CD133	**Finite Element Analysis**	**3**	**0**	**0**	**100**

1. 1D FINITE ELEMENT ANALYSIS **10**

Historical Background - Weighted Residual Methods - Basic Concepts of FEM - Variational Formulation of B.V.P - Ritz Method - Finite Element Modeling - Element Equations - Linear and Quadratic Shape functions - Bar, Beam Elements - Applications to Heat Transfer.

2. FINITE ELEMENT ANALYSIS OF 2D PROBLEMS **10**

Basic Boundary Value Problems in 2 Dimentions - Triangular, quadrilateral, higher order elements - Poissons and Laplace Equations - Weak Formulation - Elements Matrices and Vectors - Application to Solid mechanics, Heat transfer, Fluid Mechanics.

3. ISO PARAMETRIC FORMULATION **8**

Natural Co-ordinate System - Lagrangian Interpolation Polynomials - Iso-parametric Elements - Formulation - Numerical Intergration - 1D -2D Triangular elements - rectangular elements - Illustrative Examples.

4. SOLUTION TO PLANE ELASTICITY PROBLEMS **9**

Introduction to Theory of Elasticity - Plane Stress - Plane Strain and Axisymmetric Formulation - Principle of virtual work - Element matrices using energy approach.

5. SPECIAL TOPICS **8**

Dynamic Analysis - Equation of Motion - Mass Matrices - Free Vibration analysis - Natural frequencies of Longitudinal - Transverse and torsional vibration - Introduction to transient field problems. Non linear analysis. Use of software - h & p elements - special element formulation.

Total No of periods: 45

CD133 Finite Element Analysis **3 0 0 100**

Text Books:

1. Reddy J.N. " An Introduction to the Finite Element Method " , Mc Graw Hill, International Edition, 1993.

References:

1. Segerlind L.J., " Applied Finite Element Analysis " , John Wiley, 1984.
2. Rao S.S., " Finite Element Method in Engineering " , Pergamon Press, 1989.
3. Chandrupatla & Belagundu , " Finite Elements in Engineering ", Prentice Hall of India Private Ltd., 1997.
4. Cook, Robert Davis et al, " Concepts and Applications of Finite Element Analysis " , Wiley, John & Sons,1999.
5.George R Buchanan, " Schaum's Outline of Finite Element Analysis ", McGraw Hill Company, 1994.

Web References:

1. http://www.vector-space.com
2. http://www.mech.port.ac.uk/sdalby/mbm/CTFRProg.htm

PD132 Concurrent Engineering **3 0 0 100**

1. INTRODUCTION **5**

Extensive definition of CE - CE design methodologies - Organizing for CE - CE tool box collaborative product development

2. USE OF INFORMATION TECHNOLOGY **10**

IT support - Solid modeling - Product data management - Collaborative product commerce - Artificial Intelligence - Expert systems - Software hardware co-design.

3. DESIGN STAGE **10**

Life-cycle design of products - opportunity for manufacturing enterprises - modality of Concurrent Engineering Design - Automated analysis idealization control - Concurrent engineering in optimal structural design - Real time constraints.

4. MANUFACTURING CONCEPTS AND ANALYSIS **10**

Manufacturing competitiveness - Checking the design process - conceptual design mechanism - Qualitative physial approach - An intelligent design for manufacturing system - JIT system - low inventory - modular - Modeling and reasoning for computer based assembly planning - Design of Automated manufacturing.

5. PROJECT MANAGEMENT **10**

Life Cycle semi realization - design for economics - evaluation of design for manufacturing cost - concurrent mechanical design - decomposition in concurrent design - negotiation in concurrent engineering design studies - product realization taxonomy - plan for Project Management on new product development - bottleneck technology development.

Total No of periods: 45

PD132 Concurrent Engineering **3 0 0 100**

References:

1. *Anderson MM and Hein, L. Berlin, "Integrated Product Development", Springer Verlog, 1987.*
2. *Cleetus, J, "Design for Concurrent Engineering", Concurrent Engg. Research Centre, Morgantown, WV, 1992.*
3. *Andrew Kusaik, "Concurrent Engineering: Automation Tools and Technology", Wiley, JOhn and Sons Inc., 1992.*
4. *Prasad, "Concurrent Engineering Fundamentals: Integrated Product Development", Prentice Hall, 1996.*
5. *Sammy G Sinha, "Successful Implementation of Concurrent Product and Process", Wiley, John and Sons Inc., 1998.*

Web Reference:

1. *www.tm.tue.nl/race/ce/ce95.html*

PE039	**Robotics and Sensors**	**3**	**0**	**0**	**100**

1. INTRODUCTION 9

Basic concepts - Robot anatomy - Robot configurations - Basic robot motions - Types of drives - Applications - Material handling - processing -Assembly and Inspection - safety considerations.

2. TRANSFORMATIONS AND KINEMATICS 9

Vector operations - Translational transformations and Rotational transformations - Properties of transformation matrices-Homogeneous transformations and Manipulator - Forward solution - Inverse solution.

3. CONTROLS AND END EFFECTORS 9

Control system concepts - Analysis - control of joints - Adaptive and optimal control - End effectors - Classsification - Mechanical - Magnetic -Vacuum - Adhesive - Drive systems - Force analysis and Gripper design.

4. ROBOT PROGRAMMING 6

Methods - Languages -Computer control and Robot Software - VAL system and Language.

5. SENSORY DEVICES 12

Non optical and optical position sensors - Velocity and Acceleration - Range - Proximity - touch - Slip - Force - Torque - Machine vision - Image components - Representation - Hardware - Picture coding - Object recognition and categoristaion - Software consideration.

Total No of periods: 45

PE039 Robotics and Sensors **3 0 0 100**

References:

1. *Fu K.S., Gonzalez R.C.., and Lee C.S.G., " Robotics control, sensing, vision, and intelligence ", McGraw-Hill Book Co., 1987.*
2. *Klafter R.D., Chmielewski T.A. and Negin M., " Robot Engineering An Intergrated approach ", Prentice Hall of India, New Delhi, 1994.*
3. *Deb S.R., " Robotics Technology and Flexible Automation ", Tata McGraw-Hill Publishing Co., Ltd., 1994.*
4. *Craig J.J., " Introduction to Robotics Mechanics and Control ", Addison-Wesley, 1999.*
5. *Groover M.P., " Industrial robotics Technology, programming and applications ", McGraw-Hill Book Co., 1995.*

Web Reference:

1. *http://www.robotics.com*

CD142	**Mechanical Vibrations**	**3**	**0**	**2**	**100**

1. FUNDAMENTALS OF VIBRATION **8**

Review of Single degree system - Response to arbitrary periodic exicitations - Duhamel's Integral - Impulse Response function - Virtual work - Lagrange's equation - Single degree freedom forced vibration with elastically coupled viscous dampers - System Identification from frequency response - Transient Vibration - Laplace transformation formulation.

