KONGU ENGINEERING COLLEGE, PERUNDURAI, ERODE – 638 052
(Autonomous Institution affiliated to Anna University of Technology, Coimbatore)

M.E. DEGREE IN ENGINEERING DESIGN (FULL-TIME)

CURRICULUM
(For the candidates admitted from academic year 2011 – 12 onwards)

SEMESTER – I

Course Code	Course Title	Hours/ Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	THEORY							
11ED101	Applied Mathematics for Engineering and Technology	3	1	0	4	50	50	100
11ED102	Optimization Techniques in Design and Manufacturing	3	1	0	4	50	50	100
11ED103	Advanced Finite Element Analysis	3	1	0	4	50	50	100
11ED104	Principles of Engineering Design	3	0	0	3	50	50	100
11ED105	Advanced Strength of Materials	3	1	0	4	50	50	100
11ED106	Integrated Product and Process Development	3	0	0	3	50	50	100
	PRACTICAL							
11ED107	Design and Analysis Laboratory	0	0	3	1	100	0	100
				Total	**23**			

CA – Continuous Assessment, ESE – End Semester Examination

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SEMESTER – II

Course Code	Course Title	Hours/ Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	THEORY							
11ED201	Mechanical Vibration	3	1	0	4	50	50	100
11ED202	Design for Manufacture and Assembly	3	0	0	3	50	50	100
11ED203	Advanced Mechanism Design	3	1	0	4	50	50	100
	Elective-I	3	0	0	3	50	50	100
	Elective-II	3	0	0	3	50	50	100
	Elective-III	3	0	0	3	50	50	100
	PRACTICAL							
11ED204	Optimization Techniques and Simulation Laboratory	0	0	3	1	100	0	100
11ED205	Automation Laboratory	0	0	3	1	100	0	100
				Total	**22**			

CA – Continuous Assessment, ESE – End Semester Examination

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M.E. DEGREE IN ENGINEERING DESIGN (FULL-TIME)

CURRICULUM
(For the candidates admitted from academic year 2011 – 12 onwards)

SEMESTER – III

Course Code	Course Title	Hours/ Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	THEORY							
	Elective-IV	3	0	0	3	50	50	100
	Elective-V	3	0	0	3	50	50	100
	Elective-VI	3	0	0	3	50	50	100
	PRACTICAL							
11ED301	Project Work Phase -I	0	0	12	6	50	50	100
				Total	**15**			

CA – Continuous Assessment, ESE – End Semester Examination

SEMESTER –IV

Course Code	Course Title	Hours/Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	PRACTICAL							
11ED401	Project Work Phase -II	0	0	24	12	100	100	200
				Total	**12**			

CA – Continuous Assessment, ESE – End Semester Examination

LIST OF ELECTIVES					
Course Code	**Course Title**	**L**	**T**	**P**	**C**
11CC011	Smart Structures and MEMS Design	3	0	0	3
11CC012	Product Data Management	3	0	0	3
11CC014	Mechatronics System Design	3	0	0	3
11ED011	Mechanical Behavior of Materials	3	0	0	3
11ED012	Applied Finite Element Analysis	3	0	0	3
11ED013	Applied Engineering Acoustics	3	0	0	3
11ED014	Vibration Control and Condition Monitoring	3	0	0	3
11ED015	Mechanics of Fracture	3	0	0	3
11ED016	Productivity Management and Reengineering	3	0	0	3
11ED017	Modeling of Dynamic Systems	3	0	0	3
11ED018	Instrumentation and Measurement	3	0	0	3
11ED019	Experimental Stress Analysis	3	0	0	3
11ED020	Tribology in Design	3	0	0	3
11ED021	Mechanics of Composite Materials	3	0	0	3
11ED022	Design of Material Handling Equipment	3	0	0	3
11ED023	Computational Fluid Dynamics	3	0	0	3
11ED024	Advanced Tool Design	3	0	0	3
11ED025	Robotic Engineering	3	0	0	3
11ED026	Design of Heat Exchangers	3	0	0	3
11ED027	Energy Conservation and Management	3	0	0	3
11ED028	Advanced Internal Combustion Engineering	3	0	0	3
11ED029	Safety in Engineering Industry	3	0	0	3
11MM105	Fluid Power System Design	3	0	0	3
11MM020	Rapid Prototyping and Tooling	3	0	0	3

11ED101 APPLIED MATHEMATICS FOR ENGINEERING AND TECHNOLOGY

(Common to Engineering Design, CAD/CAM & Chemical Engineering branches)

3 1 0 4

Objective:

On completion of the course the students are expected

- To understand the concept of the variational problems.
- To understand the concept of linear and non linear equations and its solutions.
- To know the concept of numerical differentiation and integration.
- To understand the concept of boundary value problems and to find its solutions.
- To acquire knowledge about the partial differential equations and its solutions.

MODULE - I **15**

Calculus of variation: Functional –definition-Variational problem: Euler Lagrange equation-Solutions of Euler Lagrange equation – Variational problems involving one& Several unknown functions – Functionals dependent on higher order derivatives – Variational problems involving Several independent variables.

Solution of system of simultaneous equations: Linear equations: Direct methods – Gauss Elimination, Gauss Jordon, Iterative methods- Gauss Jacobi, Gauss Seidal method. Non-linear equations- Newton Raphson method.

MODULE – II **15**

Numerical Differentiation and Integration: Equal intervals – Newton's forward and backward interpolation formula – unequal intervals – Newton's divided difference formula. Newton-Cotes integration formulas, Trapezoidal rule, Simpson's rules, Gaussian quadrature.

Ordinary Differential Equations: Single step methods for Taylor series method – Euler method – Modified Euler method – Runge-Kutta Method of Fourth order .

MODULE -III **15**

Partial Differential Equations: Solving boundary value problems by finite difference method –Finite difference solution for one dimensional heat equation by Implicit and Explicit methods – One dimensional wave equation – Two dimensional Laplace and Poisson equations.

Lecture: 45, Tutorial: 15, TOTAL: 60

REFERENCE BOOKS

1. Gerald, Curtis F and Wheatley, Patrick O, "Applied Numerical Analysis", Pearson Education, New Delhi, 2002.
2. Jain, M.K. Iyengar, S.R.K and Jain R.K., "Numerical Methods for Scientific and Engineering Computation", New Age International (P) Ltd., Publishers, 2008.
3. Venkataraman, M. K, "Numerical Methods", National Publishing Company, Chennai, 2000.
4. Venkataraman. M.K, "Higher Mathematics for Engineering & Science", National Publishing Company, 2006.

11ED102 OPTIMIZATION TECHNIQUES IN DESIGN AND MANUFACTURING

(Common to M.E. Engineering Design, Mechatronics and CAD/CAM branches)

3 1 0 4

Objective:

- To understand clearly where optimization fits into the problem;
- To formulate a criterion for optimization;
- To have sufficient understanding of the theory of optimization to select an appropriate optimization strategy for static and dynamic applications.

MODULE - I **15**

Introduction and Unconstrained Optimization: General Characteristics of mechanical elements, adequate and optimum design, principles of optimization, formulation of objective function, design constraints – Classification of optimization problem. Single variable and multivariable optimization, Techniques of unconstrained minimization – Golden section, pattern and gradient search methods – Interpolation methods -Quadratic function method.

MODULE - II **15**

Constrained Optimization: Optimization with equality and inequality constraints - Indirect methods using penalty functions, Lagrange multipliers; Geometric programming- Constrained, mixed inequality and unconstrained minimization; Introduction - GA, SA and NN based on optimization - Fuzzy systems - Taguchi Technique - Parallel processing

MODULE - III **15**

Static and Dynamic Applications: Structural applications – Design of simple truss members-Re analysis techniques Design applications – Design of simple axial, transverse loaded members for minimum cost, maximum weight – Design of shafts and torsionally loaded members – Design of springs. Dynamic Applications – Optimum design of single and two degree of freedom systems, vibration absorbers. Optimum design of simple linkage mechanisms. Case study: optimization of process parameters in production operation.

Lecture: 45, Tutorial: 15, TOTAL: 60

REFERENCE BOOKS

1. Rao Singiresu S, “Engineering Optimization: Theory and Practice”, New Age International (P) Limited, Publishers New Delhi, 2010.
2. Deb Kalyanamoy, “Optimization for Engineering Design: Algorithms and Examples”, Prentice Hall of India Pvt. New Delhi, 2009
3. Johnson, Ray C., “Optimum Design of Mechanical Elements”, John Wiley & Sons, New York, 1990.
4. Goldberg D.E., “Genetic Algorithms in Search, Optimization and Machine”, Barnen, Addison-Wesley, New York, 2005.

