BharatiVidyapeeth University
College of Engineering
Department of Mechanical Engineering
M.Tech. (CAD/CAM) CBCS 2015 Course

Semester I	Total Duration: 24 Hrs/Week Total Marks: 500 Total Credits: 20

Subjects	Teaching Scheme (Hrs) Hrs/Week		Examination Scheme (Marks)						Examination Scheme (Credits)		Total Credits
	L	P	Theory	Unit Test	Atten dance	Tutorial /Assign ments	TW	Pract/ Orals	TH	TH/ PR/ OR	
Computer Aided Design	4	4	60	20	10	10	-	50	4	2	6
Modeling and Simulation	4	4	60	20	10	10	-	50	4	2	6
Computer Integrated Manufacturing	4	-	60	20	10	10	-	-	4	-	4
Product Design and Development	4	-	60	20	10	10	-	-	4	-	4
Total	16	8	240	80	40	40	-	100	16	4	20

Semester II	Total Duration: 24 Hrs/Week Total Marks: 500 Total Credits: 20

Subjects	Teaching Scheme (Hrs) Hrs/Week		Examination Scheme (Marks)						Examination Scheme (Credits)		Total Credits
	L	P	Theory	Unit Test	Atten dance	Tutorial /Assign ments	TW	Pract/ Orals	TH	TH/ PR/ OR	
Advanced Finite Element Methods	4	4	60	20	10	10	-	50	4	2	6
Control Systems	4	4	60	20	10	10	-	50	4	2	6
Precession Engineering	4	-	60	20	10	10	-	-	4	-	4
Optimization for Engineering Design	4	-	60	20	10	10	-	-	4	-	4
Total	16	8	240	80	40	40	-	100	16	4	20

Semester III

Total Duration:24 Hrs/Week
Total Marks:375
Total Credits:34

Subjects	Teaching Scheme (Hrs) Hrs/Week		Examination Scheme (Marks)						Examination Scheme (Credits)		Total Credits
	L	P	Theory	Unit Test	Atten dance	Tutorial /Assign ments	TW	Pract/ Orals	TH	TH/ PR/ OR	
Elective I	4	-	60	20	10	10	-	-	4	-	4
Elective II	4	-	60	20	10	10	-	-	4	-	4
Self-Study paper I	4	-	60	20	10	10	-	-	4	-	4
Dissertation Stage I	-	7	-	-	-	-	25	25	-	15	15
Seminar	-	5	-	-	-	-	25	-	-	7	7
Total	12	12	180	60	30	30	50	25	12	22	34

Elective I

1. Advanced Stress analysis
2. Manufacturing Information Systems
3. Computational Fluid Dynamics
4. Micro-electro Mechanical Systems

Elective II

1. Composite Materials
2. Analysis and Synthesis of Mechanisms
3. Artificial Intelligence
4. Design of Experiment

Self-Study Paper I

1. Advanced Manufacturing Processes
2. Machine Condition Monitoring and Diagnostics
3. Product Lifecycle Management
4. Robust Design of Product & Process
5. Computer Aided Process Planning
6. Flexible Manufacturing System
7. Product Design & Process Planning
8. Experimental Technique and Data analysis
9. Tribology in Design
10. Manufacturing System and Simulation

Semester IV

Total Duration: 14 Hrs/Week
Total Marks: 325
Total Credits:36

Subjects	Teaching Scheme (Hrs) Hrs/Week		Examination Scheme (Marks)						Examination Scheme (Credits)		Total Credits
	L	P	Theory	Unit Test	Atten dance	Tutorial /Assign ments	TW	Pract/ Orals	TH	TH/ PR/ OR	
Self-Study paper II	4	-	60	20	10	10	-	-	4	-	4
Dissertation Stage II	-	10	-	-	-	-	150	75	-	32	32
Total	4	10	60	20	10	10	150	75	4	32	36

Self-Study Paper II

1. CAD/CAM Practices in Metal Forming
2. Optimization Techniques
3. Robotics and Sensors
4. Rapid Prototyping
5. Design for Manufacture
6. Theory of Elasticity & Plasticity
7. Design of Dies
8. Integrated Product Design & Development
9. Design for Manufacturing & Assembly
10. Concurrent Engineering

Computer Aided Design

TEACHING SCHEME

Lectures : 04 Hrs/week
Practicals : 04 Hrs/week

EXAMINATION SCHEME

Theory : 60 Marks
Duration : 03 Hours
Internal Assessment : 40 Marks
Pract/Oral : 50 Marks
Total Credits : 06

Unit I (08 Hours)

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 (08 Hours)

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 (08 Hours)

SURFACE MODELING

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 (08 Hours)

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 (08 Hours)

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 (08 Hours)

COLLABORATIVE ENGINEERING:

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

Text Books/ References

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 McGraw Hill-1992.

Termwork

Eight Assignments using either of UG, SolidWorks, CATIA, ProE, Hyperwork

Syllabus for Unit Test

Unit Test I	Unit I,II,III
Unit Test II	Unit IV,V,VI

Modeling and Simulation

TEACHING SCHEME

Lectures : 04 Hrs/week
Practicals : 04 Hrs/week

EXAMINATION SCHEME

Theory : 60 Marks
Duration : 03 Hours
Internal Assessment : 40 Marks
Pract/Oral : 50 Marks
Total Credits : 06

Unit I (08 Hours)

System Concept and Modeling

Physical model, Mathematical model, Types of mathematical model, Dynamic Versus Static Models, Continuous-Time Versus Discrete-Time, Dynamic Models, Quantitative Versus Qualitative Models, Mechanical system modeling examples.

Simulation Basics,When Simulation Is the Appropriate Tool, when Simulation Is Not Appropriate, Advantages and Disadvantages of Simulation, Areas of Application, Steps in a Simulation Study

Unit II (08 Hours)

Simulation Concepts

Simulation Basics, When Simulation Is the Appropriate Tool, when Simulation Is Not Appropriate, Advantages and Disadvantages of Simulation, Areas of Application, Steps in a Simulation Study

Simulation and analytical methods, Basic nature of simulation, The simulation process, Types of system simulation, Generation of random numbers .Monte Carlo Simulation.

Unit III (08 Hours)

Probability as Used in Simulation

Basic Probability Concepts, Discrete Random Variable, Expected Value and Variance of a Discrete Random Variable, Measure of Probability Function, Continuous Random Variable, Exponential Distribution, Mean and Variance of Continuous Distribution, Normal Distribution.

Unit IV (08 Hours)

System Simulation

Introduction, Simulation of Pure pursuit problem, exponentional growth model, simulation of water reservoir system, Trajectory simulation, suspension system, simulation of pendulum.

Unit V (08 Hours)

Simulation Models

Discrete Simulation, Continuous System Simulation. Simulation of Queuing Systems, Inventory Control Models

Unit VI (08 Hours)

Design and Evaluation of Simulation Experiments.

Introduction, development of simulation experiments, principles of verification, validation and accreditation, Simulation experimentation, classical experimental design, validation of simulation experiments, evaluation of simulation experiments.

Simulation Languages

Text Books/ References

1. Robert E. Shannon, “System Simulation The art and science”, , Prentice Hall, New Jersey, 1995.
2. D.S. Hira, “System Simulation”, S.Chand and company Ltd, New Delhi, 2001.
3. Geoffrey Gordon ,System Simulation; Prentice Hall.
4. Robert E. Shannon ; System Simulation: The Art and Science ;Prentice Hall
5. J. Schwarzenbach and K.F. Gill Edward Arnold; System Modelling and Control

6. M Close and Dean K. Frederick; Modeling and Analysis of Dynamic Systems ;Houghton Mifflin

Term Work

1. Simulation of water reservoir system.
2. Trajectory simulation.
3. Suspension system.
4. Simulation of pendulum.
5. Discrete Simulation,
6. Continuous System Simulation.
7. Simulation of Queuing Systems,
8. Inventory Control Models

Syllabus for Unit Test

Unit Test I	Unit I,II,III
Unit Test II	Unit IV,V,VI

Computer Integrated Manufacturing

TEACHING SCHEME

Lectures : 04 Hrs/week

EXAMINATION SCHEME

Theory : 60 Marks
Duration : 03 Hours
Internal Assessment : 40 Marks

Total Credits : 04

Unit I (08 Hours)

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 (08 Hours)

CIM DATABASE

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

Unit III (08 Hours)

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 (08 Hours)

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 (08 Hours)

WEB BASED MANUFACTURING

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

Unit VI (08 Hours)

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.

Text Books/ References

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

Syllabus for Unit Test

Unit Test I	Unit I,II,III
Unit Test II	Unit IV,V,VI

Product Design And Development

TEACHING SCHEME		EXAMINATION SCHEME	
Lectures	: 04 Hrs/week	Theory	: 60 Marks
		Duration	: 03 Hours
		Internal Assessment	: 40 Marks
		Total Credits	: 04

Unit I (08 Hours)

Introduction

Characteristics of successful product development, Design and development of products, duration and cost of product development, the challenges of product development.
Development Processes and Organizations: A generic development process, concept development: the front-end process, adopting the generic product development process, the AMF development process, product development organizations, the AMF organization.

Unit II (08 Hours)

Product Planning

The product planning process, identify opportunities. Evaluate and prioritize projects, allocate resources and plan timing, complete pre project planning, reflect all the results and the process. Identifying Customer Needs: Gather raw data from customers, interpret raw data in terms of customer needs, organize the needs into a hierarchy, establish the relative importance of the needs and reflect on the results and the process.
Product Specifications: What are specifications, when are specifications established, establishing target specifications, setting the final specifications.

Unit III (08 Hours)

Concept Generation

The activity of concept generation clarify the problem, search externally, search internally, explore systematically, reflect on the results and the process.
Concept Selection: Overview of methodology, concept screening, and concept scoring,
Concept Testing: Define the purpose of concept test, choose a survey population, choose a survey format, communicate the concept, measure customer response, interpret the result, reflect on the results and the process.

Unit IV (08 Hours)

Product Architecture

What is product architecture, implications of the architecture, establishing the architecture, variety and supply chain considerations, platform planning, related system level design issues.

Unit V (08 Hours)

Industrial Design

Assessing the need for industrial design, the impact of industrial design, industrial design process, managing the industrial design process, assessing the quality of

	industrial design. Design for Manufacturing: Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, impact of DFM on other factors. Prototyping: Prototyping basics, principles of prototyping, technologies, planning for prototypes.		
Unit VI			(08 Hours)
Product Development Economics			
	Elements of economic analysis, base case financial mode,. Sensitive analysis, project trade-offs, influence of qualitative factors on project success, qualitative analysis. Managing Projects: Understanding and representing task, baseline project planning, accelerating projects, project execution, postmortem project evaluation.		
Text Books/ References			
	1. Product Design and Development - Karl.T.Ulrich, Steven D Eppinger - Irwin McGrawHill - 2000. 2. Product Design and Manufacturing - A C Chitale and R C Gupta, PH1, - 3rd Edition, 2003. 3. New Product Development - Timjones. Butterworth Heinmann -Oxford. UCI -1997 4. Product Design for Manufacture and Assembly - Geoffery Boothroyd, Peter Dewhurst and Winston Knight - 2002		
Syllabus for Unit Test			
	Unit Test I	Unit I,II,III	
	Unit Test II	Unit IV,V,VI	

Semester II

K60504: ADVANCE FINITE ELEMENT METHOD

TEACHING SCHEME		EXAMINATION SCHEME	
Lectures	: 04 Hrs/week	Theory	: 60 Marks
Practicals	: 02 Hrs/week	Duration	: 03 Hours
		Internal Assessment	: 40 Marks
		Term Work	: 25 Marks
		Pract/Oral	: 25 Marks
		Total Credits	: 05

Unit I		(08 Hours)
	Basic concepts of FEM, Weak formulation, Variational methods of approximation-Rayleigh Ritz Method, Stress strain relations, shape functions- linear and quadratic. Approximation errors in FEM, Accuracy of solution, p & h refinement	
Unit II		(08 Hours)
	One dimensional problems – Finite element modeling, Basic boundary condition, Multipoint constraints, Convergence of results , Potential energy approach, Global stiffness matrix, properties of stiffness matrix, load vector, Penalty approach, Elimination approach, Methods of Weighted Residuals-Least Square Method, Subdomain Method, Collocation Method, Garlekin's method.	
Unit III		(08 Hours)
	Finite Element Analysis of 2-D problems. Basic boundary value problems in 2-D, Triangular, Quadrilateral, Higher order elements. Constant strain triangle. Introduction to plate bending problems. Kirchhoff's theory, Mindlin plate element.	
Unit IV		(08 Hours)
	Isoparametric formulation – Natural Co-ordinate system, Lagrangian interpolation polynomials, Isoperimetric element, Numerical Integration Newton Cotes formula, Guass Quadrature formula in two and three dimensions, triangular elements, rectangular elements.	
Unit V		(08 Hours)
	Dynamic Analysis, Formulation of Dynamic problems, Consistent and Lumped Mass Matrices. Solution of Eigen Value Problems. Transformation Method, Jacobi Method, Vector Iteration Method, Subspace Iteration Method. Forced Vibration- Steady State and Transient vibration analysis, Analysis of damping, Mode of Super position Scheme, Direct Integration Method, Implicit and Explicit numerical methods.	
Unit VI		(08 Hours)
	Special Topics: - Linear Buckling Analysis, Adaptive Finite Element Technique .Sub modeling and substructuring. .	

