Revised Syllabus Structure of M.E. Mechanical (Product Design & Development)

WITH EFFECT FROM THE ACADEMIC YEAR JUNE/JULY 2012-2013

M.E. MECHANICAL (PRODUCT DESIGN & DEVELOPMENT) SEMESTER : I

Sr.	Subject	L	P	T	Total	PT	TW	OE	POE	Total
1	Applied Machine Design	3	--	1	4	100	25	--	--	125
2	Computer Aided Design and Simulation	3	2	--	5	100	50	--	25	175
3	Design of Experiments and Research Methodology	3	--	1	4	100	25	--	--	125
4	Elective I	3	2	--	5	100	25	--	--	125
5	Elective II	3	2	--	5	100	25	--	--	125
6	Seminar I *	--	1	--	1	--	25	--	--	25
	Total	**15**	**7**	**2**	**24**	**500**	**175**	**--**	**25**	**700**

ELECTIVE – I	ELECTIVE – II
Advanced Material and Processing	Dynamic Analysis & Testing Methodology
Industrial Automation	Reverse Engineering
System Design	Computational Fluid Dynamics
Material Handling Equipment Design	Design Optimization

M.E. MECHANICAL (PRODUCT DESIGN & DEVELOPMENT) SEMESTER : II

Sr.	Subject	L	P	T	Total	PT	TW	OE	POE	Total
1	Manufacturing System Design	3	2	--	5	100	25	--	25	150
2	Creativity, Innovation & New Product Development	3	2	--	5	100	25	--	--	125
3	Product Life Cycle Management	3	--	1	4	100	25	--	--	125
4	Elective III	3	2	--	5	100	25	--	--	125
5	Elective IV	3	--	1	4	100	25	--	--	125
6	Seminar II *	--	1	--	1	--	50	--	--	50
7	Comprehensive Viva	--	--	--	--	--	--	50	--	50
	Total	**15**	**7**	**2**	**24**	**500**	**175**	**50**	**25**	**750**

ELECTIVE – III	ELECTIVE – IV
Experimental Stress Analysis	Rapid Prototyping
Reliability Engineering	Engineering Optimization in Design
Industrial Robotics & Expert Systems	AI & Neural Network
Open Elective **	TQM & Six Sigma

M.E. MECHANICAL (PRODUCT DESIGN & DEVELOPMENT) SEMESTER: III

Sr.	Subject	L	P	Total	PT	TW	OE	POE	Total
1	Mini Project	--	--	--	--	50	--	--	50
2	Dissertation Phase-I ***	--	5	5	--	50	50	--	100
	Total	**--**	**5**	**5**	**--**	**100**	**50**	**--**	**150**

M.E. MECHANICAL (PRODUCT DESIGN & DEVELOPMENT) SEMESTER: IV

Sr.	Subject	L	P	Total	PT	TW	OE	POE	Total
1	Dissertation Phase-II ***	--	5	5	--	100	100	--	200
	Total	**--**	**5**	**5**	**--**	**200**	**100**	**--**	**300**

* For Seminar-I & II, work load will be for two students.

** Open Elective –

Students can take any subject from other discipline being conducting in the same institute and with consent of their guide.

*** For Dissertation Phase-I and Dissertation Phase-II, work load will be for one student.

M.E. (PRODUCT DESIGN & DEVELOPMENT) Sem – I
1. APPLIED MACHINE DESIGN

Teaching Scheme:
Lecture: 3 Hrs/week
Tutorial: 1 Hr/week

Examination Scheme:
Theory Paper: 100 Marks
Term Work: 25 Marks

1. **DESIGN PROCESS** – The design process - Morphology of Design - Design drawings - Computer Aided Engineering - Designing of standards - Concurrent Engineering - Product life cycle - Technological Forecasting - Market Identification - Competition Bench marking - Systems Engineering - Life Cycle Engineering - Human Factors in Design - Industrial Design. **(8)**
2. **DESIGN METHODS** – Creativity and Problem Solving - Product Design Specifications - Conceptual design - Decision theory - Embodiment Design - Detail Design - Mathematical Modeling - Simulation - Geometric Modeling - Finite Element Modeling - Optimization - Search Methods - Geometric Programming - Structural and Shape Optimization. **(8)**
3. **INTRODUCTION TO SOLID MECHANICS**: Stress, Strain in 2-d and 3-d, relation between stress and strain, theories of failure. **(8)**
4. **MATERIAL SELECTION PROCESSING AND DESIGN** – Material selection Process - Economics - Cost Vs Performance - Weighted property Index - Value Analysis - Role of Processing and Design - Classification of Manufacturing Process - Design for Manufacture - Design for Assembly - Design for castings, Forging, Metal Forming, Machining and Welding - Residual stresses - Fatigue, Fracture and Failure. **(8)**
5. **ENGINEERING STATISTICS AND RELIABILITY** – Probability - Distributions - Test of Hypothesis - Design of Experiments - Reliability Theory - Design of Reliability - Reliability centered Maintenance. **(4)**
6. **QUALITY ENGINEERING** – Total Quality Concept - Quality Assurance - Statistics Process Control - Taguchi Methods - Robust Design - Failure Model Effect Analysis. **(4)**

TERM WORK: **Minimum six assignments based on the above topics**

TEXT BOOKS:

1. Dieter George E., "Engineering Design – A Materials and Processing Approach", McGraw Hill, International Edition Mechanical Engg ., Series ,1991.
2. Karl t. Ulrich and Steven d Eppinger "Product Design and Developement " ,McGraw Hill,Edition 2000.
3. Palh .G. and Beitz .W., " Engineering Design ", Springer - Verlag , NY. 1985.
4. Ray .M.S., " Elements of Engg. Design ", Prentice Hall Inc . 1985.
5. Suh .N.P. , " The Principle of Design ", Oxford University Press , NY. 1990.

M.E. (PRODUCT DESIGN & DEVELOPMENT) Sem – I
2. COMPUTER AIDED DESIGN & SIMULATION

Teaching Scheme:
Lecture: 3 Hrs/week
Practical: 2 Hrs/week

Examination Scheme:
Theory Paper: 100 Marks
Term Work: 50 Marks
Pract/Oral: 25 Marks

1. **INTRODUCTION:** Nature and scope of product engineering - creative thinking and organizing for product innovation criteria for product success in life cycle of a product, role of models in product design, Material selection - problems of material selection-performance characteristics of materials - the materials selection process-economics of materials-cost versus performance relations **(3)**

2. **DESIGN CONSIDERATIONS:** Functional and production design-form design-influence of basic design, mechanical loading and material on form design - form design of gray castings, malleable iron castings, aluminium castings, pressure die castings, plastic mouldings, welded fabrications, forging and manufacture by machining methods. Influence of space, size, weight, etc., on form design, aesthetic and ergonomic considerations. **(7)**

3. **TOLERANCE AND ANALYSIS:** Dimensioning and tolerancing a product-functional production and inspection datum-tolerance analysis. **(3)**

4. **INTRODUCTION TO COMPUTER GRAPHICS FUNDAMENTALS:** Output primitives (points, lines, curves Etc.,) , 2-D transformation (Translation, scaling, rotators) windowing , view ports clipping transformation. Visual Realism: Hidden - Line - Surface - solid removal algorithms shading - coloring. Introduction to parametric and variational geometry based on softwares and their principles creation of prismatic and lofted parts using these packages. **(4)**

5. **SOLID MODELING:** Introduction to solid modeling concepts**,** sketching and constraining the geometry generating primitive shapes by using part modeling workbench, creation of surfaces-types and applications of various types of surfaces, Assembly of parts , tolerance analysis mass property calculations. **(4)**

6. **FINITE ELEMENT ANALYSIS:** Historical background - Wieghted residual methods - Basic concept of FEM - Variational formulation of B.V.P. - Ritz method - Finite element modelling - Element Equation - Linear and quadratic shape functions - Bar ,Beam ,Elements - Application to heat transfer. **(5)**

7. **FINITE ELEMENT ANALYSIS OF 2D PROBLEM:** Basic boundary value problems in 2 Dimensions - Triangular, quadrilateral, higher order elements - Poisons and Laplaces Equation - Weak formulation - Element Matrices and vectors - Application to solid mechanics, Heat transfer, Fluid Mechanics. **(5)**

8. **ISO-PARAMETRIC FORMULATION:** Natural Coordinate Systems-Lagrangian Interpolation Polynomials-Isoparametric, Elements - Formulation - Numerical Integration - ID - IID Triangular elements - Rectangular elements - Illustrative Examples. **(4)**

9. **SIMULATION**: System and System Environment: Components of a system, Continuous and discrete systems, Models of a system, Modeling. Random Number Generation: Methods and Tests for random number generation, Random Variable Generation, Simulation of Systems: Simulation of continuous system, Simulation of discrete system, Simulation of event occurrences using random numbers. Simulation of component failures, using Exponential and weibull models. Input modeling and output analysis, Simulation Applications: Single server queue problems and multi-server queue problems, Inventory system, Network problem, Shop Floor problems in a manufacturing environment. **(5)**

TERM WORK:

1. Preparation of solid models for minimum two assemblies of any industrial products using solid modeling software like CATIA, Solid works, UGS etc.
2. Solution of two problems in statics for using FEA software like Ansys, Hypermesh, Nastran etc.
3. Simulation of any mechanical system using simulation software
4. Writing interactive programs to solve design problems and production of drawings using any languages like Auto LISP/C/FORTRAN etc.
5. Two assignments on generation of surfaces using modelling software like CATIA.