2. TWO DEGREE OF FREEDOM SYSTEMS **8**

Free vibration of spring - coupled system - mass coupled system - Bending vibration of two degree of freedom system - forced vibration - Vibration Absorber - Vibration isolation.

3. MULTI-DEGREE OF FREEDOM SYSTEM **12**

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

4. VIBRATION OF CONTINUOUS SYSTEMS **8**

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

5. EXPERIMENTAL METHODS IN VIBRATION ANALYSIS **9**

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

6. PRACTICALS **30**

Total No of periods: 75

CD142 Mechanical Vibrations **3 0 2 100**

References:

1. Thomson, W.T. - "Theory of Vibration with Applications", CBS Publishers and Distributors, New Delhi, 1990.
2. Rao, J.S., & Gupta, K. - "Introductory Course on Theory and Practice of Mechanical Vibrations" , New Age International Ltd., 1984.
3. Den Hartog, J.P. "Mechanical Vibrations", Dover Publication 1990.
4. Rao, S.S., "Mechanical Vibrations", Addison Wesley Longman 1995.

Web References:

1. http://www.ecgcorp.com/velav/
2. http://www.auburn.edu/isvd/
3. http://www.vibetech.com/techpaper.htm

ED132	**Computer Applications in Design**	**3**	**0**	**2**	**100**

1. INTRODUCTION TO COMPUTER GRAPHICS FUNDAMENTALS **10**

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

2. INTRODUCTION TO CAD SOFTWARE **10**

Writing interactive programs to solve design problems and production of drawings, using any languages like Auto LISP/C/FORTRAN etc. , creation of surfaces, solids etc., using solid modeling pack (prismatic and revolved parts).

3. VISUAL REALISM **10**

Hidden - Line - Surface - solid removal algorithms shading - coloring. Introduction to parametric and variational geometry based on softwares and their principles creation of prismatic and lofted parts using these packages.

4. ASSEMBLY OF PARTS **8**

Assembly of parts , tolerance analysis mass property calculations, mechanism simulation.

5. SOLID MODELING **7**

Solid modelling - Rapid prototyping - Data exchange - Documentation - Customizing - solid modelling system.

Total No of periods: 45

ED132 Computer Applications in Design **3** **0** **2** **100**

References:

1. *William .M. Neumann and Robert .F. Sproul " Principle of Computer Graphics ", McGraw Hill Book Co. Singapore ,1989.*
2. *Donald Hearn and .M. Pauline Baker " Computer Graphics " Prentice Hall ,Inc., 1992.*
3. *Mikell .P. Grooves and Emory .W. Zimmers Jr. " CAD/CAM Computer -- Aided Design and Manafacturing " Prentice Hall ,Inc., 1995.*
4. *Ibrahim Zeid " CAD/CAM -- Thoery and Practice " - McGraw Hill , International Edititon , 1998.*

CD035	**Computer Integrated Manufacturing Systems**	**3**	**0**	**0**	**100**

1. INTRODUCTION **7**

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

2. GROUP TECHNOLOGY AND COMPUTER AIDED PROCESS PLANNING **5**

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

3. 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.

4. 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.

5. INTEGRATED MANUFACTURING SYSTEM **13**

Definition - application - features - types of manufacturing systems-machine tools-materials 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 labour in the manufacturing system-computer integrated manufacturing system benefits.
Rapid prototyping - Artificial Intelligence and Expert system in CIM.

Total No of periods: 45

CD035 Computer Integrated Manufacturing Systems 3 0 0 100

Text Books:

1. Groover, M.P., "Automation, Produ tion 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.

ED043	**Product Design and Development Strategies**	**3**	**0**	**0**	**100**

1. INTRODUCTION **5**

Nature and scope of product engineering - creative thinking and organizing for product innovation criteria for product success in life cycle of a product.

2. MODELLING AND SIMULATION **6**

Modeling and simulation - the role of models in product design mathematical modeling similitude relations - weighted property index.

3. MATERIAL SELECTION **8**

Material selection - problems of material selection-performance characteristics of materials - the materials selection process-economics of materials-cost versus perforamance relations-weighted property index.

4. DESIGN CONSIDERATIONS **20**

Functional and production design-form design-influence of basic design, mechanical loading and material on form design - form design of gray castings, malleable iron castings, aluminium castings, pressure die castings, plastic mouldings, welded fabrications, forging and manufacture by machining methods. Influence of space, size, weight, etc., on form design, aesthetic and ergonomic considerations.

5. TOLERANCE AND ANALYSIS **6**

Dimensioning and tolerancing a product-functional production and inspection datum-tolerance analysis.

Total No of periods: 45

ED043 Product Design and Development Strategies 3 0 0 100

References:

1. Jones J.C., "Design Methods", interscience, 1970.
2. Buhl, H.R., "Creative Engineering Design", Iowa State University Press, 1960.
3. Dieter, G.E., "Engineering Design", McGraw Hill, 1983.
4. Robert Matouseek, "Engineering Design", Blackie & Sons Ltd., 1963.
5. Niebel, B.W. & Draper, A.B., "Product Design and Process Engineering, McGraw Hill, 1974.
6. Harry Peck, "Designing for Manufacturing", Sir Issac Pitman and Sons Ltd., 1973.
7. Gladman, C.A., "Manual for Geometric Analysis of Engineering Designs", Austrlian Trade Publications Ltd.,
8. Wade, Or., "Tolerance Control in Design and Manufacture", Industrial Press, Inc.

ED142 Computer Integrated Design **3 0 0 100**

1. INTRODUCTION **6**

Phases of design - Standardization and interchangeability of machine elements - Tolerances for process and function - Individual and group tolerances - Selection of fits for different design situations - Design for assembly and modular constructions - Concepts of integration.

2. SHAFTING **6**

Analysis and design of shafts for different applications - detailed design - preparation of production drawings - Integrated design of shaft, bearing and casing - Design for rigidity.

3. GEARS AND GEAR BOXES **18**

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

4. CLUTCHES **5**

Integrated design of automobile clutches and over running clutches.

5. BRAKES **10**

Dynamic and thermal aspects of vehicle braking - Integrated design of brakes for machine tools, automobiles and mechanical handling equipments.

