FACULTY OF ENGINEERING

SYLLABUS FOR

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

W.E.F. 2012-2013

UNIVERSITY OF PUNE
### M.E. [MECHANICAL] –[COMPUTER AIDED DESIGN, MANUFACTURE & ENGINEERING] [CADME]

<table>
<thead>
<tr>
<th>CODE</th>
<th>SUBJECT</th>
<th>TEACHING SCHEME</th>
<th>EXAMINATION SCHEME</th>
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<td>Theory</td>
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#### Semester- II

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#### Semester- III

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**Elective I**
- A. Material for Engineering Applications
- B. Advanced Manufacturing Processes
- C. Customization of CAD/CAM Software’s
- D. CAD/CAM Practices in Metal Forming

**Elective II**
- A. Finite Element Analysis
- B. Integrated Product Design & Development
- C. Computational Fluid Dynamics
- D. Robotics

**Elective III**
- A. Design for X
- B. Automated Manufacturing System Modeling
- C. Simulation and Modelling
- D. Optimization Techniques

**Elective IV**
- A. Product Lifecycle Management
- B. Rapid Prototyping
- C. Data Base Management System
- D. Robust Design of Product/Process
- E. Open Elective
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**


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<th><strong>LAB PRACTICE:</strong> ANY FOUR ASSIGNMENTS FROM BELOW LIST OR ANY OTHER FROM SYLLABUS</th>
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<tbody>
<tr>
<td>1. Elasticity Problems In 3D</td>
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<td>3. Energy Methods</td>
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<td>7. Gear Design</td>
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UNIT-I: BOUNDARY VALUE PROBLEMS AND APPLICATIONS

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

UNIT-IV: NUMERICAL METHODS

UNIT-V: COMPUTER METHODS IN MECHANICAL ENGINEERING

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

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:

UNIT VI: COLLABORATIVE ENGINEERING:

**TEXT/REFERENCE BOOKS:**


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
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: CERMICS
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
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:**

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

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
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.
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)

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<tbody>
<tr>
<td>1. Scripts &amp; Macros</td>
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<tr>
<td>5. Automated Solid Modelling</td>
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<td>7. Automated Drafting</td>
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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

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

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:

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<td>1.</td>
<td>Stress and deflection (small &amp; large) study of short and long beams with different end conditions and cross-sections subjected to different loading conditions (i.e., point load – force &amp; moment, distributed load etc)</td>
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<tr>
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<td>2. Stress and deflection (small &amp; 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 &amp; moment, distributed load etc)</td>
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<td>Stress analysis of rotating disc (solid and hollow discs)</td>
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<td>Large scale deformation of hyperelastic material</td>
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<td>Buckling mode analysis of a thin shell cylinder</td>
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<td>Design of machine elements like shaft, gear, bearing etc</td>
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UNIT-I: COLLABORATIVE PRODUCT DESIGN

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:


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<td>5. Product Tear Down</td>
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<td>7. Concept Generation &amp; Design</td>
<td>8. Physical Prototyping</td>
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</table>
UNIT-I: BASIC CONCEPTS

UNIT-II: PARTIAL DIFFERENTIAL EQUATIONS

UNIT-III: GRID GENERATION

UNIT-IV: FINITE DIFFERENCE SOLUTIONS

UNIT- V: FINITE VOLUME METHODS

UNIT- VI: TURBULENCE MODELING
Turbulence energy equation- one-equation model, the k-ω model, the k- ε model
TEXT/REFERENCE BOOKS:

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 Lagrangian 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:**

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.