REFERENCE JOURNALS AND WEBSITES

1. Journal of Mechanical Design - www.asmedl.org
2. Journal of Design for Manufacturability-www.informationworld.com
3. International Journal of fuzzy systems
4. 1. www.searchengineoptimization.com
   2. www.plosntds.org
   3. www.mahalo.com

11ED103 ADVANCED FINITE ELEMENT ANALYSIS

(Common to M.E. Engineering Design and CAD/CAM branches)

3 1 0 4

Objective:

- To familiarize the fundamentals of FEA in one and two dimensional solid mechanical and heat transfer.
- To understand the element formulation of one dimensional and two dimensional finite element models.
- To know the applications of one dimensional, two dimensional and structural dynamics.

MODULE - I **15**

One Dimensional Elasticity: Introduction of finite element analysis in design - Weighted-Integral statements – Weak formulations

One dimensional solid mechanics: Co-ordinates and shape functions- Linear and quadratic finite element equation for bar structure. One dimensional Heat transfer: conduction – convection - finite element equation- Potential energy approach or Galerkin's approach. Application of structural bar and heat transfer.

MODULE – II **15**

Two-Dimensional Elasticity: Introduction of 2D elements- Two dimensional solid mechanics: shape function- Element matrices equation for CST element- Potential energy approach- Load consideration – Point load and Pressure-plane stress and plane strain conditions. Two dimensional Heat transfer: finite element matrices equation for CST element- Potential energy approach- Load consideration - conduction – side and face convection – internal heat generation. Problems in structural application.

MODULE - III **15**

Numerical Integration and Structural Dynamics: Numerical integration – Gauss quadrature – Newton cotes quadrature - 1D and 2D applications.

Dynamic analysis – Consistent and lumped mass matrices - Natural frequencies and modes- bar and beam structure – Assemble of dynamics equation - Example problems. Reduction of number of DOF-Component mode synthesis. Material non-linearity– Geometric non-linearity –Refinement.

Lecture: 45, Tutorial: 15, TOTAL: 60

REFERENCE BOOKS

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, 2007.
3. Cook, Robert Davis et al "Concepts and Applications of Finite Element Analysis", Wiley, John & Sons, 2003.
4. Segerlind L.J., "Applied Finite Element Analysis", John Wiley, 1984.
5. S.S.Rao, "Finite Element Analysis", McGraw Hill, 2002

11ED104 PRINCIPLES OF ENGINEERING DESIGN

3 0 0 3

Objective:

- To understand the tools used in engineering design.
- To understand the selection of materials and design for manufacture.
- To understand legal, ethical environmental and safety issues in design.

MODULE - I **17**

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

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.

MODULE - II **14**

Material Selection and Process Selection in Design: 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. Classification of manufacturing processes and their role in design, Factors determining the process selection, use of process selection chart and computerized database

MODULE - III **14**

Design for Manufacturing. Legal, Ethical Environmental and safety issues in design and Quality Engineering: 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. 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

REFERENCE BOOKS

1. Dieter, George E, “Engineering Design: A Materials and Processing Approach”. McGraw-Hill, International Edition, Singapore, 2000.
2. Ulrich Karl T. and Eppinger Steven D. “Product design and Development”, McGraw-Hill, International Edition, 2005
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.

11ED105 ADVANCED STRENGTH OF MATERIALS

(Common to M.E. Engineering Design and CAD/CAM branches)

3 1 0 4

Objective:

- To know the behavior of engineering materials under various stresses.
- To understand the effect of stress in plates, cylinders, disc and also torsion in noncircular members.

MODULE - I **15**

Elasticity: Stress – Strain relation and General equation of elasticity in cartesian, polar and spherical coordinates- differential equation of equilibrium – compatibility equation – boundary conditions, representations of three dimensional stress in tension – generalized Hooke's law – St.Vennant's principle – Plane strain, plane stress – Airy's stress function.

Shear Centre: Location of shear centre for various sections – shear flow.

MODULE - II **15**

Unsymmetrical Bending and Stresses Due to Rotation: 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. Stresses due to rotation – Radial and tangential stresses in solid disc and ring of uniform thickness and varying thickness – allowable speed.

MODULE - III **15**

Stresses in Flat Plates, Contact Stresses and Torsion of Non Circular Sections: 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 Torsion of rectangular cross section – St.Vennant Theory – elastic membrance analogy – torsional stresses in hollow thin walled tubes.

Lecture: 45, Tutorial: 15, TOTAL: 60

(Use of approved data book is permitted)

REFERENCE BOOKS

1. Shigley.J.E "Applied Mechanics of Materials", Tata McGraw Hill, 2000.
2. Timoshenko.S, "Strength of Materials", Third Edition. CPS Publishers, 2008
3. Den-Hartog, "Advanced Strength of Materials", Dover Publications, New York, 1987.
4. Timoshenko and Gaodler, "Theory of Elasticity", Tata McGraw-Hill, 2006
5. Wang,C.T "Applied Elasticity", Pergaman Press, New York, 1987

11ED106 INTEGRATED PRODUCT AND PROCESS DEVELOPMENT

(Common to M.E. Engineering Design and CAD/CAM branches)

3 0 0 3

Objective:

- To study the product development process and organization.
- To study the product planning and organization needs.
- To select the concept for different product planning.

MODULE - I **15**

Introduction and Product Planning: Characteristics of Successful Product Development-Who Designs and Develops Products-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 Genetic Product Development Process- Product Development Process Flows-The AMF Development Process-Product Development Organizations-The AMF Organization. Product Planning Process- Identify Opportunities- Evaluating and Prioritizing Projects- Allocating Resources and Timing- Pre-Project Planning-Reflect on the Results and the Process.

MODULE - II **15**

Identifying Customer Needs and Product Specifications: 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. What Are Specifications -When Are 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.

MODULE - III **15**

Concept Selection and Product Architecture: 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. Product Architecture-Implications of the Architecture-Establishing the Architecture-Delayed Differentiation-Platform Planning-Related System-Level Design Issues

TOTAL : 45

REFERENCE BOOKS

1. Ulrich ,Karl T and Steven D. Eppinger, Product Design and Development, McGraw –Hill International Edns.2005.
2. Otto, Kevien and Wood, Kristin ., "Product Design" Pearson Publications, New Delhi, 2004
3. Stephen Rosenthal, "Effective Product Design and Development", Business One Orwin, Homewood, 1992,
4. Stuart Pugh, "Tool Design – Integrated Methods for successful Product Engineering", Addison Wesley Publishing, Neyourk, NY, 1991,
5. Kemnneth Crow, Concurrent Engg. /Integrated Product Development. DRM Associates, 26/3,Via Olivera, Palos Verdes, CA 90274(310) 377-569,Workshop Book

11ED107 DESIGN AND ANALYSIS LABORATORY

(Common to M.E. Engineering Design and CAD/CAM branches)

0 0 3 1

Objective:

- To understand the basic concepts and procedure for analysis of the given structural member..
- To analyse and simulate the structural members with external load for different applications.
- To determine the velocity & acceleration of given links.

LIST OF EXPERIMENTS

1. Modeling a component using Pro/E, Importing to ANSYS and Meshing
2. Modeling and Meshing a component using ANSYS
3. Modeling and Assembly of Screw Jack using Pro/E
4. Modeling and Assembly of an Industrial Application using Pro/E and Meshing the model using ANSYS
5. Shear Force and Bending Moment diagram using ANSYS
6. Structural Analysis of a 3D Cantilever Beam and Validating the results with 1D and 2D options in ANSYS
7. Non-Linear Structural Contact Analysis of the Screw Jack using ANSYS
8. Thermal Analysis of a Building using ANSYS
9. Contact Analysis of a two spherical balls using ANSYS and validating the results with Hertz Solutions
10. Modal and Harmonic Analysis of a steel structure using ANSYS
11. Coupled Field Analysis of a Corner Bracket using ANSYS
12. Creating APDL in ANSYS for a parametric case study
13. Rotor Dynamic Analysis of a rotating shaft using ANSYS
14. Fatigue Analysis of a component using ANSYS

REFERENCES/ MANUALS/ SOFTWARE

Lab Manuals
www.ansys.com

11ED201 MECHANICAL VIBRATIONS

(Common to M.E. Engineering Design and CAD/CAM branches)

3 1 0 4

Objective:

- To study the fundamental of vibration in single and multi degrees of freedom systems and continuous system.
- To study the various vibration tests and measuring instruments of vibration.

MODULE – I **15**

Fundamentals of Vibration, Single and Two Degrees of Freedom System: Single degree freedom systems –Free-Damped and Undamped – Lagrange's equation – Single degree freedom forced vibration with elastically coupled viscous dampers – System Identification from frequency response – Transient Vibration

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

MODULE - II **15**

Multi-Degree Freedom System: 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 determining natural frequencies.

MODULE - III **15**

Vibration of Continuous Systems and Experimental Methods in Vibration Analysis: 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. Vibration instruments – Vibration exciters Measuring Devices – Analysis – Vibration Tests – Free and Forced Vibration tests. Industrial, case studies.