Term Work	
	Term work shall consists of three assignment based on above syllabus. Four computer program assignments to be developed for FEA. Using programming language. Two assignment of structural Analysis using FEA Software
Oral/Practical	
	Term work and Oral will be based on above syllabus.
Text Books/ References	
	1. K. J. Bathe, "Finite Element Procedures", PHI 2. R. D. Cook, D. S. Malus, M. E. Plesha, "Concepts and Applications of Finite Element Method Analysis", John Wiley 3. J. N. Reddy, "An introduction to Finite Element Method Analysis", MGH 4. Desai & Abel, "Introduction to Finite Element Methods" 5. S. Riaseleharan, "FEA in Engineering Design" 6. D. L. Logan, "A course in the Finite Element Method", Third Edition, Thomson Learning 7. T. R. Chandrupatia, A. D. Belegundu, "Introduction to Finite Elements in Engineering", Third Edition, PHI 8. Seshu P, "Text Book of Finite Element Analysis", PHI Learning Pvt..Ltd. New Delhi.
Syllabus for Unit Test	

	Unit Test I	Unit I,II,III	
	Unit Test II	Unit IV,V,VI	

Control Systems

TEACHING SCHEME		EXAMINATION SCHEME	
Lectures	: 04 Hrs/week	Theory	: 60 Marks
Practicals	: 04 Hrs/week	Duration	: 03 Hours
		Internal Assessment	: 40 Marks
		Pract/Oral	: 50 Marks
		Total Credits	: 06

Unit I (08 Hours)

Introduction to Control System

Introduction to control systems. Classification of control system, basic characteristic of feedback control systems. Mathematical modeling of control systems, concept of transfer function. Basic control actions:-On-Off Control, Proportional, Integral, Derivative and PID, Feedback and feed forward control system and their applications.

Unit II (08 Hours)

Time Response Analysis of Control System

Time response analysis: Time response of control system, standard test signal, Time Response Analysis of First and Second order system, Time Domain specifications. Step response of second order system. Steady-state errors, static error constants, steady state, analysis of different type of Systems using step. Ramp and parabolic inputs.

Unit III (08 Hours)

Control System Stability Analysis

Classification of control systems according to types of systems, Stability Analysis: Introduction to concepts of stability. The Routh-Hurwitz's Stability criteria. Stability in the sense of Lyapunov and absolute stability, autonomous systems, the invariance principle, linear systems and linearization, non autonomous systems, linear time varying systems and linearization.

Unit IV (08 Hours)

Root Locus and Frequency Response Methods

Frequency Response Analysis, Frequency domain specifications Correlation between time and frequency response. Polar Plots. Bode Plots, Nyquist Plots stability in frequency domain,
frequency domain methods of design, compensation and their realization in time and frequency domain, improving system performance.

Unit V (08 Hours)

State Space Modeling

Concept of state, state variable, state model State space method. State space representation using physical and phase variables, decomposition of transfer function, diagonalisation. solutions of homogeneous and non homogenous equations, zero and pole placement using state space techniques. Transfer function from state model. Controllability and observabilty of linear system. State transition matrix, state controllability matrix, state observabilty matrix.

Unit VI (08 Hours)

Non-Linear Control Systems

Discrete time systems and Z-Transformation methods, State space analysis, Optimal and adaptive control systems, Non-Linear Systems Phase plane analysis: Phase portraits, Singular points characterization. Compensation (Introduction only): Types of compensator, selection of Compensator, Lead, Lag and Lag-Lead compensation. Control system Components : servomotor, stepper motors, Synchros, Potentiometer, amplifiers

Text Books/ References			
	1. Control System Engineering: by Nagrath LT. and Gopal .M., Wiley Eastern Lid. 2. Modem Control engineering: by K.Ogata, Prentice Hall. 3. Benjamin C. Kuo, Automatic Control Systems, Pearson education, seventh edition. 4. Madan Gopal, Control Systems Principles and Design, Tata McGraw Hill, seventh edition, 1997 5. Nise, control system Engineering, John wiley& sons, 3rd edition 6.Norman Nise,‖Control System Engineering‖, Prentice Hall India, Fourth Edition 7. Anand Kumar, ―Control System Theory‖, Prentice Hall India. 8. M.Vidyasagar, "Nonlinear systems analysis", Second Edition, Prentice Hall, 1993 9. H.Khalil, "Nonlinear Systems", Macmillan Publishing Company, NY, 1992. 10.A. Isidori, ―Nonlinear Control Systems‖ 3rd edition, Springer Verlag, London, 1995. 11. Jack Golten, Andy Verwer, "Control System Design and Simulation", McGraw Hill 12. F.H.Raven,"Automatic Control Engineering", Third edition, McGraw Hill, 1983. 13. Schaum Series," Theory and Problems of Feedback and Control Systems". (MGH) 14. Dr.N.K.Jain,"Automatic Control Systems Engineering", Dhanpat Rai Publishing Company.		
Term Work			
	Two Experiments on PID controller Four computer based assignments using MATLAB		
Syllabus for Unit Test			
	Unit Test I	Unit I,II,III	
	Unit Test II	Unit IV,V,VI	

Precession Engineering

TEACHING SCHEME		EXAMINATION SCHEME	
Lectures	: 04 Hrs/week	Theory	: 60 Marks
		Duration	: 03 Hours
		Internal Assessment	: 40 Marks
		Total Credits	: 04

Unit I (08 Hours)

Concepts Of Accuracy

Introduction - concept of accuracy of machine tools - spindle and displacement accuracies - Accuracy of numerical control systems - Errors due to numerical interpolation - Displacement measurement system and velocity lags.

Unit II (08 Hours)

Geometric Dimensioning And Tolerancing

Interpretation, measurement and application of form tolerances - datum system and targets – tolerance of position Tolerance zone conversions - Surfaces, features, features of size, datum features-Datum, oddly configured and curved surfaces as datum features, equalizing datum.

Unit III (08 Hours)

Surface and form metrology

Flatness, roughness, waviness cylindricity etc. Methods of improving accuracy & surface finish, Influence of forced vibration on accuracy, Dimensional wear of cutting tools and its influences on accuracy

Unit IV (08 Hours)

Precision Measuring Systems

Units of length - legal basis for length measurement – Traceability - Processing system of nanometer accuracies - LASER light source - LASER interferometer - LASER alignment telescope - LASER micrometer-on-line and in-process measurements of diameter and surface roughness using LASER - Micro holes and topography measurements -.- In processing or in-situ measurement of position of processing point-Post process and on-machine measurement of dimensional features and surface-mechanical and optical measuring systems. Straightness and flatness measurement – Optoelectronic Measurement Systems in Metrology, Opto electronic devices contact and non contact types Applications - Tool wear measurement - 3D Surface roughness - Pattern generation studies.

Unit V (08 Hours)

Nano-Positioning Systems Of Nano Accuracy & Repeatability

Guide systems for moving elements - Servo control systems for tool positioning - Computer Aided digital and ultra precision position control.

Unit VI (08 Hours)

Computer Integrated Quality Assurance

Concept of Total quality control & quality assurance - Zero defects-POKA-YOKE Statistical evaluation of data using computer- CNC CMM applications - Computer Aided measurement, data integration of 3D-CMM

Text Books/ References

1. MURTHY,R.L., - " Precision Engineering in Manufacturing ", New ageInternational(P) Limited, publishers, 1996.

2. JAMESD. MEADOWS, - “Geometric Dimensioning and Tolerancing ", Marcel Dekker Inc.1995.
3. “Dimensioning and tolerancing of mass production”, Prentice Hall, 1983
4. WATSON .J., " Optoelectronics " - Van Nostrand Rein hold(UK)Co ltd.,1988
5. ROBERT.G. SEIPPEL, - “Optoelectronics for technology and engineering ", Prentice Hall NewJersey,1989
6. ULRICH-REMBOLD, ARMBRUSTER AND ULZMANN-" Interface technology for computer controlled manufacturing processes ", Marcel Dekker Pub. New York, 1993
7. Engg.Metrlogy by Shotbolt.
8. THOMAS.G.G. - “Engineering metrology", Butterworth PUB.1974.
9. NORIO TANIGUCHI, - " Nano Technology ", Oxford university,Press,1996.

Syllabus for Unit Test

	Unit Test I	Unit I,II,III	
	Unit Test II	Unit IV,V,VI	

Optimization for Engineering Design

TEACHING SCHEME		**EXAMINATION SCHEME**	
Lectures	: 04 Hrs/week	Theory	: 60 Marks
		Duration	: 03 Hours
		Internal Assessment	: 40 Marks
		Total Credits	:04

Unit I		(08 Hours)
Introduction		
	Optimal problem formulation-Design variables, constraints, objective function, variable bound. Engineering optimization problems, Optimization algorithms	
Unit II		(08 Hours)
Single Variable Optimization		
	Optimality criteria, Bracketing methods, region elimination method, point estimate method, gradient based method, root finding using optimization techniques.	
Unit III		(08 Hours)
Multivariable Optimization		
	Optimality criteria, unidirectional search, direct search method- evolutionary optimization, simplex search, Hooke-Jeeves pattern search method, gradient based methods,-steepest descent method, Newton's method, Marquardt's method.	
Unit IV		(08 Hours)
Constrained Optimization		
	Kuhn-Tucker conditions, transformation methods, sensitivity analysis, direct search for constrained minimization, linearized search techniques, feasible direction method.	
Unit V		(08 Hours)
Specialized Algorithms		
	Integerprogramming, penaltyfunction, branch-and-bound method Geometric programming	
Unit VI		(08 Hours)
Nontraditional Optimization		
	Genetic algorithm, simulated annealing, global optimization using steepest descent, genetic algorithm and simulated annealing.	

Text Books/ References

1. Optimization for Engineering Design: Algorithms and Examples-Kalyanmoy Deb, PHI Learning Pvt. Ltd., 2004
2. Optimization Concepts and Applications in Engineering-Ashok D. Belegundu, Tirupathi R. Chandrupatla, Cambridge University Press, 2011
3. An Introduction to Numerical Methods and Optimization Techniques-Richard W. Daniels, North-Holland, 1978
4. Optimization: theory and applications-S. S. Rao, Wiley Eastern, 1979

Syllabus for Unit Test

	Unit Test I	Unit I,II,III	
	Unit Test II	Unit IV,V,VI	

Semester III

Elective I : Advanced Stress analysis

TEACHING SCHEME		**EXAMINATION SCHEME**	
Lectures	: 04 Hrs/week	Theory	: 60 Marks
		Duration	: 03 Hours
		Internal Assessment	: 40 Marks
		Total Credits	: 04

