BHARATI VIDYAPEETH
(DEEMED TO BE UNIVERSITY), PUNE

Faculty of Engineering And Technology
M. Tech. - Mechanical (CAD/CAM)
New Syllabus

M. Tech. Mechanical (CAD/CAM)
CBCS 2019 Course

COURSE STRUCTURE & SYLLABUS

Semester I											**Total Duration: 20 Hrs./Week** **Total Marks: 500** **Total Credits: 18**
Subjects	**Teaching Scheme Hrs./Week**		**Examination Scheme (Marks)**						**Examination Scheme (Credits)**		**Total Credits**
	L	P	Theory	Unit Test	Attendance	Tutorial/Assignments	TW & Orals	TW & Pract.	TH	PR	
Computer Aided Design	4	2	60	20	10	10	50	-	4	1	5
Modeling and Simulation	4	2	60	20	10	10	50	-	4	1	5
Computer Integrated Manufacturing	4	-	60	20	10	10	-	-	4	-	4
Product Design and Development	4	-	60	20	10	10	-	-	4	-	4
Total	**16**	**4**	**240**	**80**	**40**	**40**	**100**	**-**	**16**	**2**	**18**

Semester II											**Total Duration: 20 Hrs./Week** **Total Marks: 500** **Total Credits: 18**
Subjects	**Teaching Scheme Hrs./Week**		**Examination Scheme (Marks)**						**Examination Scheme (Credits)**		**Total Credits**
	L	P	Theory	Unit Test	Attendance	Tutorial/Assignments	TW & Orals	TW & Pract.	TH	PR	
Advanced Finite Element Methods	4	2	60	20	10	10	50	-	4	1	5
Control Systems	4	2	60	20	10	10	50	-	4	1	5
Precision Engineering	4	-	60	20	10	10	-	-	4	-	4
Optimization for Engineering Design	4	-	60	20	10	10	-	-	4	-	4
Total	**16**	**4**	**240**	**80**	**40**	**40**	**100**	**-**	**16**	**2**	**18**

Semester III											Total Duration: 28 Hrs./Week Total Marks: 475 Total Credits: 40
Subjects	**Teaching Scheme Hrs./Week**		**Examination Scheme (Marks)**						**Examination Scheme (Credits)**		**Total Credits**
	L	**P**	**Theory**	**Unit Test**	**Attendance**	**Tutorial/Assignments**	**TW & Orals**	**TW & Pract.**	**TH**	**PR**	
Elective I	4	2	60	20	10	10	50	-	4	1	5
Elective II	4	2	60	20	10	10	50	-	4	1	5
Self-Study paper I	4	-	60	20	10	10	-	-	4	-	4
Seminar	-	5	-	-	-	-	50	-	-	5	5
Dissertation Stage I	-	7	-	-	-	-	25	-	-	21	21
Total	**12**	**16**	**180**	**60**	**30**	**30**	**175**	**-**	**12**	**28**	**40**

Elective I

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

Elective II

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

Semester IV											Total Duration: 14 Hrs./Week Total Marks: 325 Total Credits:34
Subjects	**Teaching Scheme Hrs./Week**		**Examination Scheme (Marks)**						**Examination Scheme (Credits)**		**Total Credits**
	L	P	Theory	Unit Test	Attendance	Tutorial/Assignments	**TW& Orals**	**TW & Pract.**	**TH**	**PR**	
Self-Study paper II	4	-	60	20	10	10	-	-	4	-	4
Dissertation Stage II	-	10	-	-	-	-	150	75	-	30	30
Total	**4**	**10**	**60**	**20**	**10**	**10**	**150**	**75**	**4**	**30**	**34**

List of Self Study Subjects

Sr. No.	SELF STUDY PAPER- I (SEM-III)	SELF STUDY PAPER- II (SEM-IV)
1.	Advanced Manufacturing Processes	CAD/CAM Practices in Metal Forming
2.	Machine Condition Monitoring and Diagnostics	Optimization Techniques
3.	Product Lifecycle Management	Robotics and Sensors
4.	Robust Design of Product & Process	Rapid Prototyping
5.	Computer Aided Process Planning	Design for Manufacture
6.	Flexible Manufacturing System	Theory of Elasticity & Plasticity
7.	Product Design & Process Planning	Design of Dies
8.	Experimental Technique and Data analysis	Integrated Product Design & Development
9.	Tribology in Design	Design for Manufacturing & Assembly
10.	Manufacturing System and Simulation	Concurrent Engineering

Computer Aided Design

TEACHING SCHEME

Lectures : 04 Hrs./week
Practical : 02 Hrs./week

EXAMINATION SCHEME

Theory : 60 Marks
Duration : 03 Hours
Internal Assessment : 40 Marks
TW/Oral : 50 Marks
Total Credits : 05

Course prerequisite

- Engineering Graphics
- Mechanical Engineering Drawing
- Advanced computer Graphics and solid modelling

Course objective:

- To impart the parametric fundamentals to create and manipulate geometric models using curves, surfaces and solids.
- Provide hands on training in classical geometric modeling as well as its modern use of computer graphics.

Course outcomes:

The students will be able to

- Create the different wireframe primitives using parametric representations.
- Create surface primitives using parametric representations.
- Create the different solid primitives using the different representation schemes.
- Apply geometric transformations on the created wireframe, surface and solid models.
- Exchange the data using the various file exchange formats.
- Apply upgraded technology to ease the modelling efforts.
- Apply interactive process of collaborative engineering and product data management.

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.

