ANNA UNIVERSITY
Chennai-25.
Syllabus for
M.E.(Full Time) Computer Aided Design

CD131 Computer Graphics **3 0 2 4**

1. INTRODUCTION **8**

Output primitives - line drawing algorithm - Circles and other curves - Attributes of output primitives - 2D , 3D transformations - Translation , Rotation , Scaling - Concatenation.

2. TECHNIQUES FOR GEOMETRIC MODELING **12**

Representation of curves - Bezier curves - Cubic spline curve - B-Spline curves - Rational curves - Surface Modeling techniques - surface patch - Coons patch - bi-cubic patch - Bezier and B-spline surfaces - Volume modeling - Boundry models - CSG other modeling techniques.

3. THREE DIMENSIONAL COMPUTER GRAPHICS **10**

Viewing transformations - perspective projection - techniques for visual realism - hidden line - Surface removal - Algorithms for shading and Rendering.

4. GRAPHICS STANDARDS FOR CAD **8**

Graphics and Computing standards - GKS - Bitmaps - Open GL - Data Exchange standards - IGES - STEP - CALS - DXF - Communication standards - WAN - LAN.

5. 3D MODELING APPLICATIONS AND SPECIAL TOPICS **7**

2D Representation - Development of surfaces - Integration of design analysis and CAD - Graphical aid for preprocessing in FEA - mesh generation techniques - Post processing - Machining from 3D Model - Generative machining - cutter location - gouge deletion - tool path generation from solid models - STL formats for rapid prototyping - Slicing techniques - Introduction to fractional geometry.

6. PRACTICALS **30**

Total No of periods: 75

Text Books:
1. Chris McMohan and Jimmi Browne , "CAD/CAM principles , practice and manufacturing management" , Pearson Education Asia,Ltd.,2000.

References:
1. Donald Hearn and M.Pauline Baker "Computer Graphics" , Prentice Hall, Inc., 1992.
2. Ibrahim Zeid "CAD/CAM - Theory and Practice" - McGraw Hill , International Edition, 1998.

CD132 Computer Applications in Design **3 0 2 4**

1. INTRODUCTION **10**

The Design process and role of CAD - Types and applications of design models - Computer representation of drawings - Three dimensional modeling schemes - Wire frames and surface representation schemes - solid modeling.

2. INTRODUCTION TO CAD SOFTWARE **10**

Writing interactive programs to solve design problems and production of drawings/Solid Models using language like Auto LISP/C++ - system customization and design automation - Features of various Solid Modeling Packages.

3. COMPUTER AIDED DESIGN OF MACHINE ELEMENTS **9**

Development of programs for design , drawing & plotting of Machine Elements shafts, gears, pulleys, flywheel, connecting rods etc., Interfacing with packages.

4. ENTITY MANIPULATION AND DATA STORAGE **8**

Manipulation of the model - Model storage - Data structures - Data base considerations - Object oriented representations - Organising data for CIM applications - Design information system.

5. EXPANDING THE CAPABILITY OF CAD **8**

Parametric and variational modeling - Feature recognition - Design by features - Assembly and Tolerance modeling - Tolerance representation - specification , analysis and synthesis - Analysis - Rapid prototyping - Al in Design

6. PRACTICALS **30**

Total No of periods: 75

References:

1. *Charles. S.Knox , "Organising data for CIM Applications" , Marcel Dekker Inc, New York , 1987.*
2. *Ibrahim Zeid "CAD/CAM - Theory and Practice", Mc Graw Hill International Edn., 1998.*
3. *Chris McMohan and Jimmi Browne, "CAD CAM Principals , practice and Manufacturing management" , Pearson Education Asia 2000.*

Web References:

1. *http://www.machinedesign.com/*
2. *http://www.cadcamnet.com*

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

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

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

CD134 Integrated Product Design and Development **3 0 0 3**

1. INTRODUCTION **5**

Need for IPPD-Strategic importance of Product development - integration of customer, designer, material supplier and process planner, Competitor and customer - behaviour analysis. Understanding customer-promoting customer understanding-involve customer in development and managing requirements - Organization - process management and improvement - Plan and establish product specifications.

2. CONCEPT GENERATION AND SELECTION **5**

Task - Structured approaches - clarification - search-externally and internally-explore systematically - reflect on the solutions and processes - concept selection - methodology - benefits.

