FACULTY OF ENGINEERING

SYLLABUS FOR

M.E.MECHANICAL-COMPUTER AIDED DESIGN, MANUFACTURE & ENGINERRING

W.E.F. 2012-2013

UNIVERSITY OF PUNE

M.E. [MECHANICAL] –[COMPUTER AIDED DESIGN, MANUFACTURE & ENGINEERING] [CADME]

CODE	SUBJECT	TEACHING SCHEME		EXAMINATION SCHEME					
		Theory	Practical	Paper	TW	Oral	Pr	Total	Credits
502401	Advanced Machine Design	03	-	100	-	-	-	100	03
502402	Mathematical Modeling	03	-	100	-	-	-	100	03
502403	Computer Aided Design	03	-	100	-	-	-	100	03
502404	Elective I	03	-	100	-	-	-	100	03
502405	Elective II	03	-	100	-	-	-	100	03
502406	Lab Practice I	-	06	-	50	-	-	50	03
502407	Seminar I	-	04	-	50	-	-	50	02
	Total	**15**	**10**	**500**	**100**	**-**	**-**	**600**	**20**

Semester- II

CODE	SUBJECT	TEACHING SCHEME		EXAMINATION SCHEME					
		Theory	Practical	Paper	TW	Oral	Pr	Total	Duration
502408	Management of Technology	03	-	100	-	-	-	100	03
502409	Computer Aided Manufacturing	03	-	100	-	-	-	100	03
502410	Computer Integrated Manufacturing	03	-	100	-	-	-	100	03
502411	Elective III	03	-	100	-	-	-	100	03
502412	Elective IV	03	-	100	-	-	-	100	03
502413	Lab Practice II	-	06	-	50	-	-	50	03
502414	Seminar II	-	04	-	50	-	-	50	02
	Total	**15**	**10**	**500**	**100**	**-**	**-**	**600**	**20**

Semester- III

CODE	SUBJECT	TEACHING SCHEME		EXAMINATION SCHEME					
		Lect.	Pract.	Paper	TW	Oral	Pr	Total	Duration
602415	Seminar III	-	04	-	50	-	-	50	02
602416	Project Stage I	-	18	-	50	-	-	50	06
	Total	**-**	**22**	**-**	**100**	**-**	**-**	**100**	**08**

Semester- IV									
CODE	**SUBJECT**	**TEACHING SCHEME**		**EXAMINATION SCHEME**					
		Lect.	**Pract.**	**Paper**	**TW**	**Oral**	**Pr**	**Total**	**Duration**
602417	Project Stage II	-	18	-	150	50	-	200	12
	Total	**-**	**18**	**-**	**150**	**50**	**-**	**200**	**12**

Elective I		**Elective II**	
A	Material for Engineering Applications	A	Finite Element Analysis
B	Advanced Manufacturing Processes	B	Integrated Product Design & Development
C	Customization of CAD/CAM Software's	C	Computational Fluid Dynamics
D	CAD/CAM Practices in Metal Forming	D	Robotics
Elective III		**Elective IV**	
A	Design for X	A	Product Lifecycle Management
B	Automated Manufacturing System Modeling	B	Rapid Prototyping
C	Simulation and Modelling	C	Data Base Management System
D	Optimization Techniques	D	Robust Design of Product/Process
		E	Open Elective

ADVANCED MACHINE DESIGN [502401]	
Teaching Scheme	**Examination Scheme**
Theory Lectures: 03 hours/week	**End Semester Examination: 100 marks 03 Hrs**

UNIT-I: THEORY OF ELASTICITY

State of stress at a point, stress components on an arbitrary plane, principal stresses, plane stress, differential equations of equilibrium, boundary conditions. State of strain at a point, plane strain, compatibility conditions, generalized Hooke's Law, relations between elastic constants, displacement equations of equilibrium. Elasticity problems in two dimension and three dimensions, Airy's stress function in rectangular & polar coordinates.

UNIT-II: THEORIES OF FAILURE:

Maximum principal stress theory, maximum shear stress theory, maximum elastic strain theory, octahedral shearing stress theory, distortion energy theory, Mohr's theory, significance of theory of failure.

UNIT-III: ENERGY METHODS

Elastic strain energy, strain energy due to axial force, shear force, torsion, bending moment, Castigliano's theorems, theory of virtual work and energy, Raleigh-Ritz method and Galerkin's method.

UNIT-IV: DESIGN FOR FATIGUE, BRITTLE FRACTURE AND CREEP

Introduction, Fatigue strength, factors affecting fatigue behaviour, Influence of super imposed static stress, Cumulative fatigue damage, fatigue under complex stresses, Fatigue strength after over stresses, True stress and true strength. Design for brittle fracture. Mechanism of creep of material at high temperature, Exponential creep law, hyperbolic sine creep law, stress relaxation, bending etc

UNIT-V: COMPOSITE MATERIALS

Composite materials and structures, classical lamination theory, elastic stress analysis of composite material, Fatigue strength improvement techniques, stresses, stress concentration around cut outs in composite laminates, stability of composite laminate plates and shells, Hybrid materials, applications.

UNIT-VI: DESIGN OF MECHANICAL COMPONENTS

a) Gear Design: - Involute gears, tooth thickness, interference, undercutting, rack shift etc. Profile modification, S and So spur, helical gears etc.

b) Spring Design: - Vibration and surging of helical springs, helical springs for maximum space efficiency, analysis of Belleville springs, ring spring, volute spring & rubber springs. Design for spring suspension.

REFERENCE BOOKS

1. L S Srinath, **Advanced Solid Mechanics**, Tata McGraw-Hill.
2. S P Timoshenko, J N Goodier, **Theory of Elasticity (Third Edition)**, McGraw-Hill.
3. M.F. Spotts & T.E. Shoup, **Design of Machine Elements**, Pearson Education.
4. Joseph E. Shigley & Chales R. Mischke **Mechanical Engineering Design**, McGraw Hill
5. George B. Dieter, **Engineering Design**, McGraw Hill.
6. Arhur H. Burr & John B. Chetham, **Mechanical Analysis & Design**, Prentice Hall India.
7. Robert C. Juvinall & Kurt, M. Marshel, **Fundamentals of Machine Component Design,** John Wiley & Sons.
8. Robert L. Norton, **Machine Design, An Integrated Approach**, Pearson Education
9. M. F. Spotts, **Mechanical Design Analysis,** Prentice-Hall.
10. A.M. Wahl, **Mechanical Springs**, McGraw-Hill Inc.
11. D. Hull and T.W. Clyne, **An Introduction to Composite Materials,** Cambridge Solid State Science Series
12. D. W. Dudley, **Handbook of Practical Gear Design**, Mc Graw-Hill Book Co.

LAB PRACTICE: ANY FOUR ASSIGNMENTS FROM BELOW LIST OR ANY OTHER FROM SYLLABUS	
1. Elasticity Problems In 3D	2. Theories Of Failures
3. Energy Methods	4. Fatigue Design
5. Brittle Fracture Design	6. Creep Design
7. Gear Design	8. Spring Design

MATHEMATICAL MODELLING [502402]	
Teaching Scheme	**Examination Scheme**
Theory Lectures: 03 hours/week	**End Semester Examination: 100 marks 03 Hrs**

UNIT-I: BOUNDARY VALUE PROBLEMS AND APPLICATIONS

Linear second order partial differential equation in two independent variables–Normal forms hyperbolic, parabolic and elliptic equations – Cauchy problem. Wave equations– Solution of initial value problem – Significance of characteristic curves. Laplace transforms solutions– Displacements in a long string–long string under its weight–a bar with prescribed force on one end–Free vibrations of a string.

UNIT-II: CALCULUS OF VARIATIONS

Concepts of functional and their stationary values – Euler's equation and solution for the problem and for more general cases – Natural boundary conditions – Variational problems with moving boundaries – Conditional variational problems – Isoperimetric problems. Direct Methods: Ritz, Kantorovich and Galerkin's techniques.

UNIT-III: EIGEN VALUE PROBLEMS

Standard Eigen value problems – properties of Eigen values and Eigen vectors – Generalized Eigen value problems – strum sequence – Jacobi, Givens and House holder transformations.

UNIT-IV: NUMERICAL METHODS

Forward and inverse iteration schemes – Graham Schmidt deflation – Simultaneous iteration method – Subspace iteration – Lanczo's algorithm – Estimation of core and time requirements.

UNIT-V: COMPUTER METHODS IN MECHANICAL ENGINEERING

Applications of digital computers to solutions of problems in mechanical engineering, matrices, roots of equations, solution of simultaneous equations, curve fitting by least squares, differential and integration, differential and partial differential equations.

UNIT-VI: STATISTICAL TECHNIQUES AND DESIGN OF EXPERIMENTS

The scientific method - The phases of an experiment - Specifying the problem and the hypotheses-Experimental designs-Analyses of experiments-Statistical inference Hypothesis testing-The Z-test, the T-test, the X2-test, and the F-test. Sample size.