Teamwork

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
Practical : 02 Hrs./week

EXAMINATION SCHEME

Theory : 60 Marks
Duration : 03 Hours
Internal Assessment : 40 Marks
TW/Oral : 50 Marks
Total Credits : 05

Course prerequisite

- Knowledge of Statistics
- Knowledge of Probability
- Basics of Programming language

Course objective:

- Use statistics and probability in simulation
- Simulate the system for given problem

Course outcomes:

The student should be able to understand

- Concept of Modeling
- Concept of simulation
- Use of probability distribution
- System simulation
- Discrete and continuous simulation

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 | **EXAMINATION SCHEME**

Lectures : 04 Hrs./week

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

Course prerequisite

- Students should have basic knowledge of computers, Engineering and Manufacturing Processes.

Course objective:

- The goal of the course is to give an introduction to collaborative views of manufacturing computer Students will get acquainted themselves with basic methodology.

Course outcomes:

The students should be able to

- Understand the effect of manufacturing automation strategies and derive production networking.
- Understand an introduction to Data base management and Model.
- Understand Group Technology, Cellular Manufacturing and Flexible Manufacturing Systems.
- Understand the process of Computer Aided Process Planning, automated Material Handling and Inspection Systems.
- Understand Web based manufacturing system and its applications.
- Understand the Future trends in manufacturing system

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

Lectures : 04 Hrs./week

EXAMINATION SCHEME

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

Course prerequisite

- Students should have basic knowledge of Design, Engineering and Manufacturing Processes

Course objective:

- The goal of the course is to give an introduction to collaborative views of product development and innovation. Students will get acquainted themselves with basic methodology and tools that can be used in product development.

Course outcomes:

The students should be able to

- Understand Characteristics of product design and development
- Understand process and Product planning
- Identify Concept Generation
- Understand Product specifications and Architecture
- Understand Industrial Design process and it management
- Understand Economic considerations and economic analysis of product.

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 McGraw-Hill - 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

Lectures : 04 Hrs./week
Practical : 02 Hrs./week

EXAMINATION SCHEME

Theory : 60 Marks
Duration : 03 Hours
Internal Assessment : 40 Marks
TW/Oral : 50 Marks
Total Credits : 05

Course prerequisite

- Engineering Mechanics
- Engineering Mathematics
- Strength of Materials
- Mechanical Vibration
- Heat Transfer

Course objective:

- Analyze a physical problem,
- Develop finite element procedures for accurately investigating the problem, and effectively perform and document findings.
- Solve 1 D, 2 D and dynamic problems using Finite Element Analysis approach

Course outcomes:

The students will be able to

- apply direct stiffness, Rayleigh-Ritz, Galerkin and variational method to solve engineering problems, outline the requirements for convergence and recognize sources of errors in FEA
- understand the role and significance of shape functions in finite element formulations and use linear, quadratic, and cubic shape functions for interpolation
- understand the formulation of element stiffness matrix, load vector by potential energy approach for 1D problems as well as able to select correct weighing functions using different methods to reduce the residual.
- understand the formulation of two-dimensional elements (triangle and quadrilateral elements) as well as able to derive the shape functions for higher order element.
- derive the shape functions for bar, rectangle and higher order elements as well as able to apply numerical methods to solve numerical integration.
- evaluate the Eigenvalues and Eigenvectors for stepped bar and beam.
- Cope up with the advanced technology to solve real life problems.

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 sub structuring.

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

Lectures : 04 Hrs./week
Practical : 02 Hrs./week

EXAMINATION SCHEME

Theory : 60 Marks
Duration : 03 Hours
Internal Assessment : 40 Marks
TW/Oral : 50 Marks
Total Credits : 05

Pre-requisites:

- Knowledge of Mathematics & Science
- Knowledge of Basic Electrical Engineering.
- Knowledge of Sensors and Measurement System.

Course Objective

- Familiarization with Control System Principles and Applications of Control System.
- Calculate and Estimate the Stability Measures, Time Response Measures from the Analysis of Mathematical Models of Some Simple Engineering Systems.
- Develop Ladder Diagrams using PLC and Apply It for Industrial Automation.

Course Outcome

Student should be able to

- Understand Introduction & classification of control systems.
- Identify time Response Analysis of Control System.
- Familiarize with Routh-Hurwitz's Stability criteria.
- Use Root Locus and Frequency Response Methods.
- Understand concept of State Space Modelling.
- Understand Non-Linear Control Systems.

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, diagonalization. solutions of homogeneous and non-homogenous equations, zero and pole placement using state space techniques. Transfer function from state model. Controllability and observability of linear system. State transition matrix, state controllability matrix, state observability 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

Precision Engineering

TEACHING SCHEME | **EXAMINATION SCHEME**

Lectures : 04 Hrs./week

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

Course prerequisite

- Students should have basic knowledge of precision Engineering and Manufacturing Processes.

Course objective:

- The goal of the course is the Students will get acquainted themselves with basic methodology and tools that can be used in precision engineering.

Course outcomes:

The students should be able to

- Understand the Concept of accuracy of machine tools
- Understand the methods and devices for dimensional measurements.
- Asses' Surface roughness and form errors.
- Identify Precision measuring system and suggest suitable measuring process.
- Understand Nano positioning system of nano accuracy & repeatability
- Understand the Concept of total quality control &quality assurance

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

Lectures : 04 Hrs./week

EXAMINATION SCHEME

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

Course prerequisite

- Differential calculus
- Concept of matrix

Course objective:

- Obtain and classify the stationary point for single and multivariable optimization

Course outcomes:

The student should be able to understand

- Optimal problem formulation
- Solve single variable optimization problem
- Solve multi variable optimization problem
- Solve constrained optimization problem
- Use of evolutionary algorithm

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

Lectures : 04 Hrs./week
Practical : 02 Hrs./week

EXAMINATION SCHEME

Theory : 60 Marks
Duration : 03 Hours
Internal Assessment : 40 Marks
TW/OR : 50 Marks
Total Credits : 05

Course prerequisite

- Engineering Mechanics, Strength of material, Machine design I & II, Theory of machines.