Lecture : 45, Tutorial: 15, TOTAL: 60

REFERENCE BOOKS

1. Thomson, W.T. "Theory of Vibration with Applications", CBS Publishers and Distributors, New Delhi, 2007.
2. Rao, J.S. and Gupta, K. "Introductory Course on Theory and Practice Mechanical Vibration", New Age International (P) Ltd., New Delhi, 2008.
3. Den Hartog, J.P, "Mechanical Vibrations," Dover Publications, 2007.
4. Rao, S.S., "Mechanical Vibrations," Addison Wesley Longman, New York, 2004.

11ED202 DESIGN FOR MANUFACTURE AND ASSEMBLY

(Common to M.E. Engineering Design and CAD/CAM branches)

3 0 0 3

Objective:

- To understand the component design for easy manufacturing.
- To study the process capability, tolerance and form design of materials.
- To know the machining and casting considerations for manufacturing oriented design.
- To expose the impact of design on environment to achieve eco-friendly component design.

MODULE - I **15**

DFMA Guidelines and Geometric Tolerance: General design principles for manufacturability - Design for assembly - strength and mechanical factors - Geometric tolerances – Worst case method - Assembly limits –Design and Manufacturing Datum – Conversion of design datum into manufacturing datum -Tolerance stacks- Process capability – Principal materials - Selection of materials and processes - Mechanisms selection - Possible solutions - Evaluation method.

MODULE - II **15**

Form Design and Machining Considerations: Influence of materials on form design - form design of grey iron, malleable iron, steel and aluminium castings, welded members and forgings. Design features to facilitate machining – Single point and multipoint cutting tools - Doweling procedures - Reduction of machined area- Simplification by separation - Simplification by amalgamation - Design for machinability - Design for economy - Design for clampability - Design for accessibility.

MODULE - III **15**

Casting Considerations and Design for the Environment: Redesign of castings based on Parting line considerations - Minimizing core requirements, machined holes – Design rules for sand castings – The die casting cycle, Determination of number of cavities and appropriate machine size in die casting- Identification of uneconomical design - Modifying the design - Computer applications in DFMA- Environmental objectives – Basic DFE methods – Lifecycle assessment –AT&T's environmentally responsible product assessment - Weighted sum assessment method – Techniques to reduce environmental impact – Design to minimize material usage – Design for recyclability – Design for remanufacture – Design for energy efficiency – Design to regulations and standards.

TOTAL : 45

REFERENCE BOOKS

1. Boothroyd, G, "Product Design for Manufacture and Assembly", New York, CRC Press, London, 2002.
2. Peck, Harry., "Design For Manufacture", Pitman Publications, London 1983.
3. Otto, Kevien and Wood, Kristin, "Product Design". Pearson Publication, New Delhi, 2004.
4. Matousek, "Engineering Design: A Systematic Approach", Blackie & Son Ltd., Glasgow, 1974.
5. Bralla, "Design for Manufacture Handbook", McGraw Hill, New York, 1999.

11ED203 ADVANCED MECHANISM DESIGN

3 1 0 4

Objective:

- To understand the basic concepts of kinematics and analysis the velocity and acceleration of complex mechanism.
- To study the synthesis of different mechanisms using graphical & analytical method and determine the link position.
- To know the principle motions of spatial and robotic mechanisms.

MODULE - I **15**

Kinematics and Mechanism: Fundamentals of kinematics – Analysis of Mobility – Formation of one D.O.F, multi loop kinematic chains - Kinematic inversion – Mechanical advantage. Position Analysis – Vector loop equations for four bar, slider crank, inverted slider crank and Geared five bar mechanism- problem. Graphical methods for velocity and acceleration analysis of plane complex mechanisms- Normal acceleration analysis - Goodman analysis - Auxiliary point method.

MODULE - II **15**

Geometry and Synthesis of Mechanisms: Path Curvature Theory - Fixed and moving centrodes - inflection points and inflection circle - Euler Savary equation - Hartmann's construction - Bobillier's construction – Graphical constructions – Cubic of stationary curvature. Type synthesis – Number synthesis - Dimensional synthesis – function generation, path generation, motion generation – Two position, three position and four position synthesis - Graphical methods - Bloch's Method- Freudenstein's Equitation. Cognate linkages -Coupler curve synthesis, design of six-bar mechanisms.

MODULE - III **15**

Spatial Robotics and Dynamics of Mechanisms: Introduction - Mobility of Four bar spatial linkage – Wobble plate mechanism - Position analysis- velocity and acceleration analysis of Spatial RGGR and RSSR mechanism- Denavit – Hartenberg Parameters- Transformation matrix. Robotic - topology arrangements of robotics arms - Forward and inverse kinematics of robotic manipulators. Static force and Dynamics force analysis of simple mechanism - Graphical Method.

Lecture: 45 and Tutorial: 15 TOTAL : 60

REFERENCE BOOKS

1 Sandor G.N., and Erdman A.G., "Advanced Mechanism Design Analysis and Synthesis", Prentice Hall, New Jersey, 1984.
2 Jack T. Kimbrell, " Kinematics analysis and synthesis", McGraw-Hill, Inc. New York.
3 Shigley, J.E., and Uicker, J.J., "Theory of Machines and Mechanisms", McGraw Hill, New York, 1995.
4 Ghosh, Amitabha and Mallik, Asok Kumar., "Theory of Mechanism and Machines", EWLP, Delhi, 2002.
5 Nortron R.L., "Design of Machinery", Tata McGraw Hill, New Delhi, 2005.
6 Waldron Kenneth J and Kinzel Gary L., "Kinematics, Dynamics and Design of Machinery", John Wiley and Sons, New York, 2004.

11ED204 OPTIMIZATION TECHNIQUES AND SIMULATION LABORATORY

0 0 3 1

OBJECTIVE:

- To study the optimization techniques used in manufacturing.

LIST OF EXPERIMENTS

1. Design of Experiments for Threading operation
2. Design of Experiments for milling operation
3. Process parameter optimization in welding by Response surface method
4. Process parameter optimization in surface grinding by Response surface method
5. Simulation of Scheduling process using Arena software
6. Simulation of three bar mechanism using ADAMS software
7. Simulation of four bar mechanism using ADAMS software
8. Simulation of slider crank mechanism using ADAMS software
9. Simulation of simple pendulum mechanism using ADAMS software

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REFERENCES / MANUALS / SOFTWARE:

1. MAT Lab
2. C, C++
3. Genetic Algorithms etc.
4. ADAMS
5. Minitab
6. DOE

11ED205 AUTOMATION LABORATORY

(Common to M.E. Engineering Design and CAD/CAM branches)

0 0 3 1

Objective:

- To know the PLC programming techniques and automation of process using PLC and SCADA
- To familiarize the students with the concepts and techniques in robot manipulator control.
- To evaluate, choose and incorporate robot in engineering systems

LIST OF EXPERIMENTS

1. Speed control of DC Motor using PLC
2. Flow control using PLC
3. Pressure control using PLC
4. Interfacing PLC With SCADA
5. Develop a SCADA for Process Plant Screens and trend analysis.
6. Study of different types of robots based on configuration and application.
7. Robot programming exercises - Point-to-point programming
8. Robot programming exercises - Continuous path programming
9. Robot programming exercises (using software) – Virtual robot programming
10. Design of hydraulic circuit for various applications.
11. Circuits with multiple cylinder sequence – Pneumatic control.

REFERENCES/ MANUALS/ SOFTWARE

1. Aristo Robot User Manual.
2. Denford virtual reality robot user's manual.
3. Mechatrat robot user manual.
4. Lab manuals.

11CC011 SMART STRUCTURES AND MEMS DESIGN

(Common to M.E. Engineering Design and CAD/CAM branches)

3 0 0 3

Objective:

- To understand processes in smart structures.
- To understand processes and applications of MEMS Design.

MODULE - I **13**

Smart Structures: Concept of Smart structures - Instrumented structures - Sensing technologies - Signal processing and control of smart structures - Vibration Control using Smart structures - Piezo electric materials - Electrostrictive materials - Magnetostrictive materials -Case studies – Applications.

MODULE - II **12**

MEMS: Shape Memory Alloys - Electroheological fluids – MR fluids- Fiber optic materials - Concept of micro system technology - Micro actuation techniques - Micro sensing devices - Micro actuating devices – Materials - Mechanical properties - Scaling laws – Applications

MODULE - III **20**

Micromechanics and Micro System Manufacturing: 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 - Clean room technology – Substrates - Single crystal silicon wafer formation - Ideal substrates - Photolithography - Ion implantation - Diffusion – Oxidation – CVD - PVD - Deposition by epitaxy - Etching process – Bulk and surface manufacturing – LIGA - SLIGA-Packaging techniques - Die preparation - Bonding techniques – Sealing - Design considerations-Process design - Mechanical design.

TOTAL: 45

REFERENCE BOOKS

1. Hsu Tai-Ran, “MEMS and Microsystems Design and Manufacture”, Tata McGraw-Hill, New Delhi, 2006.
2. Culshaw Brian, “Smart Structures and Materials”, Artech house, London, 1996.
3. Fatikow, S. and Rembold, U., “Microsystem Technology and Microrobotics“, Springer-Verlag Berlin Heidelberg, 1997.
4. Gad-el-Hak, Mohamed., “The MEMS Hand book”, CRC Press, London, 2002.
5. Gardner Julian W., Varadan Vijay K. and Osama O.Awadel Karim, “Microsensors MEMS and Smart Devices”, John Wiley & Sons, New York, 2001.