TEXT/REFERENCE BOOKS

1. Kreyszig, Erwin, I.S., **Advanced Engineering Mathematics**, Wiley, 1999.
2. Jennings. A., **Matrix Computation for Engineers and Scientists**, John Wiley and Sons, 1992.
3. Prem. K. Kythe, Pratap Puri, Michael R. Schaferkotter, **Introduction to Partial Differential Equations and Boundary Value Problems with Mathematics**, CRC Press, 2002
4. Hicks and Turner, **Fundamental Concepts in the Design of Experiments**, 5th Edition.
5. Devore, Jay L., **Probability and Statistics for Engineering and the Sciences**, 5th edition, Brooks-Cole, 1999.

COMPUTER AIDED DESIGN [502403]	
Teaching Scheme	**Examination Scheme**
Theory Lectures: 03 Hours/Week	**End Semester Examination: 100 Marks 03 Hrs**

UNIT-I: CAD TOOLS

Definition of CAD Tools, Types of system, CAD/CAM system evaluation Criteria, Graphics standards, functional areas of CAD, Modeling and viewing, software documentation, efficient use of CAD software.

Wire frame modeling -Types of mathematical representation of curves, wire frame models, wire frame entities, parametric representation of synthetic curves - Hermite cubic splines, Bezier curves, B-Splines, rational curves - NURBS.

UNIT-II: SURFACE MODELING

Mathematical representation of surfaces, Surface model, Surface entities, surface representation, Parametric representation of surfaces, plane surface, ruled surface, surface of revolution, Tabulated surface.

UNIT-III: PARAMETRIC REPRESENTATION OF SYNTHETIC SURFACES

Hermite Bicubic surface, Bezier surface, B-Spline surface, COONs surface, Blending surface, Sculptured surface, Surface manipulation - Displaying, Segmentation, Trimming, Intersection, Transformations - 2D and 3D, Orthogonal and Perspective transformations.

UNIT-IV: SOLID MODELLING

Solid Representation - Boundary Representation (B-rep), Constructive Solid Geometry (CSG) and other methods, Design Applications: Mechanical tolerances, Mass property calculations, CAD database structure.

CAD/CAM Data Exchange: Evaluation of data- exchange formats, IGES data representations and structure, STEP Architecture, implementation, ACIS & DXF.

UNIT-V: ADVANCED MODELING CONCEPTS:

Feature Based Modeling, Assembly Modeling, Behavioral Modeling, Conceptual Design & Top-down Design. Techniques for visual realism - hidden line - Surface removal - Algorithms for shading and Rendering. Parametric and variational modeling, Feature recognition, Design by features, Assembly and Tolerance Modeling, Tolerance representation - specification, analysis and synthesis, AI in Design.

UNIT VI: COLLABORATIVE ENGINEERING:

Collaborative Design, Principles, Approaches, Tools, Design Systems. Product Data Management (PDM).

TEXT/REFERENCE BOOKS:

1. Ibrahim Zeid, **CAD/CAM Theory and Practice**, McGraw Hill international.
2. P. N. Rao, **CAD/CAM** Tata McGraw Hill.
3. Foley, Van Dam, Feiner and Hughes, **Computer Graphics Principles and Practice,** second edition, Addison–Wesley, 2000.
4. Martenson, E. Micheal, **Geometric Modelling**, John Wiley & Sons, 1995.
5. Hill Jr, F.S., **Computer Graphics using Open GL**, Pearson Education, 2003.
6. Singeresu S. Rao, **Engineering Optimization-Theory and Practice,** New Age International Limited Publishers, 2000.
7. Johnson Ray, C. **Optimum Design of Mechanical Elements**, Wiley, John & Sons, 1981.
8. P. Radhakrishnan, S. Subramanyam, **CAD/CAM/CIM**, New Age International.
9. V. Ramamurti, **Computer Aided Mechanical Design and Analysis**, Tata Mc Graw Hill-1992.

Software Documentation, tutorials, manuals of following software

1. UG/NX
2. Solid Works
3. CATIA
4. Autodesk Inventor Professional
5. AutoCAD
6. Open CASCADE
7. ANSYS Design modeler
8. Pro/E

MATERIALS FOR ENGINEERING APPLICATIONS [502404-A]	
Teaching Scheme	**Examination Scheme**
Theory Lectures: 03 Hours/Week	**End Semester Examination: 100 Marks 03 Hrs**

UNIT-I: FUNDAMENTAL REVIEW & MECHANICAL BEHAVIOR OF METALS AND ALLOYS

Covalent, Ionic, Metallic, Vander Walls Bond, Bond strength and Melting point, crystalline structures, Vacancies, dislocations and other crystal defects. Metals Vs Alloys, Micro structural Characterization. Tensile and Compressive stress strain relations, fracture toughness, fatigue, creep, wear and abrasion.

UNIT-II: ADVANCED MATERIALS

HSLA steels, tool and die materials, alloy cast irons, stainless steels, PH and maraging steels, materials for low temperature applications, refractory metals and super alloys, Hadfield steels, ball bearing steels and bearing metals,

UNIT-III: ALLOYS

Automobile alloys and aerospace alloys, Inter metallics, Ni and Ti Aluminides - Smart materials, shape memory alloys -Metallic glass - Quasi crystal and nano Crystalline materials.

UNIT-IV: CERAMICS

Ceramic crystal structures – Binary ceramic structures: Rock salt, Fluorite, Rutile and Silica structures. Ternary ceramic structures. Introduction to phase equilibria in ceramics, Phase equilibrium diagrams and composition calculations. Thermal, Electrical, magnetic and optical behavior of ceramics, Mechanical behavior of ceramics, Toughening mechanisms in ceramics, cyclic fatigue of ceramics, thermal stresses in ceramics, creep in ceramics, Ceramics for engineering applications, Engineering ceramics and their applications, (Glass and Glass-ceramics, Aluminum oxide, Silicon nitride, Zirconia and zirconia-Toughned Aluminum, Sailons) Environmental Effects in ceramics.

UNIT-V: COMPOSITES

Fundamentals, Definition, classification of composite materials, laws of mixtures, factors affecting composite properties: interfacial bonding. Mechanical Behavior of composite, Young's Modulus and strength considerations for continuous FRCs & short FRCs, Hal pin Tsai Equations. Interfacial Mechanics, Mechanics of load transfer from matrix to fiber, Toughening Mechanisms in composites. Fabrication & Properties of

fibers-Glass fibers, carbon fibers, Aramid fibers, Silicon Carbide Fibers & Metallic Glasses. Comparative study, illustrations & Applications, PMCs, CMCs & MMCs. Fatigue of Laminate Composites.

REFERENCE BOOKS:

1. R.S.Kurmi & R.S.Sedha, **Material Science**, S. Chand & company Ltd.
2. Thomas H. Courtney, **Mechanical Behavior of Materials,** McGraw-Hill.
3. Michael F. Ashby, **Material Selection in Mechanical Design,** Butterworth-Heinemann Ltd.
4. Flinn, R.A. and Trojan, P.K., **Engineering Materials and their Applications,** Wiley 1995.
5. Issac Daniel, Ori Ishai, **Engineering Mechanics of Composite Materials,** Oxford University Press, 2006.

ADVANCED MANUFACTURING PROCESSES [502404-B]	
Teaching Scheme	**Examination Scheme**
Theory Lectures: 03 Hours/Week	**End Semester Examination: 100 Marks 03 Hrs**

UNIT-I: METAL CUTTING AND MECHANICS OF METAL CUTTING

Introduction to metal removal processes, Chip formation, forces acting on cutting tool and their measurement, Chip thickness, Theory of Ernest and Merchant, theory of Lee and Shafer, Tool wear and tool life, surface finish, thermal aspects, friction in metal cutting and testing of machine tools.

UNIT-II: ABRASIVE PROCESSES

Introduction, Grinding wheel-designation and selection, grinding process, grinding process parameters, creep feed grinding, honing, lapping and other finishing processes

UNIT-III: FORMING PROCESSES

Sheet metal forming, punching, extrusion, coning. Plastic molding process, injection molding, blow molding, compression molding. Metal injection molding, powder injection molding, sintering process, and their applications.

UNIT-IV: UNCONVENTIONAL MACHINING PROCESSES

Need for unconventional processes, Range of non conventional machining processes USM, WJM, AJM, chemical machining, Electrochemical machining, Electrolytic grinding, EDM, LBM, EBM, Plasma arc cutting.

UNIT-V: HIGH SPEED MACHINING

Introduction to high speed machining, economics of high speed machining, brief historical perspective, material properties at high strain rates, influence of increasing speed on chip formation, stainless steel, aerospace aluminum and titanium and recommendations.