Course objective:

- To provide students concept of elasticity, and relation between stress and strain.
- To provide students the tools required for design and analysis of complex problems in mechanics of materials by using theory of plasticity.
- To provides students the failure mode analysis of plastic and plastic composites
- To learn and enable the student to find the contact stresses for different mechanisms.
- To provide students concept of plate bending for circular plates, thick and thin plates with centre hole.
- To learn and enable the student for different experimental stress analysis techniques.

Course outcomes:

- Explain the concept of elasticity, and the difference between stress and strain
- Explain the terms: isotropic, orthotropic and anisotropic, as applied to materials by using theory of plasticity.
- Explain the terms: Stress Analysis of Engineering Plastics and Composites
- Solve problems for plate bending and bending of circular plates for thick and thin plates
- Find contact stresses for different mechanisms like cam and follower, gear contact, ball bearing, etc.
- Apply the analytical procedures involved in strain gauge measurements, in particular the transformation equations

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
Practical : 02 Hrs./week

EXAMINATION SCHEME

Theory : 60 Marks
Duration : 03 Hours
Internal Assessment : 40 Marks
TW/OR : 50 Marks
Total Credits : 05

Course prerequisite

- Students should have basic knowledge of Information system and technology

Course objective:

- The goal of the course is the Students will get acquainted themselves with basic methodology of manufacturing information system.

Course outcomes:

The students should be able to

- Understand Knowledge based information system
- Understand Interference mechanism of forward and backward chain
- Understand the Coding language and LISP
- Use of Robot technology and quality control
- Understand Knowledge based approaches for engineering design.
- Understand basics of Artificial intelligence.

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
Practical : 02 Hrs./week

EXAMINATION SCHEME

Theory : 60 Marks
Duration : 03 Hours
Internal Assessment : 40 Marks
Tw/Oral : 50 Marks
Total Credits : 05

Course prerequisite

- Engineering Mathematics
- Numerical methods
- Fluid mechanics
- Heat transfer

Course objective:

- Impart knowledge to solve complex fluid flow problems using computational fluid dynamics.
- Familiar with modern trends in computational fluid dynamics.

Course outcomes:

Student should be able to

- Apply basic principles of fluid dynamics and understand theoretical basis of computational fluid dynamics
- Create geometric models on computer based modeling package with minimized CAD errors
- Derive governing equations by understanding flow physics and mathematical behaviour.
- Analyse different mathematical models by using computational methods for flow simulations.
- Create grid and improve mesh quality using advanced tools and techniques
- Develop turbulence models and und understand approaches used in multiphase models.

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

Lectures : 04 Hrs./week
Practical :02 Hrs./week

EXAMINATION SCHEME

Theory : 60 Marks
Duration : 03 Hours
Internal Assessment : 40 Marks
Tw/Oral : 50 Marks
Total Credits : 05

Course prerequisite

- Students should have basic knowledge of nano materials.

Course objective:

- The goal of the course is t Students will get acquainted themselves with basic methodology of micro electromechanical system.

Course outcomes:

The students should be able to

- Generate conceptual design for MEMS products based on potential customer requirements
- Understand MEMS fabrication techniques
- Design a control system for effective functioning of Microprocessor and types of actuators
- Understand the selection of materials, process and techniques of micro system design
- Understand Nano materials and Nano structure.
- Understand and apply the nano finishing techniques.

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, ion implantation; 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, micro machined 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

Syllabus for Unit Test

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

Elective-I: World Class Manufacturing

Designation of Course	**World Class Manufacturing**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 04 Hours/ Week	End Semester Examination	60	04
Practical: - 02 Hours/ Week	Internal Assessment	40	01
	Term Work & Oral	50 Marks	
	Total	**150 Marks**	**05**

Course Prerequisites: -	Student should have knowledge of 1. Students should have Basic knowledge of Industrial Engineering. 2. Students should have Basic knowledge of Statistics
Course Objectives: -	Student should be able to 1. Use of six sigma technique to reduce variation 2. Use of Lean manufacturing for process improvement 3. Use of Agile manufacturing
Course Outcomes: -	Learner will be able to… 1.Understand and work with the Lean manufacturing process 2. Understand and work with the Agile Production System 3. Management in the Agile Organization. 4. Understand basic statistical processes. 5. Understand and calculate the six sigma levels 6. Understand and work with the DMAIC process

Course Contents

Unit 1	**Lean Manufacturing**	**08 Hrs.**

Origin and objectives of lean manufacturing, 3M concept, study of Ford and Toyota Production system, Just in Time (JIT) manufacturing, lean building blocks.

Value Creation and Waste elimination, seven types of waste, pull production, different models of pull production, Kanban system, design of Kanban quantities, Kaizen, tools for continuous improvement.

The value stream-benefits, mapping process. Current state maps-mapping icons, mapping steps. VSM exercise. Takt time calculations standardize work- standard work sequence, timing and working progress

Quality at source-Automation/Jidoka, Visual management system, Mistake Proofing/Poka-Yoke.5s technique-Elements and waste elimination through 5s. advantages and benefits, 5s audit, Visual control aids for improvements, Flexible work force.

Unit 2	**Agile Production system and Practices**	**08 Hrs.**

Agile production system-the task allied organization-production planning and control, quality assurance, purchasing maintenance, overview of production support, business operations, engineering, finance and accounting. Agile Practices-Agile practice for product development, manufacturing Agile practice, understanding the value of investment in people.

Unit 3	**Management in the Agile Organization**	**08 Hrs.**

Old management styles, role of management in agile organization-vision champion, team leader, coach, business analyzer, supporting the new culture-performance appraisal system, selection system, reward and recognition system, organizational measurement, organizational learning processes.