References:

1. William .M. Neumann and Robert .F. Sproul " Principle of Computer Graphics ", McGraw Hill Book Co. Singapore ,1989.
2. Donald Hearn and .M. Pauline Baker " Computer Graphics " Prentice Hall ,Inc., 1992.
3. Mikell .P. Grooves and Emory .W. Zimmers Jr. " CAD/CAM Computer -- Aided Design and Manafacturing "Prentice Hall ,Inc., 1995.
4. Ibrahim Zeid " CAD/CAM -- Thoery and Practice " - McGraw Hill , International Edititon , 1998.
5. Jones J.C., "Design Methods", interscience, 1970.
6. Buhl, H.R., "Creative Engineering Design", Iowa State University Press, 1960.
7. Dieter, G.E., "Engineering Design", McGraw Hill, 1983.
8. Robert Matouseek, "Engineering Design", Blackie & Sons Ltd., 1963.
9. Niebel, B.W. & Draper, A.B., "Product Design and Process Engineering, McGraw Hill, 1974.
10. Harry Peck, "Designing for Manufacturing", Sir Issac Pitman and Sons Ltd., 1973.
11. Gladman, C.A., "Manual for Geometric Analysis of Engineering Designs", Austrlian Trade publications Ltd.,
12. Wade, Or., "Tolerance Control in Design and Manufacture", Industrial Press, Inc. Banks J., Carson. J.S., and Nelson B.L., Discrete Event System Simulation, Prentice Hall of India, New Delhi, 1996.
13. Gottfried B.S., Elements of Stochastic Process Simulation, Prentice Hall, London, 1984.
14. Geoffrey Gordon., System Simulation, Prentice Hall of India, 1984.
15. Narsingh Deo., System simulation with Digital Computer, Prentice Hall of India, 1979

M.E. (PRODUCT DESIGN & DEVELOPMENT) Sem – I
3. DESIGN OF EXPERIMENTS AND RESEARCH METHODOLOGY

Teaching Scheme:
Lecture: 3 Hrs/week
Tutorial: 1 Hr/week

Examination Scheme:
Theory Paper: 100 Marks
Term Work: 25 Marks

1. **Introduction:** Defining Research, Scientific Enquiry, Hypothesis, Scientific Method, Types of Research, Research Process and steps in it. Research Proposals – Types, contents, sponsoring agent's requirements, Ethical, Training, Cooperation and Legal aspects. **(5)**
2. **Research Design:** Meaning, Need, Concepts related to it, categories; Literature Survey and Review, Dimensions and issues of Research Design, Research Design Process – Selection of type of research, Measurement and measurement techniques ,Selection of Sample, Selection of Data Collection Procedures, Selection of Methods of Analysis, Errors in Research. **(5)**
3. **Research Problem:** Problem Solving – Types, Process and Approaches – Logical, Soft System and Creative; Creative problem solving process, Development of Creativity, Group Problem Solving Techniques for Idea Generation – Brain storming and Delphi Method. **(4)**
4. **Research Modelling:** (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. **(7)**
5. **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, Basis. **(6)**
6. **Process Optimization:** Factorial Design principles, Two factor Factorial Design, General Factorial Design, Fitting response Curves and Surfaces, Blocking, Taguchi Approach to Parameter Design, Robust Design. **(7)**
7. **Analysis:** Analysis of Variance and Co-variance, Hypothesis Testing – Parametric and Non-Parametric Tests, Uni-variate and Bi-variate analysis **(3)**
8. **Report Writing:** Pre-writing Considerations, Principles of Thesis Writing, Formats of Report Writing & Publication in Research Journals, Oral Presentations (Briefing) **(3)**

TERM WORK:

1. Collection and review of literature on a specific topic related to design or manufacturing engineering.
2. Assignment on data collection processing, analysis, interpretation, inferences and conclusions for an engineering problem.
3. Assignment on design of experiments using Taguchi technique.
4. Assignment on modeling and simulation of an engineering problem.
5. Presentation of any one above using MS power-point or similar.

Reference Books:

1. Krishnaswamy, K.N., Sivakumar, Appa Iyer & Mathirajan M., (2006) - Management Research Methodology: Integration of Principles, Methods & Techniques (New Delhi, Pearson Education)
2. Montgomery, Douglas C. (2004) – Design & Analysis of Experiments, 5/e. (New York, John Wiley & Sons)
3. Kothari, C.K. (2004) – Research Methodology, Methods & Techniques, 2/e. (New Delhi, New Age International Ltd. Publishers)
4. Ross, Phillip J. (1996) – Taguchi Techniques for Quality Engineering, 2/e. (New York, McGraw Hill)
5. Rao S. S. (2004) – Engineering Optimization Theory & Practices, 3/e (New Delhi, New Age International Ltd., Publishers)
6. Handbook of Industrial Automation – Richard L. Shell & Ernest L. Hall (Marcel Decker Inc.)
7. Trochim, William M.K. (2003), - Research Methods 2/e, (New Delhi, Biztantra, Dreamtech)

M.E. (PRODUCT DESIGN & DEVELOPMENT) Sem – I
4. ELECTIVE – I
1. ADVANCED MATERIAL & PROCESSING

Teaching Scheme:
Lecture: 3 Hrs/week
Practical: 2 Hrs/week

Examination Scheme:
Theory Paper: 100 Marks
Term Work: 25 Marks

SECTION – I

1. Review of engg materials- metals, alloys- ferrous & non-ferrous, plastics & polymers, ceramics and composites. Dual phase steels, micro alloyed steels, High strength low alloy steels, transformation inducted plasticity (TRIP) steels, Maraging steels. Heat treatment of ferrous and non ferrous alloys for modification of structure and properties. **(3)**

2. Modern materials- Compositions, properties & applications of: Inter-metallics, Ni & Ti aluminides, smart materials, shape memory alloys, Metallic glass-quassi crystals, Dielectrics, semi conductors, conductors & super conducting materials. Magnetic & photoelectric materials, optical materials, Bio materials, micro electronic materials & nano materials. **(4)**

3. Non Metallic Materials- Polymer materials, formation of polymer structures, production techniques of fibers, foams, adhesives and coatings. Structure, properties and applications of engineering polymers. Advanced structural ceramics, WC, TiC, TaC, Al_2O_3, SiC, Si3N4, CBN and diamond- properties, processing and applications. **(4)**

4. Composites: Fibers-glass, boron, carbon, organic, ceramic and metallic fibers-matrix materials- polymers, metals and ceramics. Processing of polymer matrix composites: open mould process, bag molding, compression molding with BMC and SM- filament winding, pultrussion- centrifugal casting, injection molding, applications of PMC's. Processing of metal matrix polymers: solid state fabrication techniques- diffusion bonding, powder metallurgy techniques, plasma spray, chemical and physical vapor deposition of matrix on fibers, Liquid state fabrication methods, Infiltration, squeeze casting, Rheo casting, compo casting. Applications of MMC's. **(6)**

5. Selection of Materials: Motivation for selection, cost basis and service requirements-selection for mechanical properties, strength, toughness, fatigue and creep. Selection for surface durability, corrosion and wear resistance. Relationship between materials selection and processing. Case studies in material selection with reference to aero, auto. Marine, machinery and nuclear applications. **(3)**

SECTION – II

1. **Classification and types of conventional manufacturing processes** - Forging, rolling, extrusion, wire drawing, sheet metal processes. Manufacturing automation, Non traditional manufacturing processes. Economics of non traditional and automated manufacturing. Introduction to micromachining and MEMS. Introduction to coatings and tribology. **(5)**
2. **Rapid prototyping:** Product development cycle & importance of prototyping. Types of prototypes, principles and advantages and different types of generative manufacturing processes, viz. stereolithography, FDM, SLS etc. Factors concerning to RP: consideration for adaptations, advantages, accuracy, economic considerations. **(5)**
3. **Non conventional machining processes:** Introduction and ned for non-conventional machining processes, Principle and theory of material removal. Process parameters,

advantages, limitations and applications of ultrasonic machining, laser beam machining and electrochemical machining. **(5)**

4. **Special processes and electronic fabrication:** Principles, salient features, advantages & applications of abrasive floor machining, magnetic abrasive finishing, wire EDM, electrochemical grinding, honing, lapping & super finishing. Principles, elements, process, advantages, applications & surface preparation etc. of physical vapor deposition, chemical vapor deposition, electro less coating & thermal metal spraying. **(5)**

TERM WORK : Minimum six exercises to be performed based on above topics.

