOOL DESIGN** **L T P C**

**3 0 0 3**

**UNIT I INTRODUCTION TO TOOL DESIGN 8**

Introduction –Tool Engineering – Tool Classifications– Tool Design Objectives – Tool Design in manufacturing- Challenges and requirements- Standards in tool design- Tool drawings -Surface finish – Fits and Tolerances - Tooling Materials- Ferrous and Non ferrous Tooling Materials- Carbides, Ceramics and Diamond -Non metallic tool materials-Designing with relation to heat treatment

**UNIT II DESIGN OF CUTTING TOOLS 9**

Mechanics of Metal cutting –Oblique and orthogonal cutting- Chip formation and shear angle - Single-point cutting tools – Milling cutters – Hole making cutting tools- Broaching Tools - Design of Form relieved and profile relieved cutters-Design of gear and thread milling cutters

**UNIT III DESIGN OF JIGS AND FIXTURES 10**

Introduction – Fixed Gages – Gage Tolerances –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 – Thrust and Turning Moments in drilling - Drill jigs and modern manufacturing- Types of Fixtures – Vise Fixtures – Milling Fixtures – Boring Fixtures – Broaching Fixtures – Lathe Fixtures – Grinding Fixtures – Modular Fixtures – Cutting Force Calculations.

**UNIT IV DESIGN OF PRESS TOOL DIES 10**

Types of Dies –Method of Die operation–Clearance and cutting force calculations- Blanking and Piercing die design – Pilots – Strippers and pressure pads- Presswork materials – Strip layout – Short-run tooling for Piercing – Bending dies – Forming dies – Drawing dies-Design and drafting.

**UNIT V TOOL DESIGN FOR CNC MACHINE TOOLS 8**

Introduction –Tooling requirements for Numerical control systems – Fixture design for CNC machine tools- Sub plate and tombstone fixtures-Universal fixtures– Cutting tools– Tool holding methods– Automatic tool changers and tool positioners – Tool presetting– General explanation of the Brown and Sharp machine.

**TOTAL: 45 PERIODS**

**REFERENCES:**

- Cyrril Donaldson, George H.LeCain, V.C. Goold, "Tool Design", Tata McGraw Hill Publishing Company Ltd., 2000.
- E.G.Hoffman," Jig and Fixture Design", Thomson Asia Pvt Ltd, Singapore, 2004
- Prakash Hiralal Joshi, "Tooling data", Wheeler Publishing, 2000
- Venkataraman K., "Design of Jigs, Fixtures and Presstools", TMH, 2005
- Haslehurst M., "Manufacturing Technology", The ELBS, 1978



Definition need and scope of Industrial robots – Robot anatomy – Work volume – Precision movement – End effectors – Sensors.

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

**UNIT II 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.

**UNIT III ROBOT SENSORS 9**

Transducers and Sensors – Tactile sensor – Proximity and range sensors – Sensing joint forces – Robotic vision system – Image Representation - Image Grabbing – Image processing and analysis – Edge Enhancement – Contrast Stretching – Band Rationing - Image segmentation – Pattern recognition – Training of vision system.

**UNIT IV 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.

**UNIT V ROBOT PROGRAMMING, ARTIFICIAL INTELLIGENCE AND EXPERT 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 AI and KBES in Robots.

**TOTAL: 45 PERIODS**

**TEXT BOOK:**

1. K.S.Fu, R.C. Gonzalez and C.S.G. Lee, "Robotics Control, Sensing, Vision and Intelligence", Mc Graw Hill, 1987.

**REFERENCES:**

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

**ED 9259 DESIGN OF MATERIAL HANDLING EQUIPMENTS L T P C**  
**(Use of Approved Data Book Is Permitted) 3 0 0 3**

<b>UNIT I</b>	<b>MATERIALS HANDLING EQUIPMENT</b>	<b>5</b>
	Types, selection and applications	
<b>UNIT II</b>	<b>DESIGN OF HOISTS</b>	<b>10</b>
	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.	
<b>UNIT III</b>	<b>DRIVES OF HOISTING GEAR</b>	<b>10</b>
	Hand and power drives - Traveling gear - Rail traveling mechanism - cantilever and monorail cranes - slewing, jib and luffing gear - cogwheel drive - selecting the motor ratings.	
<b>UNIT IV</b>	<b>CONVEYORS</b>	<b>10</b>
	Types - description - design and applications of Belt conveyors, apron conveyors and escalators Pneumatic conveyors, Screw conveyors and vibratory conveyors.	
<b>UNIT V</b>	<b>ELEVATORS</b>	<b>10</b>
	Bucket elevators: design - loading and bucket arrangements - Cage elevators - shaft way, guides, counter weights, hoisting machine, safety devices - Design of fork lift trucks.	
<b>TOTAL : 45 PERIODS</b>		

**TEXT BOOKS**

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.