Unit 4	Statistics and probability distribution	08 Hrs.
Basic statistics, probability distributions, normal distribution, central limit theorem, measurement system analysis – precision, accuracy, bias, linearity, gage repeatability & reproducibility. Process capability analysis. Multi-Vari analysis, sampling techniques, Hypothesis testing, testing with normal data, One Way ANOVA, nonparametric tests for non-normal data. Chi-square tests		
Unit 5	**Introduction to Six Sigma**	**08 Hrs.**
Six Sigma Defined, Calculating the Sigma Level – Toolset, Six Sigma Framework, DMAIC – The Six Sigma Improvement Process, Introduction to Measure, Introduction to Define, Process Thinking, Spaghetti Charts, Value Stream Mapping Toolset, Pareto Chart Toolset, Project Selection Toolset, Project Charter Toolset		
Unit 6	**Six Sigma in manufacturing**	**08 Hrs.**
Introduction to Measure, Measurements, Discrete vs. Continuous Measurements, Measurement Subjects, Measurement as a Process, The Analysis of Measurement Systems, Statistical Process Control – Introduction and Background, Introduction to Control Charts , Control Chart Limits, More On Control Limits, Cause & Effect Diagram Toolset, Introduction to Hypothesis Testing, The Process on Trial, The Hypothesis – Accept or Reject, Types of Error, Hypothesis Testing , Confidence Intervals, Design of Experiments, Design for Six Sigma (DFSS), Benchmarking , Brainstorming		

Term Work:

1. Case study on JIT and Toyota production system
2. Case study on Kanban and Kaizen production system
3. Case study on Management in the Agile Organization
4. To find the Process capability.
5. Application of Chi-square tests
6. Sigma level calculations

Textbooks:

1. Jain R. K., "Engineering Metrology", Khanna Publishers
2. Hume K. J., "Engineering Metrology", Macdonald, 1950
3. Sharp K. W. B., "Practical Engineering Metrology", Pitman Publication, 1970.

Reference Book:

1. Productions and Operations Management - Chasel Aquilino - Dreamtech latest edition.
2. Toyota Production System -An integrated approach to Just in Time - Yasuhiro Monden – Engineering and Management Press -Institute of Industrial Engineers Norcross Georgia-1983.
3. The Machine that changed the World. The Story of Lean Production - James P Womack – Daniel T Jones - and Daniel Roos -Harper Perennial - edition published 1991.
4. Lean Thinking - James Womack – ISBN 0743249275 – 2003.
5. Japanese Manufacturing Techniques. The Nine Hidden Lessons by simplicity - Richard Stumberger - ASQC Press 1991.
6. Quality Function Development - James Bossert - ASQC Press 1991.

Unit Test -

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

Elective II : Composite Materials

TEACHING SCHEME

Lectures : 04 Hrs./week
Practical : 02 Hrs./week

EXAMINATION SCHEME

Theory : 60 Marks
Duration : 03 Hours
Internal Assessment : 40 Marks
Tw/Oral : 50 Marks
Total Credits : 05

Course prerequisite

- Students should have basic knowledge of traditional engineering materials and properties of materials.

Course objective:

- The objective of the course is to give insight of application of composite material over traditional engineering material.
- Understanding the use of composite material in various fields and overcoming issues related to composite materials by focusing on various research aspects.

Course outcomes:

The students should be able to

- Understand Basic concepts and characteristics of composite materials
- Understand Micromechanical behaviors' of lamina:
- Understand Micromechanical behavior of a lamina
- Understand Hydrothermal effects
- Understand Micromechanical behaviors of a laminate
- Understand Manufacture and testing of composite materials

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)

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

Elective II : Analysis and Synthesis of Mechanisms

TEACHING SCHEME

Lectures : 04 Hrs./week
Practical : 02 Hrs./week

EXAMINATION SCHEME

Theory : 60 Marks
Duration : 03 Hours
Internal Assessment : 40 Marks
TW/Oral : 50 Marks
Total Credits : 05

Course prerequisite

Students should know the basic knowledge of theory of machines, Robotics etc.

Course objective:

Students should learn the velocity and acceleration analysis of the mechanisms.

- They should learn the dimensional synthesis of the mechanisms.
- They will get the knowledge of synthesis of mechanisms, static and Dynamic force analysis of mechanisms & Robotics.

Course outcomes:

Students should able to understand

- Different kinematic motion and their multi loop and vector loop equations.
- Velocity and acceleration analysis of different kinematic linkages.
- Dimensional synthesis of mechanisms and different generations.
- Graphical, algebraic methods and applications in synthesis of mechanisms.
- Static and Dynamic force analysis of the mechanisms.
- Kinematic analysis of the mechanisms and Robotics.

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

Lectures : 04 Hrs./week
Practical : 02 Hrs./week

EXAMINATION SCHEME

Theory : 60 Marks
Duration : 03 Hours
Internal Assessment : 40 Marks
Tw/Oral : 50 Marks
Total Credits : 05

Course prerequisite

Optimization techniques
Computer programming

Course objective:

Student is able to design fuzzy logic and ANN for practical problem

Course outcomes:

The student shall be able to:

- Demonstrate fundamental understanding of the history of artificial intelligence (AI) and its foundations.
- Apply basic principles of fuzzy logic in solutions that require problem solving, inference, perception, knowledge representation, and learning.
- Demonstrate awareness and a fundamental understanding of various applications of fuzzy logic techniques in intelligent agents, expert systems, artificial neural networks and other machine learning models.
- Demonstrate proficiency developing applications in artificial neural network.
- Demonstrate proficiency in applying scientific method of associative memory in artificial intelligence.
- Understand the concept of industrial applications of artificial intelligence and expert systems.