Total No of periods: 45

ED142 Computer Integrated Design **3 0 0 100**

References:

1. Newcomb, T.P. and Spur, R.T. , "Automobile brakes ad braking systems", Chapman and Hall , 2nd Edition , 1975.
2. Juvinall, RL.C. ,"Fundamentals of Machine Component Design", John Wiley ,1983.
3. Maitra G.M. , "Hand Book for Gear Design", Tata McGraw Hill , 1985.
4. Shigley , J.E. ,"Mechanical Engineering Design ", McGraw Hill , 1986.

Web References:

http://www.agma.org/

PE034 Manufacturing Information Systems **3 0 0 100**

1. INTRODUCTION **5**

The evolution of order policies, from MRP to MRP II, the role of Production organization, Operations control.

2. DATABASE **7**

Terminologies - Entities and attributes - Data models, schema and subschema - Data Independence - ER Diagram - Trends in database.

3. DESIGNING DATABASE **13**

Hierarchical model - Network approach - Relational Data model -concepts, principles, keys, relational operations - functional dependence -Normalisation, types - Query languages.

4. MANUFACTURING CONSIDERATION **10**

The product and its structure, Inventory and process flow - Shop floor control - Data structure and procedure - various model - the order scheduling module, input / output analysis module the stock status database - the complete IOM database.

5. INFORMATION SYSTEM FOR MANUFACTURING **10**

Parts oriented production information system - concepts and structure -computerised production scheduling, on-line production control systems, Computer based production management system, computerised manufacturing information system - case study.

Total No of periods: 45

PE034 Manufacturing Information Systems **3** **0** **0** **100**

References:

1. *Luca G. Sartori, " Manufacturing Information Systems ", Addison-Wesley Publishing Company, 1988.*
2. *Date.C.J., " An Introduction to Database systems ", Narosa Publishing House, 1997.*
3. *Orlicky.G., " Material Requirements Planning ", McGraw-Hill Publishing Co., 1975.*
4. *Kerr.R, " Knowledge based Manufacturing Management ", Addison-wesley, 1991.*

Web Reference:

1. *www.ist.psu.edu*

CD141 Optimization in Design **3 0 0 100**

1. INTRODUCTION **5**

General Characteristics of mechanical elements, adequate and optimum design, prinicples of optimization, formulation of objective function, design constraints -Classification of optimization problems.

2. OPTIMIZATION TECHNIQUES **20**

Single variable and multivariable optimization, Techniques of unconstrained minimization - Golden Section - Random , pattern and gradient search methods -Interpolation methods; Optimization with equality and inequality constraints - Direct methods - Indirect methods using penalty functions Lagrange multipliers; Geometric programming and stochastic programming; Multi objective optimization, Genetic algorithms and Simulated Annealing techniques.

3. ENGINEERING APPLICATIONS **20**

Structural applications - Design of simple truss members. Design application - 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, two degree freedom system, vibration absorbers. Application in Mechanism - Optimum design of simple linkage mechanism.

Total No of periods: 45

Text Books:

1. Singeresu S. Rao, "Engineering Optimization - Theory and Practice" New Age Intl. Ltd., Publishers, 2000.

References:

1. Johnson Ray, C., "Optimum design of mechanical elements" , Wiley , John & Sons, 1981.
2. Goldberg, D.E., "Genetic algorithms in search, optimization and machine", Barnen, Addison-Wesley, New York, 1989.
3. Kalyanamoy Deb, "Optimization for Engineering design algorithms and Examples", Prentice Hall of India, 1995.

ED031	**Tribology in Design**	**3**	**0**	**0**	**100**

1. SURFACES,FRICTION AND WEAR **8**

Topography of the surfaces - Surface features - Surface interaction - Theory of Friction - Sliding and Rolling Friction, Friction properties of metallic and non-metallic materials - friction in extreme conditions - Wear, types of wear - Mechanism of wear - Wear resistance materials - Surface treatment - Surface modifications - Surface coatings.

2. LUBRICATION THEORY **8**

Lubricants and their physical properties lubricants standards - Lubrication Regimes Hydrodynamic lubrication - Reynolds Equation, Thermal, inertia and turbulent effects - Elasto hydrodynamic and plasto hydrodynamic and magneto hydrodynamic lubrication - Hydro static lubrication - Gas lubrication.

3. DESIGN OF FLUID FILM BEARINGS **12**

Design and performance analysis of thrust and journal bearings - Full, partial, fixed and pivoted journal bearings design - Lubricant flow and delivery - power loss, Heat and temperature rotating loads and dynamic loads in journal bearings - special bearings - Hydrostatic Bearing design.

4. ROLLING ELEMENT BEARINGS **10**

Geometry and Kinamatics - Materials and manufacturing processes - contact stresses - Hertzian stress equation - Load divisions - Stresses and deflection - Axial loads and rotational effects, Bearing life capacity and variable loads - ISO standards - Oil films and their effects - Rolling Bearings Failures.

5. TRIBO MEASUREMENT IN INSTUMENTATION **7**

Surface topography measurements - Electron microscope and friction and wear measurements - Laser method - Instrumentaton - International standards - Bearings performance measurements - Bearing vibration measurement.

Total No of periods: 45

ED031 Tribology in Design **3 0 0 100**

References:

1. Cameron, A. "Basic Lubricaton Theory", Ellis Herward Ltd. , UK,1981.
2. Hulling , J. (Editor) --"Principles of Tribology", MacMillan ,1984.
3. Williams J.A . "Engineering Tribology" ,Oxford Univ. Press ,1994.
4. Neale M.J , "Tribology Hand Book ", Butterworth Heinemann, 1995.

Web References:

1. http://www.csetr.org/link.htm
2. http://www.me.psu.edu/research/tribology.htm

ED032	**Design of Hydraulic and Pneumatic Systems**	**3**	**0**	**0**	**100**

1. OIL HYDRAULIC SYSTEMS **2**

Hydraulic Power Generators - Selection and specification of pumps, pump characteristics.

2. HYDRAULIC ACTUATORS **2**

Linear and Rotary Actuators - selection, specification and characteristics.

3. CONTROL AND REGULATION ELEMENTS **12**

Pressure - direction anf flow control valves - relief valves, non return and safety valves - actuation systems.

4. HYDRAULIC CIRCUITS **4**

Reciprocation, quick return, sequencing, synchronising 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.

5. PNEUMATIC SYSTEMS AND CIRCUITS **18**

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.

6. 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 No of periods: 45

ED032 Design of Hydraulic and Pneumatic Systems 3 0 0 100

References:

1. Antony Espossito, " Fluid power with Applications ", Prentice Hall, 1980.
2. Dudleyt, A.Pease and John J.Pippenger, " Basic Fluid Power ", Prentice Hall, 1987.
3. Andrew Parr, " Hydraulic and Pneumatics ", (HB), Jaico Publishing House, 1999.
4. Bolton. W. " Pneumatic and Hydraulic Systems ", Butterworth - Heineman, 1997.