REFERENCE BOOKS :

1) "HMT Handbook" – Production Technology (TMH)
2) "Non- traditional machining processes", Willer, SME publications.
3) "Advanced Manufacturing Processes", G.F.Benidict, Marcel Dekker Publisher
4) "Materials & Processes in Manufacturing", E. Paul DeGarmo, J. T. Black & Ronald A. Kohser, (PHI)
5) "Design & Manufacturing of Composite Structures", Geoff Eckold (Jaico Publishing House)
6) "Manufacturing Processe for Engineering Materials", S. Kalpaljian & Steven R. Schmidt, (Pearson Education)
7) Krishnan K.Chawla, "Composite Material Science and Engineering", Springer- Verlog, 1987
8) Agarwal D & Brontman L.J., "Analysis & Performance of fibre composites", John Willey Publications, 1990
9) Mallik P.K. & Newman S.,"Composite Materials Technology", Henser Publications, 1990
10) Charles J A, Crane F.A.A. & Furness J A G ,"Selection and use of Engineering Materials", (3 rd edition), Butterworth – Heiremann – 1977
11) "Materials and their applications", (4 th edition)- Jaico- 1999
12) "Non Conventional Machining", – P.K.Mishra (IIT, Kharagpur), Narosa Publishing House
13) "Manufacturing Science" - A. Ghosh and Malik – Affiliated East West Press Pvt. Ltd.
14) " Physical Metallurgy" – Vijendra Singh (Standard Publishers Distributors, New Delhi)

M.E. (PRODUCT DESIGN & DEVELOPMENT) Sem – I
4. ELECTIVE – I
2. INDUSTRIAL AUTOMATION

Teaching Scheme:
Lecture: 3 Hrs/week
Practical: 2 Hrs/week

Examination Scheme:
Theory Paper: 100 Marks
Term Work: 25 Marks

SECTION – I

1. Overview of Automation : (5)
Types of automation, significance and importance, evaluation of automation, components of automation in various automation types.

2. Application of PLC in Manufacturing : (5)
PLC Hardware components, Monory organization,, use of PLC for various industrial applications, layout of PLC interfacing.

3. Sensors interfacing for PLC : (4)
Sensors used for various applications in industry. Types and classification of sensors, features, construction and working.

4. Basics of PLC Programming : (8)
Ladder Systems used in ladder logic, writing ladder for given condition, guidelines for ladder writing. Basic instructions of ladder programming like Relay type, instructions, logical instructions, program control instructions.
Data Manipulation.
Data comparison instructions, data compilation instructions, data conversion instruction, data transfer instructions. Concept of file handling in PLC.

SECTION – II

5. Timers and Counters : (8)
Introduction to Timers, types of timers, timer instructions. Introduction to counters, types of counters, counter instructions.

6. Networking PLC : (3)
Introduction, Levels of industrial control, types of Networking, Network communications, PLC and internet cell control by PLC Network.

7. Controlling Robot with PLC : (3)
Introduction, Basic two-axis control with PLC, sequence control, industrial three-axis control with PLC.

8. SCADA (Supervisory Control And Data Acquisition) and PLC Interfacing : (4)
Concept, Methodology, types by which supervisory control can be effected, merits and disadvantages.

TERM WORK :

Maximum Six assignments based on above topics giving understanding of practical exposure and working experience.

REFERENCES :

1. "Programmable Logic Controller – Principles and Applications" by J. W. Webb, R. A. Reis; Prentice Hall of India Ltd. ISBN 81-203-2308-4.

2. "Programmable Logic Controller : Principles and Applications" by NIT, PHI Pub.
3. "Desirable facility on equivalent make PLC with supporting programming software and interfacing sensor" by Allen Bradley.
4. "Industrial Robotics – Technology, Programming and Applications"; M. P. Groover, M. Weiss, R. N. Nagel, N. G. Ordey; McGraw Hill International Editions, Industrial Engineering Series, ISBN 0-0-100442-4
5. "Programmable Logic Controller – Programming methods and Applications" Hackworth John R. and Hackworth Frederick D. Jr.; Pearson Education LCE, ISBN 81-297-0340-8.
6. Introduction to 8085 – Gaonkar
7. Process control and instrumentation – Johnson C.D.
8. Introduction to PLC – Gary Dumming – Delmar Pub.
9. Programmable Logic Controller – FESTO Pneumatics, - Bangalore
10. PLC Textbook and related literature by FESTO.
11. Various PLC manufacturers catalogue

M.E. (PRODUCT DESIGN & DEVELOPMENT) Sem – I
4. ELECTIVE – I
3. SYSTEM DESIGN

Teaching Scheme:
Lecture: 3 Hrs/week
Practical: 2 Hrs/week

Examination Scheme:
Theory Paper: 100 Marks
Term Work: 25 Marks

1. **Engineering Process & System Approach:** Introduction. General model of engineering system, elements of system identification of engineering functions, characteristics of engineering system, Problem formulation, identification & analysis of need, problem scope & constraints. **(10)**
2. **System theories and modeling:** System analysis, various approaches to system design, need for modeling, various modeling concepts- linear graph, mathematical modeling.**(10)**
3. **System Evaluation:** Feasibility assessment, time value of money financial analysis, selection between alternatives **(4)**
4. **Optimization :** Theory of optimization, calculus methods of optimization for two or more variables. **(5)**
5. **Design Analysis:** Decision models, scientific approach to decision process, quantitative methods in decision making. **(4)**
6. **System Simulation:** Simulation models, Queuing theory, monte carlo method, **(4)**
7. Application of system approach to mechanical systems. **(3)**

TERM WORK:

Design and analysis of any mechanical system, using system approach & simulating the same, using suitable software.

Reference Books:

1. Mechanical System Design – Siddiqui, Manoj Kumar Singh; New Age International
2. Machine Design By Dieter

M.E. (PRODUCT DESIGN & DEVELOPMENT) Sem – I
4. ELECTIVE – I
4. MATERIAL HANDLING EQUIPMENT DESIGN

Teaching Scheme:
Lecture: 3 Hrs/week
Practical: 2 Hrs/week

Examination Scheme:
Theory Paper: 100 Marks
Term Work: 25 Marks

1. Elements of Material Handling System: ( )

Importance, Terminology, Objectives and benefits of better Material Handling; Principles and features of Material Handling System; Interrelationships between material handling and plant layout, physical facilities and other organizational functions; Classification of Material Handling Equipments.

2. Selection of Material Handling Equipments:

Factors affecting for selection; Material Handling Equation; Choices of Material Handling Equipment; General analysis Procedures; Basic Analytical techniques; The unit load concept; Selection of suitable types of systems for applications ; Activity cost data and economic analysis for design of components of Material Handling Systems; functions and parameters affecting service; packing and storage of materials.

3. Design of Mechanical Handling Equipments: ( )

[A] Design of Hoists –

Drives for hoisting, components, and hoisting mechanisms; rail traveling components and mechanisms; hoisting gear operation during transient motion; selecting the motor rating and determining breaking torque for hoisting mechanisms.

[B] Design of Cranes –

Hand-propelled and electrically driven E.O.T. overheat Traveling cranes; Traveling mechanisms of cantilever and monorail cranes; design considerations for structures of rotary cranes with fixed radius ; fixed post and overhead traveling cranes; Stability of stationary rotary and traveling rotary cranes.

4. Design of load lifting attachments: ( )

Load chains and types of ropes used in Material Handling System; Forged, Standard and Ramshorn Hooks; Crane Grabs and Clamps; Grab Buckets; Electromagnet; Design consideration for conveyor belts; Application of attachments.

5. Study of systems and Equipments used for Material Storage: ( )

Objectives of storage; Bulk material handling; Gravity flow of solids through slides and chutes; Storage in bins and hoppers; Belt conveyors; Bucket-elevators; Screw conveyors; Vibratory Conveyors; Cabin conveyors; Mobile racks etc.

6. Material Handling / Warehouse Automation and Safety considerations: ( )

[A] Storage and warehouse planning and design; computerized warehouse planning; Need, Factors and Indicators for consideration in warehouse automation; which function, When and How to automate; Levels and Means of Mechanizations.

[B] Safety and design; Safety regulations and discipline.

TERM WORK:

- Following assignments comprise the laboratory practice:-

1. Design and development on Material Handling Equipments applicable to various process industries such as Sugar Industry, Power plants, Automobile manufacturing, Harbor, Foundries etc.
2. Repot based on visits to industries manufacturing or using various Material Handling Equipments.

REFERENCE BOOKS

1] N. Rudenko, 'Material Handling Equipments', Peace Publishers, Moscow.
2] James M. Apple, 'Material Handling System Design', John-Willlwy & Sons Pub. NY.
3] John R. Immer, 'Material Handling' McGrawHill Co. Ltd., New York.
4] Colin Hardi, 'Material Handling in Machine Shops'. Machinery Publi. Co. Ltd., Landon.
5] M .P. Nexandrn, 'Material Handling Equipment', MIR Publication, Moscow.
6] C. R. Cock and J. Mason, 'Bulk Solid Handling', Leonard Hill Publication Co. Ltd., USA
7] Spivakovsy, A.O. & Dyachkov, V.K., 'Conveying Machines', Vol.I, II, MIR Publi. 1985.
8] Kulwiac R. A., 'Material Handling Hand Book', 2nd Edi. JohnWilly Publi. New York.