11CC012 PRODUCT DATA MANAGEMENT

(Common to M.E. Engineering Design and CAD/CAM branches)

3 0 0 3

Objective:

- To understand configuration and change management in PDM.
- To understand generic products and variants.
- To understand and apply PDM technologies in a PLM environment

MODULE - I **15**

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

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. Life cycle of a product - life cycle management - case studies.

MODULE - II **15**

Configuration Management and Change Management: Base lines-product structure - Structuring the Bill of Material - Engineering Structure - Manufacturing Structure - configuration management - case studies.

Change issue - change request - change investigation - change proposal - change activity - Change Cost - Design and Development Cost - Manufacturing and Field Costs - Materials and Parts Costs - Charge Back of Costs – Fast change - case studies.

MODULE - III **15**

Projects, Roles, Generic Products and Variants: Creation of projects and roles - automating information flow - work flows - creation of work flow templates - life cycle - work flow integration - 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

REFERENCE BOOKS

1. Ivica Crnkovic, Ulf Asklund, Annita Persson Dahlqvist, “Implementing and Integrating Product Data Management and Software Configuration Management” ,Artech House, USA, 2003.
2. Antti Saaksvuori, Anselmi Immonen, “Product Lifecycle Management”, Springer, New York, Second Edition.
3. Otto Kevin and Wood Kristin, “Product Design”, Pearson Education, New Delhi, 2004.
4. Bedworth David, Henderson Mark and Phillip Wolfe., “Computer Integrated Design and Manufacturing”. Tata McGraw-Hill, New Delhi, 1991.
5. Amor Daniel, “The E-Business Revolution”, Pearson Edition, New York, 2000
6. Terry, Quatrain., “Visual Modeling with Rational Rose and UML”, Addison Wesley, New York, 1998.
7. www.cimdata.com

11CC014 MECHATRONICS SYSTEM DESIGN

(Common to M.E. Engineering Design and CAD/CAM branches)

3 0 0 3

Objective:

- To give integrated approach to the design of intelligent product by using hybrid electro mechanical devices.
- To create a path to the students to Design Mechatronics systems to fulfill the Industrial requirements.

MODULE – I **15**

Mechatronics System: Introduction to Mechatronics system – Key elements – Mechatronics design process – Types of design – Traditional and Mechatronics designs – Advanced approaches in Mechatronics - Industrial design and Ergonomics, Safety. Advanced applications in Mechatronics – Mechatronic Control in Automated Manufacturing – Artificial Intelligence in Mechatronics – Fuzzy Logic Applications in Mechatronics – Microsensors in Mechatronics.

MODULE - II **15**

Real Time Interfacing: Introduction - Elements of Data Acquisition and Control - Overview of I/O process, Analog signals, Discrete signals and Frequency signals – Over framing.

MODULE - III **15**

Case Studies on Data Acquisition and Control: Introduction – Cantilever Beam Force Measurement system–Testing of Transportation bridge surface materials – Transducer calibration system for Automotive applications – Strain gauge weighing system – Solenoid Force-Displacement calibration system – Rotary optical Encoder – Controlling temperature of a hot/cold reservoir – pick and place robot. Thermal cycle fatigue of a ceramic plate – pH control system – Dc-Icing Temperature Control system – Skip control of a CD Player – Autofocus Camera, exposure control.

TOTAL : 45

REFERENCE BOOKS

1. Shetty, Devdas and Kolk, Richard A., "Mechatronics System Design", Vikas publishing house, New Delhi, 2001.
2. Bolton, "Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering", Second Edition, Addison Wesley Longman Ltd., 1999.
3. Brian Morriss, "Automated Manufacturing Systems: Actuators, Controls, Sensors and Robotics, McGraw-Hill International Edition, New York, 1995.
4. Bradley, D.Dawson, Burd N.C. and Loader A.J., "Mechatronics: Electronics in Products and Processes", Chapman and Hall, London, 1991.

11ED011 MECHANICAL BEHAVIOR OF MATERIALS

3 0 0 3

Objective:

- To understand the material properties and their behaviour.
- To understand the fracture problems due to fracture

MODULE - I **15**

Elasticity*:* Analysis of stress-definition and notation of stress –equation of equilibrium –specification of stress at a point- principal stresses and Mohr's diagram. Boundary condition in terms of surface forces.

Analysis of strain-strain components-specification of strain at a point-compatibility equations of elasticity: Generalized Hook's law-formulations of elastic problems –strain energy-existence and uniqueness of solution-St.Venant's principle.

MODULE - II **15**

Plane Stress, Plane Strain Problems and Plasticity of Metals: Plane stress and plane strain problems: The governing differential equations – bending of narrow cantilever beam of rectangular cross section under an end load –General equations in cylindrical co-ordinates – effect of small circular holes in strained plates-stress concentration. Plasticity of metals : Tensile test –true stress/true strain-slip line theory. Creep definition-creep tests and properties of creep. Theories of failure

MODULE- III **15**

Fracture and Fracture Mechanic Design: Fracture: overview of problem of fracture and fatigue in structures-stress analysis for members with cracks-stress intensity equations- Relationship between stress intensity factor and fracture toughness .Experimental determination $-K_{IC}$ and Kc values-effect of temperature, loading rate and plate thickness on fracture toughness. Fracture mechanics design-fatigue crack initiation-- fatigue crack propagation under constant load and variable load - fatigue damage tolerance, Elastic –plastic fracture mechanics.

TOTAL: 45

REFERENCE BOOKS

1. Barsoom, John M and Rolte, Stanley T., "Fracture and Fatigue Control in Structures", Prentice-Hall, New Jersey, 1987.
2. Wang C.T, "Applied Elasticity", McGraw-Hill, New York, 1953.
3. Martin Joseph., "Mechanical Behaviour of Materials", Prentice-Hall, New Jersey, 1985.

11ED012 APPLIED FINITE ELEMENT ANALYSIS

3 0 0 3

Objective:

- To understand the element formulation of plate and shell elements and applications.
- To study the dynamic and fluid flow applications.
- To study error estimation.

MODULE – I **15**

Bending of Plates and Shells: 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.

MODULE - II **15**

Non-Linear Problems and Dynamic Problem: 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. Direct Formulation – Free, Transient and Forced Response – Solution Procedures – Subspace Iterative Technique – Houbolt, Wilson, Newmark Methods – Examples.

MODULE - III **15**

Fluid Mechanics, Error Estimates and Adaptive Refinement: Governing Equations of Fluid Mechanics – Inviscous and Incompressible Flow – Potential Formulations – Slow Non-Newtonian Flow – Metal and Polymer Forming – Navier Stokes Equation – Steady and Transient Solution. Error norms and Convergence rates – h-refinement with adaptivity – Adaptive refinement.

TOTAL : 45

REFERENCE BOOKS

1. Cook R.D, "Concepts and Applications of Finite Element Analysis", John Wiley and Sons Inc., New York, 2003.
2. Bathe K.J, "Finite Element Procedures in Engineering Analysis", Prentice Hall, New Jersey, 1996.
3. Scgelindlg, "Applied Finite Element Analysis", John Wiley & Sons, New York, 1984.

11ED013 APPLIED ENGINEERING ACOUSTICS

3 0 0 3

Objective:

- To understand the basic concepts of acoustics and characteristics of sound.
- To understand the assessment and measurement of sound and the basic concepts of noise control.

MODULE – I **15**

Basic Concepts of Acoustics and Characteristics of Sound: Scope of Acoustics – Sound pressure – Sound intensity – Sound pressure 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

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.

MODULE – II **15**

Transmission Phenomena, The Assessment and Measurement of Sound: 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.

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.

MODULE – III **15**

Basic Concepts of Noise Control: 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

REFERENCE BOOKS

1. Kinsler Lawrence E. and Frey Austin R., "Fundamentals of Acoustics", New Age International Publishers, New Delhi, 1992.
2. Bies, David, A. and Hansen, Colin H., "Engineering Noise Control: Theory and Practice", Second Edition, E and FN Spon, Chapman-Hall, 2003.
3. Hansen C.H. and Snyder, S.D., "Active Control of Sound and Vibration", E and FN Spon, London, 1996.

11ED014 VIBRATION CONTROL AND CONDITION MONITORING

3 0 0 3

Objective:

- To study the vibration control of mechanics under various working condition.
- To understand the condition monitoring of rotating machine, specially, dynamic balancing and misalignment.

MODULE -I **15**

Introduction of Vibration Control: Review of Fundamentals of Single Degree Freedom Systems – Two Degree Freedom Systems, Continuous system, Determination of Natural frequencies and mode shapes.