3. PRODUCT ARCHITECTURE **10**

Implications - Product change - variety - component standardization - product performance - manufacturability - product development management - establishing the architecture - creation - clustering - geometric layout development - fundamental and incidental interactions - related system level design issues - secondary systems - architecture of the chunks - creating detailed interface specifications.

4. INDUSTRIAL DESIGN **10**

Integrate process design - Managing costs - Robust design - Integrating CAE, CAD, CAM tools - Simulating product performance and manufacturing processes electronically - Need for industrial design-impact - design process - investigation of customer needs - conceptualization - refinement - management of the industrial design process - technology driven products - user - driven products - assessing the quality of industrial design.

5. DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT **15**

Definition - Estimation of Manufacturing cost-reducing the component costs and assembly costs - Minimize system complexity - Prototype basics - principles of prototyping - planning for prototypes - Economic Analysis - Understanding and representing tasks-baseline project planning - accelerating the project-project execution.

Total No of periods: 45

References:

1. Kari T. Ulrich and Steven D. Eppinger, "Product Design and Development", McGraw-Hill International Edns, 1999
2. Kemnneth Crow, "Concurrent Engg. / Integrated Product Development", DRM Associates, 26/3, Via Olivera, Palos Verdes, CA 90274 (310) 377-569, workshopBook.
3. Stephen Rosenthal, " Effective Product Design and Development", Business One Orwin, Homewood, 1992, ISBN, 1-55632-603-4.
4. Staurt Pugh, "Tool Design - Integrated Methods for Successful Product Engineering, Addison Wesley Publishing, New York, NY,1991. ISBN 0-202-41639-5.

Web Reference:
1. www.me.mit/2.7444.

CD134 Integrated Product Design and Development **3 0 0 3**

1. INTRODUCTION **5**

Need for IPPD-Strategic importance of Product development - integration of customer, designer, material supplier and process planner, Competitor and customer - behaviour analysis. Understanding customer-promoting customer understanding-involve customer in development and managing requirements - Organization - process management and improvement - Plan and establish product specifications.

2. CONCEPT GENERATION AND SELECTION **5**

Task - Structured approaches - clarification - search-externally and internally-explore systematically - reflect on the solutions and processes - concept selection - methodology - benefits.

3. PRODUCT ARCHITECTURE **10**

Implications - Product change - variety - component standardization - product performance - manufacturability - product development management - establishing the architecture - creation - clustering - geometric layout development - fundamental and incidental interactions - related system level design issues - secondary systems - architecture of the chunks - creating detailed interface specifications.

4. INDUSTRIAL DESIGN **10**

Integrate process design - Managing costs - Robust design - Integrating CAE, CAD, CAM tools - Simulating product performance and manufacturing processes electronically - Need for industrial design-impact - design process - investigation of customer needs - conceptualization - refinement - management of the industrial design process - technology driven products - user - driven products - assessing the quality of industrial design.

5. DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT **15**

Definition - Estimation of Manufacturing cost-reducing the component costs and assembly costs - Minimize system complexity - Prototype basics - principles of prototyping - planning for prototypes - Economic Analysis - Understanding and representing tasks-baseline project planning - accelerating the project-project execution.

Total No of periods: 45

References:

1. *Kari T. Ulrich and Steven D. Eppinger, " Product Design and Development ", McGraw-Hill Internationakl Edns. 1999.*
2. *Kemnneth Crow, " Concurrent Engg./Integrated Product Development ", DRM Associaates, 26/3, Via Olivera, Palos Verdes, CA 90274 (310) 377-569, Workshop Book.*
3. *Stephen Rosenthal, " Effective Product Design and Development ", Business One Orwin, Homewood, 1992, ISBN, 1-55623-603-4.*
4. *Staurt Pugh, " Tool Design - Integrated Methods for Successful Product Engineering ", Addison Wesley Publishing, Neyourk, NY, 1991, ISBN 0-202-41639-5.*

Web Reference:

1. *http:// www.me.mit/2.7444.*

MA148 Applied Mathematics for Mechanical Engineers **3 1 0 4**

1. TRANSFORM METHODS **9**

Laplace transform methods for one dimensional wave equation - Displacements in a line string - Longitudinal vibration of elastic bar - Fourier transform methods for one- dimentional heat conduction problems in infinite and semi-infinite rod.

2. ELLIPTIC EQUATION **8**

Laplace equation - Properties of harmonic functions - Fourier transform methods for Laplace equation. Solution for Possion equation by Fourier transform method.