M.E. (PRODUCT DESIGN & DEVELOPMENT) Sem – I
5. ELECTIVE – II
1. DYNAMIC ANALYSIS & TESTING METHODOLOGY

Teaching Scheme:
Lecture: 3 Hrs/week
Practical: 2 Hrs/week

Examination Scheme:
Theory Paper: 100 Marks
Term Work: 25 Marks

1. **FUNDAMENALS OF VIBRATION**: Review of Single degree freedom systems - Response to arbitrary periodic executions - Duhamel's integral - Impulse response function - Virtual work - Lagrange's equations - Single degree freedom forced vibration with elastically coupled viscous dampers - System identification from frequency response - Transient vibration - Laplace transformation formulation. **(3)**
2. **TWO DEGREE FREEDOM SYSTEM:** Free vibration of spring-coupled system - Mass coupled system - Bending variation of two degree freedom system - Forced vibration - Vibration Absorber - Vibration isolation. **(2)**
3. **MULTI DEGREE FREEDOM SYSTEM :** Normal mode of vibration - Flexibility matrix and stiffness matrix - Eigen value and Eigen vector – Orthogonal properties - Modal matrix - Modal analysis - Forced vibration by matrix inversion - Modal damping in forced vibration - Numerical methods of fundamental frequencies. **(3)**
4. **VIBRATION OF CONTINUOUS SYSTEMS:** Systems governed by wave equations - Vibration of strings - Vibration of rods - Euler 's equation for beams - Effect of Rotary inertia and shear deformation - Vibration of plates. **(4)**
5. **EXPERIMENTAL METHODS IN VIBRATION ANALYSIS:** Vibration instruments - Vibration exciters Measuring Devices - Analysis - Vibration Tests - Free and Forced Vibration tests. Collection of FRF, experimental modal analysis methods, Examples of vibration tests - Industrial case studies. **(5)**
6. **ANALYTICAL DYNAMIC ANALYSIS:** : Dynamic analysis - Equation of motions - Mass matrices - Free vibration analysis - Natural frequencies of Longitudinal - Trasverse and torsional vibration - Introduction to transient field problem. Non linear analysis. Uses of softwares - h & p elements - special element formulation. **(4)**
7. **Eigen values & Eigenvectors,** Examples, Modal matrix Diagonalization and Jordan Form, Homogeneous Solutions State transition matrix Particular solution, Stability of state equations, transfer functions- definition, amplitude and phase, poles and zeros, Impedances and Admittances, Elements in series and in parallel, One-port and two-port elements, Relating impedance to transfer function, Frequency response functions: definition, Relation to transfer functions, first and second order systems, bode and nequiest plot, Fourier transforms- definition, Relation to transfer functions, First order systems ,applications. **(6)**
8. **VALIDATION OF ANALYTICAL MODELS:** Preliminary check, correlation of analytical model with experimental model, model updating- fundamentals **(3)**

9. **ENGINEERING APPLICATIONS:** Structural applications-Design of simple truss members. Design applications-Design of simple axial,Transverse loaded members for minimum cost, maximum weight-Design of shafts and Torsionally loaded members-Design of Springs, Dynamic applications-Optimum design of single ,two degree of freedom systems, Vibration absorbers. Application in Mechanisms- optimum design of Simple linkage mechanisms **(5)**

10. **VIBRATION CONTROL:** Introduction-Reduction of Vibration at the source-Control of vibration-by structural design-Material selection- Localized additions-Artificial Damping-Resilient isolation, Vibration isolation, Vibration absorbers, Active Vibration control: Introductions-Concepts and Applications, Review of smart materials-Types and characteristic review of smart structures - Characteristic Active vibration control in smart structures Dynamic balancing and alignment of machinery -Dynamic balancing of Rotors, Field Balancing in one plane, Two planes and in several planes, Machinery alignment. **(5)**

TERM WORK:

1. Two assignments on measurement of dynamic test data of machine elements
2. One assignment on experimental modal analysis of machine element.
3. Two assignments on dynamic analysis using FEA software like Nastran, Hyperworks etc.
4. One Assignment on model data correlation for any one model used in sr. no. 1 and 2

References:

1. Roa, J.S. & Gupta K., "Ind. Course on Theory and Practice Mechanical Vibration", New Age International (P) Ltd.,1984.
2. Thomson, W.T., "Theory of Vibration with Applications" CBS Publishers and Distributors, New Delhi ,1990
3. Den Hartog, J.P., "Mechanical Vibrations", Dover Publications, 1990.
4. Roa, S.S., "Mechanical Vibrations", Addison Wesley Longman, 1995.
5. D.J. Ewins, Modal Testing: Theory and Practice, Research Press Ltd, Letchworth (Herefordshire, England) (1984).
6. M.I. Friswell, J.E. Mottershead, Finite Element Model Updating in Structural Dynamics (Solid Mechanics & Its Applications.) Kluwer Academic Publishers (1995)

Web References:

1. http://www.ecgcorp.com/velav/
2. http://www.auburn.edu/isvd/
3. http://www.vibetech.com/techpaper.htm

M.E. (PRODUCT DESIGN & DEVELOPMENT) Sem – I
5. ELECTIVE – II
2. REVERSE ENGINEERING

Teaching Scheme:
Lecture: 3 Hrs/week
Practical: 2 Hrs/week

Examination Scheme:
Theory Paper: 100 Marks
Term Work: 25 Marks

1. Introduction **(5)**
Scope and tasks of RE - Domain analysis- process of duplicating

2. Tools for **(8)**
Functionality- dimensional- developing technical data - digitizing techniques - construction of surface model - solid-part material- characteristics evaluation -software and application- prototyping - verification

3. Concepts **(9)**
History of Reverse Engineering – Preserving and preparation for the four stage process – Evaluation and Verification- Technical Data Generation, Data Verification, Project Implementation

4. Data Management **(9)**
Data reverse engineering – Three data Reverse engineering strategies – Definition – organization data issues - Software application – Finding reusable software components – Recycling real-time embedded software – Design experiments to evaluate a Reverse Engineering tool – Rule based detection for reverse Engineering user interfaces – Reverse Engineering of assembly programs: A model based approach and its logical basics

5. Integration **(9)**
Cognitive approach to program understated – Integrating formal and structured methods in reverse engineering – Integrating reverse engineering, reuse and specification tool environments to reverse engineering -–coordinate measurement – feature capturing – surface and solid members

TERM WORK:
Minimum Six assignments based on above topics, which also include at least one case study.

REFERENCE:

1. Design Recovery for Maintenance and Reuse, T J Biggerstaff, IEEE Corpn. July 1991
2. White paper on RE, S. Rugaban, Technical Report, Georgia Instt. of Technology, 1994
3. Reverse Engineering, Katheryn, A. Ingle, McGraw-Hill, 1994
4. Data Reverse Engineering, Aiken, Peter, McGraw-Hill, 1996
5. Reverse Engineering, Linda Wills, Kluiver Academic Publishers, 1996
6. Co-ordinate Measurment and reverse engineering, Donald R. Honsa, ISBN 1555897, American Gear Manufacturers Association

M.E. (PRODUCT DESIGN & DEVELOPMENT) Sem – I
5. ELECTIVE – II
3. COMPUTATIONAL FLUID DYNAMICS

Teaching Scheme:
Lecture: 3 Hrs/week
Practical: 2 Hrs/week

Examination Scheme:
Theory Paper: 100 Marks
Term Work: 25 Marks

1. Introduction: (10)
CFD as the third dimension of fluid mechanics. Numerical Discretization methods such as Finite Difference, FEM and FVM. Why FVM as preferred method in CFD. (25%)

2. Basic Equations of Fluid Dynamics : (6)
Potential flow , Nonlinear Potential flow, In viscid flows and viscous flows. Navier Stokes Equations. Primitive variable vs. conservation form. Dimensional form vs. Non dimensional form. (15%)

3. Numerical methods for Convection – Diffusion eqns : (10)
Upwinding and central difference schemes. Stability condition in terms of Courant number. (25%)

4. Numerical Methods for Inviscid Flows: (8)
Characteristic form of eqns . Flux difference splitting. Application to 2-D flows such as flow through a nozzle. (20%)

5. Numerical methods for Incompressible flows: (6)
The continuity eqn divergence constraint. Poisson eqn. for pressure. Schemes such as SIMPLE due to Patankar and Spalding. (15%)

TERM WORK:

Practical exercises (6 to 8) using Software packages like ANSYS, ICEM HEXA, FLUENT, CFX, COSMOS or equivalent on the following topics like –

1. Convection equation in one dimension.
2. Diffusion equation in one dimension.
3. One dimensional flow through a nozzle.
4. Flow over a cylinder and backward facing step.