Web References:

1. www.pneumatics.com
2. www.fluidpower.com.tw

ED041 Advanced Machine Tool Design **3 0 0 100**

1. INTRODUCTION **5**

Introduction to Metal Cutting Machine tools, Kinematics, Basic Principles of Machine tool design, estimation of drive power.

2. DESIGN OF MACHINE TOOLS, SPINDLES, FRAMES, SLIDEWAYS **20**

Design of Machine tool spindle and bearings, Design of power Screws - Static deformation of various machine tool structures - thin walled box structures with open and compliant cross sections - correction coefficients - design of beds, columns, tables and supports.
Dynamics of cutting forces - tool chatter - design of slideways.
Concepts of aesthetics and ergonomics applied to machine tools, latest trends in Machine Tool Design, Introduction to CAD techniques

3. DESIGN OF DRIVES AND CONTROL MECHANISMS **16**

Design considerations of electrical, mechanical and Hydraulic drives in machine tool, stepped and stepless arrangements and systems.
Design of control mechanisms - selection of standard components - Dynamic measurement of forces and vibrations in machine tools - Stability against chatter - use of vibration dampers.

4. TESTING AND STANDARDISATION **4**

Acceptance tests and standardisation of machine tools - machine tools reconditioning.

Total No of periods: 45

ED041 Advanced Machine Tool Design **3** **0** **0** **100**

References:

1. Mehta,N.K.,"Machine Tool design",Tata McGraw Hill, 1989
2. Koenisberger,F., "Design Principles of Metal cutting Machine Tools",Pergamon Press, 1964.
3. Acherkan,N.,"Machine Tool Design",Vol.3&4,MIR Publishers,Moscow, 1968
4. Sen.G. and Bhattacharya,A.,"Principles of Machine Tools",Vol.2,NCB.Calcutta, 1973

ED044	**Advanced Strength of Materials**	**3**	**0**	**0**	**100**

1. ELASTICITY **7**

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

2. SHEAR CENTRE **4**

Location of shear centre for various sections -shear flows.

3. UNSYMMETRICAL BENDING **4**

Stresses and deflections in beams subjected to unsymmetrical loading-kern of a section.

4. CURVED FLEXIBLE MEMBERS **5**

Circumference and radial stresses-deflections-curved beam with restrained ends-closed ring subjected to concentrated load and uniform load-chain links and crane hooks.

5. STRESSES IN FLAT PLATES **5**

Stresses in circular and rectangular plates due to various types of loading and end conditions buckling of plates.

6. TORSION OF NON-CIRCULAR SECTIONS **10**

Torsion of rectangular cross section - S.Venants theory - elastic membrane analogy Prandtl's stress function torsional stress in hollow thin walled tubes.

7. STRESSES DUE TO ROTARY SECTIONS **5**

Radial and tangential stresses in solid disc and ring of uniform thickness and varying thickness allowable speeds.

8. CONTACT STRESSES **5**

Methods of computing contact stress-deflection of bodies in point and line contact applications.

Total No of periods: 45

ED044 Advanced Strength of Materials **3 0 0 100**

References:

1. Seely and Smith, "Advanced Mechanics of Materials", John Wiley International Edn, 1952.
2. Rimoahwnko, "Strenbgth of Materials", Van Nostrand.
3. Timoshenko and Goodier, "LTheory of Elasticity", McGraw Hill.
4. Wang, "Applied Elasticity", McGraw Hill.
5. Cas, "Strength of Materials", Edward Arnold, London 1957.
6. Robert D. Cook, Warren C. Young, "Advanced Mechanics of Materials", Mc-millan pub. Co., 1985.

ED045	**Design of Material Handling Equipments**	**3**	**0**	**0**	**100**

. (USE OF APPROVED DATA BOOK IS PERMITTED)

1. MATERIALS HANDLING EQUIPMENT **4**

Types, selection and applications

2. DESIGN OF HOISTS **15**

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.

3. DRIVES OF HOISTING GEAR **6**

Hand and power drives - Travelling gear - Rail traveling mechanism - cantilever and monorail cranes - slewing, jib and luffing gear - cogwheel drive - selecting the motor ratings.

4. CONVEYORS **10**

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

5. ELEVATORS **10**

Bucket eleevators: design - loading and bucket arrangements - Cage elevators - shaftway, guides, counter weights, hoisting machine, safety devices - Design of form lift trucks.

Total No of periods: 45

ED045 Design of Material Handling Equipments **3** **0** **0** **100**

Text Books:

1. Rudenko, N., Materials handling equipment, ELnvee Publishers, 1970.
2. Spivakovsy, A.O. and Dyachkov, V.K., LConveying 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.

ED141 Advanced Mechanisms Design **3 1 0 100**

1. INTRODUCTION **5**

Review of fundamentals of kinematics--Mobility analysis --Formation of one D.O.F. multiloop kinematics chains, Network formula - Gross motion concepts.

2. KINEMATIC ANALYSIS **5**

Position analysis -Vectorloop equations for four bar, slider crank, inverted slider crank - Geared five bar and six bar linkages. Analytical method for velociy and acceleration analysis - Four bar linkage jerk analysis - Plane complex mechanism

3. PATH CURVATURE THEORY **6**

Fixed and Moving centrodes, inflection points and inflection circle. Euler Savary equation, Graphical constructions - Cubic of stationary curvature.

4. SYNTHESIS OF MECHANISMS **15**

Type synthesis - Number sythesis - Assosiated linkage concept. Dimensional systhesis - Function generation , path generation, motion generation. Graphical methods. Cognate linkage - Coupler curve synthesis, design of six bar mechanisms .Algebraic methods. Application of instant centre in linkage design. Cam mechanism - Determination of optimum size of Cams.

5. DYNAMIC OF MECHANISMS **9**

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

6. SPATIAL MECHANISM AND ROBOTICS **5**

Kinematic analysis of spatial RSSR mechanism - Denavit - Hartenberg parameters. Forward and inverse Kinematics of robotic manipulators

.

7. TUTORIAL AND USE OF MECHANICAL SOFTWARE PACKAGES **15**

Total No of periods: 60

ED141 Advanced Mechanisms Design **3** **1** **0** **100**

References:

1. Sandor G.N. and Erdman A.G., "Advanced Mechanism Design Analysis and Synthesis", Prentice Hall, 1984.
2. Shigley, J.E., and Uicker, J.J., "Theory of Machines and Mechanisms", McGraw Hill, 1995.
3. Amitabha Ghosh and Ashok Kumar Mallik, "Theory of Mechanism and Machines", EWLP, Delhi, 1999.
4. Nortron R.L., "Design of Machinery", McGraw Hill, 1999.
5. Kenneth J. Waldron, Gary L. Kinzel, "Kinematics, Dynamics and Design of Machinery", John Wiley-sons, 1999.