Unit I	(08 Hours)
Theory of Elasticity	
	Elasticity problems in two dimensions - stress strain relationship for brittle materials, ductile materials. Compatibility equations in two and three dimensions, free body diagram of complicated structures and stress calculations, stress functions in rectangular and cylindrical coordinate systems, evaluation of stresses in flat rectangular plates with different clamp and load conditions evaluation of the stresses in the flat and circular plate with center hole/holes using stress function
Unit II	(08 Hours)
Theory of Plasticity	
	Different criterions for three dimensional stress analysis using plasticity, evaluation of stress concentration factors in different geometries using plasticity theorem, practical problems on stress analysis for plasticity-stress in the sharp groove of the shaft, stress in the L shaped bracket under cantilever load, strain rate effects on highly deformable materials and stress calculations.
Unit III	(08 Hours)
Stress Analysis of Engineering Plastics and Composites	
	Types of engineering plastics (Nylon, ABS, PP) failure modes, failure phenomenon in two and three dimensional stress analysis, wear and tear of plastics, impact properties of plastics, types of composites (fiber reinforced plastics), evaluation of elastic properties of composites, stress analysis of composite circular tubes (internal and external pressure), flat plate fixed at the edges and concentrated load, uniformly distributed load
Unit IV	(08 Hours)
Plate bending	
	Bending of plate to cylindrical surface, bending of a long uniformly loaded rectangular plate, pure bending in two perpendicular directions, bending of circular plates loaded symmetrically w.r.t. center, bending of circular plates of variable thickness, circular plate with circular hole at center symmetrically loaded and load distributed along inner and outer edges
Unit V	(08 Hours)
Contact stresses	
	Geometry of contact surfaces, method of computing contact stresses and deflection of bodies in point contact, stress for two bodies in line contact with load normal to contact area and load normal and tangent to contact area, gear contacts, contacts between cam and follower, ball bearing contacts
Unit VI	(08 Hours)
Experimental stress analysis	
	Dimensional analysis, analysis techniques, strain gauges, types of strain gauges, materials, configuration, instrumentation, characteristics of strain gauge measurement, theory of photoelasticity, elements of polariscope, simple and circular polariscope, fringes in dark and white field, isoclinic and isochromatic fringe patterns, evaluation of stresses from these fringe patterns

Text Books/ References			
	1. Advanced Mechanics of Materials – Cook and Young, Prentice Hall 2. Advanced Strength and Applied Stress Analysis – Richard G. Budynas, McGraw Hill 3. Advanced Mechanics of Materials – Boresi, Schmidt, Sidebottom, Willey 4. Theory of Elasticity – Timoshenko and Goodier, Mc Graw Hill 5. Advanced Strength of Materials, Vol. 1, 2 – Timoshenko, CBS 6. Advanced Strength of Materials – Den Harteg 7. Experimental Stress Analysis – Dally & Riley 8. Theory of Plates and Shells – Timoshenko Mc Graw Hill 9. The Mathematical Theory of Plasticity - R. Hill, Oxford University Press, 1998		
Syllabus for Unit Test			
	Unit Test I	Unit I,II,III	
	Unit Test II	Unit IV,V,VI	

Elective I: Management Information Systems

TEACHING SCHEME

Lectures : 04 Hrs/week

EXAMINATION SCHEME

Theory : 60 Marks
Duration : 03 Hours
Internal Assessment : 40 Marks
Total Credits : 04

Unit I (08 Hours)

Knowledge based system, Introduction, Development of data base and knowledge bases, knowledge representing paradigms – rule based, object oriented, semantic nets and frames, uncertainty, fuzzy logic, neural nets.

Unit II (08 Hours)

Interference mechanism, goals, control strategies forward and backward chaining, conflict resolution, explanation, blackboard model.

Unit III (08 Hours)

Implementation issues: knowledge acquisition, coding, expert system shells, PROLOG, and LISP

Unit IV (08 Hours)

Selected applications in manufacturing: product design, process planning and scheduling, robot movement, factory layout, defect analysis, diagnostic maintenance, quality control.

Unit V (08 Hours)

Knowledge based approaches for engineering design, blackboard architecture, other knowledge based approaches.

Unit VI (08 Hours)

Artificial intelligence.

Term Work

Three case studies from the following

- Ÿ Information and knowledge requirement in Manufacturing Function
- Ÿ Inventory control systems
- Ÿ Production Planning and Control System – Scheduling and capacity requirement calculation.
- Ÿ Design information systems.

Oral/Practical

Based on above termwork.

Text Books/ References

1. Kerr R., ”Knowledge Based Manufacturing Management”, Addision Wiley, 1991
2. Ÿ Addis T. R., ”Designing Knowledge Based System”, Prentice Hall, 1985
3. Ÿ Roltson D. W., ”Principles of Artificial Intelligence and Expert Systems Development”, McGraw Hill Publications, 1988
4. Ÿ Chung P. W. H., Love Grove G., “Industrial Engineering Applications of AI and Expert Systems”, Gordon & Breach Science Pub., 1993
5. Ÿ Maus R. and Keyes J., “Hand Book of Expert Systems in Manufacturing”, McGraw Hill Publications, 1991
6. Ÿ C. S. Krishnamurthy, S. Rajeev, “Computer Aided Design” Narosa Pub. House

Syllabus for Unit Test

Unit Test I	Unit I,II,III
Unit Test II	Unit IV,V,VI

Elective I: Computational Fluid Dynamics

TEACHING SCHEME

Lectures : 04 Hrs/week

EXAMINATION SCHEME

Theory : 60 Marks
Duration : 03 Hours
Internal Assessment : 40 Marks
Total Credits : 04

Unit I (08 Hours)

Introduction to Fluid Dynamics, Concepts of Fluid Flow, Pressure distribution in fluids, Reynolds transport theorem, Integral form of conservation equations, Differential form of conservation equations, Different Types of Flows, Euler and Navier Stokes equations, Properties of supersonic and subsonic flows, Flow characteristics over various bodies.

Unit II (08 Hours)

Geometric Modeling and CAD Repairing Geometric transformations, Parametric representation of curves and surfaces, Concept of topology, Surface modeling, Faceted models, Solid modeling. Creation of water tight geometry, Faceted Boolean operations, Dependent and independent CAD errors.

Unit III (08 Hours)

Introduction to CFD, Philosophy of CFD, Governing equations of fluid dynamics and there physical meaning, Mathematical behavior of governing equations and the impact on CFD , Simple CFD techniques and CFL condition.

Unit IV (08 Hours)

Numerical Methods in CFD, Finite Difference, Finite Volume, and Finite Element, Upwind and downwind schemes, Simple and Simpler schemes, Higher order methods, Implicit and explicit methods, Study and transient solutions

Unit V (08 Hours)

Surface mesh generation, Surface mesh repair, Volume grid generation, Volume mesh improvement, mesh smoothing algorithms, grid clustering and quality checks for volume mesh. Adaptive, Moving and Hybrid Grids, Need for adaptive and, moving grids, Tet, pyramid, prism, and hex grids, using various elements in combination.

Unit VI (08 Hours)

Introduction to Turbulence Modeling, Introduction and background, Algebraic models, One equation models, Two equation models, Near wall treatment, Reynolds stress models, Introduction to Multiphase Modeling Fundamentals of multiphase flows, Eulerian - Lagrangian (ELAG) approach, Eulerian- Eulerian (E2P) approach, Volume Of Fraction (VOF) approach.

Term Work

Minimum four assignments on above topic to study CFD analysis.
Use of Any CFD software like FLUENT – Basic issues, model development, and post process sing.

Oral/Practical

Based on Term work.

Text Books/ References

1. John D. Anderson, "Computational Fluid Dynamics: The Basics with Applications", McGraw Hill, 1995
2. V. V. Ranade, "Computational Flow Moeling for Chemical Reactor Engineering", Process Engineering Science, Volume 5, 2001
3. Patrick Knupp and Stanly Steinberg, "Fundamentals of Grid Generation", CRC Press, 1994
4. D. C. Wilcox, "Turbulence Modelling for CFD", 1993
5. Pieter Wesseling, "An Introduction to Multigrid Methods", John Wiley & Sons, 1992
6. J. F.Thompson, Z. U., A. Warsi and C. W. Mastin, "Numerical Grid Generation: Foundations and Applications", North Holland, 1985
7. S. V. Patankar, "Numerical Heat Transfer and Fluid Flow", McGraw-Hill,1981
8. Thomas B. Gatski, M. Yousuff Hussaini, John L. Lumley,, "Simulation and Modelling of Turbulent Flows", Eds., Oxford University Press, 1996
9. Laney, C. B., "Computational Gas Dynamics", Cambridge Uni. Press, 1998

Syllabus for Unit Test

Unit Test I	Unit I,II,III
Unit Test II	Unit IV,V,VI

Elective I : Micro-electro Mechanical Systems

TEACHING SCHEME		**EXAMINATION SCHEME**	
Lectures	: 04 Hrs/week	Theory	: 60 Marks
		Duration	: 03 Hours
		Internal Assessment	: 40 Marks
		Total Credits	: 04

Unit I	(08 Hours)
Introduction	
	Micro-Electro-Mechanical Systems (MEMS), Microsystems and their products, miniaturization, applications, mechanical MEMS, thermal MEMS, micro-opto electromechanical systems, magnetic MEMS, radio frequency (RF) MEMS, micro fluidic systems, bio and chemo devices, Nanotechnology - definition, nanoscale, consequences of the nanoscale for technology and society, need and applications of nano electromechanical systems (NEMS)
Unit II	(08 Hours)
Micro Fabrication Processes & Materials	
	Materials for MEMS - substrate and wafers, silicon as a substrate material, crystal structure, single crystal and polycrystalline, mechanical properties, silicon compounds, silicon piezo-resistors, gallium arsenide, quartz, piezo-electric crystals, polymers, packaging materials; Fabrication Processes - Bulk micro manufacturing, photolithography, photoresists, structural and sacrificial materials, X-ray and electron beam lithography, Thin film deposition - spin coating, thermal oxidation, chemical vapour deposition (CVD), electron beam evaporation, sputtering; Doping - diffusion, ionimplantation; Etching - wet etching, dry etching; Surface micromachining, bulk vs. surface micromachining; Wafer bonding - glass-frit, anodic and fusion bonding; LIGA process and applications.
Unit III	(08 Hours)
Microsensors and actuators	
	Sensing and actuation, Chemical sensors, Optical sensors, Pressure sensors, Thermal sensors - thermopiles, thermistors, micromachined thermocouple probes, thermal flow sensors, MEMS magnetic sensor, Piezoelectric material as sensing and actuating elements - capacitance, piezomechanics, Piezoactuators as grippers, microgrippers, micromotors, microvalves, micropumps, microaccelerometers, microfluidics, shape memory alloy based optical switch, thermally activated MEMS relay, microspring thermal actuator, data storage cantilever.
Unit IV	(08 Hours)
Microsystem Design	
	Design constraints and selection of materials, selection of manufacturing process, selection of signal transduction technique, electromechanical system and packaging.
Unit V	(08 Hours)
Nanomaterials:	
	Molecular building blocks to nanostructures - fullerenes, nanoscaled biomolecules, chemical synthesis of artificial nanostructures, molecular switches and logic gates, nanocomposites; Carbon nanotubes -structure, single walled, multi walled, properties of carbon nanostructures and their synthesis, Potential applications of nano-structures.
Unit VI	(08 Hours)
Nanofinishing Techniques	
	Abrasive flow machining, magnetic abrasive finishing, magnetorheological finishing, elastic emission machining, ion beam machining, chemical mechanical polishing, Nanomanipulation,

	Nanolithography, Top-down versus bottom - up assembly, Visualisation, manipulation and characterization at the nanoscale; Applications - in Energy, Tribology, Informatics, MDSicine, etc.		
Text Books/ References			
	1. Bharat Bhushan (Ed.), (2004), Handbook of Nanotechnology, Spinger-Verlag Berlin Heidelberg New York, ISBN 3-540-01218-4 2. Hsu, Tai-Ran, (2003), MEMS & MICROSYSTEMS: Design & Manufacture, TMH, ISBN:0-07-048709-X 3. Mahalik, N. P., (2007), MEMS, TMH, ISBN: 0-07-4454. Mahalik, N.P. (Ed.) (2006), Micromanufacturing & Nanotechnology, Springer India Pvt. Ltd., ISBN: 978-81-8128-505-8 (Distributed by New Age International, New Delhi) 5. Nanosystems: Molecular Machinery, Manufacturing & Computation, K E Drexler, (Wiley),1992), ISBN 0471575186 6. P.Rai- Choudhury, Handbook of Microlithography, Micromachining & Microfabrication, SPIE,1997. 7. David Ferry, Transports in Nanostructures, Cambridge University Press, 2000. 8. Poole, Charles & Owen, Frank J., - Introduction to Nanotechnology, Wiley (India) Pvt. Ltd. ISBN: 978-81-265-10993		
<u>Syllabus for Unit Test</u>			
	Unit Test I	Unit I,II,III	
	Unit Test II	Unit IV,V,VI	

Elective II : Composite Materials

TEACHING SCHEME		**EXAMINATION SCHEME**	
Lectures	: 04 Hrs/week	Theory	: 60 Marks
		Duration	: 03 Hours
		Internal Assessment	: 40 Marks
		Total Credits	: 04

Unit I	(08 Hours)
Basic concepts and characteristics	
	Definition and characteristics of composite materials, overview of advantages and limitations of composite materials, significance and objectives, sciences and technology, types and classification of typical composite materials, current status and future prospects.
Unit II	(08 Hours)
Macromechanical behaviours of lamina:	
	Stress-strain relations for anisotropic materials, engineering constants for orthotropic materials, stress-strain relations for a lamina of arbitrary orientation, biaxial strength theories.
Unit III	(08 Hours)
Micromechanical behaviour of a lamina	
	Mechanics of materials approach to stiffness, elasticity approach to stiffness, comparison of approaches to stiffnes, mechanics of materials approach to strength.
Unit IV	(08 Hours)
Hygrothermal effects	
	Hygrothermal effects on mechanical behaviours, hygrothermal stress-strain relations, coefficients of thermal and moisture expansion of unidirectional lamina
Unit V	(08 Hours)
Macromechanical behaviours of a laminate	
	Classical lamination theory, lamina stress-strain behaviour, strain and stress variation in a laminate, laminate forces and moments, special cases of laminate, interlaminar stresses, design of laminates.
Unit VI	(08 Hours)
Manufacture and testing of composite materials	
	Manufacturing: Stamp moulding, diaphragm forming, thermoforming, filament winding, pultrution, compression moulding, injection moulding. Testing: Determination of physical properties such as density, fibre volume ratio, void volume ratio, co-efficient of thermal expansion, determination of tensile, compressive and shear properties of unidirectional lamina, determination of interlaminar and intralaminar strength, biaxial testing, characterisation of composites with stress concentration.
Text Books/ References	
	1. Mechanics of Composite Materials by R.M.Jones, McGrawhill-Kogakusha Ltd., Tokyo. 2. Engineering Mechanics of Composite Materials by Issac M.Daniel and Ori Ishai, Oxford University Press. 3. Analysis and Performance of Fiber Composites by B.D.Agarwal and L.J.Brotuman, John Wiley & Sons.