Reference Books:

1. CFD: The Finite Volume Method by Veersteeg and Malalasekara, Prentice Hall, 1996
2. Computational Fluid Mechanics and Heat Transfer by Anderson, Tannehill and Pletcher, Hemisphere Publishers, 1984.
3. C A J Fletcher: Computational Methods for Fluid dynamics: Vol 1 and 2.Springer Verlag, 1987
4. C. Hirsch: Numerical Computation of Internal and External Flows Vol.1 and 2.
5. D C Wilcox: Turbulence Modeling for CFD, DCW Industries.

M.E. (PRODUCT DESIGN & DEVELOPMENT) Sem – I
5. ELECTIVE – II
4. DESIGN OPTIMIZATION

Teaching Scheme:
Lecture: 3 Hrs/week
Practical: 2 Hrs/week

Examination Scheme:
Theory Paper: 100 Marks
Term Work: 25 Marks

1. Classical Optimization Techniques: Single-variable and Multi-variable Optimization, Hessian Matrix, Saddle Point, Lagrange Multipliers Method and Kuhn-Tucker Conditions. **(4)**
2. Single-variable Optimization Techniques: Unrestricted Search, Exhaustive Search, Dichotomous Search, Interval-halving Method, Fibonacci Method, Golden-section Method, Quadratic Interpolation Method, Newton Method, Quasi-Newton Method, Secant Method **(12)**
3. Multi-variable Optimization Techniques: Evolutionary Optimization Method, Simplex Search Method, Pattern Search Method, Conjugate Direction Method, Steepest Descent Method, Newton's Method, Conjugate Gradient Method, Davidon- Fletcher-Powell Method **(12)**
4. Constrained Optimization Techniques: Interior Penalty Function Method, Exterior Penalty function Method **(4)**
5. Genetic Algorithm, Simulated Annealing, Artificial Neural Networks **(3)**
6. Theory of Constraints: Introduction to TOC, Optimized Production Technology (OPT), Nine principles of OPT, Five Focusing Steps (The 5FS) of TOC, Capacity Constrained Resources and the Time Buffer, Modeling the Time Buffer, Modeling Return-On-Investment (ROI) in TOC, Comparison of TOC and Local Optimization Approaches. **(5)**

TERM WORK : Minimum six exercises based on the above syllabus.

REFERENCE BOOKS:

1. Deb K (2004). Optimization for Engineering Design: Algorithms and Examples, Prentice Hall of India.

2. Dennis J Jr, Schnabel R (1996). Numerical Methods for Unconstrained Optimization and Nonlinear Equations, Society for Industrial and Applied Mathematics.

3. Rao S (1996). Engineering optimization, Theory and Practice, New Age International Publishers

4. Ravindran A, Ragsdell K and Reklaitis G (2006). Engineering Optimization: Methods and Applications, 2nd edition, John Wiley and Sons Inc.

5. Goldratt, E. M. and Cox, J. (2004). The Goal: A Process of Ongoing Improvement. 3rd Edition, North River Press. ISBN-10: 0884271781, ISBN-13: 978-0884271789

6. Dettmer, H. William (1997). Goldratt's Theory of Constraints: A Systems Approach to Continuous Improvement, American Society for Quality. ISBN 0873893700, 9780873893701

M.E. (PRODUCT DESIGN & DEVELOPMENT) Sem – I
6. SEMINAR – I

Teaching Scheme:
Practical: 1 Hr/week

Examination Scheme:
Term Work: 25 Marks

- Seminar–I should be based on the literature survey on any topic relevant to 'Product Design & Development'. It may be leading to selection of a suitable topic of dissertation.
- Each student has to prepare a write-up of about 25 pages. The report typed on A4 sized sheets and bound in the necessary format should be submitted after approved by the guide and endorsement of the Head of Department.
- The student has to deliver a seminar talk in front of the teachers of the department and his classmates.
- The Guide based on the quality of work and preparation and understanding of the candidate shall do an assessment of the seminar.

M.E. (PRODUCT DESIGN & DEVELOPMENT) Sem – II
1. MANUFACTURING SYSTEM DESIGN

Teaching Scheme:
Lecture: 3 Hrs/week
Practical: 2 Hrs/week

Examination Scheme:
Theory Paper: 100 Marks
Term Work: 25 Marks
Pract/Oral: 25 Marks

1. **Design of Sheet Metal Blanking and Piercing Dies – (7)**

Introduction, Fundamentals of die cutting operations, General Press information types, cutting action in punch and die operations, types of die construction, die clearances, sheet metal material handling and feeding devices.

2. **Fundamentals of die design – (7)**

Introduction, Press work materials and selection criteria, Blanking and piercing die construction, pilots, strippers and pressure pads, short run tooling for piercing, strip layout and design, calculations for sheet optimization.

3. **Bending, Forming and drawing die design – (7)**

Introduction of bending, forming dies, Bending and forming die design, Calculation of various parameters as per ASTME, effect of various process parameters during drawing, Drawing force and related parameter calculation as per ASTME, blank size calculations.

4. **Development of non metallic components using injection moulding – (7)**

Introduction, types of dies, die design considerations, calculation of important parameters, material properties of injection moulding materials.

5. **Design of Fixtures for Fabrication, Assembly and Inspection – (7)**

Introduction, significance of fixtures in fabrication, Assembly and inspection, Types and classification, Materials used for above applications, design considerations, calculation of clamping force, various approaches used in design of fixtures for above applications.

6. **Gauge and Gauge Design – (5)**

Introduction, requirement of a gauge, Types of gauges, Gauge tolerances, Selection of material for gauges, indicating gauges and automatic gauges, design of simple gauges like snap gauge, plug gauge and thread gauge.

CMM – Construction, working, features, software interface, elaboration of capabilities for various measurement requirement.

Use of CMM in reverse engineering, generation of drawing details from the existing component.

TERM WORK :

Minimum six assignments based on any of the following topics –

1. Blanking & Piercing die design.
2. Bending, forming, drawing die design.
3. Die design for injection moulded components.
4. Fixtures for Assembly, fabrication, inspection.
5. Use of CMM for component measurement and reverse engineering.
6. Use of softwares like Mould flow / Mouldex for suitable applications.

REFERENCE BOOKS :

1. Tool Design – Cyrill Donaldson, G.H LeCain, V.C. Goold, Tata McGraw Hill Publi.
2. Jigs & Fixtures- Kempster ,ELBS.

M.E. (PRODUCT DESIGN & DEVELOPMENT) Sem – II
2. CREATIVITY, INNOVATION & NEW PRODUCT DEVELOPMENT

Teaching Scheme:
Lecture: 3 Hrs/week
Practical: 2 Hrs/week

Examination Scheme:
Theory Paper: 100 Marks
Term Work: 25 Marks

1. Introduction **(8)**
The process of technological innovation - factors contributing to successful technological innovation - the need for creativity and innovation - creativity and problem solving - brain storming - different techniques.

2. Project Selection and Evaluation **(8)**
Collection of ideas and purpose of project - Selection criteria - screening ideas for new products (evaluation techniques).

3. New Product Development **(7)**
Research and new product development - Patents - Patent search - Patent laws - International code for patents - Intellectual property rights (IPR).

4. New Product Planning **(7)**
Design of proto type - testing - quality standards - marketing research - introducing new products.

5. Journeys in Product Development, Product Development Process Tools, Scoping Product Developments: Technical and Business Concerns. **(4)**

6. Understanding Customer Needs, Establishing Product Function. **(2)**

7. Product Teardown and Experimentation, Benchmarking and Establishing Engineering Specifications, Product Architecture. **(4)**

TERM WORK :

Creative design - Model Preparation - Testing - cost evaluation - Patent application.

References:

1. HARRY NYSTROM, " Creativity and innovation", John Wiley & Sons, 1979.
2. BRAIN TWISS, " Managing technological innovation", Pitman Publishing Ltd., 1992.