Web References:

1. http://www.machinedesign.com

ED143	**Design for Manufacture**	**3**	**0**	**0**	**100**

1. INTRODUCTION **8**

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

2. FACTORS INFLUENCING FORM DESIGN **13**

Working principle, Material, Manufacture, Design - Possible solutions - Materials choice - Influence of materials on from design - from design of welded members, forgings and castings.

3. 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 - simplificaation by amalgamation - Design for machinability - Design for economy - Design for clampability - Design for accessibility - Design for assembly.

4. COMPONENT DESIGN - CASTING CONSIDERATIONS **8**

Redesign of castings based on parting line considerations - Minimising core requirements, machined holes, redesign of cast members to obviate cores.

5. REDESIGN FOR MANUFACTURE AND CASE STUDIES **8**

Identification of uneconomical design - Modifying the design - group technology - Computer Applications for DFMA

Total No of periods: 45

ED143 Design for Manufacture **3 0 0 100**

Text Books:

1. Harry Peck, "Design for Manufacture", Pittman Publication, 1983.
2. Robert Matousek, "Engineering Design - A systematic approach", Blackie & sons Ltd., 1963.

References:

1. James G. Bralla, "Hand Book of Product Design for Manufacturing", McGraw Hill Co., 1986.
2. Swift K.G., "Knowledge based design for manufacture, Kogan Page Ltd., 1987.

IC034	**Computational Fluid Dynamics**	**3**	**0**	**0**	**100**

1. GOVERNING DIFFERENTIAL EQUATION AND FINITE DIFFERENCE METHOD 10

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

2. CONDUCTION HEAT TRANSFER 10

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

3. INCOMPRESSIBLE FLUID FLOW 10

Governing Equations, Stream Function - Vorticity method, Determination of pressure for viscous flow, SIMPLE Procedure of Patankar and Spalding, Computation of Boundary layer flow, Finite deference approach.

4. CONVECTION HEAT TRANSFER AND FEM 10

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

5. TURBULENCE MODELS 5

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

Total No of periods: 45

References:

1. Muralidhar, K.,and Sundararajan,T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House ,New Delhi1995.
2. Ghoshdasdidar, P.S.,"Computer Simulation of flow and heat transfer" Tata McGraw-Hill Publishing Company Ltd., 1998.
3. Subas, V.Patankar "Numerical heat transfer fluid flow", Hemisphere Publishing Corporation, 1980.
4. Taylor, C and Hughes J.B.,Finite Element Programming of the Navier Stock Equation, Pineridge Press Ltd.,U.K.1981.
5. Anderson, D.A.,Tannehill, I.I., and Pletcher, R.H., Computational Fluid Mechanics and Heat Transfer, Hemishphere Publishing Corporation, New York, USA, 1984.
6. Fletcher, C.A.J.,"Computational Techniques for Fluid Dynamics 1" Fundamental and General Techniques, Springer-Verlag,1987.
7. Flectcher, C.A.J., "Computational Techniques for Different Flow Categories, Springer-Verlage 1987.
8. Bose,T.K.,"Numerical Fluid Dynamics" Narosa Publishing House, 1997.

ID036 Total Quality Management **3 0 0 100**

1. CONCEPT OF TQM **5**

Philosophy of TQM, Customer focus, organisation, top management commitment, teamwork, Quality philosophies of Deming, Crossby and Muller.

2. TQM PROCESS **10**

QC tools, problem solving methodologies, new management tools, work habits, quality circles, bench marking, strategic quality planning.

3. TQM SYSTEMS **10**

Quality policy deployment, quality function deployment, standardization, designing for quality, manufacturing for quality.

4. QUALITY SYSTEM **10**

Need for ISO 9000 system, advantages, clauses of ISO 9000, Implementation of ISO 9000, quality costs, quality auditing, case studies.

5. IMPLEMENTATION OF TQM **10**

Steps in KAIZEN, 5S, JIT, POKAYOKE, Taguchi methods, case studies.

Total No of periods: 45

ID036	**Total Quality Management**	**3**	**0**	**0**	**100**

References:

1. Rose., J.E. " Total Quality Management ", Kogan Page Ltd., 1993.
2. John Bank, " The Essence of total quality management ", PHI 1993.
3. Greg Bounds, Lyle Yorks et al, " Beyond Total Quality Management ", McGraw Hill, 1994.
4. Takashi Osada,The 5S's The Asian Productivity Organisations, 1991.
5. Masaki Imami, KAIZEN, McGraw Hill, 1986.

ID037 Reliability Engineering **3 0 0 100**

1. RELIABILITY CONCEPT **7**

Reliability function - failure rate - Mean time between failures (MTBF) - Mean time to failure (MTTF) - a priori and a posteriori concept - mortality curve - useful life availability - maintainability - system effectiveness.

2. RELIABILITY DATA ANALYSIS **10**

Time to failure distributions - Exponential, normal, Gamma, Weibull, ranking of data - probability plotting techniques - Hazard plotting.

3. RELIABILITY PREDICTION MODELS **12**

Series and parallel systems - RBD approach - Standby systems - m/n configuration - Application of Baye's theorem - cut and tie set method - Markov analysis - FTA - Limitations.

4. RELIABILITY MANAGEMENT **10**

Reliability testing - Reliability growth monitoring - Non parametric methods - Reliability and life cycle costs - Reliability allocation - Replacement model.

5. RISK ASSESSMENT **6**

Definition and measurement of risk - risk analysis techniques - risk reduction resources - industrial safety and risk assesment.

Total No of periods: 45

ID037 Reliability Engineering **3 0 0 100**

References:

1. Modarres, " Reliability and Risk analysis ", Mara Dekker Inc., 1993.
2. John Davidson, " The Reliability of Mechanical system ", published by the Institution of Mechanical Engineers, London, 1988.
3. Smith C.O." Introduction to Reliability in Design ", McGraw Hill, London, 1976.

IS033	**Maintenance Management**	**3**	**0**	**0**	**100**

1. INTRODUCTION **6**

Maintenance functions - Tero technology -Maintenance costs - Organisation for maintenance - Japanese concept.

2. RELIABILITY ANALYSIS **9**

Reliability function - useful life - repair time distribution - Weibull application - Standby systems - Maintainability and availability - RCM.

3. MAINTENANCE POLICIES **10**

Maintenance types - Preventive maintenance - PM for functional characteristics and large scale systems - repair policy - PM and break down maintenance - Statistical applications - replacement models.