UNIT-VI: GENERATIVE MANUFACTURING PROCESSES (GMP) FOR RAPID PROTOTYPING

General features and classification, Issues related to CAD and GMP software, Overviews of generative manufacturing processes, two dimensional layer-by-layer techniques and direct three-dimensional techniques for RP

TEXT/REFERENCE BOOKS

1. G. Boothroyd and W. A. Knight, **Fundamentals of Machining and Machine Tools,** CRC Press.
2. E. M. Trent and P. K. Wright, **Metal Cutting,** Butterworth- Heinemann, Boston.
3. P. N. Rao, **Manufacturing Technology,** Tata Mc-Graw Hill.
4. D. A. Stephenson and J. S. Agapiou, **Metal Cutting Theory and Practice,** CRC Press
5. Amitabha Ghosh, **Rapid Prototyping**
6. Kalpak Jain S. and Schmid S. R., **Manufacturing Processes for Engineering Materials, Addition Wesley,**
7. Mikell P. Groover, Fundamentals **of Modern Manufacturing: Materials, Processes, and Systems**, John Wiley & Sons.

CUSTOMIZATION OF CAD/CAM SOFTWARE [502404-C]	
Teaching Scheme	**Examination Scheme**
Theory Lectures: 03 Hours/Week	**End Semester Examination: 100 Marks 03 Hrs**

UNIT-I: INTRODUCTION TO CUSTOMIZATION

Customization, Application Programming Interface (API), macros, scripts

UNIT-II: TOOLS FOR CUSTOMIZATION

Object Oriented Programming (OOP), OLE interfaces in CAD/CAM software; Use of General programming interfaces like VB, VBS, VC++, Open GL programming and System dependent programming interfaces like Visual LISP (AutoCAD), GRIP (Unigraphics), Pro-Programming (Pro/Engineer)

UNIT-III: COMPUTER-BASED SYSTEM ENGINEERING

System Engineering process, Software product development life cycle, software processes, software development project management, software prototyping.

UNIT-IV: RAPID DEVELOPMENT

Core issues in rapid development, rapid development languages, lifecycle planning and customer oriented development.

UNIT-V: SOLID MODELLING ALGORITHMS

Euler operations, basic solid modelling algorithms

UNIT-VI: AUTOMATED SOLID MODELING USING CUSTOMIZATION:

Creating 2D, 3D and solid entities through API, Editing 2D, 3D and solid entities through API, Design and development of user interfaces - icons, menus, dialog boxes, Integrating databases with CAD; creating BOM or part lists, Automated Assembly modelling through customization, Automated drafting and dimensioning using customization, Creating Automated Animations using API and animation software.

REFERENCE BOOKS:

1. Steve McConnell, **Rapid development**, Microsoft Press.
2. Ian Summerville, **Software Engineering**, Pearson Education.
3. Foley, van Dam, **Computer Graphics**, Pearson Education.
4. Mason Woo, et al, **OpenGL Programming Guide.**
5. George Omura**, Advanced AutoCAD**.
6. Sham Tickoo, **Customizing AutoCAD**, Thomson learning
7. Martti Mantilya, **Solid Modelling**, Computer Science Press.

8. Solid Works API using VB and C++; Custom Programming Unlimited LLC
9. GRIP programming manuals for Unigraphics (Vol. 1 and 2)
10. User Function Programming manuals for Unigraphics (Vol. 1)

LAB PRACTICE: ANY FOUR ASSIGNMENTS FROM BELOW LIST OR ANY OTHER FROM SYLLABUS	
1. Scripts & Macros	2. Object Oriented Programming
3. Open GL Programming	4. Solid Modelling Algorithms
5. Automated Solid Modelling	6. Creating & Editing Entities
7. Automated Drafting	8. Animations

CAD/CAM PRACTICES IN METAL FORMING [502404-D]	
Teaching Scheme	**Examination Scheme**
Theory Lectures: 03 Hours/Week	**End Semester Examination: 100 Marks 03 Hrs**

UNIT-I SHEET METAL MODELING

Sheet Metal Methods, Stages in the Process, Designing with Sheet Metal Features, Miter & Edge Flanges, Bend Angles, Adding a Tab, Flat Pattern, Cuts, Sheet Metal Parts in Drawings, Sheet Metal Forming Tools, Edge Flanges and Closed Corners, Hems, Curved Edge Flanges, Designing in Flat, Existing Rounds, Using Symmetry, Manual Relief Cut, Break Corner, Jog Feature, Lofted Bends, Sheet Metal Topics, Recognize Bends Method, Using the Rip Feature, Adding Bends in Place of Sharp, Corners, Sheet Metal Features, Making Changes, Adding a Welded Corner, Sheet Metal from Shelled Parts, Unrolling Cones and Cylinders, Process Plans.

UNIT-II: PLASTIC DEFORMATION IN METALS

The flow curve, true stress, true strain, yielding criteria for ductile metals, plastic stress – strain relations, strain hardening coefficient, normal anisotropy coefficient, formability evaluations, drawability tester, high strength, low alloy steels developed for formability: HSLA steels, Dual phase steels, DQAK steels, CHR-X steels, two-dimensional plastic, flow – slip line field theory, Mechanics of metal working, Temperature in metal working, strain rate effects, metallurgical structures, Friction and lubrication, lubricants for hot and cold working, Deformation zone geometry, workability and residual stresses

UNIT-III: FORMING EQUIPMENTS

Forming Equipment - types and press construction, Principle of working of Mechanical, Hydraulic and Pneumatic press. Press control system in forging equipments, Presses for hydro forming, selection of presses

UNIT-IV: SHEET METAL FORMING

Press tool operations - classification based on type of stresses, Shearing operations (blanking and piercing), and effect of clearance, Calculation of punching force, Trimming, Shaving, Nibbling and Notching operations, Drawing and Deep drawing, redrawing, limiting draw ratio, forming limit criteria draw die design. Bending, spring back in bending. Spinning, stretch forming, Embossing, Coining, Rubber forming. Defects in formed parts. Sheet Metal Forming Dies – progressive die, compound and

combination die. Die Construction, Center of pressure calculation, Stock strip layout, Strip development

1. Dieter G. E. Bacon David, **Mechanical Metallurgy**, McGraw Hill, ISBN-0-07-100406-8.
2. Grobh Schuler, **Metal Forming Handbook**, Springer Verlag Berlin, Heidelberg, 1998, ISBN-3-540-61185-1.
3. Cyril Donaldson, George H. Locain, V. C. goold, **Tool Design**, Tata McGraw Hill, ISBN-0-07-099274-6.
4. Frank w. Wilson, **Fundamentals of Tool Design**, ASTME, prentice Hall of India, New Delhi ISBN-0- 87692-058-10.
5. Roy A. Lindberg, **Processes and Materials of Manufacturing**, Prentice Hall of India, New Delhi, ISBN-81-203-0663-5.
6. Prakash H. Joshi, **Press Tools: Design and Construction**, Wheeler Publishing, New Delhi, ISBN-81-85814-46-5.

ADVANCED FINITE ELEMENT ANALYSIS [502405-A]	
Teaching Scheme	**Examination Scheme**
Theory Lectures: 03 Hours/Week	**End Semester Examination: 100 Marks 03 Hrs**

UNIT-I: INTRODUCTION

Finite element method, brief history, basic steps, advantages and disadvantages, weak formulation, variational methods of approximation – Rayleigh-Ritz methods, Methods of Weighted Residuals (Galerkin, Least-squares & Collocation methods), Variational formulation of 1D bar and beam elements (Euler Bernoulli and Timoshenko beam) – governing equation, domain discretization, elemental equations, assembly and element connectivity, application of boundary condition, solution of equations, post processing of the results.

UNIT-II: ISOPARAMETRIC ELEMENTS AND FORMULATION OF PLANE ELASTICITY PROBLEMS

Introduction, shape functions – linear & quadratic, displacement function – criteria for the choice of the displacement function, polynomial displacement functions, displacement function in terms of nodal parameters, strain-nodal parameter relationship, stress-strain relationship, element stiffness matrix, convergence of iso parametric elements, numerical integration – Trapezoidal rule, Simpson's 1/3 rule, Newton-Cotes Formula, Gauss Quadrature formula, Guass Quadrature in two and three dimensions.

UNIT-III: PLATE BENDING PROBLEMS – PLATE AND SHELL ELEMENTS

Introduction, thin and thick plates – Kirchoff theory, Mindlin plate element, triangular and rectangular, conforming and nonconforming elements, degenerated shell elements, reduced and selective integration, shear locking and hour glass phenomenon.

UNIT-IV: NONLINEAR PROBLEMS – GEOMETRIC, MATERIAL AND CONTACT PROBLEMS

Introduction to non-linear analysis, formulation for geometrical, material and contact nonlinear problems, Nonlinear equation solving procedure - direct iteration, Newton-Raphson method, modified Newton-Raphson method, incremental techniques.

UNIT-V: DYNAMIC PROBLEMS – EIGEN VALUE AND TIME DEPENDENT PROBLEMS

Formulation of dynamic problems, consistent and lumped mass matrices Solution of Eigen value problems – transformation methods, Jacobi method, Vector Iteration methods, subspace iteration method Forced vibration – steady state and transient vibration analysis, modeling of damping, the mode superposition scheme, direct integration methods – implicit and explicit numerical integration.