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

Lectures : 04 Hrs./week
Practical : 02 Hrs./week

EXAMINATION SCHEME

Theory : 60 Marks
Duration : 03 Hours
Internal Assessment : 40 Marks
TW/Oral : 50 Marks
Total Credits : 05

Course prerequisite

- Basics of statistics
- Basic concepts of probability

Course objective:

- Analyze the system for optimum yield using design of experiment

Course outcomes:

Student should be able to

- Basics principles of design of experiment
- Understand inferential statistics
- ANOVA for single factor
- To design of two factorial experiment
- To design General 2k
- To understand response surface methodology

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

Elective-II: FUTUTE FACTORY

Designation of Course	**Future Factory**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory: - 04 Hours/ Week	End Semester Examination	60 Marks	04
Tutorial: - --Hours/ Week	Internal Assessment	40 Marks	
Practical: - 02 Hours/ Week	Term Work	25 Marks	01
	Oral/Practical	25 Marks	
	Total	**150 Marks**	**05**

Course Prerequisites: -	The students should have knowledge of 1) Manufacturing Technology-I, II 2) Automatic Control System 3) Electro-Hydraulic and Pneumatics 4) Power Electronics & Drives 5) Object Oriented Programming (Using Python) 6) Programmable Logic Controller
Course Objectives: -	To provide Knowledge about 1. Modern manufacturing systems 2. To understand the concepts and applications of flexible manufacturing systems 3. To introduce the concept of smart factories, especially the various technologies involved within the smart manufacturing. 4. To introduce the applications and scope for technology involved in Industry 4.0.
Course Outcomes: -	The students should be able to– 1. Recognize the recent manufacturing trends related to Industry 4.0, FMS, and its implementation in manufacturing 2. Perform Planning, Scheduling, and control of Flexible Manufacturing systems 3. Identify the role of cloud manufacturing for smart factories, challenges, and scope 4. Understand and apply the concept of agile manufacturing and cyber security in future factory 5. Identify applications of AR and VR in smart manufacturing. 6. Understand and apply the concept of digital twins in future factory

Course Contents

Unit I	**Introduction to smart manufacturing technologies**	**(08 Hrs.)**
Introduction to Industry 4.0, Smart manufacturing, Related technologies, Traditional Factory and Smart Factory, The Smart Factory Opportunity, CIM wheel, CIMS Structure and Functions, Future Trends of smart Factory and applications. Introduction & composition of FMS, hierarchy of computer control, computer control of work center and assembly lines, FMS supervisory computer control, types of software specification and selection.		
Unit II	**Applications of FMS and factory of the future**	**(08 Hrs.)**
FMS application in machining, sheet metal fabrication, prismatic component production, aerospace application, FMS development towards factories of the future. Flexibility rules, Sustainability, Man in the factory, building blocks for the factory of the future, Building architecture and factory planning, IT Infrastructure and cyber security, Data Management, Machines and manufacturing systems.		

Unit III	**Cloud Manufacturing and connected factory**	**(08 Hrs.)**
Introduction to Cloud computing, Industrial Internet of Things, supply chain management, Big Data and Analytics, Big Data decision-making, , Automotive Cloud, warehouse operations, Augmented reality. Virtualization, Cloud Platforms, Big data in production, Cloud-based ERP and MES solutions, Connected factory applications, IT security for cloud applications.		
Unit IV	**Agile Manufacturing and Safety with Future Factory**	**(08 Hrs.)**
Agile Manufacturing: Introduction to Agile Manufacturing, Agile Manufacturing Principles, Implement Agile Manufacturing, Applications of Agile Manufacturing, Real-Time Data to Guide Iteration, Computer Vision to Augment Operators, Manufacturing Apps to Amplify Training Programs, Mass Customization. **Safety with Future Factory**: Introduction to cybersecurity, security principles, risk and opportunities in cybersecurity technology,		
Unit V	**Virtual and Augmented Reality, Machine Learning in Industry 4.0**	**(08 Hrs.)**
Introduction, Difference in AR and VR, Hardware and Software Technology, Industrial Applications of Augmented reality and Virtual reality. Basics of Machine Learning, The Machine Learning Process, Into Machine Learning working cycle, Preparing Data, Running Experiments, Finding the Model, Training the Model, Deploying and using a Model, Machine Learning in practice (examples of existing or future applications in the field of manufacturing)		
Unit VI	**Digital Twins**	**(08 Hrs.)**
Introduction to Digital Twins, Benefits, impact and challenges, Features and Implementation of Digital Twins, Computational tools, Types of Digital Twins, Applications for digital twins in production (examples of existing or future applications in the field of manufacturing), digital twin in dynamical systems, Data-driven digital twins, methods in digital twin technology, Deep learning in digital twin technology.		

Term Work

List of Practical /Term work: -

(Term work shall consists of minimum 8 experiments based on above syllabus)

1. Study of FMS/CIM/Industry 4.0 technology in smart manufacturing applications.
2. Study of different applications of FMS and factory of future
3. Case studied on cloud manufacturing
4. Study of Cloud-based ERP.
5. Study of Agile manufacturing in smart manufacturing applications
6. Study of cyber security and its different applications in future factory
7. Design and Simulation of process automation using simulation software
8. Study of integration of robotics system with CNC Machine
9. Study of factory simulation using simulation software
10. Industrial visit to Automation Factory

Project Based Learning

Students have to prepare and submit a demonstration models based on above syllabus.

Prepare a model/a chart/a case study based on following topic (Not limited to this)

1. FMS/CIM/Industry 4.0 technology
2. Smart manufacturing
3. Cloud-based ERP

4. Agile Manufacturing
5. Safety with Future Factory
6. Use of Virtual and Augmented Reality for industrial applications.
7. Machine Learning working cycle
8. Digital Twins
9. Cyber security for mechanical industry.