4. LOGISTICS **10**

Spare parts control - overall/optimum availability - Maintenance planning - priority rules - Maintenance staffing - UMS -Maintenance manual.

5. ADVANCED TECHNIQUES **10**

Condition monitoring - WDM, SPM, Vibration monitoring - Maintenance information system - TPM - Maximise equipment effectiveness.

Total No of periods: 45

IS033 Maintenance Management **3 0 0 100**

References:

1. Edward Hartman, "Maintenance Management", Productivity and Quality Publishing Pvt. Ltd., Madras, 1995.
2. Smith D.J. "Reliability and Maintainability in perspective", Mac Millan Ltd., London, 1985.
3. Seiichi Nakagrima, "Introduction to Total Productive Maintenance", Productivity press (India) Pvt. Ltd., 1993.

PE036	**Mechatronics in Manufacturing Systems**	**3**	**0**	**0**	**100**

1. INTRODUCTION **3**

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

2. SENSORS AND TRANSDUCERS **12**

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

3. MICROPROCESSORS IN MECHATRONICS **15**

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

4. PROGRAMMABLE LOGIC CONTROLLERS **8**

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

5. DESIGN AND MECHATRONICS **7**

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

Total No of periods: 45

PE036 Mechatronics in Manufacturing Systems 3 0 0 100

Text Books:

1. *Michael B.Histand and David G. Alciatore, " Introduction to Mechatronics and Measurement Systems", McGraw-Hill International Editions, 1999.*
2. *Bradley, D.A., Dawson, D, Buru, N.C. and Loader, AJ., " Mechatronics ", Chapman and Hall, 1993.*
3. *Ramesh.S, Gaonkar, " Microprocessor Architecture, Programming and Applications ", Wiley Eastern, 1998.*
4. *Lawrence J.Kamm, " Understanding Electro-Mechanical Engineering, An Introduction to Mechatronics ", Prentice-Hall, 2000.*
5. *Ghosh, P.K. and Sridhar, P.R., 0000 to 8085, " Introduction to Microprocessors for Engineers and Scientists ", Second Edition, Prentice Hall, 1995.*

Web Reference:

1. *www.cs. indiana.edu.*

PE038 Computer Aided Process Planning **3 0 0 100**

1. INTRODUCTION **5**

The Place of Process Planning in the Manufacturing cycle - Process Planning and Production Planning - Process Planning and Concurrent Engineering, CAPP, Group Technology.

2. PART DESIGN REPRESENTATION **10**

Design Drafting - Dimensioning - Conventional tolerancing - Geometric tolerancing - CAD - input / output devices - topology - Geometric transformation - Perspective transformation - Data structure - Geometric modelling for process planning - GT coding - The optiz system - The MICLASS system.

3. PROCESS ENGINEERING AND PROCESS PLANNING **10**

Experienced, based planning - Decision table and decision trees - Process capability analysis - Process Planning - Variant process planning - Generative approach - Forward and Backward planning, Input format, Al.

4. COMPUTER AIDED PROCESS PLANNING SYSTEMS **10**

Logical Design of a Process Planning - Implementation considerations -manufacturing system components, production Volume, No. of production families - CAM-I, CAPP, MIPLAN, APPAS, AUTOPLAN and PRO, CPPP.

5. AN INTERGARTED PROCESS PLANNING SYSTEMS **10**

Totally intergarted process planning systems - An Overview - Modulus structure - Data Structure, operation - Report Generation, Expert process planning.

Total No of periods: 45

PE038 Computer Aided Process Planning **3 0 0 100**

References:

1. *Gideon Halevi and Roland D. Weill, " Principles of Process Planning ", A logical approach, Chapman & Hall, 1995.*
2. *Tien-Chien Chang, Richard A.Wysk, "An Introduction to automated process planning systems ", Prentice Hall, 1985.*
3. *Chang, T.C., " An Expert Process Planning System ", Prentice Hall, 1985.*
4. *Nanua Singh, " Systems Approach to Computer Intergrated Design and Manufacturing ", John Wiley & Sons, 1996.*
5. *Rao, " Computer Aided Mnufacturing ", Tata McGraw Hill Publishing Co., 2000.*

Web References:

1. *http://claymore.engineer.gusu.edu/jackh/eod/automate/capp/capp.htm*
2. *http://Estraj.ute.sk/journal/engl/027/027.htm*

PE050 Data Communication in CAD/CAM **3 0 0 100**

1. DIGITAL COMPUTERS & MICRO PROCESSORS **8**

Block diagram - register transfer language - arithmetic, logic and shift micro operations - instruction code - training and control instruction cycle - I/O and interrrupt design of basic computer., Machine language - assembly language - assembler.
Registers ALU and Bus Systems - timing and control signals - machine cycle
and timing diagram - functional block diagrams of 80 x 86 and modes of operation. Features of Pentium Processors

2. OPERATING SYSTEM & ENVIRONMENTS **9**

Types - functions - UNIX & WINDOWS NT - Architecture - Graphical User Interfaces.
Compilers - Analysis of the Source program - the phases of a compiler - cousins of the compiler, the grouping of phases - compiler construction tools.

3. COMMUNICATION MODEL **10**

Data communication and networking - protocols and architecture - data transmission concepts and terminology - guided transmission media - wireless transmission - data encoding - asynchronous and synchronous communication - base band interface standards RS232C, RS449 interface.

4. COMPUTER NETWORKS **10**

Network structure - network architecture - the OSI reference model services - network standardization - example - Managing remote systems in network - network file systems - net working in manufacturing.

5. INTERNET **8**

Internet services - Protocols - intranet information services - mail based service - system and network requirements - internet tools - usenet - e.mail - IRC - www - FTP - Telnet.

Total No of periods: 45

PE050 Data Communication in CAD/CAM **3 0 0 100**

References:

1. Morris Mano. M., "Computer System Architecture", Prentice Hall of India, 1996.
2. Gaonkar R.S., "Microprocessor Architecture, Programming and Applications of 8085", Penram International, 1997
3. Peterson J.L., Galvin P. and Silberschaz, A., "Operating Systems Concepts", Addison Wesley, 1997.
4. Alfred V. Aho, Ravi Setjhi, Jeffrey D Ullman, "Compilers Principles Techniques and Tools", Addison Wesley, 1986.
5. William Stallings, "Data of Computer Communications" Prentice Hall of India, 1997.
6. Andrew S. Tanenbanum "Computer Networks", Prentice Hall of India 3rd Edition, 1996.
7. Christian Crumlish, "The ABC's of the Internet", BPB Publication, 1996.