3. CALCULUS OF VARIATIONS **9**

Variation and its properties - Euler's equation - Functional dependent on first and higher order derivatives - Functionals dependent on functions of several independent variables - Some applications - Direct methods - Ritz and Kantorovich methods.

4. NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS **10**

Solution of Laplace's and Possion's equations on a rectangular region by Liebmann's method - Diffusion equation by explicit and Crank Nicklson - Implicit methods - Stability and Convergence criterion - Solution of wave equation by explicit scheme.

5. CONFORMAL MAPPING AND APPLICATIONS **9**

The Schwarz - Christoffel transformation - Transformation of bounderies in parametric form - Physical applications - Application to fluid flow - Application to heat flow.

6. TUTORIAL **15**

Total No of periods: 60

References:

1. *Sneeddon , I.N., Elements of partial differential equations,McGraw-Hill ,1986.*
2. *Spiegel ,M.R., Theory and problems of complex variables with an introduction to confomal mapping and its application, Schaum's outline series , McGraw-Hill ,1987.*
3. *Sankara Rao, k., Introduction to partial differential equations , prentice --Hall of India,New Delhi,1995.*
4. *Elsgoth, L, Differential equation and calculus of variations, Mir Publishers, Moscow, 1966*

CD143 CAD Lab **0 0 2 1**

.

Exercises will be given on Modelling of mechanical Components using packages like AtuoCAD,IDEAS,PRO-E,Unigraphics etc.

1.

Creation of working drawings of components and preparation of assembly models of screw jack, leaf jig, plummer block, lathe chuck, machine-vice, box type drilling jig assembly etc. by using the following techniques.
Generation of surfaces of revolution.
Generation of surfaces of extrusion
Generation of surfaces by skinning operation.
Generation of solid models using constructive solid geometry, method shading and rendering.

2.

Generation of Ferguson's cubic surface patches, Generation of Bezier UNISURF surface patches, Generation of Coon's patches.

3.

Finite element modeling of two dimensional problems in heat transfer, plane elasticity, viscous fluid flow, etc.,

4.

Finite element analysis of time dependent problems in incompressible viscous fluid flow, heat transfer, plane elasticity, etc.,

5.

Familiarization of available artificial intelligence interpreters and compilers.

6.

Familiarization with file inquiry, access to data sorting & indexing.

7. **30**

Exercises in database managemenet, Familiarization with multiple file operations and preparation of various reports with respect to CIM.

Total No of periods: 30

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

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.

CD142 Mechanical Vibrations **3 0 2 4**

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

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

CD144 Computer Aided Manufacturing **3 0 0 3**

1. AUTOMATION AND NUMERICAL CONTROL **10**

Production types - Automation strategies - N.C. systems -NC Part programming - Manual part programming - Computer assisted part programming - APT language - DNC - CNC and Adaptive Control.

2. INDUSTRIAL ROBOTICS **9**

Terminology - Accuracy Repeatability - End Effectors - Sensors - Control Systems - Types of Programming - Robot Languages.

3. CONTROL SYSTEM **9**

Linear Feed back control system - process model formulation, Transfer function and Block diagram, Laplace Transforms, Control Actions - Linear System Analysis - Root locus Method system Design, Optimal Control - Structural Model of a Manufacturing Process, Steady state optimal control, Adaptive Control, on-line search strategies.

4. GROUP TECHNOLOGY & FLEXIBLE MANUFACTURING SYSTEMS **9**

Part families - Classification and Coding - Production flow Analysis - Machine Cell Design FMS workstations - Analysis methods - Automated Materials Handling - Types _ ASRS

5. MANUFACTURING PLANNING SYSTEMS AND PROCESS CONTROL **8**

Computer Aided Process Planning - Computer Integrated Production Planning System - Materials Requirement Planning - Computer Processes Interface - Process Monitoring - Supervisory Computer Control - Computer Monitory - Types & Strategies.

Total No of periods: 45

Text Book:

1. Mikell P. Groover, "Automation, Production and Systems and Computer - Integrated Manufacturing", Prentice Hall of India Pvt. Ltd., 1998.

References:

1. Paul G. Ranky, "Computer Integrated Manufacturing", Prentice Hall, 1990.
2. Chang. T.C. & Wysk, "An Introduction to Automated Process Planning", Prentice Hall Inc., Englewood Cliffs - New Jersey.
3. Radhakrishnan, P. and Subramanyan. S. "CAD/CAM/CIM", Wiley Eastern Ltd., 1994..
4. Yoram Koren, "Computer Integrated Manufacturing Systems" McGraw Hill, 1983.