MODULE -II **15**

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

MODULE -III **15**

Condition Based Maintenance, Dynamic Balancing and Alignment of Machinery: 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. 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

REFERENCE BOOKS

1. Bathe, K.J. and Wilson, F.I., "Numerical Methods in Finite Element Analysis", Prentice Hall of India, New Delhi, 1987.
2. Den Hartog, J.P., "Mechanical Vibrations", Dover Publications, New York, 2007.
3. Rao, J.S., "Vibratory Condition Monitoring of Machines", CRC Press, London, 2000.
4. Science Elsevier," Hand Book of Condition Monitoring", Elsevier Science, Amsterdam, 1996.
5. Rao.J.S and Guptha.K" Theory and Practices of Mechanical Vibration ", New Age International publication,2008

11ED015 MECHANICS OF FRACTURE

3 0 0 3

Objective:

- To understand the behavior of crack under load.
- To understand how design is done using fracture mechanics principles.

MODULE – I **15**

Elements of Solid Mechanics and Stationary Crack Under Static Loading: The geometry of stress and strain, elastic deformation, plastic and elasto-plastic deformation - limit analysis. 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.

MODULE - II **15**

Energy Balance, Crack Growth and Fatigue Crack Growth Curve: Griffith analysis – Linear Fracture Mechanics-Crack Opening displacement – Dynamic energy balance – crack arrest. Empirical Relation describing crack growth by fatigue – Life calculations for a given load amplitude – effects of changing the load spectrum – Effects of Environment.

MODULE - III **15**

Elements of Applied Fracture Mechanics: 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

REFERENCE BOOKS

1. David Broek, "Elementary Engineering Fracture Mechanics", Fifthoff and Noerdhoff International Publisher, 1978.
2. Kare Hellan, "Introduction of Fracture Mechanics", Tata McGraw-Hill Book Company, New Delhi, 1985.
3. Preshant Kumar, "Elements of Fracture Mechanics", Wheeler Publishing, Ahmedabad, 1999.

11ED016 PRODUCTIVITY MANAGEMENT AND RE-ENGINEERING

3 0 0 3

Objective:

- To understand the impact of productivity in engineering solutions at global and societal context
- To analyze and interpret data to use modern technology in reengineering concepts
- To give exposure in areas like reengineering process, tools and the productivity models.

MODULE – I **15**

Introduction and Productivity Models: Definitions and various factors for productivity –problems in productivity and production –comparison of productivity measures- Productivity concepts - Macro and Micro factors of productivity, Productivity benefit model-case study- productivity cycle. Productivity measurement at International, National and Organizational level-External Environment-Economic utility model with productivity index, Total productivity models-Strategies for productivity improvement.

MODULE - II **15**

Productivity Management and Organizational Transformation: Productivity management in manufacturing and service sector-case study -Productivity evaluation models, Productivity improvement models and techniques – laboratory -case study. Principles of organizational transformation and re-engineering, fundamentals of process reengineering, preparing the workforce for transformation and reengineering, methodology, guidelines, DSMCQ and PMP model-case study

MODULE - III **15**

Re-Engineering Process Improvement Models, Re-Engineering Tools and Implementation: PMI models, Edosomwan model, Moen and Nolan strategy for process improvement, LMICIP model, NPRDC model. Analytical and process tools and techniques process tools and packages - Information and communication technology - Enabling role of IT, RE-opportunities, process redesign - cases. Software methods in BPR tools and techniques matrix-case study based on information resources - specification of BP, case study - Order, processing, user interfaces, maintainability and reusability-case study from few information resources-application models

TOTAL : 45

REFERENCE BOOKS

1. Sumanth, D.J., "Productivity Engineering and Management ", Tata McGraw-Hill, 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 publishing, New Delhi, 1997.
4. Premvrat, Sardana, G.D. and Sahay, B.S, "Productivity Management: A systems approach", Narosa Publications, New Delhi, 1998.

REFERENCE JOURNALS and WEBSITES

1. International Journal of Production Economics- www.elsevier.com
2. Journal of Business and Economic Research
3. International Journal Productivity Analysis -www.springer.com
4. Journal Productivity Performance - www.emeraldinside.com
5. Journal of Manufacturing Systems - SME
6. Journal of Organizational Dynamics - www.elsevier.com
7. Indian Journal of Industrial Engineering- www.iiie-india.com

11ED017 MODELING OF DYNAMIC SYSTEMS

3 0 0 3

Objective:

- To study the mathematical modeling of dynamical system and control of the various components.
- To study the stability of system in time domain and frequency domain.
- To give an exposure on design and steady state analysis of the dynamic system.

MODULE – I **15**

Mathematical Models of Physical Systems, Feedback Characteristics of Control Systems and Components: Introduction to control systems, differential equations of physical systems, dynamics of robotic mechanism, transfer functions, block diagram algebra, single flow graphs.

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.

MODULE - II **15**

Response Analysis of Time and Frequency Domain: Standard test signals, time response - first-order and second-order systems, steady-state errors and error constants, effect of adding a zero to a system, 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.

MODULE - III **15**

Stability in Time and Frequency Domain: concept of stability, necessary conditions, stability criterion Routh and Hurtwitz, relative stability analysis. Preliminary considerations, Nyquist stability criterion, assessment of relative stability, closed loop frequency response, sensitivity analysis in frequency domain..

TOTAL : 45

REFERENCE BOOKS

1. Nagrath, I J, and Gopal, M, "Control Systems Engineering", Fourth Edition, New Age International Publishers, New Delhi, 2005.
2. Okata, K, "Modern Control Engineering", Pearson/Prentice Hall of India, New Delhi, 1997.
3. Gopal, M., "Control Systems: Principles and Design", Second Edition, Tata McGraw-Hill, New Delhi, 2002.
4. Norman, S Nise., "Control System Engineering", John Wiley & Sons Inc, New York, 2001.
5. Lyshevski, Sergey Edward., "Control Systems: Theory with Engineering Applications", Springer-Verlag, New York, 2002.

11ED018 INSTRUMENTATION AND MEASUREMENTS

3 0 0 3

Objective:

- To understand the fundamentals of instrumentation devices and its features
- To study the measurement systems and its applications

MODULE-I **15**

Instruments and Their Representation: Introduction, Typical Applications of Instrument Systems, Functional Elements of a Measurement System, Classification of Instruments, Standards and Calibration.

Static and Dynamic characteristics of Instruments : Introduction, Accuracy, Precision, Resolution, Threshold, Sensitivity, Linearity, Hysteresis, Dead Band, Backlash, Drift, Formulation of Differential Equations for Dynamic Performance- Zero Order, First Order and Second order systems, Response of First and Second Order Systems to Step, Ramp, Impulse and Harmonic Functions.

MODULE-II **15**

Transducer Elements: Introduction, Analog and Digital Transducers, Variable Capacitance, Piezo-Electric Transducer and Associated Circuits, Unbonded and Bonded Resistance Strain Gages. Strain Gage Bridge circuits, Digital Transducers, Frequency Domain Transducer, Vibrating String Transducer, Binary codes, Digital Encoders.

Intermediate, Indicating and Recording Elements : Introduction Amplifiers, Mechanical, Hydraulic, Pneumatic, Optical, Electrical Amplifying elements, Compensators, Differentiating and Integrating Elements, Filters, Classification of Filters, A-D and D-A Converters, Digital Voltmeters (DVMs), Cathode Ray Oscillo scopes (CROs), Galvanometric Recorders, Magnetic Tape recorders, Data Acquisition Systems, Data Display and Storage.

MODULE-III **15**

Motion, Force and Torque Measurement : Introduction, Relative motion Measuring Devices, Electromechanical, Optical, Photo Electric, Moire-Fringe, Pneumatic, Absolute Motion Devices, Seismic Devices, Spring Mass & Force Balance Type, Calibration, Hydraulic Load Cell, Pneumatic Load Cell, Elastic Force Devices, Separation of Force Components, Electro Mechanical Methods, Strain Gage, Torque Transducer, Torque Meter.

Pressure and Temperature Measurement : Pressure & Flow Measurement, Introduction : Moderate Pressure Measurement, Monometers, Elastic Transducer, Dynamic Effects of Connecting Tubing, High Pressure Transducer, Low Pressure Measurement, Calibration and Testing, Quantity Meters, Positive Displacement Meters Introduction, Measurement of Temperature, Non Electrical Methods – Solid Rod Thermometer, Bimetallic Thermometer, Pressure Thermometer, Electrical Methods – Electrical Resistance Thermometers, Semiconductor Resistance Sensors (Thermistors), Thermo–Electric Sensors, Thermocouple Materials.

Total : 45

REFERENCE BOOKS

1. Measurement systems Application and Design. Ernest O. Doebelin, Tata McGraw Hill Edition (Fourth Edition) 2002.
2. Measurement and Instrumentation in Engineering, Francis S. Tse and Ivan E. Morse, Marcel Dekker.
3. Principles of Measurement and Instrumentation – Alan S. Morris Prentice Hall of India.
4. Mechanical Measurements: T.G. Beckwith, W.L. Buck and R.D. Marangoni Addison Wesley.
5. Instrumentation, Measurement and Analysis – B.C. Nakra and K.K. Chaudhary, TMH.
6. Mechanical Measurements by D. S. Kumar, Kataria & Sons.