Reference Books

1. Solanki, Kumar, Nayyar, Emerging Trends and Applications of Machine Learning, IGIGlobal, 2018.
2. Mohri, Rostamizdeh, Talwalkar, Foundations of Machine Learning, MIT Press, 2018.
3. Kumar, Zindani, Davim, Artificial Intelligence in Mechanical and Industrial Engineering,CRC Press, 2021.
4. Zsolt Nagy - Artificial Intelligence and Machine Learning Fundamentals-Apress (2018)
5. Artificial Intelligence by Elaine Rich, Kevin Knight and Nair, TMHWeb

Textbooks

1. Deisenroth, Faisal, Ong, Mathematics for Machine Learning, Cambridge University Press,2020
2. B Joshi, Machine Learning and Artificial Intelligence, Springer, 2020.
3. Parag Kulkarni and Prachi Joshi, "Artificial Intelligence – Building Intelligent Systems", PHI learning Pvt. Ltd., ISBN – 978-81-203-5046-5, 2015
4. Stuart Russell and Peter Norvig (1995), "Artificial Intelligence: A Modern Approach," Third edition, Pearson, 2003
5. Groover M.P., "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall of India Pvt., New Delhi, 1996.
6. Kalpakjian, "Manufacturing Engineering and Technology", Addison-Wesley Publishsing Co., 1995.
7. Radhakrishnan P. and Subramanyan S., "CAD/CAM/CIM", Wiley Eastern Ltd., New AgeInternational Ltd., 1994.
8. Raouf, A. and Ben-Daya, M., Editors, "Flexible manufacturing systems: recent development", Elsevier Science, 1995.
9. Taiichi Ohno, "Toyota Production System: Beyond large-scale Production", Productivity Press (India) Pvt. Ltd. 1992.
10. Smid P., CNC Programming Handbook, Industrial Press, 2005
11. Leong W., Nine pillars of technologies for Industry 4.0, IET publishers, 2020
12. Gilchrist A., Industry 4.0: The Industrial Internet of Things, Apress, 2017

Unit Tests

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

Self-Study Paper I : Advanced Manufacturing Processes

TEACHING SCHEME **EXAMINATION SCHEME**

Lectures : 04 Hrs./week

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

Course prerequisite

- Students should have basic knowledge of design and Manufacturing Processes.

Course objective:

- The goal of the course is Students will get acquainted themselves with basic methodology and tools that can be used in Advanced manufacturing processes.

Course outcomes:

The students should be able to

- Understand Metal cutting and mechanics of metal cutting
- understand the selection of Abrasive machining processes
- Understand Various Advanced manufacturing metal forming Processes
- Select appropriate the Unconventional machining processes for advanced components with characterization of work pieces.
- Understand to select high speed machining processes
- Understand the Generative manufacturing processes

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

Self-Study Paper I: Machine Condition Monitoring and Diagnostics

TEACHING SCHEME

Lectures : 04 Hrs./week

EXAMINATION SCHEME

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

Course prerequisite

- Engineering Materials, Manufacturing Process, Materials science.

Course objective:

- To provide different maintenance techniques used in industries.
- To understand fundamental of vibrations and its limit's and standards
- To provide knowledge to collect vibration data
- To understand concept of vibrational signal processing
- To defects in any system by using vibrational analysis.
- To provide different types of lubricant used in industries and its properties.

Course outcomes:

- Learn different maintenance techniques used in industries.
- understand fundamental of vibrations and its limit's and standards
- get the knowledge to collect vibration data
- understand concept of vibrational signal processing
- find defects in any system by using vibrational analysis.
- Learn different types of lubricant used in industries and its properties.

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

Course prerequisite

Students should have

- Knowledge of Manufacturing Engineering
- Knowledge of Product Design and Development

Course objective:

- To study an important aspect for life cycle management is a subset within system engineering.
- To study the product data management is focused on capturing and maintaining information on products and services through their development.

Course outcomes:

Students should be able to

- Know concept of Product Life Cycle and product life management strategy.
- Understand validate and analyse the product development process.
- Understand product and process systemization and solving methodologies for product development approaches.
- Understand fundamental issues and Industrial demands for product modelling.
- Understand product data management acquisition and implementation technology.
- Understand knowledge-based products and process models for Recent Advances

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 **EXAMINATION SCHEME**

Lectures : 04 Hrs./week

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

Course prerequisite

- Student should have the knowledge of Engineering Mathematics
- Student should have the knowledge of Machine Design
- Student should have the knowledge of Metrology and Quality control
- Student should have the knowledge of different Optimisation Technique
- Student should have the knowledge of Design of Experiment

Course objective:

- To study advanced concepts of quality engineering
- To acquaint with the different robust design of product and process
- To study Taguchi's experiment design and data analysis methodology

Course outcomes:

- Taguchi's approach to quality, design parameter and strategy
- Robustness strategy, their tools, quality, orthogonal arrays and steps in design parameter.
- Taguchi's experiment design and ANOVA
- Parameter design according to Taguchi like direct, indirect Signal to noise ratio analysis
- Different methods and modelling techniques of data analysis
- Linear and quadratic experiments design for response surface methodology

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

Course prerequisite

- Computer aided design
- Product design and development
- Computer aided Manufacturing

Course objective:

- Provide approach-based learning to integrate CAD and CAM
- Generate consistent and dynamic process plans.

Course outcomes:

Student should be able to

- Understand fundamentals of group technology and computer aided process planning
- Design and represent parts using geometric tolerancing, modeling and transformation
- Analyze process planning using generative approach.
- Apply codes and algorithms to design process planning logically
- Develop modulus structure and data structure for expert process planning
- Analyze manufacturing systems using simulation packages

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

Course prerequisite

- Students should have basic knowledge of Manufacturing processes, organization behavior, CAD CAM Software.

Course objective:

- To familiarize students to advance manufacturing system, to provide knowledge of computer programming related to advanced manufacturing system.