UNIT-V: SPECIAL TOPICS

Linear buckling analysis, adaptive finite element technique, error estimation, h & p refinements, symmetry – mirror/plane, axial, cyclic & repetitive, sub modeling and sub structuring.

REFERENCE/TEXT BOOKS:

1. Seshu P., **Text book of Finite Element Analysis**, PHI Learning Private Ltd., New Delhi, 2010.
2. Mukhopadhyay M and Sheikh A. H., **Matrix and Finite Element Analyses of Structures**, Ane Books Pvt. Ltd., 2009.
3. Bathe K. J., **Finite Element Procedures**, Prentice-Hall of India (P) Ltd., New Delhi.
4. Cook R. D., **Finite Element Modeling for Stress Analysis**, John Wiley and Sons Inc, 1995
5. Chandrupatla T. R. and Belegunda A. D., **Introduction to Finite Elements in Engineering**, Prentice Hall India.
6. Liu G. R. and Quek S. S. **The Finite Element Method – A Practical Course**, Butterworth-Heinemann, 2003.
7. Reddy, J. N., **An Introduction to The Finite Element Method**, Tata McGraw Hill, 2003.
8. Reddy, J. N., **An Introduction to Nonlinear Finite Element Analysis**, Oxford University Press, 2010.
9. Dixit U. S., **Finite Element Methods for Engineers**, Cengage Learning India Pvt. Ltd., 2009.

LAB PRACTICE: ANY FOUR ASSIGNMENTS FROM BELOW LIST OR ANY OTHER FROM SYLLABUS	
1. Stress and deflection (small & large) study of short and long beams with different end conditions and cross-sections subjected to different loading conditions (i.e., point load – force & moment, distributed load etc)	2. Stress and deflection (small & large) study of thin and thick rectangular and circular plates/shells with different end conditions subjected to different loading conditions (i.e., point load – force & moment, distributed load etc)
3. Stress analysis of rotating disc (solid and hollow discs)	4. Large scale deformation of hyperelastic material
5. Buckling mode analysis of a thin shell cylinder	6. Design of machine elements like shaft, gear, bearing etc

INTEGRATED PRODUCT DESIGN & DEVELOPMENT [502405-B]	
Teaching Scheme	**Examination Scheme**
Theory Lectures: 03 Hours/Week	**End Semester Examination: 100 Marks 03 Hrs**

UNIT-I: COLLABORATIVE PRODUCT DESIGN

Product lifecycle management-concepts, benefits, value addition to customer. Lifecycle models- creation of projects and roles, users and project management, system administration, access control and its use in life cycle. Product development process and functions. Data transfer. Variants of e-commerce. Multi system information sharing. Workgroup collaboration. Development of standard classification for components and suppliers. Model assembly process-link product and operational information. Customization factors-creation of business objects, user interfaces, search facile ties as designed by the enterprise. Software-PDM/PLM and their comparison.

UNIT-II: PRODUCT DEVELOPMENT

Quality function deployment-quality project approach and the problem solving process. Design creativity-innovations in design alternatives. Concurrent engineering, industrial design principles. Product development versus design, types of design and redesign, modern production development process, reverse engineering and redesign product development process, examples of product development process, scoping product development – S-curve, new product development.

UNIT-III: UNDERSTANDING CUSTOMER NEEDS

Gathering customer needs, organizing and prioritizing customer needs, establishing product function, FAST method, establishing system functionality.

UNIT-IV: PRODUCT TEAR DOWN AND EXPERIMENTATION

Tear down method, post teardown report, benchmarking and establishing engineering specifications, product portfolios.

UNIT-V: GENERATING CONCEPTS: Information gathering, brain ball, C-sketch/6-3-5 method, morphological analysis, concept selection, technical feasibility, ranking, measurement theory, DFMA, design for robustness.

UNIT-VI: PHYSICAL PROTOTYPES: Types of prototypes, use of prototypes, rapid prototyping technique scale, dimensional analysis and similitude, physical model and experimentation-design of experiments, statistical analysis of experiments.

TEXT/REFERENCE BOOKS:

1. John W Gosnay and Christine M Mears, **Business Intelligence with Cold Fusion**, Prentice Hall India, New Delhi, 2000.
2. David S Linthicum, "**B2B Application Integration**", Addison Wesley, Boston, 2001.
3. Alexis Leon, **Enterprise Resource Planning**, Tata McGraw Hill, New Delhi, 2002.
4. David Ferry and Larry Whipple, **Building and Intelligent e-business**, Prima Publishing, EEE Edition, California, 2000.
5. David Bedworth, Mark Hederson and Phillip Wolfe, **Computer Integrated Design and Manufacturing**, McGraw Hill Inc., New York, 1991.
6. Kevin Otto and Kristin Wood, **Product Design – Techniques in Reverse Engineering and New Product Development**, Pearson Education, New Delhi,
7. 2004.
8. Karl T Ulrich and Stephen D Eppinger, **Product Design and Development**, McGraw Hill, New York, 1994.

LAB PRACTICE: ANY FOUR ASSIGNMENTS FROM BELOW LIST OR ANY OTHER FROM SYLLABUS	
Collaborative Product Design	2. Reverse Engineering
3. Technology S-Curve.	4. Customer Needs
5. Product Tear Down	6. Benchmarking
7. Concept Generation & Design	8. Physical Prototyping

COMPUTATIONAL FLUID DYNAMICS [502405-C]	
Teaching Scheme	**Examination Scheme**
Theory Lectures: 03 Hours/Week	**End Semester Examination: 100 Marks 03 Hrs**

UNIT-I: BASIC CONCEPTS

Review of basic equations of fluid dynamics: Continuity, Momentum and Energy equations, Navier Stokes equations, Reynolds and Favre averaged N – S equations. Differential equations for steady and unsteady state heat conduction. Differential equations for diffusion. Introduction to turbulence, Turbulence models-mixing length model, K-ε turbulence Model.

UNIT-II: PARTIAL DIFFERENTIAL EQUATIONS

Classification of PDEs – Elliptic, parabolic and hyperbolic equations. Initial and boundary value problems. Concepts of Finite difference methods – forward, backward and central difference. Errors, Consistency, Stability analysis by von Neumann. Convergence criteria.

UNIT-III: GRID GENERATION

Types of grid O,H,C. Coordinate transformation, algebraic methods. Unstructured grid generation.

UNIT-IV: FINITE DIFFERENCE SOLUTIONS

Parabolic PDEs – Euler, Crank Nicholson, Implicit methods, Elliptic PDEs – Jacobi, Gauss Seidel, ADI, methods. FD- solution for Viscous incompressible flow using Stream function – Vorticity method & MAC method.

UNIT- V: FINITE VOLUME METHODS

Introduction to Finite volume method. Finite volume formulations for diffusion equation, convection diffusion equation. Solution algorithm for pressure velocity coupling in steady flows. Use of Staggered grids SIMPLE Algorithm.

UNIT- VI: TURBULENCE MODELING

Turbulence energy equation- one-equation model, the k-ω model, the k- ε model

TEXT/REFERENCE BOOKS:

1.John D Anderson, **Computational Fluid Dynamics – The Basics with Applications**, McGraw Hill, New Delhi, 1995.

2.Muralidhar K and Sundararajan T, **Computational Fluid Flow and Heat Transfer**, Narosa Publications, 2003.

3.Chung T J, **Computational Fluid Dynamics**, Cambridge University Press, London, 2002.

4.David C Wilcox, **Turbulence Modeling for CFD**, DCW Industries, Inc., 1993.

5.Versteeg H K and Malalasekara W, **An Introduction to Computational Fluid Dynamics - The Finite Volume Method**, Longman, 1995.

6.Pradip Niyogi, Chakrabartty SK, Laha M.K., **Introduction to Computational Fluid Dynamics**, Pearson Education, 2005.

7.Patankar, S.V, **Numerical Heat Transfer and Fluid flow**, Hemisphere Publishing Company, New York, 1980.

ROBOTICS [502405-D]	
Teaching Scheme	**Examination Scheme**
Theory Lectures: 03 Hours/Week	**End Semester Examination: 100 Marks 03 Hrs**

UNIT-I: ROBOTS-BASIC CONCEPTS

Brief History, Types of robots, Overview of robot subsystems, resolution, repeatability and accuracy, Degrees of freedom of robots, Robot configurations and concept of workspace, Mechanisms and transmission, End effectors and Different types of grippers, vacuum and other methods of gripping. Pneumatic, hydraulic and electrical actuators, applications of robots, specifications of different industrial robots.

UNIT-II:

Rotation matrices, Euler angle and RPY representation, Homogeneous transformation matrices, Denavit- Hartenberg notation, representation of absolute position and orientation in terms of joint parameters, direct kinematics.

UNIT-III

Inverse Kinematics, inverse orientation, inverse locations, Singularities, Jacobian, Trajectory Planning: joint interpolation, task space interpolation, executing user specified tasks, sensor based motion planning: The Bug Algorithm, The Tangent Bug Algorithm, The Incremental Voronoi Graph.