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

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

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/

PD132 Concurrent Engineering **3 0 0 3**

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

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

CD145	**Seminar**	**0**	**0**	**3**	**1**

. **45**

Students have to present a minimum of three seminar papers on the topics of current interest. The evaluation will be based on the knowledge of the students on the subject of presentation, their communication abilities, the method of presentation and the way questions are answered.

Total No of periods: 45

CD031 Modal Analysis of Mechanical Systems **3 0 0 3**

1. OVERVIEW **6**

Introduction to Modal Testing - Application of Modal Testing - Philosophy of Modal Testing - Summary of Theory - Summary of Measurement Methods - Summary of Analysis - Review of Test Procedure.

2. THEORETICAL BASIS **12**

Introduction - Single Degree of Freedom(SDOF) System Theory - Presentation and Properties of Frequency Response Function Data for SDOF System - Undamped Multi-degreee of freedom(MDOF) system - Proportional Damping - Hysteretic Damping - General Case - Viscous Damping - General Case - Characteristics and presentation of MDOF - FRF Data - Complete and Incomplete models - Non-sinusoidal vibration and FRF properties - Analysis of Weakly Non linear Structures.

3. MOBILITY MEASUREMENT TECHNIQUES **10**

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

4. MODAL PARAMETER EXTRACTION METHODS **11**

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

5. DERIVATION OF MATHEMATICAL MODELS **6**

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

Total No of periods: 45

References:

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

Web References:

1. http://www.vibetech.com/tech.paper.html
2. http://scholar.lib.vt.edu/ejournals/MODAL/abstracts/ijaema-1987.html

CD032 Advanced Mechanism Design **3 0 0 3**

.

1. INTRODUCTION **5**

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

2. KINEMATIC ANALYSIS **5**

Position Analysis - Vector loop equations for four bar, slider crank, inverted slider crank, geared five bar and six bar linkages. Analytical Methods for velocity and accelaration Analysis - Four bar linkage jerk analysis. Plane complex mechanisms.

3. PATH CURVATURE THEORY **6**

Fixed and moving centrodes, inflection points and inflection circles - Euler Savary equation, graphical constructions - Cubic stationary curvature.

4. SYNTHESIS OF MECHANISMS **15**

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

5. DYNAMICS OF MECHANISMS **9**

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

6. SPATIAL MECHNISMS AND ROBOTICS **5**

Kinematic Analysis of Spatial RSSR mechanism - Denavit - Hartenberg Parameters - Forward and inverse Kinematics of Robotic Manipulators - Study and use of mechanism software packages.

Total No of periods: 45

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 Mechines", EWLP, Delhi, 1999.
4. Norton 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.

CD033 Rapid Prototyping **3 0 0 3**

1. INTRODUCTION **7**

Basic Concept - Overview of existing technologies of proto typing and tooling - Need for speed design to market operations

2. PRODUCT DEVELOPMENT **10**

State of the technology - Conceptual design - Development - Detail design - Prototype - Tooling - Engineering Pilot - Limitations

3. CAD PROCESSES **8**

Data requirements - Solid modeling - Data representation - Part orientation and support - STL format - Slicing - Post processing.

4. RAPID PROTOTYPING SYSTEMS **10**

Selective laser sintering - Working principles - Advantages and limitations - Sterolithography - Working principle - Applications, advantages and limitations - Case studies.

5. OTHER SYSTEMS **10**

Laminated object modeling - Waving principles, applications - Advantages and limitations - Fused deposition modeling - Direct shell production casting - Applications.

Total No of periods: 45

References:

1. Paul F. Jacobs, " Rapid Prototyping and Manufacture Fundamentals of Stereolithography ",1995.
2. Soenen. R and Olling, "Advanced CAD / CAM Systems ", Narosa Publishing house, 1995.
3. Duvvent.W.R " The Lithographic Handbook", Narosa Publishing house, 1995.
4. Rapid News, University of Warwick, UK, 1995.

Web References:

1. http://www.cc.utah.edu / ~asn8200/rapid.html

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

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

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.

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

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

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 3**

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 condition modules and these intergration-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

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, "Hydraulics and Pneumatics",(HB),Jaico Publishing House, 1999.
4. Bolton. W. "Pneumatic and Hydraulic systems",Butterworth-Heinneman, 1997.