Syllabus for Unit Test			
	Unit Test I		Unit Test I
	Unit Test II		Unit Test II

Elective II : Analysis and Synthesis of Mechanisms

TEACHING SCHEME

Lectures : 04 Hrs/week

EXAMINATION SCHEME

Theory : 60 Marks
Duration : 03 Hours
Internal Assessment : 40 Marks
Total Credits : 04

Unit I (08 Hours)

Introduction:

Review of fundamentals of kinematics, D. O. F; Multi loop kinematics chains, Gross motion concepts; Position analysis -Vector loop equations for four bar slider crank.

Unit II (08 Hours)

Kinematic Analysis:.

Inverted slider crank - Geared five bar and six bar linkages; Analytical method for velocity and acceleration analysis - Four bar linkage jerk analysis - Plane complex mechanism

Unit III (08 Hours)

Path Curvature Theory:

Fixed and Moving centroids, inflection points and inflection circle; Graphical constructions - Cubic of stationary curvature; Dimensional synthesis – Function generation; path generation, motion generation.

Unit IV (08 Hours)

Synthesis of Mechanisms

Graphical methods; Coupler; curve synthesis, design of six bar mechanisms. Algebraic methods. Application of instant centre in linkage design; Cam mechanism - Determination of optimum size of Cams.

Unit V (08 Hours)

Dynamic of Mechanisms

Static force analysis with friction - Inertia force analysis - combined static and inertia force analysis; shaking force, Kinetostatic analysis.Introduction to force and moment; balancing of linkages. The Matrix Method.

Unit VI (08 Hours)

Spatial Mechanism and Robotics:

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

Term Work

Practical in Use Of Mechanical Software Packages- Tutorials.

Oral/Practical

Based on Term work.

Text Books/ References

1. Ÿ Erdman A G & Sandor, G N, “Mechanism Design: Analysis and Synthesis”, prentice hall of India
2. Ÿ Mallik, A K, Ghosh A, and Gunter Dittrich, “Kinematic Analysis and Synthesis of Mechanisms”, CRC Press London
3. Ÿ Robert L Norton, “Design of Machinery” McGraw Hill Book Co.
4. Ÿ Robert HA, “Mechanical Design Systems Handbook”, McGraw Hill Book Co.

Syllabus for Unit Test

Unit Test I	Unit I,II,III
Unit Test II	Unit IV,V,VI

Elective II : Artificial Intelligence

TEACHING SCHEME		**EXAMINATION SCHEME**	
Lectures	: 04 Hrs/week	Theory	: 60 Marks
		Duration	: 03 Hours
		Internal Assessment	: 40 Marks
		Total Credits	: 04

Unit I	(08 Hours)
Human and machine intelligence	
	Concepts of fifth generation computing, programming in AI environment, developing artificial intelligence system, natural language processing, neural networks.
Unit II	(08 Hours)
Introduction to fuzzy logic	
	Basic concepts in fuzzy set theory – operations of fuzzy sets – fuzzy relational equations – propositional, predicate logic – inference – fuzzy logic principles – fuzzy inference – fuzzy rule based systems – fuzzification and defuzzification – types.
Unit III	(08 Hours)
Fuzzy logic applications	
	Fuzzy logic controllers – principles – various industrial applications of fuzzy logic control – adaptive fuzzy systems – fuzzy decision making – fuzzy classification – fuzzy pattern recognition – image processing applications – fuzzy optimization.
Unit IV	(08 Hours)
Introduction to artificial neural networks	
	Fundamentals of neural networks – neural network architectures – learning methods – taxonomy of neural network architectures – standard back propagation algorithms – selection of various parameters – variations.
Unit V	(08 Hours)
Associative memory	
	Associative memory – exponential bidirectional associative memory – adaptive resonance theory – introduction – adaptive resonance theory 1 – adaptive resonance theory 2 – applications – Kohen self organizing maps – counter propagation networks – industrial applications. Expert system development: Definition, choice of domain, collection of knowledge base, selection of inference mechanism, case studies of expert system development in design and manufacturing.
Unit VI	(08 Hours)
Industrial application of AI and expert systems	
	Robotic vision systems, image processing techniques, application to object recognition and inspection, automatic speech recognition. Recent advances: Fundamentals of genetic algorithms – hybrid systems – meta heuristic techniques like simulated annealing, tabu search, ant colony optimization, perpetual self organizing, artificial immune systems – applications in design and manufacturing
Text Books/ References	

	1. Robert Levine et al, "A comprehensive guide to AI and expert systems", McGraw Hill Inc, 1986 2. Henry C. Mishkoff, "Understanding AI", BPB Publication, New Delhi, 1986 3. Peter Jackson, "Introduction to expert systems", First Indian Reprint, 2000, Addison Wesley 4. Stuart Russell and Peter Norvig, "Artificial intelligence: a modern approach", Prentice Hall, 1995 5. Elaine Rich et al., "Artificial intelligence", McGraw Hill, 1995 6. Winston P H, "Artificial intelligence", Addison Wesley, Massachusetts, Third Edition, 1992

Syllabus for Unit Test

	Unit Test I	Unit I,II,III	
	Unit Test II	Unit IV,V,VI	

Elective II : Design of Experiment

TEACHING SCHEME		**EXAMINATION SCHEME**	
Lectures	: 04 Hrs/week	Theory	: 60 Marks
		Duration	: 03 Hours
		Internal Assessment	: 40 Marks
		Total Credits	: 04

Unit I	(08 Hours)
Introduction	
	Strategy of Experimentation, Some Typical Applications of Experimental Design, Basic Principles, Guidelines for Designing Experiments, A Brief History of Statistical Design, Summary: Using Statistical Techniques in Experimentation
Unit II	(08 Hours)
Simple Comparative Experiments	
	Introduction, Basic Statistical Concepts, Sampling and Sampling Distributions, Inferences About the Differences in Means, Randomized Designs, Hypothesis Testing, Confidence Intervals, Choice of Sample Size, Comparing a Single Mean to a Specified Value
Unit III	(08 Hours)
Experiments with a Single Factor:	
	The Analysis of Variance, Analysis of the Fixed Effects Model, Decomposition of the Total Sum of Squares, Statistical Analysis, Estimation of the Model Parameters ,Unbalanced Data, Model Adequacy Checking, The Normality Assumption,Plot of Residuals in Time Sequence, Plot of Residuals Versus Fitted Values, Plots of Residuals Versus Other Variables, Practical Interpretation of Results, A Regression Model, Comparisons Among Treatment Means ,Graphical Comparisons of Means
Unit IV	(08 Hours)
Introduction to Factorial Designs	
	Basic Definitions and Principles, The Advantage of Factorials, The Two-Factor Factorial Design, Statistical Analysis of the Fixed Effects Model , Model Adequacy Checking , Estimating the Model Parameters , Choice of Sample Size ,The General Factorial Design, Fitting Response Curves and Surfaces , Blocking in a Factorial Design
Unit V	(08 Hours)
The 2^k Factorial Design	
	Introduction, the 2^2 Design, the 2^3 Design, the General 2^k Design, a Single Replicate of the 2^k Design, 2^k Designs are Optimal Designs, The Addition of Center Points to the 2^k Design
Unit VI	(08 Hours)
Response Surface Methods and Designs	
	Introduction to Response Surface Methodology, The Method of Steepest Ascent, Analysis of a Second-Order Response Surface, Location of the Stationary Point, Characterizing the Response Surface, Ridge Systems, Multiple Responses, Experimental Designs for Fitting Response Surfaces, Designs for Fitting the First-Order Model, Designs for Fitting the Second-Order Model, Blocking in Response Surface Designs, Optimal Designs for Response Surfaces
Text Books/ References	
	1. Design and analysis of experiments, Douglas C. Montgomery, Wiley, 2008 2. Introduction to the Design And Analysis of Experiments, Geoffrey Mallin Clarke, R. E. Kempson, Arnold, 1994

	3. Experimental Design and Statistics, Stephen Henry Miller, Methuen, 1975		
Syllabus for Unit Test			
	Unit Test I	Unit I,II,III	
	Unit Test II	Unit IV,V,VI	

Self Study Paper I : Advanced Manufacturing Processes

TEACHING SCHEME

Lectures : 04 Hrs/week

EXAMINATION SCHEME

Theory : 60 Marks
Duration : 03 Hours
Internal Assessment : 40 Marks
Total Credits : 04

Unit I (08 Hours)

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 (08 Hours)

ABRASIVE PROCESSES

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

(08 Hours)

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 (08 Hours)

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 (08 Hours)

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.

(08 Hours)

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 Books/ References

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.

Syllabus for Unit Test

Unit Test I	Unit I,II,III
Unit Test II	Unit IV,V,VI

Elective II : Machine Condition Monitoring and Diagnostics

TEACHING SCHEME

Lectures : 04 Hrs/week
Practicals : 02 Hrs/week

EXAMINATION SCHEME

Theory : 60 Marks
Duration : 03 Hours
Internal Assessment : 40 Marks
Term Work : 25 Marks
Pract/Oral : 25 Marks
Total Credits : 05

Unit I (08 Hours)

Predictive Maintenance Techniques:

Predictive maintenance basics, Maintenance philosophies, Evolution of maintenance philosophies, Plant machinery classification and recommendations, Principles of predictive maintenance, Predictive maintenance techniques, Vibration analysis – a key predictive maintenance technique.

Unit II (08 Hours)

Fundamentals of Vibrations:

Vibration basics, Spring-mass system: mass, stiffness, damping, System response, What is vibration? The nature of vibration, Harmonics, Limits and standards of vibration.

Unit III (08 Hours)

Data Acquisition:

Introduction, Collection of vibration signal – vibration transducers, characteristics and mountings, Conversion of vibrations to electrical signal.

Unit IV (08 Hours)

Signal Processing, Applications and Representation:

The fast Fourier transform (FFT) analysis, Time waveform analysis, Phase signal analysis, Spectral signal processes.

Unit V (08 Hours)

Machinery Fault Diagnosis Using Vibration Analysis:

Commonly witnessed machinery faults diagnosed by vibration analysis, correcting faults that cause vibration; Balancing, Alignment, Resonance vibration control with dynamic absorbers.

Unit VI (08 Hours)

Oil and Particle Analysis Oil Fundamentals:

Condition-based maintenance and oil analysis, Setting up an oil analysis program, Oil analysis – sampling methods, Oil analysis – lubricant properties, Oil analysis – contaminants in lubricants, Particle analysis techniques, Alarm limits for various machines.

Term Work

Term work shall consists of
Data acquisition using a velocity pickup.
Data acquisition using an accelerometer.

Data acquisition of sound signals.
Spectral analysis of velocity, acceleration noise signals.
Experiment demonstrating balancing of rotating shaft shaft.
Three assignments based on above syllabus.

Oral/Practical

Based on Term work.