11ED019 EXPERIMENTAL STRESS ANALYSIS

3 0 0 3

Objective:

- To study the Experimental Methods for analysis.
- To study the Various Techniques for stress analysis

MODULE – I **15**

Strain Gauges and circuits: Choice of experimental methods – standards and accuracy of measurements – principles of model analysis - P1 Theorem-direct and indirect models. Mechanical, optical and acoustic and pneumatic strain gauges – Electrical strain gauges – gauge factor-types of Resistance gauges-gauge materials - backing materials – adhesives – protective coatings – semiconductor gauges. Introduction – Wheatstone bridge – constant – current resistance bridge balancing – Reference Bridge –Potentiometer circuit – temperature compensation – effects of lead wires. Introduction –three-element rectangular rosette – Three-Element Delta rosette-Four-Element rectangular rosette and Tee Delta rosette – Two- element rectangular rosette.

MODULE - II **15**

Brittle Coating Method Bi-Refringent Coating Techniques :

Introduction – relation between the state of stress in coating and that on model – Isostatics and Isoentacties-Types of brittle coating materials – relative merits of stress – coat and all-temp coatings-crack detection Techniques – variables influencing accuracy of brittle coating application-model – surface preparation and application of coating- calibration of brittle coating materials- brittle coatings technique applied to a specific Problem. Reflection plariscope- sensitivity of the method- principle stress – separation- comparison of brittle coating and bi- refringent coating techniques

MODULE - III **15**

Photoelasticity and Holography:

Background optics- plane and circular polarization – stress optic law – phtoelastic materials- casting and Modeling techniques –calibration methods- Isoclinics, Isochromatics and stress trajectories- stress separation Methods,Fringe sharpening- stress freezing- three dimensional analysis from models slicing – axisymmetric Stress – torsion problem Plane and spherical waves – coherence – holographic setup – Interferometry –Displacement measurement-Obtaining Isopachics

TOTAL : 45

REFERENCE BOOKS

1. Srinath,L.S., Experimental stress analysis, Tata Mcgraw Hill, New Delhi,1984
2. Dally and Riley, Experimental stress analysis, Mcgraw Hill Co., 1978

11ED020 TRIBOLOGY IN DESIGN

(Common to M.E. Engineering Design and CAD/CAM branches)

3 0 0 3

Objective:

To familiarize students with the basic concepts of tribology which would be useful in choosing and designing various tribological machine elements.

MODULE - I **15**

Surfaces, Friction, Wear and Lubrication Theory: 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. 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.

MODULE – II **15**

Design of Fluid Film Bearings: Dynamic analysis of hydrodynamic bearing performance, thrust 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 lubrication -hydrostatic bearing design.

MODULE - III **15**

Industrial Components and Tribo Measurement: Slider bearings – self acting finite bearings, failure modes, materials for 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. Surface topography measurements- friction and wear measurements, bearing performance measurements, bearing vibration measurements

TOTAL: 45

(Use of approved data book is permitted)

REFERENCE BOOKS

1. Williams, J.A. "Engineering Tribology", Oxford University Press, 1994.
2. Cameron, A. "Basic Lubrication Theory", Ellis Herward Ltd., UK, 1987.
3. Bharat Bhushan, "Principles and Applications of Tribology", New York, John Wiley & Sons, New York, 1999.
4. Neale, M.J. "Tribology Handbook", Butterworth Heinemann, 1997.
5. Hulling, J. "Principles of Tribology", Macmillan, London, 1984.

11ED021 MECHANICS OF COMPOSITE MATERIALS

(Common to M.E. Engineering Design and CAD/CAM branches)

3 0 0 3

Objective:

- To understand mechanics of composite materials.
- To understand the performance, manufacturing and design of composite materials.

MODULE – I **15**

Introduction and Mechanics: 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. 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

MODULE - II **15**

Performance and Manufacturing: Static Mechanical Properties – Fatigue and Impact Properties – Environmental effects – Long term properties, Fracture Behavior and Damage Tolerance. Manufacturing- Bag Moulding – Compression Moulding – Pultrusion – Filament Winding – Other Manufacturing Processes – Quality Inspection methods. Processing of MMC –diffusion bonding – stir casting – squeeze casting and PM methods.

MODULE - III **15**

Design: 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

REFERENCE BOOKS

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 & Sons, New York, 1990.
4. Gibson Ronald, "Principles of Composite Material Mechanics", Tata McGraw-Hill, New Delhi, 1994.
5. Chawla, K.K., "Composite Materials", Springer – Verlag, Boston, 2006.

11ED022 DESIGN OF MATERIAL HANDLING EQUIPMENT

(Common to M.E. Engineering Design and CAD/CAM branches)

3 0 0 3

Objective:

- To study about the different types of MHE in industries.
- To study about design of different MHE for various applications.

MODULE - I **15**

Flexible Hoisting Appliances: 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. Forged standard hooks – forged Ramshorn hooks – solid triangular eye hooks – crane grabs, electric lifting magnetic – grabbing attachments for loose materials,

MODULE - II **15**

Brakes and Transportation Equipment: Arresting gear – brakes: shoe, band and cone types – elements of shoe brakes – thermal calculation in shoe brakes. 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.

MODULE - III **15**

Elevating Equipment and Conveying Equipment: 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. Conveyors -Belt conveyors - chain conveyors – apron conveyors – escalators – flight conveyors – roller conveyors - oscillating conveyors. Design of belt conveyors, screw conveyors and pneumatic conveyors.

TOTAL: 45

(Use of approved data book is permitted)

REFERENCE BOOKS

1. Rudenko. N., “Materials Handling Equipment”, MIR Publishers, Moscow, 1969.
2. Spivakovsky, A.O and Dyachkov, V.K., “Conveying Machines”, Volume. I & II, MIR Publishers, Moscow**,** 1985
3. Alexandrov, M., Materials Handling Equipments, MIR Publishers, Moscow, 1981
4. Boltzharol, A., Materials Handling Handbook, The Ronald Press Company, 1958.
5. Lingaiah. K, “Machine Design Data Book”, Second Edition, McGraw Hill, New York, 2003.

11ED023 COMPUTATIONAL FLUID DYNAMICS

(Common to M.E. Engineering Design and CAD/CAM branches)

3 0 0 3

Objective:

- To understand the governing equations and discretization techniques in CFD.
- To synthesize analytical model on physical processes.
- To perform numerical analysis on heat transfer and fluid flow problems.

MODULE - I **15**

Governing Equations and Turbulence Models: Problem solving with CFD – Comparison of Experimental, Theoretical and Computational Approaches - Conservation laws of fluid motion – Governing equations – Navier Stokes equation for Newtonian fluid – Classification and physical behavior of partial differential equation – Turbulence modeling – Mixing length model - K-$\in$ Models – Reynolds stress equation model – Algebraic stress model – Transition from laminar to turbulent flow – Effect of turbulence on time averaged Navier stokes equation – Characteristics of simple turbulent flow – Discretization

MODULE - II **15**

Finite Difference Method: Finite difference representation of partial differential equation – Truncation error – Round off error and discretization error – Consistency – Stability - Convergence with marching problems – Use of Taylor's series – Stability analysis for systems of equations – Explicit and Implicit methods – Solution methodology for wave equation and heat equation – Crank Nicolson method – ADI method – Viscous shock layer equations – Conical Navier Stokes equation – Compressible Navier Stokes equation at low speeds – Incompressible Navier Stokes equation

MODULE- III **15**

Finite Volume Method: FVM for one dimensional and two dimensional diffusion problems – Steady one dimensional convection-diffusion problem – FVM for unsteady one dimensional heat conduction – Explicit, Implicit and Crank Nicolson methods - Discretization schemes - Central, Upwind differencing schemes – Power law scheme – QUICK scheme – Grid generation - Pressure and Velocity corrections – SIMPLE, SIMPLER, SIMPLEC and PISO algorithms.

TOTAL : 45

REFERENCE BOOKS

1. Versteeg, H., and Malalasekera, W., "An Introduction to Computational Fluid dynamics: A Finite Volume Approach", Addison Wesley Longman Limited,
2. Anderson, D.A., Tannehill J.C. and Pletcher, R.H., "Computational Fluid Mechanics and Heat Transfer ", Hemisphere Publishing Corporation, New York, USA, 1997.
3. Abbott, M.B., Bosco, D.R., "Computational Fluid Dynamics: An Introduction for Engineers", Longman Singapore Publishers Limited, 1997
4. "Proceedings of Parallel Computational Fluid Dynamics 2002 Conference", Elsevier, 2003.
5. Ghoshdastidar, P.S., "Computer Simulation of Flow and Heat Transfer" Tata McGraw-Hill New Delhi, 1998.