PE051	**Industrial Safety Management**	**3**	**0**	**0**	**100**

1. SAFETY MANAGEMENT **8**

Evaluation of modern safety concepts - Safety management functions - safety organization, safety department - safety committee, safety audit - performance measurements and motivation - employee participation in safety - safety and productivity.

2. OPERATIONAL SAFETY **10**

Hot metal Operation - Boiler, pressure vessels - heat treatment shop - gas furnace operation-electroplating-hot bending pipes - Safety in welding and cutting. Cold-metal Operation - Safety in Machine shop - Cold bending and chamfering of pipes - metal cutting - shot blasting, grinding, painting - power press and other machines.

3. SAFETY MEASURES **8**

Layout design and material handling - Use of electricity - Manaagement of toxic gases and chemicals - Industrial fires and prevention - Road safety - highway and urban safety - Safety of sewage disposal and cleaning - Control of environmental pollution - Managing emergencies in Industries - planning, security and risk assessments , on-site and off site. Control of major industrial hazards.

4. ACCIDENT PREVENTION **9**

Human side of safety - personal protecive equipment - Causes and cost of accidents. Accident prevention programmes - Specific hazard control strategies - HAZOP - Training and development of employees - First Aid-Fire fighting devices - Accident reporting, investigation.

5. SAFETY, HEALTH, WELFARE & LAWS **10**

Safety and health standards - Industrial hygiene - occupational diseases prevention - Welfare facilities - History of legislations related to Safety-pressure vessel act-Indian boiler act - The environmental protection act - Electricity act - Explosive act.

Total No of periods: 45

PE051 Industrial Safety Management **3 0 0 100**

Text Books:

1. John V. Grimaldi and Rollin H. Simonds, "Safety Management", All India Travellers bookseller, New Delhi-1989.
2. Krishnan N.V., "Safety in Industry", Jaico Publishery House, 1996.

References:

1. Occupational Safety Manual BHEL.
2. Industrial safety and the law by P.M.C. Nair Publisher's, Trivandrum.
3. Managing emergencies in industries, Loss Prevention of India Ltd., Proceedings, 1999.
4. Safety security and risk management by U.K. Singh & J.M. Dewan, A.P.H. Publishing company, New Delhi, 1996.
5. Singh, U.K. and Dewan, J.M., "Safety, Security and risk management", APH Publishing Company, New Delhi, 1996.

PE052 Manufacturing System and Simulation **3 0 0 100**

1. COMPUTER MODELING AND SIMULATION SYSTEMS **8**

Monte Carlo simulation, Nature of computer modelling and simulation. Limitation of simulation, areas of application.
Components of a system - discrete and continuous systems. Models of a system - a variety of modelling approaches.

2. RANDOM NUMBER GENERATION **10**

Techniques for generating random numbers - midsquare method - the mid product method - constant multiplier technique - additive congruential method - linear congruential method - tests for random numbers - the Kolmogorov - Smirnov test - the Chi-Square test.

3. RANDOM VARIABLE GENERATION **8**

Inverse transform technique - exponential distribution - uniform distribution - Weibull distribution. Empirical continuous distribution - generating approximate normal variates - Erlang distribution.

4. DISTRIBUTION AND EVALUATION OF EXPERIMENTS **10**

Discrete uniform distribution - Poisson distribution - geometric distribution - acceptance rejection technique for Poisson distribution gamma distribution.
Simulation Experimenets - Variance reduction techniques - antithetic variables - verification and validation of simulation models.
Variance reduction techniques - antithetic variables - verification and validation of simulation models.

5. DISCRETE EVENT SIMULATION **9**

Concepts in discrete-event simulation, manual simulation using event scheduling, single channel queue, two server queue, simulation of inventory problem.
Programming for discrete event systems in GPSS - Case studies.

Total No of periods: 45

PE052 Manufacturing System and Simulation **3 0 0 100**

Text Books:

1. Jerry Banks and John S. Carson, II, "Discrete Event System Simulation", Prentice Hall Inc. 1984.
2. Gordon G, " Systems Simulation", Pentice Hall of India Ltd., 1991.

References:

1. Narsing Deo, "System Simulation with Digital Computer", Prentice Hall of India, 1979.
2. Francis Neelamkovil, "Computer Simulation and Modelling", John Wiley & Sons, 1987.
3. Ruth M. Davis and Robert M.O' Keefe, " Simulation Modelling with Pascal", Prentice Hall, Inc. 1989.

PE053	**Performance Modelling and Analysis of Manufacturing System**	**3**	**0**	**0**	**100**

1. MANUFACTURING SYSTEMS & CONTROL **10**

Automated Manufacturing Systems - Modelling - Role of performance modelling - simulation models- Analytical models.
Product cycle - Manufacturing automatiion - Economics of scale and scope - input/output model - plant configurations.
Performance measures - Manufacturing lead time - Work in process -Machine utilization - Throughput - Capacity - Flexibility - performability - Quality.
Control Systems - Control system architecture - Factory communications - Local area networks - Factory net works - Open systems interconnection model - Net work to network interconnections - Manufacturing automation protocol - Databse management system.

2. MANUFACTURING PROCESSES **10**

Examples of stochastic processes - Poisson process
Discrete time Markov chain models - Definition and notation - Sojourn times in states - Examples of DTMCs in manufacturing - Chapman - Kolmogorov equation - Steady-state analysis.
Continuous Time Markov Chain Models - Definitions and notation - Sojourn times in states - examples of CTMCs in manufacturing - Equations for CTMC evolution - Markov model of a transfer line.
Birth and Death Processes in Manufacturing - Steady state analysis of BD Processes - Typical BD processes in manufacturing.

3. QUEUING MODELS **8**

Notation for queues - Examples of queues in manufacturing systems - Performance measures - Little's result - Steady state analysis of M/M/m queue, queues with general distributions and queues with breakdowns - Analysis of a flexible machine center.

4. QUEUING NETWORKS **8**

Examples of QN models in manufacturing - Little's law in queuing networks - Tandem queue - An open queuing network with feed back - An open central server model for FMS - Closed transfer line - Closed server model - Garden Newell networks.

5. PETRI NETS **9**

Classical Petri Nets - Definitions - Tansition firing and reachability - Representational power - properties - Manufacturing models.
Stochastic Petri Nets - Exponential timed Petri Nets - Generalized Stochastic Petri Nets - modelling of KANBAN systems - Manufacturing models.