**REFERENCES**

1. Alexandrov, M., Materials Handling Equipments, MIR Publishers, 1981.
2. Boltzharol, A., Materials Handling Handbook, The Ronald Press Company, 1958.
3. P.S.G. Tech., "Design Data Book", Kalaikathir Achchagam, Coimbatore, 2003.
4. Lingaiah. K. and Narayana Iyengar, "Machine Design Data Hand Book", Vol. 1 & 2, Suma Publishers, Bangalore, 1983.

<b>ED 9260</b>	<b>PLASTICITY AND METAL FORMING</b>	<b>L T P C</b>
		<b>3 0 0 3</b>

<b>UNIT I</b>	<b>THEORY OF PLASTICITY</b>	<b>9</b>
	Theory of plastic deformation - Engineering stress and strain relationship – Stress tensor - Strain tensor - Yield criteria's - Plastic stress strain relationship – Plastic work - Equilibrium conditions - Incremental plastic strain	
<b>UNIT II</b>	<b>CONSTITUTIVE RELATIONSHIPS AND INSTABILITY</b>	<b>7</b>
	Uniaxial tension test - Mechanical properties - Work hardening, Compression test,	

bulge test, plane strain compression stress, plastic instability in uniaxial tension stress, plastic instability in biaxial tension stress

**UNIT III ANALYSIS OF METAL FORMING PROBLEMS 2**

Slab analysis - Slip line method, upper bound solutions, statistically admissible stress field, numerical methods, contact problems, effect of friction, thermo elastic Elasto plasticity, elasto visco plasticity - Thermo mechanical coupling – Analysis of forging, rolling, extrusion and wire drawing processes - Experimental techniques of the evaluation of metal forming

**UNIT IV ANALYSIS OF SHEET METAL FORMING 8**

Bending theory - Cold rolling theory - Hill's anisotropic theory, Hill's general yield theory - Sheet metal forming - Elements used - Mesh generation and formulation - Equilibrium equations - Consistent full set algorithm - Numerical solutions procedures - examples of simulation of simple parts - Bench mark tests – Forming limit diagrams

**UNIT V ADVANCES IN METAL FORMING 9**

Orbital forging, Isothermal forging, Warm forging, Hot and Cold isotropic pressing, high speed extrusion, rubber pad forming, micro blanking –Superplastic forming - Overview of Powder Metal techniques - Powder rolling - Tooling and process parameters

**TOTAL : 45 PERIODS**

**REFERENCES**

1. Wagoner. R H., and Chenot. J.J., Metal Forming analysis, Cambridge University Press, 2002.
2. Slater. R A. C., Engineering Plasticity - Theory & Applications to Metal Forming, John Wiley and Sons, 1987.
3. Shiro Kobayashi, Altan. T, Metal Forming and Finite Element Method, Oxford University Press, 1989.
4. Narayanaswamy. R, Theory of Metal Forming Plasticity, Narosa Publishers, 1999.
5. Hosford. W. F and Caddell. RM., Metal Forming Mechanics and Metallurgy, Prentice Hall Eaglewood Cliffs, 1993.
6. Surender Kumar, “ Technology of Metal Forming Processes”, Prentice Hall of India, New Delhi, 2008.

**ED 9261**

**THEORY OF PLATES AND SHELLS**

**L T P C  
3 0 0 3**

**OBJECTIVE:**

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

**UNIT I GENERAL INTRODUCTION 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, 2<sup>nd</sup> 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



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 SDOF 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.

**ED 9264 DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS L T P C  
3 0 0 3**

**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 2**

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 Esposito, “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)

**ED 9265 EXPERIMENTAL STRESS ANALYSIS L T P C**

**3 0 0 3**

**UNIT I 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.

**UNIT II 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.

**UNIT III 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

**UNIT IV 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.

**UNIT V NON DESTRUCTIVE TESTING METHODS 9**



Asset and spare part management, - Conventional spare Parts management techniques such as Economic Order Quantity, two bin systems - Latest trends in monitoring through bar codes, mobile computer and wireless data transmissions - Different aspects of planning and scheduling of Maintenance, such as shutdowns- Critical aspects of both routine and shut down Maintenance -. bar charts - PERT network during shut down -Man power Training and utilization of skilled manpower - Sequencing of activities.