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.
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

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:**

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 MANUFACTURING
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:

| LAB PRACTICE: ANY FOUR ASSIGNMENTS FROM BELOW LIST OR ANY OTHER FROM SYLLABUS |
|---------------------------------------------|-----------------------------|
| APT Programming                            | 2. Controllers              |
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

REFERENCE BOOKS:
5. Scolz B. Reiter *C.I.M Interfaces* Chapman & Hall 1992
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

REFERENCE BOOKS:
3. Assembly Automation and Product Design, Geoffrey Boothroyd, Marcel Dekker, Inc,
5. Swift and Booker, Process section from Design to Manufacturing, Butterworth Heinemann
<table>
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<tr>
<th>LAB PRACTICE: ANY FOUR ASSIGNMENTS FROM BELOW LIST OR ANY OTHER FROM SYLLABUS</th>
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<tbody>
<tr>
<td>Design for Failure Methods &amp; Analysis</td>
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<td>3. Design for Assembly</td>
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<td>7. Design for Reliability/Cost</td>
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</tbody>
</table>
UNIT-I: INTRODUCTION

UNIT-II: AUTOMATED MANUFACTURING SYSTEMS

UNIT-III: MARKOV CHAIN MODELS

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

REFERENCE BOOKS:

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<tr>
<td>5. Semi-Markov Processes</td>
<td>6. The M/M/1 Queue &amp; M/M/m Queue</td>
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</tbody>
</table>
UNIT-I: INTRODUCTION TO SIMULATION

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

UNIT-IV: STAGES IN MODEL BUILDING

UNIT-V: MANUFACTURING SYSTEMS MODELING

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

**TEXT/REFERENCE BOOKS:**


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<th><strong>LAB PRACTICE:</strong> ANY FOUR ASSIGNMENTS FROM BELOW LIST OR ANY OTHER FROM SYLLABUS</th>
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<tbody>
<tr>
<td>1. Discrete and Continuous Systems</td>
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<tr>
<td>3. Tests For Random Numbers</td>
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</table>
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:

**REFERENCE BOOKS:**


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**


**OTHER REFERENCES**

Relevant recent technical articles, research papers, key note addresses, etc.
UNIT–I: INTRODUCTION:

UNIT–II: LIQUID-BASED RAPID PROTOTYPING SYSTEMS

UNIT–III: SOLID-BASED RAPID PROTOTYPING SYSTEMS

UNIT–IV: POWDER BASED RAPID PROTOTYPING SYSTEMS

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

UNIT –VI: RP APPLICATIONS:

TEXT/REFERENCE BOOKS
UNIT-I

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

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:
UNIT-I: INTRODUCTION TO ROBUST DESIGN


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:

3. A. Mitra, Quality Control and Improvement, Pearson Publications.
4. Logothetis, TQM and Taguchi Methods,
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.

LAB PRACTICE: ANY FOUR ASSIGNMENTS FROM BELOW LIST OR ANY OTHER FROM SYLLABUS

<table>
<thead>
<tr>
<th>Orthogonal Arrays</th>
<th>2. Quality Loss Function</th>
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<tr>
<td>3. P-Diagrams</td>
<td>4. Taguchi Experiment Design</td>
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<tr>
<td>5. ANOVA</td>
<td>6. Design According to Shainin</td>
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<td>7. Inner Outer Array Design</td>
<td>8. Response Surface Methodology</td>
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LAB PRACTICE-II SIMULATION & OPTIMIZATION [502413]

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<tr>
<th>Teaching Scheme</th>
<th>Examination Scheme</th>
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<tbody>
<tr>
<td>Theory Lectures: 06 hours/week</td>
<td>Term work: 50 marks</td>
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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]

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<tr>
<th>Teaching Scheme</th>
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<tr>
<td>Theory Lectures: 04 hours/week</td>
<td>Term work : 50 marks</td>
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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.
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.

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<th>SEMINAR-III [502415]</th>
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<tr>
<td>Teaching Scheme</td>
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<td>Theory Lectures: 04 hours/week</td>
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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.

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<th>DISSERTATION PART-I [502416]</th>
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<tr>
<td>Teaching Scheme</td>
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<td>Theory Lectures: 18 hours/week</td>
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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.