Total No of periods: 45

PE053	**Performance Modelling and Analysis of Manufacturing System**	**3**	**0**	**0**	**100**

References:

1. Viswanadham, N and Narahari, Y. "Performance Modelling of Automated Manufacturing Systems", Prentice Hall of India, New Delhi, 1994.
2. Trivedi, K.S., "Probability and Statistics with Reliability, Queuing and Computer Science Applications", Prentice Hall, New Jersey, 1982.
3. Gupta S.C., & Kapoor V.K., "Fundamentals of Mathematical Statistics", 3rd Edition, Sultan Chand and Sons, New Delhi, 1988.

PE132 Applied Materials Engineering **3 0 0 100**

1. ELASTIC AND PLASTIC BEHAVIOUR **10**

Elasticity in metals and polymers - Mechanism of plastic deformation, role of dislocations, yield stress, shear strength of perfect and real crystals - 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 behavious - Super plasticity - Deformation of non crystalline material.

2. FRACTURE BEHAVIOUR **10**

Griffith's theory, stress intensity factor and fracture toughness - Toughening mechanisms - Ductile, brittle transition in steel - High temperature fracture, creep - Larson-Miller parameter - Deformation and fracture mechanism maps - Fatigue, low and high cycle fatigue test, crack initiation and propagation mechanisms and Paris law - Effect of surface and metallurgical parameters on fatigue - Fracture of non metallic materials - Failure analysis, sources of failure, procedure of failure analysis.

3. 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.

4. MODERN METALLIC MATERIALS **8**

Dual phase steels, Micro alloyed, High strength low alloy (HSLA) steel, Transformation induced plasticity (TRIP) steel, Maraging steel - Intermetallics, Ni and Ti aluminides - Smart materials, shape memory alloys - Metallic glass - Quasi crystal and nano crystalline materials.

5. NON METALLIC MATERIALS **7**

Polymeric materials - Formation of polymer structure - Production techniques of fibres, foams, adhesives and coatings - Structure, properties and applications of engineering polymers - Advanced structural ceramics, WC, TiC, TaC, AI2O3, SiC, Si3N4, CBN and diamond - properties, processing and applications.

Total No of periods: 45

PE132 Applied Materials Engineering **3 0 0 100**

References:

1. *Thomas H.Courtney, " Mechanical Behaviour of Materials ", (2nd Edition), McGraw-Hill, 2000.*
2. *Charles J.A., Crane, F.A.A and Furness, J.A.G., " Selection and use of Engineering Materials ", (3rd Edition), Butterworth-Heiremann, 1977.*
3. *Flinn, R.A. and Trojan, P.K., " Engineering Materials and their Applications ", (4th Edition), Jaico, 1999.*
4. *George E.Dieter, " Mechanical Metallurgy ", McGraw Hill, 1988.*
5. *Metals Hand Book, Vol.10, " Failure Analysis and Prevention ", (10th Edition), 1994.*

Web References:

1. *www.astm.org/labs/pages/131350.htm*
2. *www.applied materials.com/carrers/agu-ei.html.*

PE141 Flexible Competitive Manufacturing System **3 0 0 100**

1. MANUFACTURING IN A COMPETITIVE ENVIRONMENT **9**

Automation of manufacturing process - Numerical control - Adaptive control - material handling and movement - Industrial robots - Sensor technology - flexible, fixturing - Design for assembly, disassembly and service.

2. GROUP TECHNOLOGY **9**

Part families - classification and coding - Production flow analysis - Machine cell design - Benefits.

3. FLEXIBLE MANUFACTURING SYSTEMS **9**

Introduction - Components of FMS - Application work stations - Computer control and functions - Planning, scheduling and control of FMS - Scheduling - Knowledge based scheduling - Hierarchy of computer control - Supervisory computer.

4. COMPUTER SOFTWARE, SIMULATION AND DATABASE OF FMS **9**

System issues - Types of software - specification and selection - Trends - Application of simulation - software - Manufacturing data systems - data flow - CAD/CAM considerations - Planning FMS database.

5. JUST IN TIME **9**

Characteristics of JIT - Pull method - quality -small lot sizes - work station loads - close supplier ties - flexible work force - line flow strategy - preventive maintenance - Karban system - strategic implications - implementation issues - MRD JIT - Lean manufacture.

Total No of periods: 45

PE141 Flexible Competitive Manufacturing System **3 0 0 100**

References:

1. *Groover M.P., " Automation, Production Systems and Computer Integrated Manufacturing ", Prentice-Hall of India Pvt. Ltd., New Delhi, 1996.*
2. *Jha, N.K. " Handbook of Flexible Manufacturing Systems ", Academic Press Inc., 1991.*
3. *Kalpakjian, " Manufacturing Engineering and Technology ", Addison-Wesley Publishing Co., 1995.*
4. *Taiichi Ohno, Toyota, " Production System Beyond Large-Scale production ", Productivity Press (India) Pvt.Ltd., 1992.*

Web Reference:

1. *http://www.engineeringtalk.com/news/lvd103.htm*

PE143 Metrology and Non Destructive Testing **3 0 0 100**

1. MEASURING MACHINES **9**

Tool Maker's microscope - Co-ordinate measuring machines - Universal measuring machine - Laser viewers for production profile checks - Image shearing microscope - Use of computers - Machine vision technology - Microprocessors in metrology.

2. STATISTICAL QUALITY CONTROL **9**

Data presentation - Statistical measures and tools - Process capability - Confidence and tolerence limits - Control charts for variables and for fraction defectives - Theory of probability - Sampling - ABC standard - Realibility and life testing.

3. LIQUID PENETRANT AND MAGNETIC PARTICLE TESTS **9**

Characteristics of liquid penetrants - different washable systems - Developers - applications - Methods of production of magnetic fields - Principles of operation of magnetic particle test - Applications - Advantages and limitations.

4. RADIOGRAPHY **9**

Sources of ray-x-ray production - properties of d and x rays - film characteristics - exposure charts - contrasts - operational characteristics of x ray equipment - applications.

5. ULTRASONIC AND ACOUSTIC EMISSION TECHNIQUES **9**

Production of ultrasonic waves - different types of waves - general characteristics of waves - pulse echo method - A, B, C scans - Principles of acoustic emission techniques - Advantages and limitations - Instrumentation - applications.

Total No of periods: 45

PE143 Metrology and Non Destructive Testing 3 0 0 100

References:

1. JAIN, R.K. " Engineering Metrology ", Khanna Publishers, 1997.
2. Barry Hull and Vernon John, " Non Destructive Testing ", MacMillan, 1988.
3. American Society for Metals, " Metals Hand Book ", Vol.II, 1976.
4. Progress in Acoustic Emission, " Proceedings of 10th International Acoustic Emission Symposium ", Japanese Society for NDI, 1990.

Web References:

1. www.metrologytooling.com
2. www.sisndt.com
3. www.iuk'tu-harburg.de