UNIT-IV

Static force analysis of RP type and RR type planar robots, Dynamic analysis using Lagrangean and Newton-Euler formulations of RR and RP type planar robots, , Independent joint control, PD and PID feedback, actuator models, nonlinearity of manipulator models, force feedback, hybrid control

UNIT-V: SENSORS AND CONTROLLERS

Internal and external sensors, position, velocity and acceleration sensors, proximity sensors, force sensors, laser range finder. Robot vision: image processing fundamentals for robotic applications, image acquisition and pre-processing. Segmentation and region characterization object recognition by image matching and based on features

UNIT-V: ROBOT PROGRAMMING

Robot languages: AL, AML, RAIL, RPL, VAL, Demonstration of points in space: Continuous path (CP), Via points (VP), Programmed points (PP).

TEXT/REFERENCE BOOKS:

1. Nagrath and Mittal, **Robotics and Control**, Tata McGraw-Hill, 2003.
2. Spong and Vidhyasagar, **Robot Dynamics and Control**, John Wiley and sons, 2008.
3. Fu. K.S, Gonzalez, R.C., Lee, C.S.G, **Robotics, Control, Sensing, Vision And Intelligence**, McGraw Hill International, 1987
4. Steve LaValle, **Planning Algorithms**, Cambridge University. Press, New York, 2006.
5. Howie Choset, Kevin Lynch, Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki and Sebastian Thurn, **Principles of Robot Motion: Theory, Algorithms, and Implementations**, Prentice Hall of India, 2005.
6. Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, **Robotic Engineering - An Integrated Approach,** Prentice-Hall of India Private Limited, 1994.

LAB PRACTICE-I GEOMETRIC MODELING & ANALYSIS [502406]	
Teaching Scheme	**Examination Scheme**
Theory Lectures: 06 hours/week	**Term Work: 50 marks**

GEOMETRIC MODELING & ANALYSIS

Solid modeling, assembly modeling, drafting assignments using software like UNIGRAPHICS, Solid Works, CATIA, Pro/Engineer, I-DEAS, Autodesk Inventor, etc and study of the various facilities in these software's.

Finite Element Analysis Assignments using software's like ANSYS, HyperMesh Ls-Dyna, Abacus etc.

SEMINAR-I [502407]	
Teaching Scheme	**Examination Scheme**
Theory Lectures: 04 hours/week	**Term Work: 100 marks**

The seminar shall consist of study of a particular topic based on 4-6 research papers or case study of one or two industries. The internal marks shall be awarded as the basis of performance of the individual student during his/her seminar presentation. Each student is also required to submit a report based on above study in the prescribed format.

MANAGEMENT OF TECHNOLOGY [502408]	
Teaching Scheme	**Examination Scheme**
Theory Lectures: 03 Hours/Week	**End Semester Examination: 100 Marks 03 Hrs**

UNIT-I: CONCEPTS OF TECHNOLOGY MANAGEMENT

Description, Scope & Implications, Its relation to business management, systems Holistic Model of Management of Technology (MOT), Operational and Management Issues, Classification of Technology, Technology cycle, Industry-Institute Interaction for targeted basic research.

UNIT-II: ORGANIZATIONAL ASPECTS OF TECHNOLOGY MANAGEMENT & STRATEGIC MANAGEMENT OF TECHNOLOGY

Human dimension of technology and concepts of the entrepreneur, Organizational cultures and structures for promotion of creativity and innovation, the learning organization, the imperative of knowledge management. Technology-strategy relationship, Elements of technology strategy and formulation of a technology strategy, Integration of technology strategy and business strategy for competitive success technology, the environment and sustainable development

UNIT-III: TECHNOLOGY FORECASTING

Approaches, Tech. Performance parameters, Use of experts in tech. Forecasting, Planning tech. Progress. Morphological analysis of a technology system.

UNIT-IV: ACQUIRING TECHNOLOGY THROUGH TECHNOLOGY TRANSFER & RESEARCH AND DEVELOPMENT

Definition, Source, Model of TT, System of TT with Public and Private Enterprises, Success and failure factors in technology transfer. The concepts of invention and innovation, Definition and classifications of research and development, new product development, Challenges in commercializing research results.

UNIT-V: INTELLECTUAL PROPERTY RIGHTS

Patentable and non-patentable inventions, statutory exceptions, Persons entitled to apply for patents.

UNIT-VI: NATIONAL INNOVATION SYSTEMS FOR FACILITATING TECHNOLOGY-BASED DEVELOPMENT

Concepts of the national innovation system (NIS) and science and technology infrastructure, Various Government Schemes.

UNIT-VII: ANALYTICAL HIERARCHICAL PROCESS (AHP)

Introduction to AHP, self AHP for Technology Selection cases like Information Technology – Software & Hardware, Machine Tools, and Industrial Products.

REFERENCE BOOKS:

1. Gerard H. Gaynor, **Hand Book of Technology Management**, McGraw Hill.
2. SCHILLING, MELISSA, **Strategic Management of Technological Innovation**, 2/e (SIE), Tata McGraw Hill Division: Higher Education SBN-13: 978-0-07-066712-9 ISBN-10: 0070667128 ©2007 | 2nd Edition,
3. Pearce, John; ROVINSON, RICHARD, **Strategic Management,** Tata McGraw Hill Authors: Division: Higher Education ISBN-13: 978-0-07-060393-6 ISBN-10:0070603936 ©2005 | 9th Edition |
4. Sharma, Radha, **Change Management**. Tata McGraw Hill Division: Higher Education ISBN-13: 978-0-07-063586-9 ISBN-10: 0070635862©2006|1st Edition.
5. Kazmi, Azhar, **Business Policy and Strategic Management**, 2E. Tata McGraw Hill Division: Higher Education ISBN-13: 978-0-07-044470-6 ISBN-10: 0070444706 ©2001 | 2nd Edition |
6. Satyawrat Ponkshe, **The Management of Intellectual Property**, by, Ponkshe & Bhate Publications, Pune.

COMPUTER AIDED MANUFACTURING [502409]	
Teaching Scheme	**Examination Scheme**
Theory Lectures: 03 hours/week	**End Semester Examination: 100 marks 03 Hrs**

UNIT-I: INTRODUCTION TO AUTOMATION

Introduction, basic elements of an automated system, advanced automation functions, levels of automation. Flexible automation, smart automation.

UNIT-II: NUMERICAL CONTROL

Basic components of an NC system, classification, merits and demerits, applications, the cost of NC/CNC, dimensioning systems, axes designation, NC motion control, interpolation, part programming formats, manual part programming, NC words, macro statements, application of NC to machine tools and other applications, NC coding systems (ISO and EIA), computer assisted part programming, APT statements, programming, NC part programming using CAD/CAM, manual data input (MDI), engineering analysis of NC positioning systems, open loop and closed loop positioning systems, precision in NC positioning

UNIT-III: COMPUTER NUMERICAL CONTROL

Computer Numerical Control (CNC) and DNC: Features of CNC, Elements of CNC machines, the machine control unit for CNC, CNC software, direct numerical control, distributed numerical control

UNIT-IV: GROUP TECHNOLOGY AND CELLULAR MANUFACTURING

Introduction to GT, benefits, part families, part classification and coding, product flow analysis, cellular manufacturing, adaptation consideration in GT, quantitative analysis in cellular manufacturing, GT applications for manufacturing processes.

UNIT-V: FLEXIBLE MANUFACTURING SYSTEMS & COMPUTER INTEGRATED MANUFACURING

Introduction to FMS, components, applications, benefits, FMS layout, FMS planning and implementation issues, quantitative analysis of FMS. Applications of FMS. FMS optimization. Computer Integrated Manufacturing (CIM): CAD, CAD/CAM, CIM, evolution of CIM, CIM hardware and software, nature and role of the elements of CIM system, development of CIM, the IBM concept of CIM, the Siemens concept of CIM, the CIM concept of Digital equipment corporation, Esprit CIM – OSA model, the NIST – AMRF Hierarchical model

UNIT-VI: MANUFACTURING SUPPORT SYSTEMS

CAPP, benefits, types, forward and backward planning implementation considerations, process planning systems, CAQC, CMM, JIT principles, the meaning of JIT, MRP–I and MRP-II, ERP, EDM, PDM & PLM.

REFERENCE BOOKS:

1. Mikell P. Grover, **Automation, Production Systems and Computer-Integrated Manufacturing,** Pearson Education, New Delhi.
2. P. Radhakrishnan & S. Subramanyan **CAD/CAM/CIM** Willey Eastern Limited New Delhi.
3. Mikell P. Grover and Enory W. Zimmers Jr. **CAD/CAM**, Pearson Education, New Delhi.
4. Hans B. Kief and J. Frederick Waters **Computer Numerical Control,** Glencae Macmillan/McGraw Hill
5. Steve Krar and Arthar Gill, **CNC Technology and Programming**, McGraw Hill Pub. Company, New Delhi.
6. Nicholas John M. **Competitive Manufacturing Management**, McGraw Hill International
7. P.N. Rao, N. K. Tewari et el **Computer Aided Manufacturing** Tata Mc Graw Hill Pub. New Delhi.