M.E. (PRODUCT DESIGN & DEVELOPMENT) Sem – II
3. PRODUCT LIFE CYCLE MANAGEMENT

Teaching Scheme:
Lecture: 3 Hrs/week
Tutorial: 1 Hr/week

Examination Scheme:
Theory Paper: 100 Marks
Term Work: 25 Marks

1. **INTRODUCTION** : Background, Overview, Need, Benefits, Concept of Product Life Cycle. Components / Elements of PLM, Emergence of PLM, Significance of PLM, Customer Involvement. **(5)**
2. **PRODUCT LIFE CYCLE ENVIRONMENT** : 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. **(4)**
3. **PRODUCT DEVELOPMENT PROCESS & METHODOLOGIES** : 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. Bottom-up design, Top-down design, Front loading design workflow, Design in context, Modular design. Concurrent engineering - work structuring and team Deployment - Product and process systemization - problem, identification and solving methodologies. Product Reliability, Mortality Curve. Design for Manufacturing, Design for Assembly. Design for Six Sigma. **(12)**
4. **PRODUCT MODELLING** : Product Modeling - 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. **(5)**
5. **TYPES OF ANALYSIS TOOLS** : Design for manufacturing - machining - casting and metal forming - optimum design - Design for assembly and disassembly - probabilistic design concepts - FMEA - QFD - Taguchi Method for design of experiments -Design for product life cycle. Estimation of Manufacturing costs, Reducing the component costs and assembly costs, Minimize system complexity. **(5)**
6. **PRODUCT DATA MANAGEMENT (PDM) TECHNOLOGY** - Product Data Management – An Introduction to Concepts, Benefits and Terminology, CIM Data. PDM functions, definition and architectures of PDM systems, product data interchange, portal integration, PDM acquisition and implementation. **(5)**
7. **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. **(4)**

Term Work :
(Minimum Six Assignments)

It shall consist of hands-on case assignments on suitable PLM software and other assignments based on the syllabus.

References :

1. Grieves, Michael. Product Lifecycle Management, McGraw-Hill, 2006. ISBN 0071452303
2. Product Life Cycle Management - by Antti Saaksvuori, Anselmi Immonen, Springer, 1st Edition (Nov.5, 2003)
3. Stark, John. Product Lifecycle Management: Paradigm for 21st Century Product Realisation, Springer-Verlag, 2004. ISBN 1852338105
4. Product Design & Process Engineering, McGraw Hill – Kogalkusha Ltd., Tokyo, 1974.
5. Product Design & Development – by Kari Ulrich and Steven D. Eppinger, McGraw Hill International Edns, 1999.
6. Effective Product Design and Development – by Stephen Rosenthol, Business One Orwin, Homewood, 1992 ISBN 1-55623-603-4.
7. Burden, Rodger PDM: Product Data Management, Resource Pub, 2003. ISBN 0970035225
8. Clement, Jerry; Coldrick, Andy; & Sari, John. Manufacturing Data Structures, John Wiley & Sons, 1992. ISBN 0471132691
9. 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
10. Crnkovic, Ivica; Asklund, Ulf; & Dahlqvist, Annita Persson. Implementing and Integrating Product Data Management and Software Configuration Management, Artech House Publishers, 2003. ISBN 1580534988
11. Garwood, Dave. Bills of Materials for a Lean Enterprise, Dogwood Publishing Co., 2004. ISBN 0962111848
12. Fan, D. (Ed.), Virtual Reality for Industrial Applications, Springer.

M.E. (PRODUCT DESIGN & DEVELOPMENT) Sem – II
4. ELECTIVE – III
1. EXPERIMENTAL STRESS ANALYSIS

Teaching Scheme:
Lecture: 3 Hrs/week
Practical: 2 Hrs/week

Examination Scheme:
Theory Paper: 100 Marks
Term Work: 25 Marks

1. Principles of Experimental approach: Introduction to ESA, Advantages of ESA techniques, Necessity of various ESA methods, methodology of problem solving by ESA Strategy **(5)**
2. Strain Measurement Techniques : Introduction to strain measurement: Review of Stress, Strain, and Hooke's Law: Definition of Stress and Strain Tensors, Constitutive Models Strain Gages: Properties of Strain gauge Systems, Types Resistance Strain gauges: Construction, Mounting methods, Gage Sensitivity, Strain Gage Circuits: Wheatstone bridge, constant current circuits Calibration of circuits, Bridge Sensitivity and Measurement Corrections, Thermal Corrections Gage Factor, Performance Characteristics, Environmental effects. Recording Instruments: Static and Dynamic Recording, Digital Data Acquisition Systems, Telemetry Systems Strategy **(8)**
3. Strain Analysis Methods: Three element rectangular strain rosette, correction, stress gauges, over-deterministic methods for strain analysis, residual stress determination Applications: Application of strain gauges for measurement of load, temperature, pressure, vibration, stress and strain etc. Strategy **(5)**
4. Optical Methods of Stress Analysis: Basic of Optics, Optical Instrumentation Moire Fringe technique-theory and experimental procedures, Fractional fringe measurement -Tardy's Method , Babinet Soleil Method. Strategy **(5)**
5. Theory of Photoelasticity, Polariscope- Plane polariscope, Circular polariscope,Different Arrangements photoelastic photography, Photoelastic materials-properties, selection, casting methods, caliberation. Analysis Techniques-Determination of direction of Principal stresses at given point, Determination of exact fringe order N and the principal stress Separation methodsMethod based on Hooke's Law, Electrical analogy method, Oblique incidence method,Shear difference method, Scaling model results to prototype. Application of photoelasticity to 2-D and 3-D Stress analysis Strategy **(8)**
6. Optical methods for Determining Fracture Parameters- Irwins methods, application. of moiré and isopachic fringe pattern to determine stress intensity factor, mixed mode intensity factors Strategy. **(3)**
7. Coating Techniques- Bifringent coating- stress-optic and strain-optic relation, sensitivity and coating materials, fringe order determination. Brittle coating technique. Strategy **(3)**
8. HOLOGRAPHY:Plane and spherical waves - coherence - holographic setup - Interferometry - Displacment measurement -obtaining Isopachics, Strategy. **(3)**

TERM WORK:

1. Determination of strain by attaching strain gauges to minimum two stressed members subjected to tension, bending , torsion or combined.
2. Use of Strain rosette for principal strain determination by mohr circle method
3. Model preparation for 2-d and 2-d photoelasticity analysis.
4. Determination of Stresses in 2-D elements
5. Determination of Stresses in 3-D elements
6. Study of coating techniques for stress and strain determination

References:

1. Sadhu Singh – Experimental Stress Analysis, Khanna Publishers, New Delhi, 1996.
2. JW Dalley and WF Riley, Experimental Stress Analysis, McGraw Hill Book Company, N.Y. 1991
3. L.S.Srinath et al, Experimental Stress Analysis, Tata McGraw Hill Company, New Delhi, 1984
4. R.S.Sirohi, HC Radhakrishna, Mechanical Measurements, New Age International (P) Ltd. 1997
5. F.K Garas, J.L. Clarke and GST Armer, Structural assessment, Butterworths, London, 1987
6. D.E. Bray & R. K.Stanley, Non-destructive Evaluation
7. Dove and Adams, Experimental Stress Analysis and Motion Measurement, Prentice Hall of India, 1965.

M.E. (PRODUCT DESIGN & DEVELOPMENT) Sem – II
4. ELECTIVE – III
2. RELIABILITY ENGINEERING

Teaching Scheme:
Lecture: 3 Hrs/week
Practical: 2 Hrs/week

Examination Scheme:
Theory Paper: 100 Marks
Term Work: 25 Marks

A) Quality Engineering

1. 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 **(4)**

2. Steps in Robust Design, Quality Characteristics and Objective Functions, Control Factors and their Levels, Noise Factors and Testing Conditions, Planning and Conducting the Experiment **(2)**

3. Response Surface Methodology – First- order and Second-order Models **(8)**

4. Crossed Array Experiments, Signal-to-Noise Ratios **(6)**

B) Reliability Engineering :

1. The Reliability Function, Failure Rate, Hazard Rate, Bath-tub Curve, Relationship between Various Reliability Characteristics **(3)**
2. Component Reliability, Mean-time-to-failure, Time-dependent Hazard Models – Constant-hazard, Linear-hazard, Nonlinear-hazard and Gamma Models **(3)**
3. System Reliability, Two-state Modeling, Series Models, Parallel Models, Series-parallel and Parallel-series Models, k-out-of-m Models, Standby Models, Non-series-parallel Models, Fault-tree Approach to System Modeling **(10)**

5. Maintained Systems, Classification of Maintenance Activities: Breakdown, Preventive and Predictive Maintenance, Condition Monitoring, Maintainability and Availability, Reliability-centered Maintenance **(4)**

TERM WORK :

Minimum Six assignments on related topics, which should include at least one case study.

REFERENCE BOOKS :

1. Antony J (2003). Design and Experiments for Engineers and Scientists, Butterworth-Heinmann.
2. Cochran W and Cox G (2000). Experimental Designs, II edition, John Wiley & Sons Inc.
3. Dean A and Voss D (2006). Design and Analysis of Experiments, Springer.
4. Jeff Wu C and Hamada M (2000). Experiments: Planning, Analysis and Parameter Design Optimization, John Wiley and Sons Inc.

5. Montgomery D (2001). Design and Analysis of Experiments, 5th edition, Wiley.
6. Phadke, M (1989). Quality Engineering using Robust Design, Prentice Hall.
7. Ross, P (1996). Taguchi Techniques for Quality Engineering, 2nd edition, McGraw Hill.
8. Balgurusamy E (2003). Reliability Engineering, Tata McGraw Hill.
9. Birolini A (2004). Reliability Engineering: Theory and Practice, 4th edition, Springer.
10. Crowder M, Kimber A, Smith R and Sweeting T (1991). Statistical Analysis of Reliability Data, Chapman and Hall.
11. Kumamoto H and Henley E (1996). Probabilistic Risk Assessment and Management for Engineers and Scientists, IEEE Press.