Text Books/ References

1. Thomson, W. T., "Theory of Vibration with Applications", CBS Publishers and Distributors, New Delhi, 1990
2. Gupta K., "Introductory Course on Theory and Practice of Mechanical Vibrations", New Age International Ltd., 1984
3. J. S. Rao., “Vibratory Condition Monitoring of Machines”, Narosa publishing house, New Delhi
4. Cyril M. Harris, Allan G. Piersol, “Shock and Vibration Handbook”, McGraw-Hill Publishing Co.
5. C. Scheffer, Paresh Girdhar, “Practical Machinery Vibration Analysis and Predictive Maintenance”, Newnes an imprint of Elsevier

Syllabus for Unit Test

Unit Test I	Unit I,II,III
Unit Test II	Unit IV,V,VI

Self Study Paper I : Product Lifecycle Management

TEACHING SCHEME

Lectures : 04 Hrs/week

EXAMINATION SCHEME

Theory : 60 Marks
Duration : 03 Hours
Internal Assessment : 40 Marks
Total Credits : 04

Unit I (08 Hours)

Product Life Cycle Environment

Background, Overview, Need, Benefits, Concept of Product Life Cycle. Components / Elements of PLM, Emergence of PLM, Significance of PLM, Customer Involvement. Product Data and Product Workflow, Company's PLM vision, The PLM Strategy, Principles for PLM strategy, Preparing for the PLM strategy, Developing a PLM strategy, Strategy identification and selection, Change Management for PLM.

Unit II (08 Hours)

Product Development Process

Integrated Product development process Conceive – Specification, Concept design, Design - Detailed design, Validation and analysis (simulation), Tool design, Realize - Plan manufacturing , Manufacture, Build/Assemble , Test (quality check) , Service - Sell and Deliver , Use , Maintain and Support, Dispose.

(08 Hours)

Unit III

Product Development Approaches

Bottom-up design, Top-down design, Front-loading design workflow, Design in context, Modular design. Concurrent engineering, partnership with supplier, collaborative and Internet based design, work structuring and team deployment, Product and process systemization, problem, identification and solving methodologies, improving product development solutions

Unit IV (08 Hours)

Product Modelling

Product Modelling - Definition of concepts - Fundamental issues - Role of Process chains and product models -Types of product models – model standardization efforts-types of process chains - Industrial demands. Foundation technologies and standards (e.g. visualization, collaboration and enterprise application integration),

Unit V (08 Hours)

Product Data Management (PDM) Technology

Product Data Management – An Introduction to Concepts, Benefits and

Terminology, PDM functions, definition and architectures of PDM systems, product data interchange, portal integration, PDM acquisition and implementation. Information authoring tools (e.g., MCAD, ECAD, and technical publishing), Core functions (e.g., data vaults, document and content management, workflow and program management), Functional applications (e.g., configuration Management)

(08 Hours)

Unit VI

Recent Advances

Intelligent Information Systems - Knowledge based product and process models - Applications of soft computing in product development process - Advanced database design for integrated manufacturing.

Text Books/ References

1. Product Life Cycle Management - by Antti Saaksvuori, Anselmi Immonen, Springer, 1st Edition (Nov.5, 2003)
2. Product Design & Process Engineering, McGraw Hill – Kogalkusha Ltd., Tokyo, 1974.
3. Product Design & Development – by Kari Ulrich and Steven D. Eppinger, McGraw Hill International Edns, 1999.
4. Effective Product Design and Development – by Stephen Rosenthol, Business One Orwin, Homewood, 1992 ISBN 1-55623-603-4.
5. Burden, Rodger PDM: Product Data Management, Resource Pub, 2003. ISBN 0970035225
6. Clements, Richard Barrett. Chapter 8 ("Design Control") and Chapter 9 ("Document Control") in Quality Manager's Complete Guide to ISO 9000, Prentice Hall, 1993. ISBN 013017534X

Syllabus for Unit Test

Unit Test I	Unit I,II,III
Unit Test II	Unit IV,V,VI

Self Study Paper I : Robust Design of Product and Process

TEACHING SCHEME

Lectures : 04 Hrs/week

EXAMINATION SCHEME

Theory : 60 Marks
Duration : 03 Hours
Internal Assessment : 40 Marks
Total Credits : 04

Unit I (08 Hours)

Concepts of Quality Engineering

Taguchi's Approach to Quality, On-line and Off- line Quality Control, Difference from Classical Approach, Quality Loss Function, System Design, Parameter Design, Tolerance Design, Causes of Variation, Classification of Parameters, Parameter Design Strategy.

Unit II (08 Hours)

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.

(08 Hours)

Unit III

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 IV (08 Hours)

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 V (08 Hours)

Data Analysis

Deterministic and random data, Uncertainty analysis, Tests for significance: Chi-square, Regression modeling, Direct and Interaction effects, ANOVA, F-test, Time Series analysis, Autocorrelation and Autoregressive modeling.

(08 Hours)

Unit VI

Response surface Methodology

Linear experiment designs, quadratic experiment designs.

Text Books/ References

1. Montgomery D (2001). Design and Analysis of Experiments, 5th edition, Wiley
2. Phadke, M (1989). Quality Engineering using Robust Design, Prentice Hall.
3. Ross, P (1996). Taguchi Techniques for Quality Engineering, 2nd edition, McGraw Hill.
4. J. Krottmaier, Optimizing Engineering Design, McGraw Hill Ltd.
5. A. Mitra, Quality Control and Improvement, Pearson Publications.

Syllabus for Unit Test

Unit Test I	Unit I,II,III
Unit Test II	Unit IV,V,VI

Self Study Paper I : Computer Aided Process Planning

TEACHING SCHEME

Lectures : 04 Hrs/week

EXAMINATION SCHEME

Theory : 60 Marks
Duration : 03 Hours
Internal Assessment : 40 Marks
Total Credits : 04

Unit I (08 Hours)

INTRODUCTION

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

Unit II (08 Hours)

PART DESIGN REPRESENTATION

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

(08 Hours)

Unit III

PROCESS ENGINEERING AND PROCESS PLANNING

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

Unit IV (08 Hours)

COMPUTER AIDED PROCESS PLANNING SYSTEMS

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

Unit V (08 Hours)

AN INTERGARTED PROCESS PLANNING SYSTEMS

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

(08 Hours)

Unit VI

Simulation

Major activities, purpose, simulation process, types methodology, simulation packages, process quality simulator, computer requirements trends, applications simulation of manufacturing systems.

Text Books/ References

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

Syllabus for Unit Test

Unit Test I	Unit I,II,III
Unit Test II	Unit IV,V,VI

Self Study Paper I : Flexible Manufacturing System

TEACHING SCHEME

Lectures : 04 Hrs/week

EXAMINATION SCHEME

Theory : 60 Marks
Duration : 03 Hours
Internal Assessment : 40 Marks
Total Credits : 04

Unit I (08 Hours)

Evolution of Manufacturing Systems

FMS definition and description, General FMS considerations, Manufacturing cells, Cellular versus Flexible Manufacturing.Systems Planning: Objective, introduction planning, preparation guidelines, the project team, supplier selection, system description and sizing, facility preparation planning, FMS layouts. Human resources: staff considerations, team work, communication and involvement, the supervisors role, personnel selection, job classifications, employee training.

Unit II (08 Hours)

Manufacturing's Driving Force

Definition, description and characteristics. Just in-time manufacturing, definition and description, benefits and relationship to FMS, implementation cornerstones, quality and quantity application principles. Single manufacture Cell – design scheduling of jobs on single manufacturing cells. Group Technology: Concepts, classification and coding, benefits and relationship to FMS, design of group technology using rank order clustering technique.

(08 Hours)

Unit III

FMS Design

Using Bottleneck, Extended bottleneck models, Processing and Quality Assurance: Turning centres, Machining centre, construction and operations performed, axes, programming, and format information, work-holding and work-changing equipment, automated features and capabilities, cleaning and deburring – station types and operation description, importance to automated manufacturing, coordinate measuring machines, types, construction and general function, operation cycle description, importance to flexible cells and systems.

Unit IV (08 Hours)

Automated movement and storage systems

AGVs, Robots, automated storage and retrieval systems, storage space design, queuing carousels and automatic work changers, coolant and chip Disposal and recovery systems, auxiliary support equipment, cutting tools and tool Management – introduction, getting control of cutting tools, Tool Management, tool strategies, data transfer, tool monitoring and fault detection, guidelines, work holding considerations, General fixturing, Modular fixturing. FMS and the relationship with workstations – Manual, automated and transfer lines design aspects.

Unit V (08 Hours)

FMS Software

Communications networks and Nanotechnology – general functions, and manufacturing usages, hardware configuration, programmable logic controllers, cell controllers, communications networks. FMS implementation.

(08 Hours)

Unit VI

FMS and Simulation

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

Text Books/ References

1. Parrish, D.J., ‗Flexible Manufacturing', - Butter Worths – Heinemann, Oxford, 1993.
2. Groover, M.P., ‗Automation, Production Systems and CIM', - Prentice Hall India, 1989.
3. Kusiak, A., ‗Intelligent Manufacturing Systems', - Prentice Hall, 1990.
4. Considine,D.M., & Considine,G.D., ‗Standard Handbook of Industrial Automation',-Chapman & Hall, 1986

Syllabus for Unit Test

Unit Test I	Unit I,II,III
Unit Test II	Unit IV,V,VI

Self Study Paper I : Product Design & Process Planning

TEACHING SCHEME

Lectures : 04 Hrs/week

EXAMINATION SCHEME

Theory : 60 Marks
Duration : 03 Hours
Internal Assessment : 40 Marks
Total Credits : 04

Unit I (08 Hours)

Product design and process design functions

Selection of a right product, essential factors of product design, Morphology of design, sources of new ideas for products, evaluation of new product ideas. Product innovation procedure-Flow chart. Qualifications of product design Engineer. Criteria for success/failure of a product. Value of appearance, colours and Laws of appearance.

Unit II (08 Hours)

Product reliability

Mortality Curve, Reliability systems, Manufacturing reliability and quality control.Patents: Definitions, classes of patents, applying for patents. Trademarks and copyrights. Cost and quality sensitivity of products, Elements of cost of a product, costing methods, cost reduction and cost control activities. Economic analysis, Break even analysis Charts. Value engineering in product design, creativity aspects and techniques. Procedures of value analysis – cost reduction, material and process selection.

(08 Hours)

Unit III

Various manufacturing processes

Degree of accuracy and finish obtainable, process capability studies. Methods of improving tolerances. Basic product design rules for Casting, Forging, Machining, Sheet metal and Welding. Physical properties of engineering materials and their importance on products. Selection of plastics, rubber and ceramics for product design.

Unit IV (08 Hours)

Industrial ergonomics

.

Man-machine considerations, ease of maintenance. Ergonomic considerations in product design-Anthropometry, Design of controls, man-machine information exchange. Process sheet detail and their importance, Advanced techniques for higher productivity. Just-in-time and Kanban System. Modern approaches to product design; quality function development, Rapid prototyping

Unit V (08 Hours)

Role of computer in product design

Management of manufacturing, creation of manufacturing data base, Computer Integrated Manufacturing, communication network, production flow analysis, Group Technology, Computer Aided product design and process Planning. Integrating product design,

manufacture and production control.