LAB PRACTICE: ANY FOUR ASSIGNMENTS FROM BELOW LIST OR ANY OTHER FROM SYLLABUS	
APT Programming	2. Controllers
3. Tool Path Generation-Turning	4. Tool Path Generation-Turning
5. Tool Path Generation-Milling	6. Tool Path Generation-Milling
7. Tool Path Generation-Robot	8. Group Technology

COMPUTER INTEGRATED MANUFACTURING [502410]	
Teaching Scheme	**Examination Scheme**
Theory Lectures: 03 hours/week	**End Semester Examination: 100 marks 03 Hrs**

UNIT-I: CONCEPT OF CIM

Introduction to CIM, Types of Manufacturing, CIM hardware and software, Elements of CIM, Product development through CIM Design Activities in a networked environment, networking in a manufacturing company, hardware elements of networking.

UNIT-II: CIM DATABASE

Introduction, Database requirements of CIM, Database, Database management, Database Models, EDM, Product Data Management (PDM), Advantage of PDM. , Collaboration Engineering.

UNIT-III: WORK CELL & FLEXIBLE MANUFACTURING SYSTEM

Manufacturing cell, Group Technology, Cellular Manufacturing. DNC system and transfer of program from PC to machine. Introduction to FMS, Manufacturing integration model, flexible manufacturing strategy, Components of Flexible Manufacturing-Pallets and fixtures, machining centers, inspection equipment, material handling stations, storage system, In-process storage, manually operated stations, allied operation centers

UNIT-IV: INTEGRATIVE MANUFACTURING PLANNING AND CONTROL

Role of integrative manufacturing in CAD/CAM integration, Over view of production control - Forecasting, Master production schedule, Capacity planning, M.R.P., Order release, Shop-floor control, Quality assurance, Planning and control systems, Cellular manufacturing, JIT manufacturing philosophy.

UNIT-V: WEB BASED MANUFACTURING

Integrating process with web, Process management and control through web, Applications of web based manufacturing, casting, machining, forming & forging.

UNIT-VI: FUTURE TRENDS IN MANUFACTURING SYSTEMS

Lean Manufacturing: Definition, Principles of Lean Manufacturing, Characteristics of Lean Manufacturing, Value of Product, Continuous Improvement, Focus on Waste, Relationship of Waste to Profit, Four Functions of Lean Production, Performance Measures, The Supply Chain, Benefits of Lean Manufacturing. Introduction to Agile and Web Based Manufacturing systems.

REFERENCE BOOKS:

1. Paul G. Ranky, **The Design and Operation of FMS**, I.F.S. Publications 1983
2. Harrington J, **Computer Integrated Manufacturing** Krieger Publications 1979
3. Richard N. Shover, **An Analysis of CAD/CAM Application with Introduction to C.I.M.** Prentice hall
4. David Bedworth et.al **Computer Integrated Design and Manufacturing** McGraw hill 1991
5. Scolz B. Reiter **C.I.M Interfaces** Chapman & Hall 1992
6. David L. Goetsch, **Fundamental of CIM Technology**, Delmar Publication 1988
7. Groover, M.P., (2004), **Automation, Production Systems & Computer Integrated Manufacturing** second edition, Pearson Education ISBN: 81-7808-511-9
8. Groover, Weiss, Nagel, Audrey, Industrial **Robotics-Technology, Programming and Applications**, McGraw Hill.
9. Nanua Singh, **Systems Approach to Computer Integrated Design and Manufacturing,** John Wiley Publications.
10. Alavudeen, Venkateshwaran, **Computer Integrated Manufacturing**, Prentice-Hall India

DESIGN FOR X [502411-A]	
Teaching Scheme	**Examination Scheme**
Theory Lectures: 03 Hours/Week	**End Semester Examination: 100 Marks 03 Hrs**

UNIT-I: INTRODUCTION

Need, evolution, fundamentals and usages of DFX. Performance characteristics and tool kits for DFX. Development and Implementation of DFX tools.

UNIT-II: DESIGN FOR MANUFACTURING, ASSEMBLY AND DISASSEMBLY

Principles, approaches, Product and component, DFMA, The R & D Experience, Evaluations for DFMA.

UNIT-III: DESIGN FOR ASSORTED TECHNICAL REQUIREMENTS/PROCESSES

Material storage and distribution, Dimensional control, Heat treatment, Coating, Casting, Plastic processes like wise.

UNIT-IV: DESIGN FOR LIFE CYCLE

Approaches to product development, Inspect ability, Serviceability.

UNIT-V: DESIGN FOR RELIABILITY, QUALITY

Approaches, QFD, Evaluations and Procedures.

UNIT-VI: DESIGN FOR COMPETITIVENESS

Modularity, Technical Merit, Optimization of Product Life cycle and allied.

REFERENCE BOOKS:

1.G. H. Haung, **Design for X: Concurrent Engineering Approach**, Chapman & Hall, 1996.

2.S. Y. Nof. W. E. Wihelm and H. J. Warnecke, **Industrial Assembly**, Chapman & Hall, 1996

3.**Assembly Automation and Product Design**, Geoffrey Boothroyd, Marcel Dekker, Inc,

4.Corrado Poli, **Design for Manufacturing: A Structured Approach**, Butterworth Heinemann

5.Swift and Booker, **Process section from Design to Manufacturing**, Butterworth Heinemann

6.James Barilla, **Design for Manufacturability Handbook,** Mc Graw Hill

7.David M. Anderson, **Design For Manufacturing And Concurrent Engineering**, CIM press, 2004

LAB PRACTICE: ANY FOUR ASSIGNMENTS FROM BELOW LIST OR ANY OTHER FROM SYLLABUS	
Design for Failure Methods & Analysis	2. Design for Manufacturing
3. Design for Assembly	4. Design for Disassembly
5. Design for Heat Treatment/ Coating	6. Design for Life Cycle
7. Design for Reliability/Cost	8. Design for Competitiveness

AUTOMATED MANUFACTURING SYSTEM MODELING [502411-B]	
Teaching Scheme	**Examination Scheme**
Theory Lectures: 03 Hours/Week	**End Semester Examination: 100 Marks 03 Hrs**

UNIT-I: INTRODUCTION

Modeling Automated Manufacturing Systems, Performance Modeling Tools.

UNIT-II: AUTOMATED MANUFACTURING SYSTEMS

Introduction, Manufacturing Systems, Performance Measures, Computer-Controlled Machines, Material Handling Systems, Plant Layout, Flexible Manufacturing Systems, Computer Control Systems,

UNIT-III: MARKOV CHAIN MODELS

Memory less Random Variables, Stochastic Processes in Manufacturing, Discrete Time Markov Chain Models, Continuous Time Markov Chain Models, An Examples Markov Model of a Transfer Line, Birth and Death Processes in Manufacturing, Time Reversible Markov Chains in Manufacturing, Semi-Markov Processes in Manufacturing.

UNIT-IV: QUEUING MODEL

Queues, Notation and Examples, The M/M/1 Queue, The M/M/m Queue, Batch Arrival Queuing Systems, Queues with General Distributions, Queues with Breakdowns, Analysis of a Flexible Machine Centre, Queuing Networks, Open Queuing Networks, Closed Queuing Networks, Product Form Queuing Networks.

UNIT-V: PETRI NET MODELS

Classical Petri Nets, Stochastic Petri Nets, Generalized Stochastic Petri Nets, GSPN Modeling of Kanban Systems, Deadlock Analysis Using Petri Nets, Extended Classes of Timed Petri Nets, Integrated PRQN-GSPN Models.

REFERENCE BOOKS:

1.Narahari Y., Viswanadham N., **Performance Modeling Of Automated Manufacturing Systems,** Prentice-Hall India.

2.Alan A. Desrochers, **Modeling and Control of Automated Manufacturing Systems** IEEE Computer Society Press 1990.

3.Paul M. Stanfield, **Performance Modeling of Automated Manufacturing Systems,** Institute of Industrial Engineers, Inc**.**

LAB PRACTICE: ANY FOUR ASSIGNMENTS FROM BELOW LIST OR ANY OTHER FROM SYLLABUS	
1. Performance Measure of Automated Systems	2. Stochastic Processes in Manufacturing
3. Markov Chain Models	4. Semi-Markov Processes
5. Semi-Markov Processes	6. The M/M/1 Queue & M/M/m Queue
7. Petri Nets-Models	8. Integrated PRQN-GSPN Models.

SIMULATION AND MODELLING [502411-C]	
Teaching Scheme	**Examination Scheme**
Theory Lectures: 03 hours/week	**End Semester Examination: 100 marks 03 Hrs**

UNIT-I: INTRODUCTION TO SIMULATION

Definition – history - nature of computer Modelling and simulation, limitations of simulation, areas of application. System and environment**:** Components of a system – types of simulation - discrete and continuous systems. Modelling approaches – simulation examples - manual simulation using event scheduling, single channel queue, two server queue, simulation of inventory problem.