Pre-requisites for Quality and Reliability Engineering

Experimental design fundamentals, Guidelines for designing experiments, Concepts of replication, blocking and randomization, Statistical techniques in experimentation, Sampling and sampling distributions, Confidence intervals, Inferences about means and variances Experiments with single factor, Analysis of variance, Fixed effect model – Parameter estimation, Model adequacy checking, Residual plots, Comparing treatment means, Designing and testing contrasts Factorial design, Two-factor factorial design, The 22 design and 23 design – Parameter estimation, Model adequacy checking

Probability – Concept, Definitions, Rules of probability, Bayesian theorem Continuous distributions – Normal, Lognormal, Exponential, Gamma, Chi-squared, and Weibull distribution Discrete distributions – Binomial, Poisson, and Negative binomial distribution

M.E. (PRODUCT DESIGN & DEVELOPMENT) Sem – II
4. ELECTIVE – III
3. INDUSTRIAL ROBOTICS & EXPERT SYSTEMS

Teaching Scheme:
Lecture: 3 Hrs/week
Practical: 2 Hrs/week

Examination Scheme:
Theory Paper: 100 Marks
Term Work: 25 Marks

1. Introduction and Robot Kinematics (9)

Definition need and scope of Industrial robots – Robot anatomy – Work volume – Precision movement – End effectors – Sensors.

Robot Kinematics – Direct and inverse kinematics – Robot trajectories – Control of robot manipulators – Robot dynamics – Methods for orientation and location of objects.

2. Robot Drives and Control (8)

Controlling the Robot motion – Position and velocity sensing devices – Design of drive systems – Hydraulic and Pneumatic drives – Linear and rotary actuators and control valves – Electro hydraulic servo valves, electric drives – Motors – Designing of end effectors – Vacuum, magnetic and air operated grippers.

3. Robot (8)

Transducers and Sensors – Tactile sensor – Proximity and range sensors – Sensing joint forces – Robotic vision system – Image Representation - Image Grabbing –Image processing and analysis – Edge Enhancement – Contrast Stretching – Band Rationing - Image segmentation – Pattern recognition – Training of vision system.

4. Robot Cell Design and Application (8)

Robot work cell design and control – Safety in Robotics – Robot cell layouts – Multiple Robots and machine interference – Robot cycle time analysis. Industrial applications of Robots.

5. Robot Programming, Artificial Intelligence and Expert Systems (7)

Methods of Robot Programming – Characteristics of task level languages lead through programming methods – Motion interpolation. Artificial intelligence – Basics – Goals of artificial intelligence – AI techniques – problem representation in AI – Problem reduction and solution techniques - Application of AI and KBES in Robots.

TERM WORK : Minimum Six assignments on related topics.

TEXT BOOK: K.S.Fu, R.C. Gonzalez and C.S.G. Lee, "Robotics Control, Sensing, Vision and Intelligence", Mc Graw Hill, 1987.

References:

1. Yoram Koren," Robotics for Engineers' Mc Graw-Hill, 1987.
2. Kozyrey, Yu. "Industrial Robots", MIR Publishers Moscow, 1985.
3. Richard. D, Klafter, Thomas, A, Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Prentice-Hall of India Pvt. Ltd., 1984.
4. Deb, S.R." Robotics Technology and Flexible Automation", Tata Mc Graw-Hill, 1994.
5. Mikell, P. Groover, Mitchell Weis, Roger, N. Nagel, Nicholas G. Odrey," Industrial Robotics Technology, Programming and Applications", Mc Graw-Hill, Int. 1986.
6. Timothy Jordanides et al ,"Expert Systems and Robotics ", Springer –Verlag, New York, May 1991.

M.E. (PRODUCT DESIGN & DEVELOPMENT) Sem – II
4. ELECTIVE – III
4. OPEN ELECTIVE

Teaching Scheme:
Lecture: 3 Hrs/week
Practical: 2 Hrs/week

Examination Scheme:
Theory Paper: 100 Marks
Term Work: 25 Marks

Students can take any subject from other discipline being conducting in the same institute and with consent of their guide.

M.E. (PRODUCT DESIGN & DEVELOPMENT) Sem – II
5. ELECTIVE – IV
1. RAPID PROTOTYPING

Teaching Scheme:
Lecture: 3 Hrs/week
Tutorial: 1 Hr/week

Examination Scheme:
Theory Paper: 100 Marks
Term Work: 25 Marks

Chapter 1: Introduction to RP, Technology Description, Definition to RP, Overview of RP, Benefits and Application. **(5)**

Chapter 2: RP Processes : Process overviews, STL file Generation, File Verification & Repair, Build File Creation, Part Construction, Part Cleaning and finishing, Process Strength & limitations. **(12)**

Chapter 3: Classes of RP systems: 3D Printers, Enterprise Prototyping centers, Direct digital tooling, Direct digital manufacturing, system classification, Stereo lithography, SL with photo polymerization, SL with liquid thermal polymerization, Selective Laser Sintering, Fused deposition modeling, Laminated object manufacturing, Laser powder forming. **(9)**

Chapter 4: Prototype properties: Material, color, dimensional accuracy, stability, surface finish, machine-ability, environmental resistance, operational properties **(6)**

Chapter 5: RP Applications: Design, Concept Models, Form & fit checking, Ergonomic Studies, Functional testing, Requesting Price quotes, CAD data verification, Rapid Tooling, Rapid manufacturing, Science & Medicine, Archeology, Paleontology & forensic Science, miniaturization **(8)**

TERM WORK :

1. Two Assignments on 3SD modeling & STL File generation of industrial components.
2. Study of RP Processes and their parameters
3. Study of 3D printing & its applications
4. Use of Rapid tooling for injection molds
5. Use of RP for reverse engineering

REFERENCES :

1. T. A. Grimm & Associates, Users Guide to Rapid Prototyping, Society of Manufacturing Engineers (SME) ISBN 0872636976
2. Frank W. Liou, Rapid Prototyping & engineering applications, CRC Press, ISBN 978-0-8493-3409-2
3. Rapid Prototyping theory & practice, Manufacturing System Engineering Series, Ali K. Kamarani, Springer Verlag
4. Rapid Prototyping- case book, J. A. McDonalds, C. J. Ryall, Wiley Eastern
5. Rapid & Virtual Prototyping & applications, C. E. Bocking, AEW Rennie, Wiley Eastern

WEBSITES

1. http://www_rpl.stanford.edu
2. http://home.utah.edu/
3. http://www.me.psu.edu
4. http://itri.loyola.edu/rp/02
5. http://www.udri.udayton.edu/

M.E. (PRODUCT DESIGN & DEVELOPMENT) Sem – II
5. ELECTIVE – IV
2. ENGINEERING OPTIMIZATION IN DESIGN

Teaching Scheme:
Lecture: 3 Hrs/week
Tutorial : 1 Hr/week

Examination Scheme:
Theory Paper: 100 Marks
Term Work: 25 Marks

1. Unconstrained Optimization Techniques (9)
Introduction to optimum design - General principles of optimization – Problem formulation & their classifications - Single variable and multivariable optimization, Techniques of unconstrained minimization – Golden section, Random, pattern and gradient search methods – Interpolation methods.

2. Constrained Optimization Techniques (9)
Optimization with equality and inequality constraints - Direct methods – Indirect methods using penalty functions, Lagrange multipliers - Geometric programming

3. Advanced Optimization Techniques (9)
Multi stage optimization – dynamic programming; stochastic programming; Multi objective optimization, Genetic algorithms and Simulated Annealing techniques; Neural network & Fuzzy logic principles in optimization.

4. Static Applications (7)
Structural applications – Design of simple truss members - Design applications – Design of simple axial, transverse loaded members for minimum cost, weight – Design of shafts and torsionally loaded members – Design of springs.

5. Dynamic Applications (6)
Dynamic Applications – Optimum design of single, two degree of freedom systems, vibration absorbers. Application in Mechanisms – Optimum design of simple linkage mechanisms.

TERM WORK :

Minimum Six assignments on related topics, which should include at least one case study.

REFERENCES:

1. Rao, Singaresu, S., "Engineering Optimization – Theory & Practice", New Age International (P) Limited, New Delhi, 2000.
2. Johnson Ray, C., "Optimum design of mechanical elements", Wiley, John & Sons, 1990.
3. Kalyanamoy Deb, "Optimization for Engineering design algorithms and Examples", Prentice Hall of India Pvt. 1995.
4. Goldberg, D.E., "Genetic algorithms in search, optimization and machine", Barnen, Addison-Wesley, New York, 1989.