11ED024 ADVANCED TOOL DESIGN

(Common to M.E. Engineering Design and CAD/CAM branches)

3 0 0 3

Objective:

- To study latest developments in tool design methods, tooling materials and design of jigs and fixtures.

MODULE - I **15**

Tool-Design Methods and Tooling Materials: Introduction – The Design Procedure – Statement of the problem – The Need 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. 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.

MODULE - II **15**

Design of Drill Jigs and Fixtures: 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. Fixtures and economics – Types of Fixtures – Vise Fixtures – Milling Fixtures – Boring Fixtures – Broaching Fixtures – Lathe Fixtures – Grinding Fixtures

MODULE - III **15**

Dies and Tool Design for Numerically Controlled Machine: 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. 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

REFERENCE BOOKS

1. Donaldson Cyrll, LeCain, George H and Goold, V.C., “Tool Design”, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2000.
2. Joshi, Prakash Hiralal, “Tooling Data”, Wheeler Publishing, Ahmedabad, 2000.
3. Cole, C.P, “Tool Design”, D.B Taraporevala, Bombay, 1972.
4. Pollock. Herman.W., “Tool Design”, D.B Taraporevala, Bombay, 1983.

11ED025 ROBOTIC ENGINEERING

(Common to M.E. Engineering Design and CAD/CAM branches)

3 0 0 3

Objective:

- To study the basic concepts of robotics.
- To study the robot drives sensors and machine vision in robots.
- To study the Trajectory Planning and Robot programming

MODULE - I INTRODUCTION TO ROBOTS AND SENSORS 15

History of Robots – Components of a Robot system – Robot Degree of Freedom – Joint Notations – Classifications of Robot – Work volume – Precision movement – Robot Drive Systems – Robot End Effectors – Proximity Sensors – Range Sensors – Touch and Slip Sensors – Accelerometers – Force and Torque Sensors – Machine Vision System – Industrial application of robots

MODULE – II ROBOT KINEMATICS AND DYNAMICS 15

Spatial Descriptions and Transformations – Forward and Inverse Kinematics – Representation of Links using Denavit- Hartenberg parameters – Velocities and Static forces: Derivation of the Jacobian for serial and parallel Manipulators, Static forces of serial and parallel Manipulators – Manipulator Dynamics : Acceleration of a rigid body – Inertia – Legrangian, Newton Euler formulation – Legrange Euler Formulation

MODULE - III TRAJECTORY PLANNING AND ROBOT PROGRAMMING 15

Introduction to Trajectory generation – General Consideration in path description – Point to Point – Continuous path – Controlled path motions – Joint, Cartesian space schemes – Trajectory planning – Trajectory following – Introduction of Robot Programming – Methods of Robot Programming – Leadthrough programming methods – Motion interpolation – Robot Languages – Off line Programming System

TOTAL : 45

REFERENCE BOOKS

1. Craig, John J., “Introduction to Robotics: Mechanics and Control”, Second edition, Prentice Hall Inc., London, 2005.
2. Mark W.Spong and M. Vidyasagar “Robotics Dynamics and control”Wiley publication.1984.
3. Groover, M.P., “Industrial Robotics, Technology, Programming and Applications”, Tata Mcgraw-Hill, New York, 2008.
4. Deb, Sathya Ranjan, “Robotics Technology and Flexible Automation”, Sixth edition, Tata Mcgraw-Hill Publication, New Delhi, 2008.
5. A shitava Ghosal, “Robotics fundamental concepts and analysis”, Oxford university press,2006.

11ED026 DESIGN OF HEAT EXCHANGERS

(Common to M.E. Engineering Design and CAD/CAM branches)

3 0 0 3

Objective:

- To study the factors influencing Heat exchanger design.
- To analysis the heat exchanger failures.
- To understand the design aspects of condenser and cooling tower.

MODULE - I **15**

Analysis of Heat Exchanger: Temperature distribution and its implications types – shell and tube heat exchangers – regenerators and recuperators – analysis of heat exchangers – LMTD and effectiveness method - Effect of turbulence – friction factor – pressure loss – stress in tubes – header sheets and pressure vessels – thermal stresses, shear stresses, types of failures.

MODULE - II **15**

Design factors: 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 - design of compact heat exchangers, plate heat exchangers – performance influencing parameters, limitations.

MODULE - III **15**

Condensers and Cooling Towers: Types of Condensors - Design of surface and evaporative condensers – Types of Cooling tower - Design of cooling tower – performance characteristics.

TOTAL : 45

REFERENCE BOOKS

1. P Arthur. Frass, “Heat Exchanger Design”, John Wiley & Sons, 1988.
2. Sadik Kakac, Hongtan Liu, “Heat Exchangers Selection, Rating and Thermal Design”, CRC Press,2002
3. Hewitt.G.F, Shires.G.L, Bott.T.R, “Process Heat Transfer”, CRC Press, 1994.
4. Taborek.T, Hewitt.G.F and Afgan.N, “Heat Exchangers, Theory and Practice”, McGraw-Hill Book Co. 1980.

11ED027 ENERGY CONSERVATION MANAGEMENT

(Common to M.E. Engineering Design and CAD/CAM branches)

3 0 0 3

Objective:

- To understand the concept of Energy Auditing
- To gain knowledge on thermal and electrical energy auditing
- To understand the economics behind various energy conservation schemes

MODULE - I **14**

Energy Auditing, Management, Monitoring and Targeting: Current energy consumption in India – Role of energy managers in industries - Energy audit – Purpose – Methodology with respect to process industries, power plants, boilers etc. - Characteristic methods employed in certain energy intensive industries.

Organizational background desired for energy management persuasion / motivation / publicity role – Tariff Analysis – Industrial energy management systems – Energy monitoring, auditing and targeting – Economics of various energy conservation schemes – Energy policy and energy labeling.

MODULE - II **17**

Thermal Energy Auditing: Conservation measures in steam system – Losses in boiler - Methodology of upgrading boiler performance – Boiler blow down control – Excess air control – Pressure reducing stations – Energy conservation in steam systems – Importance of correct pressure, temperature, and quality of steam – Condensate recovery – Condensate pumping – Thermo compressors – Recovery of flash steam – Air removal and venting – Moisture removal – Steam Traps – Types – Function – Necessity – Selection and application.

Centrifugal pumps – Energy consumption and energy saving potentials – Design consideration – minimizing over design – Case studies – Fans and blowers – Specification, safety margin, choice of fans, controls and design considerations – Air compressor and compressed air systems – selection of compressed air layout – Energy conservation aspects to be considered at design stage – Case studies.

MODULE - III **14**

Electrical Energy Auditing: Potential areas for electrical energy conservation in various industries – Conservation methods – Energy management opportunities in electrical heating, lighting system, cable selection – Energy efficient motors – Factors involving in the determination of motor efficiency – Adjustable AC drives – Application and its use – Variable speed drives / belt drives – Energy efficiency in electrical systems – Energy efficiency in lighting – Case Studies.

TOTAL: 45

REFERENCE BOOKS

1. Trivedi, PR, Jolka KR, “Energy Management”, Commonwealth Publication, New Delhi, 1997
2. White, L. C., “Industrial Energy Management and Utilization”, Hemisphere Publishers, 1988.
3. Hamies, “Energy Auditing and Conservation; Methods Measurements, Management and Case study”, Hemisphere, Washington, 1980
4. Reay, D. A., “Industrial energy conservation”, Pergamon Press, 1979
5. Diamant, R.M.E., “Total Energy”, Pergamon, Oxford Press, 1970

11ED028 ADVANCED INTERNAL COMBUSTION ENGINEERING

(Common to M.E. Engineering Design and CAD/CAM branches)

3 0 0 3

Objective:

- To study the combustion process in SI & CI engines
- To study the pollution control and norms.
- To get a knowledge about alternative fuels.

MODULE - I **15**

Spark ignition engine mixture requirements-fuel-injection systems-Monopoint, Multipoint injection, Direct injection-Stages of combustion-Normal and abnormal combustion-factors affecting knock-combustion chambers.

States of combustion in C.I. engine-Direct and indirect injection systems-Combustion chambers-Fuel spray behaviour- spray structure, spray penetration and evaporation – air motion – Introduction to Turbo charging.

MODULE - II **15**

Pollutant-Sources-Formation of carbon monoxide, Unburnt hydrocarbon, NOx, Smoke and Particulate matter-Methods of controlling emissions-Catalytic converters and Particulate Traps-Methods of measurements and introduction to emission norms and Driving cycles.

MODULE - III **15**

Alcohol, Hydrogen, Natural gas and LPG- Properties, suitability, Merits and demerits as fuels, Engine Modifications.

Lean burn engines-Stratified charge engines –homogeneous charge compression ignition engines-Plasma ignition-Measurement techniques.

TOTAL : 45

REFERENCE BOOKS

1. R.B.Mattur and R.P.Sharma, "A Course In Internal Combustion Engines", Dhanpath Rai, 2002.
2. V.Ganesan, "Internal Combustion Engines", II Edition, TMH, 2002.
3. Duffy Smith, "Autofuel systems", The Good Heart Wilox Company, Inc.