Course outcomes:

The students should be able to

- Understand Evolution of Manufacturing Systems
- Understand Manufacturing's Driving Force
- Understand FMS Design
- Understand Automated movement and storage systems
- Understand FMS Software
- Understand FMS and Simulation

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 **EXAMINATION SCHEME**

Lectures : 04 Hrs./week

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

Course prerequisite

Students should have

- Knowledge of Computer Integrated Manufacturing
- Knowledge of Product Design and Development

Course objective:

- To study an important aspect for Product Design in mechanical engineering.
- To study process planning to increased output, higher precision, and faster turnover for various system tasks.

Course outcomes:

Student should be able to

- Understand Product design and process design functions.
- Familiarize with Manufacturing reliability and quality control.
- Understand various manufacturing processes.
- Understand concept of Industrial ergonomics.
- Understand role of computer in product design.
- Identify Concept of Computer Aided Process Planning.

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

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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

Course prerequisite

- Basics of statistics
- Basic concepts of probability

Course objective:

- Analyze the system for optimum yield using design of experiment

Course outcomes:

Student should be able to

- Basics principles of design of experiment
- Understand inferential statistics
- ANOVA for single factor
- To design of two factorial experiment
- To design General 2^k
- To understand response surface methodology

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.

(08 Hours)

Unit III

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 | **EXAMINATION SCHEME**

Lectures : 04 Hrs./week

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

Course prerequisite

- Student should have knowledge of Fundamentals of Engineering Mechanics
- Student should have knowledge of Engineering Mathematics
- Student should have knowledge of Machine Design and Computer Aided Drafting
- Student should have Knowledge of fluid mechanics, turbomachinery
- Student should have Knowledge of mechanical measurement

Course objective:

- To develop within each student a measurable degree of competence in the design, construction, operation and maintenance
- To analyse specific problems, design solutions and evaluate the problems in industrial applications.
- Ability to apply the statistical considerations in design of bearings and mechanical systems

Course outcomes:

- Students will be able to understand Wear Characterization and Regimes of lubrication
- Students will be able to analyse the loading of different types of bearing bearings.
- Students will be able to understand the concept of lubrication for different types of bearings
- Students will be able to the concept of Porous, Gas Bearings and Magnetic Bearings
- Students will be able to aware about International standards and measuring technics of bearing performance

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

Course prerequisite

- Have to do activity of independently research work
- Have to investigate the work solution to solve industrial problems.
- Development the working solution to solve practical problems..
- Have ability to write and present a substantial technical report

Course objective:

- Students will able to independently carry out research
- Students will be able Investigate the work solution to solve industrial problems
- Students will be able to Development the working solution to solve practical problems..
- Students will be having ability to write and present a substantial technical report
- Students will be able to write technical report document.
- Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program.
- Students will have mastery over level higher than the requirements in the appropriate bachelor program and shall fulfill the requirements of industries

Course outcomes:

Students will able to

- Understand concept of manufacturing system
- Understand product life cycle management
- Understand optimization techniques in manufacturing
- Understand automatic data collection systems
- Understand computer simulation in manufacturing system analysis
- Understand the concept of group technology

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 **EXAMINATION SCHEME**

Practical : 07 Hrs./week

TW/Oral : 25 Marks
Total Credits : 21

Course prerequisite

The Students should have

- Knowledge of Mathematics & Science
- Knowledge of basic concepts in heat transfer.
- Basic information of thermodynamics.
- Basic knowledge of design
- Knowledge of basic concepts in mechanical engineering.

Course objective:

- To identify problem for a specific need of an organization
- To review literature on specific research topic
- To make feasible, sustainable design
- To work sincerely as a member of a team
- To communicate ideas to supervisors as well as subordinates
- To develop new equipment or make modifications in existing one

Course outcomes:

The student should be able to

- Identify the problem
- Review the necessary literature
- Make suitable design
- Work in a team

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

Practical : 05 Hrs./week

EXAMINATION SCHEME

TW/Oral : 50 Marks

Total Credits : 05

Course prerequisite

- Read the research paper
- Prepare technical report

Course objective:

- Read and interpret research paper and write technical report

Course outcomes:

- Develop interest towards research-oriented field with ability to search the literature and brief report preparation.
- Develop the skills, competencies and points of view needed by professionals in the field most closely related to the course
- Discussion and critical thinking about topics of current intellectual importance
- Improve the interpersonal & communication skills and awareness about the industrial environment.
- Development of presentation skills.

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

Course prerequisite

Students should know the knowledge of

- Advance manufacturing process
- Computer aided design and manufacturing
- Computer integrated manufacturing

Course objective:

- To study the use of computers in metal forming operations: planning and optimization.
- To study the use of Finite Element Analysis.

Course outcomes:

Students should be able to

- Understand introduction to different forming process and heat treatment on these processes with lubrication and various force calculations.
- Understand the working construction and principle of forging processes.
- Understand Scope and importance of rolling processes by considering their effects and defects of process variables.
- Execute the knowledge of sheet metal working and their different tools used.
- Implement the knowledge of extrusion processes in conventional and advanced metal forming process.
- Apply the knowledge of Finite Element Analysis to solve the problems of deformation in various metal forming process.

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.

Unit V (08 Hours)

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

Course prerequisite

- Differential calculus
- Concept of matrix

Course objective:

- Obtain and classify the stationary point for single and multivariable optimization

Course outcomes:

The student should be able to understand

- Optimal problem formulation
- Solve single variable optimization problem
- Solve multi variable optimization problem
- Solve constrained optimization problem
- Use of evolutionary algorithm

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

Course prerequisite

- Basic programming language
- Kinematics of machines

Course objective:

- To understand the basic concepts associated with the design and Functioning and applications of Robots
- To study about the drives and sensors used in Robots
- To learn about analyzing robot kinematics and robot programming

Course outcomes:

Upon completion of the course, students will be able to understand:

- importance of robotics in today and future goods production
- robot configuration and subsystems
- principles of robot programming and handle with typical robot
- working of mobile robots

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

Course prerequisite

- Knowledge of manufacturing processes
- Knowledge of material sciences
- Knowledge of automation

Course objective:

- Understand various additives processes in manufacturing
- Understand various types of Rapid Prototyping processes

Course outcomes:

Student should be able to

- understand rapid prototyping and tooling systems.
- understand the role of CAD modelling in Rapid Prototyping.
- understand the working of different liquid based Rapid Prototyping Systems
- understand the working of different solid based Rapid Prototyping Systems
- understand the working of different powder based Rapid Prototyping Systems
- understand the working of 3D printing Systems.