UNIT-II: RANDOM NUMBER GENERATION AND TESTING

Techniques for generating random numbers – mid square method – mid product method - constant multiplier technique - additive congruential method - linear congruential method – combined linear congruential generators – feedback shift register generators - tests for random numbers – frequency test - the Kolmogorov-Smirnov test, the chi-square test. Independence test – runs up and runs down, runs above and below the mean, autocorrelation.

UNIT-III: RANDOM VARIATE GENERATION

Inverse transform technique - exponential distribution, uniform distribution, Weibull distribution, Triangular distribution. Empirical continuous distribution - generating approximate normal variates - Erlang distribution. empirical discrete distribution - discrete uniform distribution-poisson distribution - geometric distribution - acceptance - rejection technique for poisson distribution - gamma distribution.

UNIT-IV: STAGES IN MODEL BUILDING

Input modelling **–** data collection, identifying the distribution with data, parameter estimation, goodness of fit tests, selecting input models without data, models of arrival processes. Verification and validation of simulation models **–** variance reduction techniques, antithetic variables, calibration and validation of models. output analysis – stochastic nature of output data, measures of performance and their estimation, output analysis for terminating simulation.

UNIT-V: MANUFACTURING SYSTEMS MODELING

Objectives and performance measures – modelling system randomness – sources of randomness, machine downtime – case study.

UNIT-VI: INTRODUCTION TO SIMULATION PACKAGES AND EXERCISES: Model building using SIMULATION PACKAGES.

TEXT/REFERENCE BOOKS:

1. Jerry Banks, John S, Carson II, Barry L Nelson and David M Nicol, **"Discrete Event System Simulation",** Prentice Hall Inc., 2006.
2. Law A M, **"Simulation Modeling and Analysis**", Tata McGraw Hill Companies Inc, 2008.
3. Gordon G, **"Systems Simulation**", Prentice Hall Ltd., 2006.
4. Narsingh Deo, **"System Simulation with Digital Computer**", Prentice Hall of India, 2007.
5. Francis Neelamkovil, **"Computer Simulation and Modeling**", John Wiley and Sons, 1987.
6. Ruth M Davis and Robert M O'Keefe, "**Simulation Modeling with Pascal",** Prentice Hall Inc., 1989.

LAB PRACTICE: ANY FOUR ASSIGNMENTS FROM BELOW LIST OR ANY OTHER FROM SYLLABUS	
1. Discrete and Continuous Systems	2. Random Number Generation Techniques
3. Tests For Random Numbers	4. Inverse Transform Technique
5. Empirical Discrete Distribution	6. Modelling System Randomness
7. Measures of Performance	8. Models Of Arrival Processes

OPTIMIZATION TECHNIQUES [502411-D]	
Teaching Scheme	**Examination Scheme**
Theory Lectures: 03 Hours/Week	**End Semester Examination: 100 Marks 03 Hrs**

UNIT-I:

Introduction to optimization, formulation of optimization problem, Classification of optimization problems, Optimum design of components like pins, beams, columns, shafts, spur gears, pressure vessels, etc.

UNIT-II:

Linear programming, simplex method and duality in linear programming, sensitivity or post-optimality analysis, Karmarkar's method

UNIT-III

One dimensional minimization, optimality criterion, minimum bracketing methods like exhaustive search method, bounding phase method; optimum seeking methods like interval halving, golden section search, successive quadratic estimation, Newton Raphson, bisection, secant, cubic search method

UNIT-IV:

Multivariable unconstrained optimization, optimality criteria, direct search methods like evolutionary optimization method, Powell's conjugate direction method; gradient search methods like Cauchy's method, Newton's method, conjugate gradient method and variable metric method.

UNIT-V:

Constrained Optimization, Optimality conditions, Optimization methods like penalty function method, method of multipliers, variable elimination method, complex search method, random search method, cutting plane method, feasible direction method, generalized reduced gradient method

UNIT-VI:

Geometric programming, integer programming methods like penalty function and branch and bound method

TEXT BOOKS:

1. S. S. Rao, **Engineering Optimization Theory and Practice**, New age international (P) Ltd., reprint 2003
2. Kalyanmoy Deb, **Optimization for Engineering Design**, PHI, New Delhi, 2005

3. J. S. Arora, **Introduction to Optimum Design**, McGraw Hill, New York, 1989.

REFERENCE BOOKS:

1. S. S. Stricker, **Optimizing Performance of Energy Systems,** Battelle Press, New York, 1985.
2. R.C. Johnson, **Optimum Design of Mechanical Elements**, Willey, New York, 1980.
3. L.C.W. Dixon, **Non-Linear Optimization - Theory and Algorithms**, Birkhauser, Boston, 1980.
4. R.J. Duffin, E.L. Peterson and C. Zener, **Geometric Programming-Theory and Applications**, Willey, New York, 1967.
5. G.B. Dantzig **Linear Programming and Extensions Princeton University Press**, Princeton, N. J. 1963.
6. R. Bellman, **Dynamic Programming** Princeton University Press, Princeton, N.J. 1957.

PRODUCT LIFECYCLE MANAGEMENT [502412-A]	
Teaching Scheme	**Examination Scheme**
Theory Lectures: 03 hours/week	**End Semester Examination: 100 marks 03 Hrs**

UNIT I: INTRODUCTION:

Background, Overview, Need, Benefits, and Concept of Product Life Cycle, Components / Elements of PLM, Emergence of PLM, Significance of PLM, Customer Involvement,. Threads of PLM- computer aided design (CAD), engineering data management (EDM), Product data management (PDM), computer integrated manufacturing (CIM, comparison of PLM to Engineering resource planning (ERP). PLM characteristics -singularity, cohesion, traceability, reflectiveness.

UNIT II: PRODUCT LIFE CYCLE ENVIRONMENT

Product Data and Product Workflow, The Link between Product Data and Product Workflow, Key Management Issues around Product Data and Product Workflow, Developing a PLM strategy, Strategy identification and selection, PLM System Architecture (2tier/3tier/4tier etc),

UNIT III: INTRODUCTION TO PDM

Benefits and Terminology, CIM Data, PDM functions, definition and architectures of PDM systems, Engineering data, engineering workflow and PDM acquisition and implementation, Resolving Data Issues, product data interchange, present market constraints, collaborative product development, Internet and developments in client server computing, portal integration

UNIT IV: COMPONENTS OF PDM

Components of a typical PDM setup - hardware and document management - creation and viewing of documents - creating parts-version - control of parts and documents, configuration management for product structure, change management and associated activities

UNIT V: FUNDAMENTAL CONCEPTS OF DATABASE MANAGEMENT

Introduction to DBMS, Entity-Relationship model, Relational model, SQL concepts, Object-Based databases and XML, DBMS architectures, Distributed databases, introduction to search with sample search algorithms,

UNIT VI: COMPONENTS OF PLM

Different phases of product lifecycle and corresponding technologies, Product development processes and methodologies, Foundation technologies and standards (e.g. visualization, collaboration and enterprise application integration), Information authoring tools (e.g., MCAD, ECAD, and technical publishing), Core functions (e.g., data vaults, document and content management, workflow and program management), Product organizational structure, Human resources in product lifecycle, Methods, techniques, Practices, Methodologies, Processes, System components in lifecycle, slicing and dicing the systems, Interfaces, Information, Standards, Vendors of PLM Systems and Components, Examples of PLM in use.

TEXT/REFERENCE BOOKS

1. Grieves, Michael, **Product Lifecycle Management**, McGraw-Hill, 2006. ISBN 0071452303
2. AnttiSaaksvuori, AnselmiImmonen, **Product Life Cycle Management** - Springer, 1st Edition (Nov.5, 2003)
3. Stark, John, **Product Lifecycle Management: Paradigm for 21st Century Product Realization**, Springer-Verlag, 2004. ISBN 1852338105
4. Kari Ulrich and Steven D. Eppinger, **Product Design & Development,** McGraw Hill International 1999.
5. Burden Rodger, **PDM: Product Data Management**, Resource Pub, 2003. ISBN 0970035225
6. Silberschatz, Korth and Sudarshan, **Database System Concepts**, McGraw Hill, 2002

OTHER REFERENCES

Relevant recent technical articles, research papers, key note addresses, etc.

RAPID PROTOTYPING [502412-B]	
Teaching Scheme	**Examination Scheme**
Theory Lectures: 03 hours/week	**End Semester Examination: 100 marks 03 Hrs**

UNIT–I: INTRODUCTION:

Prototyping fundamentals, Historical development, Fundamentals of Rapid Prototyping, Advantages and Limitations of Rapid Prototyping, Commonly used Terms, Classification of RP process, Rapid Prototyping Process Chain: Fundamental Automated Processes, Process Chain.