**UNIT V SAFETY AND OTHER ASPECTS OF MAINTENANCE FUNCTIONS**

**10**

Safety Engineering. - Hazard analysis -General rules and guidelines in safety and hazard prevention - Analytical tools - Hazard analysis- Fault Tree Analysis - Sneak Circuit analysis - Integrated approach to Maintenance- Statistical distributions such as normal, gamma and “Weibull” in Maintenance- Maintenance effectiveness.

**TOTAL: 45 PERIODS**

**TEXT BOOK:**

1. “Maintenance Engineering and Management”: K.Venkataraman-PHI Learning-2007

**REFERENCES:**

1. Kelly. A and Harris, M. J, “Management of Industrial maintenance”, Butter worth & Co., 1978
2. David J. Smith, “Reliability and Maintainability in Perspective”, McMillan, 2<sup>nd</sup> Edition, 1985.
3. Gwidon W Stachowiak and Andrew W. Batchelor, “Engineering Tribology”, Butterwork-Heinmann, 2001
4. John V.Grimaldi & Rollin H.Simonds, “Safety Management”, AITBS Publishers & Distributors, 2001.

**ED 9267**

**BEARING DESIGN AND ROTOR DYNAMICS**

**LT P C  
3 0 0 3**

**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- Fatigue life calculations- Bearing operating temperature- Lubrication- Selection of lubricants- Internal clearance – Shaft and housing fit- -Mounting

arrangements-Materials for rolling bearings- Manufacturing methods- Ceramic bearings-Rolling bearing cages-bearing seals selection

**UNIT IV DYNAMICS OF 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

**ED 9271 RAPID PROTOTYPING AND TOOLING LT P C  
3 0 0 3**

**UNIT I INTRODUCTION 7**

Need - Development of RP systems – RP process chain - Impact of Rapid Prototyping and Tooling on Product Development – Benefits- Applications – Digital prototyping - Virtual prototyping.

**UNIT II LIQUID BASED AND SOLID BASED RAPID PROTOTYPING SYSTEMS 10**

Stereolithography Apparatus, Fused deposition Modeling, Laminated object manufacturing, Three dimensional printing: Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies.

**UNIT III POWDER BASED RAPID PROTOTYPING SYSTEMS 10**

Selective Laser Sintering, Direct Metal Laser Sintering, Three Dimensional Printing, Laser Engineered Net Shaping, Selective Laser Melting, Electron Beam Melting: Processes, materials, products, advantages, applications and limitations – Case Studies.

**UNIT IV REVERSE ENGINEERING AND CAD MODELING 10**

Basic concept- Digitization techniques – Model Reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data Requirements – geometric modeling techniques: Wire frame, surface and solid modeling – data formats - Data interfacing, Part orientation and support generation, Support structure design, Model

Slicing and contour data organization, direct and adaptive slicing, Tool path generation.

**UNIT V RAPID TOOLING 8**

Classification: Soft tooling, Production tooling, Bridge tooling; direct and indirect – Fabrication processes, Applications. Case studies - automotive, aerospace and electronic industries.

**TOTAL :45 PERIODS**

**TEXT BOOKS**

1. Rapid prototyping: Principles and applications, second edition, Chua C.K., Leong K.F., and Lim C.S., World Scientific Publishers, 2003.
2. Rapid Tooling: Technologies and Industrial Applications, Peter D.Hilton, Hilton/Jacobs, Paul F.Jacobs, CRC press, 2000.

**REFERENCES**

1. Rapid prototyping, Andreas Gebhardt, Hanser Gardener Publications, 2003.
2. Rapid Prototyping and Engineering applications : A tool box for prototype development, Liou W.Liou, Frank W.Liou, CRC Press, 2007.
3. Rapid Prototyping: Theory and practice, Ali K. Kamrani, Emad Abouel Nasr, Springer, 2006

**EY 9256 DESIGN OF HEAT EXCHANGERS L T P C  
3 0 0 3**

**AIM:**

The course is intended to build up necessary background for the design of the various types of heat exchangers.

**OBJECTIVE:**

- To learn the thermal and stress analysis on various parts of the heat exchangers
- To analyze the sizing and rating of the heat exchangers for various applications

**UNIT I FUNDAMENTALS OF HEAT EXCHANGER 9**

Temperature distribution and its implications types – shell and tube heat exchangers – regenerators and recuperators – analysis of heat exchangers – LMTD and effectiveness method.