(08 Hours)

Unit VI

Computer Aided Process Planning

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

Text Books/ References

1. Niebel, B.W., and Draper, A.B., Product design and process Engineering, Mc Graw Hill – Kogalkusha Ltd., Tokyo, 1974
2. Chitale, A.K, and Gupta, R.C., Product Design and Manufacturing, Prentice Hall of India Pvt. Ltd., New Delhi, 2004.
3. Mahajan, M. Industrial Engineering and Production Management, Dhanpath Rai & Co., 2000.
4. Considine,D.M., & Considine,G.D., _Standard Handbook of Industrial Automation‘,-Chapman & Hall, 1986

Syllabus for Unit Test

Unit Test I	Unit I,II,III
Unit Test II	Unit IV,V,VI

Self Study Paper I : Experimental Technique and Data analysis			
TEACHING SCHEME		**EXAMINATION SCHEME**	
Lectures	: 04 Hrs/week	Theory	: 60 Marks
		Duration	: 03 Hours
		Internal Assessment	: 40 Marks
		Total Credits	: 04
Unit I			(08 Hours)
Research Modeling			
	(a) Mathematical – Classification of Models, Development of Models, Stages in Model building, Principles of Modelling, Use of Analogy, Models as Approximations, Data consideration and Testing of Models (b) Heuristics and Simulation – Definition, Applications and reasons for using Heuristics, Heuristic Methods and approaches, Meta-Heuristics; Simulation – Meaning, Applications and Classification of Simulation Models, Process of Simulation, Steps and Features of Simulation Experiments and their Validation.		
Unit II			(08 Hours)
Experimentation			
	Objective, Strategies, Factorial Experimental Design,Applications of Experimental Design, Basic Principles – Replication, Randomization and Blocking, Guidelines for designing experiments; Laboratory Experiments, Methods of manipulating Variables, Errors in Experiments, Steps in Design of Experiments.		
Unit III			(08 Hours)
Introduction to Data and Errors			
	Types Of Data counts, measurements. Types of error: inherent, instrument, operator.Statistical distributions: Uniform, Binomial, Poisson, Exponential, Normal Estimation of means, proportions, population sizes, variances		
Unit IV			(08 Hours)
Hypothesis testing			
	Procedures for hypothesis testing, means, proportions, variances, contingency, goodness of fit of data to a proposed model. Use of hypothesis tests to compare products or processes.		
Unit V			(08 Hours)
Design and analysis			
	Principles of experimental design: randomisation, replication, blocking. Analysis of variance: one-way and two-way analyses, with and without interaction. Cross-classified and nested forms. Fixed and random effect models. Factorial experiments versus one-at-a time experiments.		
			(08 Hours)

Unit VI	
Regression analysis	
	Simple and multiple regression analysis. Use of transformation, analysis of residuals, variable selection procedures
Text Books/ References	
	1. C.R Kothari, Research Methodology, Methods & Technique; New Age International Publishers, 2004 2. R. Ganesan, Research Methodology for Engineers, MJP Publishers, 2011 3. Experimental Methods for Engineers, J. P. Holman, McGraw-Hill Education (2000) ISBN 0071181652. 4. Experimental Methods: An Introduction to the Analysis and Presentation of Data, L. Kirkup, Wiley Text Books (1995) ISBN 0471335797 5. An Introduction to Error Analysis: The Study of Uncertainties in Physical Measurements, 2nd Edition, J. R. Taylor, University Science Books (1997) ISBN 093570275X.

Syllabus for Unit Test

	Unit Test I	Unit I,II,III	
	Unit Test II	Unit IV,V,VI	

Self Study Paper I : TRIBOLOGY IN DESIGN

TEACHING SCHEME

Lectures : 04 Hrs/week

EXAMINATION SCHEME

Theory : 60 Marks
Duration : 03 Hours
Internal Assessment : 40 Marks
Total Credits : 04

Unit I (08 Hours)

Introduction to Tribology:

Introduction, Friction, Wear, Wear Characterization, Regimes of lubrication, Classification of contacts, lubrication theories. Newton's Law of viscous forces, Effect of pressure and temperature on viscosity.

Unit II (08 Hours)

Hydrodynamic Lubrication:

Newton's Law of viscous forces, Flow through stationary parallel plates. Hagen's poiseuille's theory, viscometers. Concept of lightly loaded bearings, Petroff's equation, Hydrodynamic Bearings, Pressure development mechanism. Converging and diverging films and pressure induced flow. Reynolds's 2D equation with assumptions. Introduction to idealized slide bearing with fixed shoe and Pivoted shoes. Expression for load carrying capacity. Location of center of pressure.

Unit III (08 Hours)

Hydrostatic Bearings:

Types of hydrostatic Lubrication systems Expression for discharge, load carrying capacity, Flow rate, Condition for minimum power loss. Torque calculations.

Unit IV (08 Hours)

Elasto Hydrodynamic Lubrication:.

Introduction to Elasto - hydrodynamic lubricated bearings. Introduction to 'EHL' constant. Grubin type solution, Different regimes in EHL contact

Unit V (08 Hours)

Porous, Gas Bearings and Magnetic Bearings:

Introduction to porous bearings. Equations for porous bearings and working principal, Fretting phenomenon and it's stages.Introduction to gas bearing, Governing Equation, Infinitely long journal bearings, Externally pressurized gas bearing. Introduction to magnetic bearings, Active magnetic bearings. Different equations used in magnetic bearings and working principal. Advantages and disadvantages of magnetic bearings, Electrical analogy, Magneto-hydrodynamic bearings.

Unit VI (08 Hours)

Tribo Measurement In Instrumentation:

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

Text Books/ References

1. Cameron, A. "Basic Lubricaton Theory", Ellis Herward Ltd. , UK,1981
2. Hulling , J. (Editor), "Principles of Tribology", MacMillan ,1984
3. Williams J. A ., "Engineering Tribology", Oxford Univ. Press ,1994
4. Neale M. J., "Tribology Hand Book ", Butterworth Heinemann, 1995
5. Basu S. K., Sengupta S. N., Ahuja B. B., “Fundamentals of Tribology” Prentice Hall of

India Privata Ltd. New Delhi, 2005
6. Mujamdar B. C ., "Introduction to Tribology of Bearing", Wheeler Publishing, New Delhi 2001
7. Susheel Kumar Srivasthava, "Tribology in industry", S. Chand and Co.
8. Dudley D. Fuller, " Theory and practice of Lubrication for Engineers", New York Company 1998
9. Moore, "Principles and applications of Tribology", Pergamon press
10. Pinkus Stemitch, "Theory of Hydrodynamic Lubrication"
11. Gerhand Schwetizer, Hannes Bleuler & Alfons Traxler, "Active Magnetic bearings", Authors working group
12. Radixmovsky, "Lubrication of Bearings - Theoretical Principles and Design" The
13. Oxford press Company, 2000

Syllabus for Unit Test

Unit Test I	Unit I,II,III
Unit Test II	Unit IV,V,VI

Self Study Paper I : Manufacturing System and Simulation

TEACHING SCHEME

Lectures : 04 Hrs/week

EXAMINATION SCHEME

Theory : 60 Marks
Duration : 03 Hours
Internal Assessment : 40 Marks
Total Credits : 04

Unit I (08 Hours)

Fundamentals System concept and design

Hierarchical structure, Decision making procedure, System types in manufacturing environments; Manufacturing Systems: Structural aspects, transformational aspects, procedural aspects, integrated manufacturing systems; Modes of Production-Jobbing/Intermittent/ Continuous; Mass Production-Economies of Scale, Optimum production scale, Mass Customization; Multi-Product Small Batch Production- Economies of Scope with Diversification; Logistic Systems- Material flow: conversion / transportation / storage

Unit II (08 Hours)

Product / Process Planning and Design

Product Life Cycle, Planning of a new product, Product Design Aspects, Design cost considerations, Concurrent Engineering; Process and Operation Design-Computer Aided Process Planning, Optimum routing analysis using Dynamic Programming and Network Techniques, Criteria for line balancing.

(08 Hours)

Unit III

Manufacturing Optimization

Criteria for Evaluation, Optimization of single stage manufacturing- Unit production time and cost; Optimization of multistage manufacturing system-Scope, basic mathematical models; Cost Estimating- Classical metal cutting cost analysis, Industrial cost estimation practices, Estimating material, setup and cycle times.

Unit IV (08 Hours)

Information Systems in Manufacturing

Database structures, hierarchical, network, Relational- concepts, keys, relational operations, query languages; Shop Floor Data Collection Systems-Types of data, on-line and off-line data collection, Automatic data collection systems

Unit V (08 Hours)

Computer Simulation in Manufacturing System Analysis

Characteristics, Models, applications of probability and statistics; Design and evaluation methodology, General framework, Analysis of situation, Setting objectives, Conceptual modeling, Detailed design, Evaluation and Decision.

(08 Hours)

Unit VI

Modern approaches in Manufacturing

Cellular Manufacturing- Group Technology, Composite part, Rank Order Clustering Technique, Hollier method for GT cell layouts; Flexible Manufacturing- Concept, components, architecture; Lean Production concept, principles, Agile Manufacturing- concept, principles and considerations for achieving agility.

Text Books/ References

1. Katsudo Hitomi, (1998), "Manufacturing Systems Engineering", Viva Low Priced Student Edition, ISBN 81-85617-88-0
2. B. Wu, "Manufacturing Systems Design & Analysis: Context and Techniques" (2/e), Chapman & Hall, UK, ISBN 041258140X
3. Mikell P. Groover, (2002), "Automation, Production Systems and Computer Integrated Manufacturing", (2/e), Pearson Education, ISBN 81-7808-511-9
4. Radhakrishan P., Subramaniyan S. and Raju V., "CAD / CAM / CIM", (3/E), New Age International Publication
5. Luca G. Sartori,(1998), " Manufacturing Information Systems", Addison Wesley Publishing Co.
6. N. Viswanadhan & Y, Narhari, (1998), "Performance Modeling of Automated Manufacturing Systems", Prentice Hall of India

Syllabus for Unit Test

Unit Test I	Unit I,II,III
Unit Test II	Unit IV,V,VI

DISSERTATION STAGE I

TEACHING SCHEME

Practicals : 07 Hrs/week

EXAMINATION SCHEME

Term Work : 25 Marks
Practical/Oral : 25 Marks

Total Credits : 15

Stage-I:

The aim of the dissertation work is to carry out research and development work. Every student will be required to choose the topic of dissertation in consultation with the faculty guide.

This stage will include a report consisting of synopsis, the plan for experimental/theoretical work and the summary of the literature survey carried out till this stage.

SEMINAR

TEACHING SCHEME

Practicals : 05 Hrs/week

EXAMINATION SCHEME

Term Work : 25 Marks

Total Credits : 07

The student will be required to choose the topic of seminar on advanced topics based on courses taught in first and second semester and present the work during the seminar.

SEMESTER – IV

Self Study Paper II : CAD/CAM Practices in Metal Forming

TEACHING SCHEME

Lectures : 04 Hrs/week

EXAMINATION SCHEME

Theory : 60 Marks
Duration : 03 Hours
Internal Assessment : 40 Marks
Total Credits : 04

Unit I (08 Hours)

Fundamentals of Material Forming:

Introduction of forming processes. Concept of Formability, formability limits and formability diagram.Wire and Tube Drawing:Introduction rod and wire drawing machines - construction and working. Preparation of stock for wire drawing. Wire drawing dies, material and design. Heat treatment, variables in wire drawing, Maximum reduction in wire in one pass, forces required in drawing. Multiple drawing, work hardening, lubrication in wire drawing. Tube drawing: Methods, force calculation , stock penetration. Lubrication in tube drawing.

Unit II (08 Hours)

Forging:

Introduction, classification of forging processes. Forging equipment- Hammers, presses, furnaces etc. construction working capacities and selection of equipment. Basic forging operations such as drawing, fullering edging, blocking etc. Forgability tests, design of forging as a product, friction in forging. Forging defects and the remedies. New technologies: Liquid metal forging, Isothermal forging, No draft forging, P/M forging, Rotary swaging, Roll forging, lubrication in forging.

(08 Hours)

Unit III

Rolling of Metals:

Scope and importance of rolling. Types of Rolling Mills- construction and working. Roll bite, reduction, elongation and spread. Deformation in rolling and determination forces required. Process variables, redundant deformation. Roll flattening, Roll camber - its effect on rolling process, mill spring. Defects in rolling. Automatic gauge control- Roll pass classification& design. Lubrication in rolling.

Unit IV (08 Hours)

Sheet Metal Working:

Sheet Metal properties, gauges and surface conditions. Study of presses and equipments used, various cutting and forming operations, types of dies used, force requirement, theory of shear, methods of force reduction, defects, lubricants used. Miscellaneous sheet metal working operations: Metal spinning, fine blanking, coining, embossing, rubber forming, stretch forming.

Design of Press Tools:

General classification and components of press tools, types of dies simple,compound, combination dies, various press working operations such as punching, blanking, deep drawing, bending, forming etc. Design and calculations for above press working

dies.

(08 Hours)

Unit V

Extrusion:

Types: Direct, reverse, impact, hydrostatic extrusion. Dies for extrusion, stock penetration. Extrusion ratio of force equipment (with and without friction), metal flow in extrusion, defects. Role of friction and lubricants. Manufacture of seam-less tubes.Advanced Metal Forming Processes:

High velocity forming- principles, comparison of high velocity and conventional forming processes. Explosive forming, Magnetic pulse forming, Electro hydraulic forming. Stretch forming, Coining Embossing, Curling, Spinning, Flow forming advantages, limitations and application of the process.

(08 Hours)

Unit VI

Finite-Element Method

Basics of Metal Forming and Finite-Element Method - Comparison of Finite-Difference and Finite Element Methods with Analytical Solutions - Spatial Discretization - Shape Functions - Assembly of the Stiffness Matrix. Finite Elements for Large Deformation - Solution of Linear Finite-Element Systems and Nonlinear Finite-Element Systems, Typical Finite Elements.