UNIT–II: LIQUID-BASED RAPID PROTOTYPING SYSTEMS

Stereo lithography Apparatus (SLA): Models and specifications, Process, working principle, photopolymers, photo polymerization, Layering technology, laser and laser scanning, Applications, Advantages and Disadvantages, Case studies. Solid ground curing (SGC): Model sand specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies

UNIT–III: SOLID-BASED RAPID PROTOTYPING SYSTEMS

Laminated Object Manufacturing (LOM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Fused Deposition Modelling (FDM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.

UNIT–IV: POWDER BASED RAPID PROTOTYPING SYSTEMS

Selective laser sintering (SLS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Three dimensional Printing (3DP): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Rapid Tooling: Introduction to Rapid Tooling (RT), Conventional Tooling Vs RT, Need for RT. Rapid Tooling Classification: Indirect Rapid Tooling Methods: Spray Metal Deposition, RTV Epoxy Tools, Ceramic tools, Investment Casting, Spin Casting, Die casting, Sand Casting, 3D Keltool process. Direct Rapid Tooling: Direct AIM, LOM Tools, DTM Rapid Tool Process, EOS Direct Tool Process and Direct Metal Tooling using 3DP.

UNIT–V: RAPID PROTOTYPING DATA FORMATS

STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs: Generic Solution, Other Translators, Newly Proposed

Formats. Rapid Prototyping Software's: Features of various RP software's like Magics, Mimics, Solid View, View Expert, 3 D View, Velocity 2, Rhino, STL View 3 Data Expert and 3 D doctor.

UNIT –VI: RP APPLICATIONS:

Application – Material Relationship, Application in Design, Application in Engineering, Analysis and Planning, Aerospace Industry, Automotive Industry, Jewelry Industry, Coin Industry, GIS application, Arts and Architecture. RP Medical and Bioengineering Applications: Planning and simulation of complex surgery, Customised Implants & Prosthesis, Design and Production of Medical Devices, Forensic Science and Anthropology, Visulization of Biomolecules.

TEXT/REFERENCE BOOKS

1. Chua C.K., Leong K.F. and LIM C.S, **Rapid prototyping: Principles and Applications, World** Scientific publications, Third Edition, 2010.
2. D.T. Pham and S.S. Dimov, **Rapid Manufacturing**, Springer , 2001
3. Wholers Report 2000 – Terry Wohlers, Wohlers Associates, 2000
4. Paul F. Jacobs, **Rapid Prototyping & Manufacturing,** ASME Press, 1996.

DATA BASE MANAGEMENT SYSTEM [502412-C]	
Teaching Scheme	**Examination Scheme**
Theory Lectures: 03 Hours/Week	**End Semester Examination: 100 Marks 03 Hrs**

UNIT-I

Introduction and E.R. Model: Purpose of database systems, Data abstraction Data models, data independent DDL, DML, DBA. Entities and entity sets. Relationships and relationship sets Mapping constraints, Primary Keys E-R diagrams, reducing E-R Diagram to tables.

UNIT-II

Relational model and relational database design: Structure of relational database, former query languages, commercial query languages. Modifying the database views. Pitfalls in relational database design and normalization.

UNIT-III

Network data model and hierarchical data model: data structure diagram, the DBTCCODASYL. Model data retrieval Update and set processing facility, Three structure diagram, data retrieval and update facility, virtual records.

UNIT-IV

File and System Structure, Indexing and Hashing: Physical storage media – file organization, buffer management, Mapping relations, networks and hierarchies to files – Index – sequential files. Bi-tree indexed files.

UNIT-V

Distributed database, security and integrity: Design, transparency and autonomy, query processing, recovery, concurrency control, deadlock handling and coordinator selection. Security and integrity, near database application.

TEXT/REFERENCE BOOKS:

1. Korth, H.F. Silbenhatz, A., **Database Concepts**, Mc Graw Hill, 1986.
2. Gio Wiederhold, **Database Design**, Mc Graw Hill, 1983.
3. Jefferey O Ullman, **Principles of database systems**.
4. C.J. Date, **An Introduction to database systems**, Addison Wisely, 1980.
5. Trembley and Soreson, **An Introduction to Data structures with applications**, Mc Graw Hills.

ROBUST DESIGN OF PRODUCT/PROCESS [502412-D]	
Teaching Scheme	**Examination Scheme**
Theory Lectures: 03 Hours/Week	**End Semester Examination: 100 Marks 03 Hrs**

UNIT-I: INTRODUCTION TO ROBUST DESIGN

Robustness Strategy & its primary tools: P-Diagram, Quality Measurement, Quality Loss Function, Signal to Noise (S/N) Ratios, Orthogonal Arrays, Steps in Robust Parameter Design. Robust design and Six-Sigma for Lean Enterprises.

UNIT-II: INTRODUCTION TO TAGUCHI'S EXPERIMENT DESIGN

Criteria for the Use of Experiment Design Methods, Applying Experiment Design Methods According To Situation; Problem Analysis and Empiric Parameter Reduction. Orthogonal Arrays, Graphical representation of factor combinations, linear graphs, Variance Analysis (ANOVA), Inner-Outer arrays Design.

UNIT-III: PARAMETER DESIGN ACCORDING TO TAGUCHI

Direct product design, indirect variance analysis, Product design with characteristic values, taking cost into account, Signal-to-noise ratio according to Taguchi.

UNIT-IV: EXPERIMENT DESIGN ACCORDING TO SHAININ

Multi-variate charts, components search, paired comparisons; Determining decisive parameters (variable search), scatter plots, randomization of experiments, B versus C test, full factorial.

UNIT-IV RESPONSE SURFACE METHODOLOGY (RSM)

Linear experiment designs, quadratic experiment designs.

TEXT/REFERENCE BOOKS:

1. J. Krottmaier, **Optimizing Engineering Design**, McGraw Hill Ltd.
2. Philip J. Ross, **Taguchi Techniques for Quality Engineering,** McGraw Hill Ltd.
3. A. Mitra, **Quality Control and Improvement**, Pearson Publications.
4. Logothetis, **TQM and Taguchi Methods,**

LAB PRACTICE: ANY FOUR ASSIGNMENTS FROM BELOW LIST OR ANY OTHER FROM SYLLABUS	
Orthogonal Arrays	2. Quality Loss Function
3. P-Diagrams	4. Taguchi Experiment Design
5. ANOVA	6. Design According to Shainin
7. Inner Outer Array Design	8. Response Surface Methodology

LAB PRACTICE-II SIMULATION & OPTIMIZATION [502413]	
Teaching Scheme	**Examination Scheme**
Theory Lectures: 06 hours/week	**Term work: 50 marks**

SIMULATION & OPTIMIZATION

Assignment on real life problems of manufacturing systems and manufacturing processes to be simulated using simulation software's as ARENA, WITNESS, FORGE, FASTFORM ADVANCED, PAMSTAMP etc.

Assignments on optimization using any process/product optimization software.

SEMINAR-II [502414]	
Teaching Scheme	**Examination Scheme**
Theory Lectures: 04 hours/week	**Term work : 50 marks**

The SEMINAR-II shall consist of few particulars amongst **literature review** based on a sizable number of publications. **Design /Development / Synthesis** related to a particular area. Implementation of existing theory for applications, pilot experiments etc. Each student is required to prepare a report and deliver a talk based on the work carried out as mini-project under the guidance of a faculty member(s). The work carried out should be preferable related to his/her dissertation topic.

SEMINAR-III [502415]	
Teaching Scheme	**Examination Scheme**
Theory Lectures: 04 hours/week	**Term work : 50 marks**

The SEMINAR-III shall consist of few particulars amongst **literature review** based on a sizable number of publications. **Design /Development / Synthesis** related to a particular area. Implementation of existing theory for applications, pilot experiments etc some where related to area of dissertation is expected. Each student is required to prepare a report and deliver a talk based on the work carried out as mini-project under the guidance of a faculty member(s). The work carried out should be preferable related to his/her dissertation topic.

DISSERTATION PART-I [502416]	
Teaching Scheme	**Examination Scheme**
Theory Lectures: 18 hours/week	**Term work : 50 marks**

The dissertation Part – I has the following two components:

1. Part Implementation of the main project
2. Proficiency Development (on a setup, software, or something relevant to the project topic)

Each component carries weight age and every student has to comply to all these components. The students will be evaluated separately for each of these components and shall be considered for collective performance in the score as Dissertation Part – I.

DISSERTATION PART-II [502417]	
Teaching Scheme	**Examination Scheme**
Theory Lectures: 18 hours/week	**Term work : 150 marks, Presentation: 50 marks**

The dissertation work shall consist of an extensive work, study or analysis of field / industrial problems with appropriate solutions or remedies. The bonafide work carried out for Dissertation Part – II should be potentially rich in terms of academics.

Dissertation Report

The project report shall be hard bound. It is a report on the work done by the student. It should have literature review, problem definition and formulation, adopted methodology, experimentation plan if any, results, conclusions, discussion and its relevance to the further work.

Examination

The viva-voce examination of the Dissertation Part – II shall consist of a presentation by the candidate and demonstration of the work carried out.