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 | **EXAMINATION SCHEME**

Lectures : 04 Hrs./week

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

Course prerequisite

- Students should know the knowledge of manufacturing processes, Machine design, Metallurgy etc.

Course objective:

- Students should get the knowledge of the design of different metallic and non-metallic components/parts in industry.
- They should learn the Composite materials and their manufacturing methods and applications.

Course outcomes:

Students should able to understand

- Methods of design principles of various metals and non metals.
- Design procedure of different metal operations are used in industry.
- Design procedures of different metallic components/parts are manufactured.
- Different Composite materials & their manufacturing methods and applications.
- Design procedures for different assembled parts of welding.
- Design procedures for different assembled parts of metal connections.

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 **EXAMINATION SCHEME**

Lectures : 04 Hrs./week

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

Course prerequisite

- Knowledge of Mechanics of Materials
- Knowledge of Mathematics & Science
- Knowledge of Machine design.

Course objective:

- To impart knowledge of Principal stresses and strain.
- To impart knowledge of engineering application of plasticity.
- To develop analytical skills of solving problem using plain stress and plain strain.

Course outcomes:

Student should be able to-

- Understand the concept of stress and its components.
- Understand the concept of Strain and its components.
- Familiarize with Generalized Hooke's Law.
- Use True stress and true strain theory.
- Apply knowledge of plastic flow pattern in the deforming material with application.
- Understand various concept of Stresses in flat Plate.

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

Course prerequisite

- Students have known the basic of manufacturing processes, workshop technology, metrology and quality control, metallurgy etc.

Course objective:

- Students should learn the design of different die and casting, forging and die blocks of forging operations.

Course outcomes:

Students should able to understand

- Design principles and standards for moulding Dies and tools.
- Design of cooling channels and use of CAD for mould design.
- Design of different die casting and other parts of machines.
- Design of various types of Dies and software used in design.
- Design of different die forging and other allowances & tolerances.
- Design of die blocks of forging operations.

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 **EXAMINATION SCHEME**

Lectures : 04 Hrs./week

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

Course prerequisite

- Student should have the knowledge of Industrial Product Design
- Student should have the knowledge of Industrial Engineering Management
- Student should have the knowledge of Machine Design
- Student should have the knowledge of Different Engineering (Design and Manufacturing) Processes
- Student should have the knowledge of Advanced Manufacturing Process

Course objective:

- To study various product development technical and business concerns
- To study how to develop product from concept and function
- To study product in the context of reverse engineering
- To study design for manufacturing, assembly, environment and product development methodology

Course outcomes:

- Basic knowledge of product design and development methods
- Different technological and business aspects for product design and development
- Development of product from concept of product function
- Product development by reverse engineering
- design for manufacturing, assembly and environment
- Integrated Product Design and Development methodology

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

Course prerequisite

- Engineering Mechanics, Strength of material, Machine design I & II.

Course objective:

- To provide students Design rules for manufacturability and knowledge Selection of appropriate materials, processes and features for various design requirements
- To know characteristics of basic manufacturing processes and their capabilities
- To know metal casting process and design considerations for casting
- To provide students different types of metal joining.
- To provide students concept of Extrusion process and sheet Metal working
- To provide students concept of manufacturing of plastic products.

Course outcomes:

Upon completing this course:

- Student will get knowledge of basic manufacturing processes and their capabilities, Selection of appropriate materials, processes and features for various design requirements.
- Student will learn knowledge of characteristics of basic manufacturing processes and their capabilities.
- Student will get knowledge of metal casting process and design considerations for casting.
- Student will understand different types of metal joining process.
- Student will understand concept of Extrusion process and sheet Metal working.
- Student will learn concept of manufacturing of plastic products.

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 Material technology – 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 | **EXAMINATION SCHEME**

Lectures : 04 Hrs./week

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

Course prerequisite

Student should have knowledge of

- Fundamentals of manufacturing engineering
- Fundamentals of statics

Course objective:

- To acquaint with Product life cycle management.
- To study concurrent design principles.

Course outcomes:

Students will be able to…

- Understand the need of concurrent engineering.
- apply the product life cycle management approach to practical problems.
- Apply the quality function deployment in industrial problems.
- Acquaint the value engineering principles.
- Apply concurrent design principles to product design.
- Apply knowledge to concurrent design case studies.

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

Practical : 10 Hrs./week

EXAMINATION SCHEME

Term Work : 150 Marks
Pract/Oral : 75 Marks
Total Credits : 30

Course prerequisite

The Students should have

- Knowledge of Mathematics & Science
- Knowledge of basic concepts in heat transfer.
- Basic information of thermodynamics.
- Basic knowledge of design
- Knowledge of basic concepts in mechanical engineering.

Course objective:

Course Objectives:

- To make feasible, sustainable design
- To work sincerely as a member of a team
- To communicate ideas to supervisors as well as subordinates
- To develop new equipment or make modifications in existing one

Course outcomes:

The student should be able to

- Identify the problem
- Review the necessary literature
- Make suitable design
- Work in a team

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.

BHARATI VIDYAPEETH
(DEEMED TO BE UNIVERSITY), PUNE

Faculty of Engineering And Technology
M. Tech. - Mechanical (CAD/CAM)
Old Syllabus

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

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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.