11ED029 SAFETY IN ENGINEERING INDUSTRY

(Common to M.E. Engineering Design and CAD/CAM branches)

3 0 0 3

Objective:

- To study the various safety aspects in industry

  To understand the various hazards and safety precautions

MODULE – I **15**

Safety in Metal Working Machinery and Wood Working machines: General safety rules, principles, maintenance, Inspections of turning machines, boring machines, milling machine, planning machine and grinding machines, CNC machines, Wood working machinery, types, safety principles, electrical guards, work area, material handling, inspection, standards and codes- saws, types, hazards.

Principles of Machine Guarding:

Guarding during maintenance, Zero Mechanical State (ZMS), Definition, Policy for ZMS – guarding of hazards - point of operation protective devices, machine guarding, types, fixed guard, interlock guard, automatic guard, trip guard, electron eye, positional control guard, fixed guard fencing- guard construction- guard opening.

Selection and suitability: lathe-drilling-boring-milling-grinding-shaping-sawing-shearing presses-forge hammer-flywheels-shafts-couplings-gears-sprockets wheels and chains-pulleys and belts-authorized entry to hazardous installations-benefits of good guarding systems.

MODULE - II **15**

Safety in Welding , Gas Cutting, Cold Forming: Gas welding and oxygen cutting, resistance welding, arc welding and cutting, common hazards, personal protective equipment, training, safety precautions in brazing, soldering and metalizing – explosive welding, selection, care and maintenance of the associated equipment and instruments – safety in generation, distribution and handling of industrial gases-colour coding – flashback arrestor – leak detection-pipe line safety-storage and handling of gas cylinders.

Cold working, power press, point of operation safe guarding, auxiliary mechanisms, feeding and cutting mechanism, hand or foot-operated press, power press electric controls, power press set up and die removal, inspection and maintenance-metal shears-press brakes.

MODULE - III **15**

Safety in Hot Working of Metals, Finishing, Inspection and Testing: Hot working safety in forging, hot rolling mill operation, safe guards in hot rolling mills – hot bending of pipes, hazards and control measures. Safety in gas furnace operation, cupola, crucibles, ovens, foundry health hazards, work environment, material handling in foundries, foundry production cleaning and finishing foundry processes. Heat treatment operations, electro plating, paint shops, sand and shot blasting, safety in inspection and testing, dynamic balancing, hydro testing, valves, boiler drums and headers, pressure vessels, air leak test, steam testing, safety in radiography, personal monitoring devices, radiation hazards, engineering and administrative controls, Indian Boilers Regulation.

TOTAL: 45

REFERENCE BOOKS

1. John V. Grimaldi and Rollin H. Simonds, “Safety Management”, All India Travelers Book Seller, New Delhi, 1989.
2. Krishnan N.V. “Safety in Industry” Jaico Publishers, 1996.
3. “Health and Safety in Welding and Allied processes”, Welding Institute, UK, High Tech. Publishing Ltd., London, 1989.
4. “Accident Prevention Manual” – NSC, Chicago, 1982.
5. “Occupational safety Manual” BHEL, Trichy, 1988.
6. “Indian Boiler acts and Regulations”, Government of India.
7. “Safety in the use of Wood Working Machines”, HMSO, UK 1992.

11MM105 FLUID POWER SYSTEM DESIGN

(Common to Engineering Design, CAD/CAM and Mechatronics Engineering)

3 0 0 3

Objectives:

To expose the students to the technology that deals with the generation, control and transmission of power using pressurized fluids and to design a setup for low cost Automation.

MODULE - I **17**

Hydraulic system components: Basics – Continuity Equation – Bernoulli's Equation – Energy Equation - Pascal's Law and its application – Fluid properties – Losses in pipes, valves and fittings – Advantages of Fluid power systems – Fluid power symbols – Hydraulic pumps: Gear, Vane and Piston pumps, Sizing of Pumps, Pump Performance, Characteristics and Selection – Direction control valves: Three way valve, Four way valve, Check valve and shuttle valve – Actuation mechanism – Pressure control valves: Pressure relief, Pressure Reducing, Counter balance, Sequencing and Unloading Valves – Flow control valves and its types – Proportional Valves – Servo valves.

MODULE - II **13**

Pneumatic system components: The perfect Gas laws – Compressors: piston, screw and vane compressor – Fluid conditioning Elements: Filter, Regulator and Lubricator unit, Pneumatic silencers, Aftercoolers, Air dryers – Air control valves – Fluid power actuators: Cylinders and Motors – Types – Cushioning mechanism – Sizing of Actuators – Hydrostatic transmission system – Basic pneumatic circuits – Electrical controls for Fluid power circuits – Introduction to Fluid logic devices and applications – PLC applications in Fluid power circuit.

MODULE - III **15**

Circuit design and Industrial circuits: Circuit design methodologies: Cascade method, Step counter method, KV Map method – Industrial circuits: Speed control circuits – Regenerative cylinder circuits – Pump unloading circuit – Double pump circuit – Counter balance valve circuit – Hydraulic cylinder sequencing circuit (using pressure sequence valve) – Automatic cylinder reciprocating circuit – Cylinder synchronizing circuits – Fail safe circuits – Accumulator – Types and application circuits – Pressure intensifier circuits – Sealing devices – Types and materials – Installation, Maintenance and trouble shooting of Fluid Power systems.

TOTAL: 45

REFERENCE BOOKS

1. Esposito Anthony, "Fluid Power with Applications", Seventh Edition, Pearson Higher Education, New York, 2009.
2. Majumdar, S.R., "Pneumatic Systems – Principles and Maintenance", Second Edition, Tata McGraw-Hill, New Delhi, 2006.
3. Majumdar, S.R., "Oil Hydraulic Systems – Principles and Maintenance", Second Edition, Tata McGraw-Hill, New Delhi, 2006.
4. Sullivan James A., "Fluid Power - Theory and Applications", Fourth Edition, Prentice Hall International, New Jersey, 1998.
5. Pippenger, John and Hicks, Tyler, "Industrial Hydraulics", Third Edition, Tata McGraw-Hill, New Delhi, 1987.

11MM020 RAPID PROTOTYPING AND TOOLING

(Common to Mechatronics, Engineering Design and CAD/CAM)

3 0 0 3

Objective:

- To learn the basics of Rapid Prototyping and its processes
- To familiarise the Principles of Rapid Tooling
- To extend students' knowledge and understanding of the current and emerging manufacturing technologies being used for rapid prototyping by today's most successful product developers and manufacturers

MODULE – I **16**

Introduction and Liquid Based RP Processes: Introduction: Need for time compression in product development, Prototype fundamentals, Fundamentals of RP systems - 3D modelling - Data format - STL files, History of RP systems, classification of RP systems, benefits of RPT, Liquid based RP systems: Stereo Lithography Apparatus (SLA) – Principle - Photo polymers - Post processes - Process parameters - Machine details - Advantages, Solid Ground Curing (SGC) – Principle - Process parameters - Process details - Machine details - Limitations.

MODULE - II **14**

Solid and Powder Based RP Processes: Solid based RP systems: Fusion Deposition Modeling (FDM) – Principle - Raw materials – BASS -Water soluble support system - Process parameters - Machine details - Advantages and limitations, Laminated Object Manufacturing – Principle - Process parameters - Process details - Advantages and limitations, Powder based RP systems: Selective Laser Sintering (SLS) – Principle - Process parameters - Process details - Machine details, 3-Dimensional Printers – Principle - Process parameters - Process details - Machine details, Concept Modelers.

MODULE – III **15**

Rapid Tooling and Applications of RP: Indirect Rapid Tooling - Silicone rubber tooling, Aluminum filled epoxy tooling, Spray metal tooling, Direct Rapid Tooling - Direct AIM, Quick cast process, Copper polyamide, Rapid Tool, DMLS, ProMetal, Sand casting tooling, soft tooling Vs hard tooling, Applications of RP in product design, automotive industry, medical field – Conversion of CT/MRI scan data -customised implant - Case studies, reverse engineering - Surface Generation from points on cloud, Growth of RP industry, Laser Engineered Net Shaping – Principle – Process details.

TOTAL: 45

REFERENCE BOOKS

1. Chua, C. K., Leong, K. F. and Lim, C. S., "Rapid Prototyping: Principles and Applications", World Scientific, New Jersey, 2003.
2. Pham, D. T. and Dimov, S. S., "Rapid Manufacturing", Springer-Verlag, London, 2001.
3. Jacobs, P. F., "Rapid Prototyping and Manufacturing: Fundamentals of Stereolithography", McGraw-Hill, New York, 1992.
4. Hilton, P. D., "Rapid Tooling", Marcel Dekker, New York, 2000.
5. home.utah.edu/~asn8200/rapid.html
6. Rapid Prototyping Journal, Emerald Group Publishing Limited
7. http://www.cheshirehenbury.com/rapid/index.html