**UNIT II FLOW AND STRESS ANALYSIS 9**

Effect of turbulence – friction factor – pressure loss – stress in tubes – header sheets and pressure vessels – thermal stresses, shear stresses, types of failures.

**UNIT III DESIGN ASPECTS 9**

Heat transfer and pressure loss – flow configuration – effect of baffles – effect of deviations from ideality – design of double pipe, finned tube, shell and tube heat exchangers, simulation of heat exchangers.

**UNIT IV COMPACT AND PLATE HEAT EXCHANGERS 9**

Types – merits and demerits – design of compact heat exchangers, plate heat exchangers – performance influencing parameters, limitations.

**UNIT V CONDENSERS & COOLING TOWERS 9**

Design of surface and evaporative condensers – cooling tower – performance characteristics.

**TOTAL : 45 PERIODS**

**TEXT BOOK:**

1. Sadik Kakac, Hongtan Liu, Heat Exchangers Selection, Rating and Thermal Design, CRC Press, 2002.

**REFERENCES:**

1. P Arthur. Frass, Heat Exchanger Design, John Wiley & Sons, 1988.
2. Taborek.T, Hewitt.G.F and Afgan.N, Heat Exchangers, Theory and Practice, McGraw-Hill Book Co. 1980.
3. Hewitt.G.F, Shires.G.L, Bott.T.R, Process Heat Transfer, CRC Press, 1994.

**IC 9262**

**COMPUTATIONAL FLUID DYNAMICS**

**L T P C**  
**3 0 0 3**

**AIM**

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

**OBJECTIVE :**

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

**UNIT I GOVERNING DIFFERENTIAL EQUATION AND FINITE DIFFERENCE METHOD 10**

Classification, Initial and Boundary conditions – Initial and Boundary Value problems – Finite difference method, Central, Forward, Backward difference, Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test.

**UNIT II CONDUCTION HEAT TRANSFER 10**

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

**UNIT III INCOMPRESSIBLE FLUID FLOW 10**

Governing Equations, Stream Function – Vorticity method, Determination of pressure for viscous flow, SIMPLE Procedure of Patankar and Spalding, Computation of Boundary layer flow, finite difference approach.

**UNIT IV CONVECTION HEAT TRANSFER AND FEM 10**

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



The management task, logistics organisation, the logistics information systems-topology of SC application- MRP, ERP, Warehouse management system, product data management- cases.

**TOTAL: 45 PERIODS**

**REFERENCES:**

1. Scharj, P.B., Lasen, T.S., Managing the global supply chain, Viva Books, New Delhi, 2000.
2. Ayers, J.B., Hand book of Supply Chain Management, The St. Lencie press, 2000.
3. Nicolas, J.N., Competitive manufacturing management- continuous improvement, Lean production, customer focused quality, McGraw-Hill, NY, 1998.
4. Steudel, H.J. and Desruelle, P., Manufacturing in the ninteens- How to become mean, lean and world class competitor, Van Nostrand Reinhold, NY, 1992.

**PD 9250**

**DESIGN PARADIGM**

**L T P C**  
**3 0 0 3**

**OBJECTIVE**

Study about the design methodologies for manufacture and assembly, value engineering techniques and analysis of product development

**UNIT I DESIGN FOR MANUFACTURE 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.

**UNIT II FORM DESIGN OF CASTINGS AND WELDMENT 9**

Redesign of castings based on parting line considerations - Minimizing core requirements - Redesigning a cast members using weldments-factors influencing form design-Working principle, Material, Manufacture, Design - Possible solutions - Materials choice - Influence of materials-on from design - form design of welded members, forgings and castings.

**UNIT III DESIGN FOR ASSEMBLY 6**

Assembly processes-Handling and insertion process-Manual ,automatic and robotic assembly-Cost of Assembly-Number of Parts-DFA guidelines

**UNIT IV VALUE ENGINEERING 12**

Value –types –functional –operational –aesthetic –cost- –material – Design process – value and worthiness –procedure -brainstorming sessions –evaluation –case studies –value estimation- Value analysis - Design for value - Selection of alternatives - optimization – Implementation

**UNIT V PRODUCT DEVELOPMENT ECONOMICS 10**

Elements of Economics analysis-Quantitative and qualitative analysis-Economic Analysis process-Estimating magnitude and time of future cash inflows and out flows-Sensitivity analysis-Project trade-offs-Trade-offs rules-Limitation of quantitative analysis-Influence of qualitative factors on project success