Web References:

1. http:// www.pneumatics.com
2. http:// www.fluidpower.com.tw

ED033 Composite Materials and Mechanics **3 0 0 3**

1. INTRODUCTION **10**

Definition-Need-General charecteristics,Applications,Fibers-Glass,Carbon,Ceramic and Aramid fibers.Matrices-Polymer,Graphite,Ceramic and Metal Matrices-Charecteristics of fibers and matrices.smart materials - types and characteristics.

2. MECHANICS AND PERFORMANCE **10**

Characteristics of fibre-reinforced Lamina-Laminates-Interlaminar stresses-Static Mechanical Properties - fatigue and Impact properties-Environmental effects-Fracture Behaviour and Damage Tolerance

3. MANUFACTURING **5**

Bag Moulding-Compression moulding-Pultrusion-Filament Winding-Other Manufacturing Processes-Quality Inspection methods

4. ANALYSIS **10**

Stress analysis of Laminated composite Beams,Plates,Shells-Vibration and Stability Analysis-Reliability of Composites-Finite Element Method of Analysis-Analysis of Sandwich structures

5. DESIGN **10**

Failure predictions-Laminate Design Consideration-Bolted and Bonded Joints.
Design Examples

Total No of periods: 45

Text Books:

1. *Mallick,P.K., " Fiber Reinforced composites:Materials,Manufacturing and Design ", Marcel Dekker Inc.,1993*

References:

1. *Halpin,J.C., " Primer on Composite Materials,Analysis ",Techomic Publishing Co., 1984*
2. *Agarwal, B.D., and Broutman L.J., "Analysis and Performance of Fiber Composites", John Wiley and Sons,New York,1990*
3. *Mallick ,P.K. and Newman,S.,(eds),"Composite Materials Technology: Processes and Properties", Hansen Publisher, Munich,1990.*

ED034 Advanced Finite Element Analysis **3 0 0 3**

1. BENDING OF PLATES AND SHELLS **9**

Review of Elasticity Equations-Bending of Plates and Shells-Finite Element Formulation of Plate and Shell Elements-Conforming and Non Conforming Elements - Co and C1 Continuity Elements-Application and Examples

2. NON-LINEAR PROBLEMS **10**

Introduction-Iterative Techniques-Material non-Linearity-Elasto Plasticity-Plasticity-Visco plasticity-Geometric Non linearity-large displacement Formulation-Application in Metal Forming Process and contact problems

3. DYNAMIC PROBLEM **8**

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

4. FLUID MECHANICS AND HEAT TRANSFER **9**

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

5. ERROR ESTIMATES AND ADAPTIVE REFINEMENT **9**

Error norms and Covergence rates- high refinement with adaptivity-Adaptive refinement

Total No of periods: 45

Text Books:

1. Zeinkiewicz,O.C and Taylor,R.L., "The Finite element Method",Fourth Edition,Volumes 1 & 2, McGraw Hill International Edition,Physics services,1991

References:

1. Cook R.D. "Concepts and Applications of Finite Element Analysis", John Wiley and Sons Inc., NewYork,1989
2. Bathe K.J..,"Finite Element Procedures in Engineering Analysis", Prentice Hall ,1990

ED040 Industrial Robotics and Expert Systems **3 0 0 3**

1. INTRODUCTION AND ROBOTIC KINEMATICS **10**

Definition need and scope of industrial robots-Robot anatomy-work volume-Precision movement-End effectors-sensors.Robot kinematics-Direct and inverse kinematics-Robot trajectories-Control of robot manipulators-Robot dynamics-Methods for orientation and location of objects.

2. ROBOT DRIVES AND CONTROL **9**

Controlling the robot motion-Position and velocity sensing devices-Design of drive systems-Hydraulic and Pneumatic drives-Linear and rotary actuators and contol valves-Electro hydraulic servo valves,electric drives-Motors-designing of end effectors-Vacuum,magnetic and air operated grippers

3. ROBOT SENSORS **9**

Transducers and sensors-Sensors in robot-Tactile sensor-Proximity and range sensors-Sensing joint forces-Robotic vision system-Image Gripping-Image processing and analysis-Image segmentation-Pattern recognition-Training of vision system

4. ROBOT CELL DESIGN AND APPLICATION **9**

Robot work cell design and control-Safety in Robotics-Robot cell layouts-Multiple robots and machine interference-Robot cycle time analysis-Industrial applications of robots

5. ROBOT PROGRAMMING ,ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS **8**

Methods of robot programming-characteristics of task level languages lead through programming methods-Motion interpolation.Artificial intelligence-Basics-Goals of artificial intelligence-AI techniques-problems representation in AI-Problem reduction and solution techniques-Application of AI and KBES in robots