M.E. (PRODUCT DESIGN & DEVELOPMENT) Sem – II
5. ELECTIVE – IV
3. ARTIFICIAL INTELLIGENCE & NEURAL NETWORK

Teaching Scheme:
Lecture: 3 Hrs/week
Tutorial : 1 Hr/week

Examination Scheme:
Theory Paper: 100 Marks
Term Work: 25 Marks

SECTION – I : ARTIFICIAL INTELLIGENCE

1. Concept of A.I., Approaches, Foundations of A.I., Underlying assumptions **(1)**
2. Problem Formulation: Problem solving agents, Components of problem definition, defining the problem as state space approach, Problem characteristics, Production System, searching for solutions, Forward and backward reasoning, means end analysis, Graphs and trees, measuring problem solving performance **(3)**
3. Search Strategies: a)Uninformed (blind) search- breadth first, depth first, and their variations, avoiding repeated states; b) Informed (heuristic) search- heuristic function, Generate and test, Best first search, A* search, Local search algorithms- Hill climbing, Simulated annealing, Branch and bound and Local beam search, **(4)**
4. Knowledge Representation: Simple rational knowledge, Inheritable knowledge, Inferential knowledge, Procedural knowledge, the Frame problem, Propositional logic- Syntax and semantics, well formed formulas (WFF), conversion to clausal form, using FOPL, inference rules, unification, non-deductive inference methods, resolution, forward and backward chaining, the knowledge engineering process, Handling uncertain knowledge, probability propositions, atomic events, unconditional (prior) and conditional (posterior), priority Bayes' rule and its use, Bayesian network, its semantics and inference. **(4)**
5. Learning: Forms of learning, inductive learning, decision tree learning, ensemble learning, Pattern recognition- Introduction, recognition, and classification process, learning classification patterns. **(2)**
6. Knowledge based systems: Expert systems, components, characteristic features of expert systems, rule based system architecture, representing & using domain knowledge, expert system shell, explaining the reasoning and knowledge acquisition, applications. **(3)**
7. A.I. in Robotics: State space search, path selection, AND-OR graphs, means end analysis in a robotic problem, robot problem solving as a production system, robot learning and task planning, symbolic spatial relationship, obstacle avoidance, graph planning. **(3)**
8. Machine Vision: Functions, imaging devices, lighting, A-D conversion, quantization, encoding image storage, image data reduction, segmentation techniques, feature extraction, object recognition, training the vision system, applications. **(2)**

SECTION – II : ARTIFICIAL NEURAL NETWORK

1. Significance, Basic building blocks. **(2)**
2. Types of ANN – and their representation. **(2)**
3. Learning Modes and Algorithms. **(4)**

4. Applications of ANN to various engineering and industrial problems. **(3)**
5. Implementation methodology to solve problems, by using softwares like MatLab on equivalent. **(5)**
6. Desirable facilities. MatLab latest version with ANN Tool box and equivalent Supporting softwares preferably like Prolog, LISP, C++. **(2)**

TERM WORK: Minimum six exercises based on above, consisting of case studies.

BOOKS:

1. Stuart Russel, Peter Norwig (2003), "Artificial Intelligence : A Modern Approach" 2/e, (Pearson Education)
2. Elaine Rich, Kevin Knight, (1991), "Artificial Intelligence" 2/e, (Tata McGraw Hill)
3. Dan W. Patterson (1999), "Introduction to Artificial Intelligence and Expert Systems" (7th Indian Reprint) (EEE) (Prentice Hall of India)
4. Rex Mauss, Jessica Keyes , "Handbook of Expert Systems in Mfg.", (McGraw Hill)
5. Groover, Weiss, Nagel, Audrey, "Industrial Robotics- Technology, Programming and Applications"", (McGraw Hill)
6. Fu, Gonzalea and Lee, "Robotics: Control, Sensing, Vision and Intelligence", (McGraw Hill)
7. Conference Proceedings and current journals for case studies and applications.
8. Introduction to A.N.N. by Anderson, Prentice Hall of India Publication.
9. A.N.N. by Yadnanarayana, Prentice Hall of India Publication
10. A.N.N. by Zurda J.M.
11. A.N.N. and MatLab by Sivanandan.
12. Fundamentals of A.N.N. by Hasson.

M.E. (PRODUCT DESIGN & DEVELOPMENT) Sem – II
5. ELECTIVE – IV
4. TOTAL QUALITY MANAGEMENT & SIX SIGMA

Teaching Scheme:
Lecture : 3 Hrs/week
Tutorial : 1 Hr/week

Examination Scheme:
Theory Paper: 100 Marks
Term Work: 25 Marks

SECTION – I

1. Overview of TQM: **(3)**
Concept and definition, Fundamentals, TQM Verses Management relationship, Elements of TQM, approaches to TQM, TQM models, Zero defect concept.

2. Contributions of Quality Gurus: **(6)**
Deming's approach, Jurans quality trilogy, Crossby and quality improvement, Ishikawas company wide quality control, Fegenbaum theory of TQC.
Revolution In Management Thinking: Customer focus, problem solving QC tools, Continuous improvement (Kaizen), Customer satisfaction, Kanos model, Customer retention.

4. Quality Circles: **(4)**
Total Employee Involvement (TEI), Employee empowerment, Employee suggestion scheme.
Creating Quality Culture: Requisite changes to implement Quality culture, developing TQM culture,

6. Total Quality in Service Sector. **(5)**
ISO 9001-2000 series of standards, overview of ISO 9000-1993 series standards, structure of ISO 9000-2000 series standards, clauses, contents, and interpretations, implementation.

SECTION – II

7. Introduction to Six Sigma : **(3)**
Concept, Approach and Orientation of Six Sigma.

8. Strategy for Six Sigma : **(4)**
Planning for Six Sigma, Prerequisites, Project Management, Performance Reporting.

9. Implementation of Six Sigma : **(7)**
Organizing Six Sigma, Team Leaders tools, corporate initiative.

10. Design for Six Sigma, Methodology, Evaluation, Result assessment, System Modification, System development, System management concept, performance evaluation. **(8)**

TERM WORK :

Minimum Eight (08) assignments on above topics preferably with case study.

Reference Books:

1. Total Quality Control Feigenban - McGraw Hill Book Company, New York
2. Implementing Total Quality-Joe Culle
3. Dale H. Besterfilee, "Total Quality Management", Pearson Education
4. Amitava Mitra, " Fundamentals of Quality Control and Improvement", Pearson Education
5. Six Sigma Black Belt Handbook – Thomas McCarty, Michael Bramer & Praveen Gupta, Tata McGraw Hill Pub.
6. Six Sigma Performance Hardware by Praveen Gupta, Tata McGraw Hill Pub.

M.E. (PRODUCT DESIGN & DEVELOPMENT) Sem – II
6. SEMINAR – II

Teaching Scheme:
Practical: 1 Hr/week

Examination Scheme:
Term Work: 50 Marks

- Seminar–II should be based on the literature survey on any topic relevant to CAD/CAM/CAE. It may be leading to selection of a suitable topic of dissertation. The report shall contain some contribution by the candidate in the form of experimental results, deductions, compilation and inferences etc.
- Each student has to prepare a write-up of about 25 pages. The report typed on A4 sized sheets and bound in the necessary format should be submitted after approved by the guide and endorsement of the Head of Department.
- The student has to deliver a seminar talk in front of the teachers of the department and his classmates. The Guide based on the quality of work and preparation and understanding of the candidate shall do an assessment of the seminar.

M.E. (PRODUCT DESIGN & DEVELOPMENT) Sem – III
1. MINI PROJECT

Examination Scheme:
Term Work: 50 Marks

A Mini Project based on the subjects studied during Semester-I and Semester-II, shall be undertaken and completed by the candidate during vacation after Semester-II.

The report of this project shall be submitted in the prescribed format at the beginning of Semester III. It will be approved by the guide and endorsed by the Head of Department. It will be assessed for term work during Semester III, by the evaluation committee(*) appointed by the Head of the Department.

M.E. (PRODUCT DESIGN & DEVELOPMENT) Sem – III
2. DISSERTATION PHASE-I

Teaching Scheme:
Practical: 5 Hrs/week

Examination Scheme:
Term Work: 50 Marks
Oral: 50 Marks

It shall include the problem definition, literature survey, approaches for handling the problem, finalizing the methodology for the dissertation work and design calculations / experimental design etc. A report of the work shall be submitted at the end of Semester III after approval by the Guide and endorsement of the Head of Department. It will be assessed for term work, by the evaluation committee(*) appointed by the Head of the Department, for appropriateness, sufficiency of contents and offer suggestions if any.

M.E. (PRODUCT DESIGN & DEVELOPMENT) Sem – IV
1. DISSERTATION PHASE-II

Teaching Scheme:
Practical: 5 Hrs/week

Examination Scheme:
Term Work: 200 Marks
Oral : 100 Marks

The candidate shall submit the detailed report as per the synopsis approved by the university, of the dissertation work in the prescribed format after approval by the Guide and endorsement by the Head of the Department. It will be assessed for term work by the evaluation committee(*) appointed by the Head of the Department, for completion of the proposed work.

(*) Note: The evaluation committee shall consist of the Guide, one senior expert faculty member and the Head of the Department or his/her representative.