Text Books/ References

1. Dieter, "Mechanical Metallurgy"
2. P. N. Rao, "Manufacturing Technology", Tata McGraw Hill
3. G.W. Rowe, "Principles of Industrial Metal Working Process", Edward Arnold
4. Dr. R. Narayanswamy, "Metal Forming Technology",Ahuja Book Co
5. Surender Kumar, "Principles of Metal Working"
6. "ASM Metal hand book Vol: 4 forming"
7. Shiro Kobayanshi, Soo Ik oh and Taylan Atlan , "Metal Forming and Finite Element Method", Oxford pub, 1992.
8.

Syllabus for Unit Test

Unit Test I	Unit I,II,III
Unit Test II	Unit IV,V,VI

Self Study Paper II : Optimization Techniques

TEACHING SCHEME

Lectures : 04 Hrs/week

EXAMINATION SCHEME

Theory : 60 Marks
Duration : 03 Hours
Internal Assessment : 40 Marks
Total Credits : 04

Unit I (08 Hours)

Introduction to Optimization

Statement of an Optimization Problem - Design Vector, Design Constraints, Constraint Surface, Objective Function, Objective Function Surfaces.Classification of Optimization Problems - Classification Based on the Existence of Constraints, Nature of the Design Variables, Physical Structure of the Problem, Nature of the Equations Involved, Permissible Values of the Design Variables, Deterministic Nature of the Variables, Separability of the Functions and Number of Objective Functions

Unit II (08 Hours)

One-Dimensional Unconstrained Minimization

Introduction , Theory Related to Single Variable (Univariate) Minimization , Unimodality and Bracketing the Minimum, Fibonacci Method, Golden Section Method ,Polynomial-Based Methods.Programming using MATLAB

(08 Hours)

Unit III

Unconstrained Optimization

Introduction Necessary and Sufficient Conditions for Optimality Convexity
Basic Concepts: Starting Design, Direction Vector, and Step Size. The Steepest Descent Method The Conjugate Gradient Method Newton's Method Quasi-Newton Methods Approximate Line Search Using MATLAB

Unit IV (08 Hours)

Stochastic Programming

Introduction, Basic Concepts of Probability Theory, Stochastic Linear Programming, Stochastic Nonlinear Programming and Stochastic Geometric Programming

Unit V (08 Hours)

Modern Methods of Optimization

Genetic Algorithms, Simulated Annealing, Particle Swarm Optimization, Neural-Network-Based Optimization and Ant Colony Optimization

(08 Hours)

Unit VI

Multiobjective Optimization

Introduction, Concept of Pareto Optimality, Generation of the Entire Pareto Curve. Methods to Identify a Single Best Compromise Solution .

Text Books/ References

1. Singeresu S. Rao, Engineering Optimization-Theory and Practice, New Age
2. International Limited Publishers.
3. J. S. Arora, Introduction to Optimum Design, McGraw Hill, New York
4. S. S. Stricker, Optimizing Performance of Energy Systems, Battelle Press,New York.
5. Ashok D. Belegundu and Tirupathi R. Chandrupatla Optimization concepts and applications in engineering

Syllabus for Unit Test

Unit Test I	Unit I,II,III
Unit Test II	Unit IV,V,VI

Self Study Paper II : Robotics and Sensors

TEACHING SCHEME

Lectures : 04 Hrs/week

EXAMINATION SCHEME

Theory : 60 Marks
Duration : 03 Hours
Internal Assessment : 40 Marks
Total Credits : 04

Unit I (08 Hours)

Introduction

Brief History, Basic concepts, Three laws of Robotics, Robot and Robotic mechanism, Automation and Robotics, Need for industrial Robots, Robot generations, Robot anatomy ,Classification , Robot performance parameters, Socio-Economic aspects of Robotisation.

Unit II (08 Hours)

Grippers

Introduction, types of end effectors, types of grippers, tools as end effectors, Guidelines for design of robotic gripper, force analysis of mechanical pneumatic and hydraulic grippers.Robot DrivesIntroduction, Classification of Drives, Characteristics of Drives, Types of Drives, Comparison of Driver system, Actuation Schemes, Reduction and Transmission Systems.

(08 Hours)

Unit III

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 IV (08 Hours)

Kinematics

Introduction, Rotation and Transformation, Denavit-Hartenberg Parameters, Mapping revisited, Forward kinematics, Inverse kinematics.

Unit V (08 Hours)

Vision System for Robotics

Introduction, Need, Robot Vision System – Levels of processing, Functions of Machine Vision System, Image Acquisition, Sampling , Image Processing, Image Processing Technique, Edge detection, A typical vision system for robot, System hardware and function.

(08 Hours)

Unit VI

Robot Programming

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

Text Books/ References

1. Groover, Weiss, "Industrial Robotics", Tata McGraw-Hill.
2. Fu Ks, Rc Congalez and CSG Lee, "Robotics- Control, Sensing, Vision and Intelligence", Tata McGraw Hill.
3. Koren Yoram, "Industrial Robotics", Tata McGraw-Hill.
4. Puranik M.T. and P.R.Ghorpade, "Robotics Fundamental", Nirali Publication, Pune.
5. Spong M.W., S. Hutchrison and M. Vidyasagar, "Robot Modelling and Control", Willey-2006.
6.

Syllabus for Unit Test

Unit Test I	Unit I,II,III
Unit Test II	Unit IV,V,VI

Self Study Paper II : Rapid Prototyping

TEACHING SCHEME

Lectures : 04 Hrs/week

EXAMINATION SCHEME

Theory : 60 Marks
Duration : 03 Hours
Internal Assessment : 40 Marks
Total Credits : 04

Unit I (08 Hours)

Introduction

Need - Development of RP systems – RP process chain - Impact of Rapid Prototyping on Product Development –Digital prototyping - Virtual prototyping-Rapid Tooling - Benefits-Applications, materials used in rapid prototyping

Unit II (08 Hours)

Reverse Engineering and CAD Modeling

Basic concept- Digitization techniques – Model Reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data Requirements – geometric modeling techniques: Wire frame, surface and solid modeling – data formats -Data interfacing, Part orientation and support generation, Support structure design.

(08 Hours)

Unit III

Liquid Based Rapid Prototyping

Stereolithography (SLA): Apparatus: Principle, per-build process, part-building, post-build processes, photo polymerization of SL resins, part quality and process planning, recoating issues, materials, advantages, limitations and applications.

Unit IV (08 Hours)

Solid Based Rapid Prototyping System

Solid Ground Curing (SGC): working principle, process, strengths, weaknessesand applications.Fused deposition Modeling (FDM): Principle, details of processes, process variables, types, products, materials and applications

Unit V (08 Hours)

Powder Based Rapid Prototyping Systems

Selective Laser Sintering(SLS): Principle, process, Indirect and direct SLS- powderstructures, modeling of SLS, materials, post processing, post curing, surface deviation and accuracy, Applications. Laser Engineered Net Shaping(LENS): Processes,materials,products, advantages, limitations and applications– Case Studies.

(08 Hours)

Unit VI

Other Rapid Prototyping Technologies

Three dimensional Printing (3DP):Principle, basic process, Physics of 3DP, types of printing, process capabilities, material system. Solid based, Liquid based and powder based 3DP systems, strength and weakness, Applications and case studies. Examples and case studies

Text Books/ References

1. Rapid prototyping: Principles and applications, second edition, Chua C.K., Leong K.F and Lim C.S., World Scientific Publishers, 2003.
2. Rapid prototyping, Andreas Gebhardt, Hanser Gardener Publications, 2003
3. Rapid Prototyping and Engineering applications : A tool box for prototypedevelopment, Liou W.Liou, Frank W.Liou, CRC Press, 2007.
4. Rapid Prototyping: Theory and practice, Ali K. Kamrani, Emad Abouel Nasr, Springer,2006.
5. Rapid Tooling: Technologies and Industrial Applications, Peter D.Hilton,Hilton/Jacobs, Paul F.Jacobs, CRC press, 2000

Syllabus for Unit Test

Unit Test I	Unit I,II,III
Unit Test II	Unit IV,V,VI

Self Study Paper II : Design for Manufacture

TEACHING SCHEME

Lectures : 04 Hrs/week

EXAMINATION SCHEME

Theory : 60 Marks
Duration : 03 Hours
Internal Assessment : 40 Marks
Total Credits : 04

Unit I (08 Hours)

Introduction

General design principles for manufacturability, strength and mechanical factors, mechanisms selection, evaluation method, geometrical tolerances, tolerance control and utilization. Economic Use of Raw Materials: Ferrous steel, hot rolled steel, cold finished steel, stainless steel, non ferrous materials aluminum, copper, brass, non metallic materials, plastics, rubber and composites

Unit II (08 Hours)

Components Design I

Metal extrusion, metal stamping, fine blanking, four slide parts, spring and wire forms, spun metal parts, cold headed parts, extruded parts, tube and section bends, rolled formed parts, power metal parts, forging electro forming parts, specialized forming methods, turned parts, machined round holes, drilled parts, milled parts.

(08 Hours)

Unit III

Components Design II

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Planned shaped and slotted parts, screw threaded contoured and internal ground parts, center less ground, electrical discharged, rolled furnished parts, electro chemical and advanced machine parts. Sand cast, die cast, investment cast and other cast products.Non Metallic Components DesignThermosetting plastic, injection moulded and rotational moulded parts, blow moulded, welded plastic articles, ceramics

Unit IV (08 Hours)

Composite Materials

Introduction, Classification of composites, Types of composite,Properties, Metal matrix composite, Ceramic matrix composite, Fiber Reinforced plastic, Manufacturing methods, Applications in Different field. Ceramic, Properties and applications of ceramics. Manufacturing of ceramics.

Unit V (08 Hours)

Assembled Parts Design I

Welded parts, arc, resistance, brazed and soldered parts, gear box assembly, bearing assembly.

(08 Hours)

Unit VI

Assembled Parts Design II

Retension, bolted connection, screwed connections, flanged connections, centred connections, press fitted connections, surface finishing, plated parts, heat treated parts, NC machining, group technology, low cost automation, computer aided manufacture, product design requirements.

Text Books/ References

1. James G. Bralla, ―Hand book of product design for manufacturing‖ McGraw Hill Co., 1986
2. K.G. Swift ―Knowledge based design for Manufacture‖, Kogan page Limited, 1987.
3. S H Avner, Physical Metallurgy, McGraw Hill Publication

Syllabus for Unit Test

Unit Test I	Unit I,II,III
Unit Test II	Unit IV,V,VI

Self Study Paper II : Theory of Elasticity & Plasticity

TEACHING SCHEME

Lectures : 04 Hrs/week

EXAMINATION SCHEME

Theory : 60 Marks
Duration : 03 Hours
Internal Assessment : 40 Marks
Total Credits : 04

Unit I (08 Hours)

Basic Concepts of Stress

Definition, State of Stress at a point, Stress tensor, invariants of stress tensor, principle stresses, stress ellipsoid, derivation for maximum shear stress and planes of maximum shear stress, octahedral shear stress, Deviatoric and Hydrostatic components of stress, Invariance of Deviatoric stress tensor, plane stress.

Unit II (08 Hours)

Basic concepts of Strain

Deformation tensor, Strain tensor and rotation tensor; invariants of strain tensor, principle strains, derivation for maximum shear strain and planes of maximum shear strain,octahedral shear strain, Deviatoric and Hydrostatic components of strain tensor, Invariance of Deviatoric strain tensor, plane strain.

(08 Hours)

Unit III

Generalized Hooke‘s Law

Stress-strain relationships for an isotropic body for three dimensional stress space, for plane stress and plane strain conditions, differential equations of equilibrium, compatibility equations, Material (D) matrix for Orthotropic Materials.

Unit IV (08 Hours)

True stress and true strain

Von-Mise‘s and Tresca yield criteria, Haigh–Westergard stress space representation of von - Mise‘s and Tresca yield criteria, effective stress and effective strain, St. Venants theory of plastic flow, Prandtle–Reuss and Levy–Mise‘s constitutive equations of plastic flow, Strain hardening and work hardening theories, work of plastic deformation.

Unit V (08 Hours)

Analysis methods

Slab method, Slip line field method, uniform deformation energy method, upper and lower bound solutions. Application of Slab method to forging, wire drawing, extrusion and rolling processes.