Total No of periods: 45

Text Books:

1. K.S.Fu, R.CGonzalez and C.S.G. Lee, Robotics control,Sensing,Vision and intelligence",McGraw Hill,1987

References:

1. Kozyrey,Yu."Industrial Robotics",MIR Publishers Moscow,1985.
2. Richard.D.,Klafter,Thomas,A,Chmielewski,Machine Negin "Robotics Engineering-An Intergrated Approach",Prentice Hall of India Pvt., Ltd., 1984
3. Deb,S.R."Robotics Technology and Flexible Automation",Tata McGraw Hill,1994
4. Mikell,P.Groover,Mitchell Weis,Roger,N.Nagel,Nicholas G.Odrey" Industrial Robotics Technology,Programming and Applications",McGraw Hill,Int.,1986
5. Timothy Jordonides etal,"Expert Systems and Robotics",Springer-Verlag,NewYork,,May 1991.

Web References:

1. http://www.ifr.org/gallery/type.htm

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

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

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

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

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

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.

ID035 Productivity Management and Re-Engineering **3 0 0 3**

1. INTRODUCTION **5**

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

2. PRODUCTIVITY MODELS **12**

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

3. ORGANISATIONAL TRANSFORMATION **8**

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

4. RE-ENGINEERING PROCESS IMPROVEMENT MODELS **10**

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

5. RE-ENGINEERING TOOLS AND IMPLEMENTATION **10**

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

Total No of periods: 45

References:

1. *Sumanth, D.J., Productivity engineering and management, TMH,New Delhi, 1990.*
2. *Edosomwan ,J.A., Organisational transformation and process re-engineering, British Library cataloging in pub. data, 1996.*
3. *Rastogi,P.N. Re-Engineering and Re-inventing the enterprise, Wheeler pub. New Delhi, 1995.*
4. *Premvrat, Sardana, G.D. and Sahay, B.S, Productivity Management - A systems approach, Narosa Pub. New Delhi, 1998.*

ID042 Applied Object Oriented Programming **3 0 0 3**

1. FUNDAMENTALS OF OBJECT ORIENTED PROGRAMMING **5**

Elements of OOP, classes, subjects, messaging, inheritance, polymorphism, OOP paradigm versus Procedural paradigm, object-oriented design.

2. C++ DATA TYPES **15**

Expression and statements, operators, precedence, type conversion, flow control, Arrays structures, argument passing, reference argument, overloaded function.

3. C++ CLASS **5**

Definition, class objects, member functions, pointer friends, class member pointer, scope, unions, bit-fields, class argument and ellises- class member functions, intialization, operator overloading, user defined conversions.

4. CLASS DERIVATION **10**

Derivation specification, Information hiding under derivation public and private base classes, standard convensions under derivation, class scope,Intialization and assignment under derivation.

5. APPLICATION **10**

OOP's applications in linear programming, integer programming , simulation, etc.

Total No of periods: 45

References:

1. *Wiener , Richard, S. and Pinson,Lewis, J. " An introduction to objective oriented programming and C++ ", 1999.*
2. *Stanley B.Lippman, " C++ primer ", Addison- Wesley Pub.Co., 1989.*
3. *Robert Lafore, " Object Oriented programming in Turbo C++ " , Galgotia publication, 1992.*
4. *Strousstrup, Bjarne, The " C++ programming languages ", Addison Wesley, 1986.*

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

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 - Ligth 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-MnemonicsTimers,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

References:

1. *Michael B.Histand and David G. Alciatore, "Introduction to Mechatronics and Measurement Systems", McGraw Hill International Editions,1999*
2. *Bradley, D.A.,. Dawspn, D, Buru, N.C. and Loader, AJ., Mechatronics, Chapman and Hall,1993*
3. *Ramesh,S,Gaonkar, "Micrprocessors Architecture, Programming and Applications", Wiley Eastern,1998*
4. *Lawrence J.Kamm, "Understanding Electro-Mechanical Engineering, AnIntroduction to Mechatronics", Prentice Hall 2000.*
5. *Ghosh,P.K. and Sridhar, P.R., 8000 to 8085 " Introduction to Micrprocessors for Engineers and Scientists", Second Edition, Prentice Hall, 1995.*

Wef Reference:

1. *http://www. cs. indiana.edu.*

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

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 solution, 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, Marging 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

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/agi-ei.html.