**TOTAL : 45 PERIODS**

**TEXT BOOKS:**



1. Harry Peck, Designing for Manufacture, Pitman Publications, 1983.
2. George E Dieter, Engineering Design, McGraw-Hill Int Editions, 2000

**REFERENCES:**

1. S.S.Iyer ,Value Engineering, New Age International, 2000
2. Charles E. Ebeling, Reliability and Maintainability Engineering, , TMH, 2000

**PD 9251                      MICRO ELECTRO MECHANICAL SYSTEMS                      L T P C**  
**3 0 0 3**

**UNIT I                      INTRODUCTION                      8**

Introduction, Materials-substrates, Additive materials. Fabrication techniques-Deposition, Lithography, etching, Surface micro machining, Thick film screen-printing and electroplating

**UNIT II                      MECHANICAL SENSOR PACKAGING                      8**

Introduction, Standard IC packages-ceramic, plastic and metal packages. Packaging process-Electrical interconnects, Methods of die attachment, sealing techniques. MEMS mechanical sensor packaging

**UNIT III                      MECHANICAL TRANSDUCTION TECHNIQUES                      9**

Piezo resistivity, Piezoelectricity, Capacitive Techniques, Optical techniques, Resonant techniques. Actuation techniques, Smart Sensors. MEMS Simulation and Design tools-Behavioral model ling simulation tools and Finite element simulation tools.

**UNIT IV                      PRESSURE SENSORS                      12**

Introduction. Techniques for sensing. Physics of pressure sensing-Pressure sensor specifications. Dynamic pressure sensing. Pressure sensor types. MEMS technology pressure sensors-Micro machined silicon diaphragms,

**UNIT V                      FORCE, TORQUE AND INERTIAL SENSORS                      8**

Introduction-Silicon based devises-Optical devises-capacitive devises-Magnetic devices-Atomic force microscope and scanning probes- micro machined accelerometer-Micro machined Gyroscope-Future inertial micro machined sensors

**TEXT BOOK**

1. Nadim Maluf and Kirt Williams,' An introduction to Micro electro mechanical System Engineering, Artech House, Inc. Boston.2003

**REFERENCE**

1. Stephen Beeby, Graham Ensell, Michael Kraft and Neil White,' MEMS Mechanical sensors' Artech House, Inc. Boston 2003

**PD 9252                                      CREATIVITY IN DESIGN                                      L T P C**  
**3 0 0 3**

**UNIT I                      INTRODUCTION                      4**

Need for design creativity – creative thinking for quality – essential theory about directed creativity –

**UNIT II MECHANISM OF THINKING AND VISUALIZATION 11**

Definitions and theory of mechanisms of mind heuristics and models : attitudes, Approaches and Actions that support creative thinking - Advanced study of visual elements and principles- line, plane, shape, form, pattern, texture gradation, color symmetry.Spatial relationships and compositions in 2 and 3 dimensional space - procedure for genuine graphical computer animation – Animation aerodynamics – virtual environments in scientific Visualization – Unifying principle of data management for scientific visualization – Unifying principle of data management for scientific visualization - Visualization benchmarking

**UNIT III CREATIVITY 11**

Methods and tools for Directed Creativity – Basic Principles – Tools of Directed Creativity – Tools that prepare the mind for creative thought – stimulation of new ideas – Development and Actions: - Processes in creativity ICEDIP – Inspiration, Clarification, Distillation, Perspiration, Evaluation and Incubation – Creativity and Motivation The Bridge between man creativity and the rewards of innovativeness – Applying Directed Creativity to the challenge of quality management

**UNIT IV DESIGN 9**

Process Design, Emotional Design – Three levels of Design – Visceral, Behavioral and Reflective- Recycling and availability-Creativity and customer needs analysis – Innovative product and service designs, future directions in this application of creativity thinking in quality management

**UNIT V INNOVATION 10**

Achieving Creativity – Introduction to TRIZ methodology of Inventive Problem Solving - the essential factors – Innovator’s solution – creating and sustaining successful growth – Disruptive Innovation model – Segmentive Models – New market disruption - Commoditization and DE-commoditization – Managing the Strategy Development Process – The Role of Senior Executive in Leading New Growth – Passing the Baton