(08 Hours)

Unit VI

Stresses in flat Plate

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

Text Books/ References

1. Timoshenko and Goodieer, Theory of Elasticity, Mcgraw Hill Publications 3Rd Edition,
2. Madleson, Theory of Plasticity,
3. J. Chakrabarty, Theory of Plasticity, 2 nd edition, McGraw Hill Publications 1998
4. George E Dieter, Mechanical Metallurgy, McGraw Hill Publications 1988

Syllabus for Unit Test

Unit Test I	Unit I,II,III
Unit Test II	Unit IV,V,VI

Self Study Paper II : Design of Dies

TEACHING SCHEME

Lectures : 04 Hrs/week

EXAMINATION SCHEME

Theory : 60 Marks
Duration : 03 Hours
Internal Assessment : 40 Marks
Total Credits : 04

Unit I (08 Hours)

Design principles

Design principles for dies of thermo-plastic and thermo-setting components. Impression core cavities, strength of cavities, guide pillars and bushes, ejection systems, cooling methods, bolster types. Split moulds, methods of actuating the splits, moulds of threaded components, internal & external under cuts, moulds with under – feed systems. Design principles and standards for Transfer and compression moulding dies. Design of Tools: Mould for a spindle component with sleeve, pin ejection. Mould with splits Multi-cavity mould with stripper plate, inserts, and ejectors.

Unit II (08 Hours)

Specifications & Elements of Blow Moulding

Determination of number of cavities, types of cooling system, design of cooling channels, heat transfer considerations, types of ejectors, determination of mould opening force & ejection force, use of CAD for mould design, defects and remedies

(08 Hours)

Unit III

Design of Dies for metal mould Castings

Design of Dies for metal mould Castings, Die casting, Shell moulding. Design of casting cavity, sprue, slug, fixed and movable cores, finger cam, core, pin, draft, ejector pins, ejector plate, gate, goose-neck, nozzle, over-flow, platen plunger, runner, slot, slide, vent, water line. Design of hot chamber, cold chamber machines, vertical, horizontal,, die locking machines, toggle and hydraulic systems, injection systems, rack and pinion, knockout pins and plates, hydraulic ejection, Other parts of die casting machines

Unit IV (08 Hours)

Design of various types of dies

Design of various types of dies – Single cavity, multi cavity, combination, unit dies. Alignment of dies with sprue. Design approach for die elements. Selection of materials and heat treatment for die casting dies and elements – die casting alloys – types of die casting alloys, Case studies on executed dies and design details. Finishing, Trimming, and inspection. Gravity die casting – Die design with cores and inserts – Bulk forming tools.Mould flow analysis.Softwares used for Die Design.

Unit V (08 Hours)

Open die forging

Open die forging, Advantages of open die forging over closed die forging. Calculation of allowances and tolerances. Methods of open die forging. Design of dies. Closed die forging. Preparation of material for forging. Calculation of raw-stock, cutting off, heating in furnaces. Allowances and tolerances for closed die forging as per IS: 3469 1974.

(08 Hours)

Unit VI

Die blocks for forging operations

Die blocks for forging operations. Design of fuller impression, Roller impression, Bender impression, Blocker impression, Finisher impression. Swaging tools. Planning layout of multi impression dies. Flash and cutter calculations –additional operations on forging, piercing, and trimming dies, coining dies. Horizontal forging machines. Design of upsetting dies. Calculations on upsetting dies

Text Books/ References

1. Rusinoff S.E., Forging & Forming Metals, Taraporewala, Bombay, 1952.
2. Dochlar H.H., Die Casting Dies, McGrawhill, 1951.
3. I.S. Standards, BSI., New Delhi.
4. Pye R.G.W., Injection Mould Design, Longman scientific & Technical Publishers, London, 1989.

Syllabus for Unit Test

Unit Test I	Unit I,II,III
Unit Test II	Unit IV,V,VI

Self Study Paper II : Integrated Product Design & Development

TEACHING SCHEME

Lectures : 04 Hrs/week

EXAMINATION SCHEME

Theory : 60 Marks
Duration : 03 Hours
Internal Assessment : 40 Marks
Total Credits : 04

Unit I (08 Hours)

Introduction

Definition and morphology of product design (seven phases), standardization, simplification and specialization in product design, modern approaches-concurrent design and quality function deployment, product development, product development versus product design, types of design and redesign, modern product development process, product development team and product development planning with reference to ISO standard, difference between product verification and production validation.

Unit II (08 Hours)

Product Development – Technical and Business Concerns

Technology Forecasting and Technology S-Curve (Technology Stage), Mission Statement and Technical Questioning, Economic Analysis of Product, Customer Needs and Satisfaction, Customer Population and Market Segmentation, Customer Needs-Types and Models, Gathering Customer Needs Information, Analysis of Gathered Information.

(08 Hours)

Unit III

Product Development from Concept to Product Function

Generating concepts, information gathering, and brainstorming, morphological analysis, concept selection-design evaluation, estimation of technical feasibility, concept selection process, Pugh,,s concept, selection charts, numerical concept scoring, process of concept embodiment, system modeling, FMEA, functional modeling and decomposition, fast method, subtract and operate procedure, establishing system functionality, augmentation and aggregation.

Unit IV (08 Hours)

Product Development in the Context of Reverse Engineering

Product Teardown Process, Tear Down Methods - Force Flow Diagrams, Measurement and Experimentation, Applications of Product Teardown, Benchmarking Approach and Detailed Procedure, Tools Used In Benchmarking -Indented Assembly Cost Analysis, Function - Form Diagrams, Trend Analysis, Setting Product Specifications, Introduction to Product Portfolio and Architecture.

Unit V (08 Hours)

Design for Manufacture, Assembly and Environment

Design guidelines, design for manufacture, design for assembly, design for piece part production,

manufacturing cost analysis, need and importance of design for environment, global, local and regional issues, basic DFE methods-guidelines and applications, life cycle assessment - basic method, weighed sum assessment method, life cycle assessment method, DFX, product testing, product validation, field trials, virtual trials, iterations.

(08 Hours)

Unit VI

Product development Methodology:

Integrated product development process invariant, Integrated product development process, steps in IPD methodology, Product requirement planning and management, problem identification and solving methodology

Text Books/ References

1. K. Chitale; R.C. Gupta, Product Design and Manufacturing, Prentice - Hall India.
2. Effective Product Design and Development, Stephen Rosenthal, Business One Orwin,Homewood, 1992,ISBN, 1-55623-603-4
3. Tool Design – Integrated Methods for successful Product Engineering, Stuart Pugh,Addison Wesley Publishing,Neyourk,NY,1991,ISBN 0-202-41639-5
4. Concurrent Engineering Fundamentals volume II Integrated Product development,Biren Prasad,Prentice Hall International series in Industrial and system Engineering
5. Product Design and Development, Karl T.Ulrich and Steven D.Eppinger, McGraw – Hill International Edns.1999
6. Dieter George E., Engineering Design McGraw Hill Pub. Company, 2000
7. Kevin Otto and Kristin Wood, Product Design: Techniques in Reverse Engineering and New Product Development, Pearson Education Inc.
8. Grieves, Michael, Product Lifecycle Management McGraw-Hill, 2006. ISBN 0071452303
9. Bralla, James G., Handbook of Product Design for Manufacturing, McGraw Hill Pub. 1986

Syllabus for Unit Test

Unit Test I	Unit I,II,III
Unit Test II	Unit IV,V,VI

Self Study Paper II : Design for Manufacturing & Assembly

TEACHING SCHEME

Lectures : 04 Hrs/week

EXAMINATION SCHEME

Theory : 60 Marks
Duration : 03 Hours
Internal Assessment : 40 Marks
Total Credits : 04

Unit I (08 Hours)

Introduction

Design philosophy – steps in Design process – General Design rules for manufacturability – basic principles of designing for economical production –creativity in design. Application of linear & non-linear optimization techniques.Materials: Selection of Materials for design – Developments in Materialtechnology – criteria for material selection – Material selection interrelationship with process selection – process selection charts.Philosophy for design for X.

Unit II (08 Hours)

Machining Process

Overview of various machining processes – general design rules for machining -Dimensional tolerance and surface roughness – Design for machining – Ease –Redesigning of components for machining ease with suitable examples. General design recommendations for machined parts.

(08 Hours)

Unit III

Metal Casting

Appraisal of various casting processes, selection of casting process, - general design considerations for casting – casting tolerances – use of solidification simulation in casting design – product design rules for sand casting.

Unit IV (08 Hours)

Metal joining

Appraisal of various welding processes, Factors in design of weldments – general design guidelines – pre and post treatment of welds – effects of thermal stresses in weld joints – design of brazed joints. Forging – Design factors for forging – Closed die forging design – parting lines of dies drop forging die design – general design recommendations

Unit V (08 Hours)

Extrusion and sheet Metal work

Design guidelines for extruded sections - design principles for Punching, Blanking, Bending, and Deep Drawing – Keeler Goodman Forming Line Diagram –Component Design for Blanking.

(08 Hours)

Unit VI

Plastics

Visco-elastic and creep behavior in plastics – Design guidelines for Plastic components – Design considerations for Injection Moulding – Design guidelines for machining and joining of plastics Assembly: Compliance analysis and interference analysis for the design of assembly Design and development of features for automatic assembly – liaison diagrams.Influence on the productivity and cost.

Text Books/ References

1. A K Chitale, R C Gupta " Product Design and Manufacturing", PHI, New Delhi, 2003
2. George E Deiter, "Engineering Design", Mc GrawHills Intl, 2002.
3. John Cobert, "Design for Manufacturing", Addison Welsely, 2000.
4. Surender Kumar and Gautham S., " Design and Manufacturing", Oxford & IBH Publishing Co Pvt Ltd, New Delhi, 1998.
5. Material Selection and Design Handbook, Vol – 20, ASM International, 1997.

Syllabus for Unit Test

Unit Test I	Unit I,II,III
Unit Test II	Unit IV,V,VI

Self Study Paper II : Concurrent Engineering

TEACHING SCHEME

Lectures : 04 Hrs/week

EXAMINATION SCHEME

Theory : 60 Marks
Duration : 03 Hours
Internal Assessment : 40 Marks
Total Credits : 04

Unit I (08 Hours)

Introduction:

Background and challenges faced by modern production environment,sequential engineering process, Concurrent engineering definition and requirement, meaning of concurrent objectives of CE, benefits of CE.Sequential engineering.

Unit II (08 Hours)

Product Life Cycle Management :

Life cycle design of products, life cycle costs. Support for CE: Classes of support for CE activity, CE organizational, structure CE, team composition and duties, Computer based Support, CE Implementation Process.

(08 Hours)

Unit III

Quality Function Deployment:

Industrial Design, Quality Function Deployment, house of quality, Translation process of quality function deployment (QFD). Modeling of Concurrent Engineering Design: Compatibility approach, Compatibility index, implementation of the Compatibility model, integrating the compatibility Concerns.

Unit IV (08 Hours)

Design for Manufacture (DFM):

Introduction, role of DFM in CE, DFM methods, e.g. value engineering, DFM guidelines, design for assembly, creative design methods, product family themes, design axioms, Taguchi design methods, Computer based approach to DFM. Evaluation of manufacturability and assimilability

Unit V (08 Hours)

Quality by Design:

Quality engineering & methodology for robust product design, parameter and Tolerance design, Quality loss function and signal to noise ratio for designing the quality, experimental approach.

(08 Hours)

Unit VI

Design for X-ability:

Design for reliability, life cycle serviceability design, design for maintainability, design for economics, decomposition in concurrent design,concurrent design case studies.

Text Books/ References

1. Concurrent Engineering- Kusiak - John Wiley & Sons
2. Concurrent Engineering- Menon - Chapman & Hall
3. David M. Anderson, Design For Manufacturing And Concurrent Engineering,CIM press,2004
4. G. H. Haung, Design for X: Concurrent Engineering Approach, Chapman & Hall, 1996.
5. Shina, S.G., Concurrent Engineering and Design for Manufacture ofElectronics Products, Van Nostrand Reinhold, New York, 1991.

Syllabus for Unit Test

Unit Test I	Unit I,II,III
Unit Test II	Unit IV,V,VI

DISSERTATION STAGE II

TEACHING SCHEME

Practicals : 10 Hrs/week

EXAMINATION SCHEME

Term Work : 150 Marks
Pract/Oral : 75 Marks
Total Credits : 32

Stage-II:

This stage will include comprehensive report on literature survey, design and fabrication of experimental set up and / or development of model, relevant computer program. The student is require to publish at least one national/international paper based on the dissertation work. The publication / accepted paper for publication shall be included in the report.

Student has to submit the authentic copy of dissertation Stage-I report.