**TOTAL : 45 PERIODS**

**REFERENCES:**

1. Rousing Creativity: Think New NowFloyd Hurr, ISBN 1560525479, Crisp Publications Inc. 1999
2. Geoffrey Petty, "how to be better at Creativity", The Industrial Society 1999
3. Donald A. Norman, "Emotional Design", Perseus Books Group New York , 2004
4. Clayton M. Christensen Michael E. Raynor, "The Innovator’s Solution", Harvard Business School Press Boston, USA, 2003
5. Semyon D. Savransky, "Engineering of Creativity – TRIZ", CRC Press New York USA, " 2000

**PD 9253**

**REVERSE ENGINEERING**

**L T P C  
3 0 0 3**

**UNIT I INTRODUCTION 5**

Scope and tasks of RE - Domain analysis- process of duplicating

<b>UNIT II</b>	<b>TOOLS FOR RE</b>	<b>8</b>
Functionality- dimensional- developing technical data - digitizing techniques - construction of surface model - solid-part material- characteristics evaluation - software and application- prototyping - verification		
<b>UNIT III</b>	<b>CONCEPTS</b>	<b>12</b>
History of Reverse Engineering – Preserving and preparation for the four stage process – Evaluation and Verification- Technical Data Generation, Data Verification, Project Implementation		
<b>UNIT IV</b>	<b>DATA MANAGEMENT</b>	<b>10</b>
Data reverse engineering – Three data Reverse engineering strategies – Definition – organization data issues - Software application – Finding reusable software components – Recycling real-time embedded software – Design experiments to evaluate a Reverse Engineering tool – Rule based detection for reverse Engineering user interfaces – Reverse Engineering of assembly programs: A model based approach and its logical basics		
<b>UNIT V</b>	<b>INTEGRATION</b>	<b>10</b>
Cognitive approach to program understated – Integrating formal and structured methods in reverse engineering – Integrating reverse engineering, reuse and specification tool environments to reverse engineering –coordinate measurement – feature capturing – surface and solid members		

**TOTAL: 45 PERIODS**

**REFERENCES:**

1. Design Recovery for Maintenance and Reuse, T J Biggerstaff, IEEE Corpn. July 1991
2. White paper on RE, S. Rugaban, Technical Report, Georgia Instt. of Technology, 1994
3. Reverse Engineering, Katheryn, A. Ingle, McGraw-Hill, 1994
4. Data Reverse Engineering, Aiken, Peter, McGraw-Hill, 1996
5. Reverse Engineering, Linda Wills, Kluiver Academic Publishers, 1996
6. Co-ordinate Measurment and reverse engineering, Donald R. Honsa, ISBN 1555897, American Gear Manufacturers Association

**PD 9254**                      **ENTERPRISE RESOURCE PLANNING**                      **L T P C**  
**3 0 0 3**

**UNIT I**                      **ENTERPRISE RESOURCE PLANNING:**                      **10**  
Principle – ERP framework – BusinessBlue Print – Business Engineering vs Business process Re-Engineering – Tools – Languages – Value chain – Supply and Demand chain – Extended supply chain management – Dynamic Models –Process Models

**UNIT II**                      **TECHNOLOGY AND ARCHITECTURE**                      **10**  
Client/Server architecture – Technology choices – Internet direction – Evaluation framework – CRM – CRM pricing – chain safety – Evaluation framework.

**UNIT III**                      **ERP SYSTEM PACKAGES:**                      **10**

SAP,. People soft, Baan and Oracle – Comparison – Integration of different ERP applications – ERP as sales force automation – Integration of ERP and Internet – ERP Implementation strategies – Organisational and social issues.

**UNIT IV** **7**

Overview – Architecture – AIM – applications – Oracle SCM. SAP : Overview – Architecture – applications -Before and after Y2k – critical issues – Training on various modules of IBCS ERP Package-Oracle ERP and MAXIMO, including ERP on the NET.

**UNIT V** **ERP PROCUREMENT ISSUES** **8**

Market Trends – Outsourcing ERP – Economics – Hidden Cost Issues – ROI – Analysis of cases from five Indian Companies.

**TOTAL : 45 PERIODS**

**REFERENCES:**

1. Sadagopan.S , ERP-A Managerial Perspective, Tata Mcgraw Hill, 1999.
2. Jose Antonio Fernandez , The SAP R/3 Handbook, Tata Mcgraw Hill, 1998.
3. Vinod Kumar Crag and N.K.Venkitakrishnan , Enterprise Resource Planning – Concepts and Practice, Prentice Hall of India, 1998.
4. ERPWARE , ERP Implementation Framework, Garg & Venkitakrishnan, Prentice Hall, 1999.
5. Thomas E Vollmann and Bery Whybark , Manufacturing and Control Systems, Galgothia Publications, 1998.