ANNA UNIVERSITY, CHENNAI

AFFILIATED INSTITUTIONS

REGULATIONS 2013

M.E. PRODUCT DESIGN AND DEVELOPMENT

I TO IV SEMESTERS (FULL TIME) CURRICULUM AND SYLLABUS

SEMESTER I

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	MA7169	Advanced Numerical Methods	3	1	0	4
2.	PD7101	Introduction to Product Development	3	0	0	3
3.	ED7102	Computer Applications in Design	3	0	2	4
4.	PD7102	Quality Concepts in Product Development	3	0	0	3
5.	PD7103	Industrial Design	3	0	2	4
6.		Elective I	3	0	0	3
PRACTICAL						
7.	PD7111	CAD and CAM Laboratory	0	0	2	1
8.	PD7112	Product Data Analysis	0	0	2	1
		TOTAL CREDITS	**18**	**1**	**8**	**23**

SEMESTER II

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	ED7201	Finite Element Methods in Mechanical Design	3	1	0	4
2.	PD7201	Integrated Product Design and Process Development	3	1	0	4
3.	PD7202	Product and Process Engineering Tools	3	0	0	3
4.	PD7203	Materials for Product Design	3	1	0	4
5.		Elective II	3	0	0	3
6.		Elective III	3	0	0	3
PRACTICAL						
7.	PD7211	Design Project	0	0	3	2
8.	PD7212	New Product Design Studio Laboratory	0	0	2	1
		TOTAL CREDITS	**18**	**3**	**5**	**24**

SEMESTER III

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	PD7301	Marketing Research	3	0	0	3
2.		Elective IV	3	0	0	3
3.		Elective V	3	0	0	3
PRACTICAL						
4.	PD7311	Project Work (Phase I)	0	0	12	6
		TOTAL CREDITS	**9**	**0**	**12**	**15**

SEMESTER IV

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
PRACTICAL						
1.	PD7411	Project Work (Phase II)	0	0	24	12
		TOTAL CREDITS	**0**	**0**	**24**	**12**

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE =74

LIST OF ELECTIVES FOR M.E. PRODUCT DESIGN AND DEVELOPMENT

SEMESTER I (Elective I)

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
1	PD7001	Creativity in Design	3	0	0	3
2	PD7002	Enterprise Resource Planning	3	0	0	3
3	ED7004	Design of Hydraulic and Pneumatic Systems	3	0	0	3
4	ED7001	Optimization Techniques in Design	3	0	0	3
5	CM7001	Additive Manufacturing	3	0	0	3

SEMESTER II (Elective II & III)

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
1	PD7003	Design Paradigm	3	0	0	3
2	PD7004	Micro Electro Mechanical Systems	3	0	0	3
3	ED7071	Industrial Robotics and Expert Systems	3	0	0	3
4	ED7007	Modal Analysis of Mechanical Systems	3	0	0	3
5	CC7201	Design for Manufacture Assembly and Environments	3	0	0	3
6	IC7072	Computational Fluid Dynamics	3	0	0	3

SEMESTER III (Elective IV & V)

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
1	PD7005	Reverse Engineering	3	0	0	3
2	PD7006	Product Design for Energy and Environment	3	0	0	3
3	PD7007	Intellectual Property Rights and Patent Laws	3	0	0	3
4	ED7010	Tribology in Design	3	0	0	3
5	ED7013	Advanced Finite Element Analysis	3	0	0	3
6	PD7008	Maintenance Engineering	3	0	0	3
7	ED7011	Bearing Design and Rotor Dynamics	3	0	0	3
8	CD7006	Integrated Manufacturing Systems	3	0	0	3

MA7169 ADVANCED NUMERICAL METHODS L T P C
3 1 0 4

OBJECTIVE:

- To impart knowledge on numerical methods that will come in handy to solve numerically the problems that arise in engineering and technology. This will also serve as a precursor for future research.

OUTCOME:

- It helps the students to get familiarized with the numerical methods which are necessary to solve numerically the problems that arise in engineering.

UNIT I ALGEBRAIC EQUATIONS (9+3)

Systems of linear equations: Gauss Elimination method, pivoting techniques, Thomas algorithm for tridiagonal system – Jacobi, Gauss Seidel, SOR iteration methods - Systems of nonlinear equations: Fixed point iterations, Newton Method, Eigenvalue problems: power method, inverse power method, Faddeev – Leverrier Method.

UNIT II ORDINARY DIFFERENTIAL EQUATIONS (9+3)

Runge Kutta Methods for system of IVPs, numerical stability, Adams-Bashforth multistep method, solution of stiff ODEs, shooting method, BVP: Finite difference method, orthogonal collocation method, orthogonal collocation with finite element method, Galerkin finite element method.

UNIT III FINITE DIFFERENCE METHOD FOR TIME DEPENDENT PARTIAL DIFFERENTIAL EQUATION (9+3)

Parabolic equations: explicit and implicit finite difference methods, weighted average approximation - Dirichlet and Neumann conditions – Two dimensional parabolic equations – ADI method; First order hyperbolic equations – method of characteristics, different explicit and implicit methods; numerical stability analysis, method of lines – Wave equation: Explicit scheme-Stability of above schemes.

UNIT IV FINITE DIFFERENCE METHODS FOR ELLIPTIC EQUATIONS (9+3)

Laplace and Poisson's equations in a rectangular region: Five point finite difference schemes, Leibmann's iterative methods, Dirichlet and Neumann conditions – Laplace equation in polar coordinates: finite difference schemes – approximation of derivatives near a curved boundary while using a square mesh.

UNIT V FINITE ELEMENT METHOD (9+3)

Partial differential equations – Finite element method - orthogonal collocation method, orthogonal collocation with finite element method, Galerkin finite element method.

T= 15, TOTAL: 60 PERIODS

REFERENCES

1. Saumyen Guha and Rajesh Srivastava, "Numerical methods for Engineering and Science", Oxford Higher Education, New Delhi, 2010.
2. Gupta S.K., "Numerical Methods for Engineers", New Age Publishers,1995.
3. Burden, R.L., and Faires, J.D., "Numerical Analysis – Theory and Applications", Cengage Learning, India Edition, New Delhi, 2009
4. Jain M. K., Iyengar S. R., Kanchi M. B., Jain , "Computational Methods for Partial Differential Equations", New Age Publishers, 1993.
5. Morton K.W. and Mayers D.F., "Numerical solution of partial differential equations",Cambridge University press, Cambridge, 2002.

PD7101 INTRODUCTION TO PRODUCT DEVELOPMENT L T P C
3 0 0 3

OBJECTIVE:

- This course aims at introducing the students to the basic concepts of engineering design and product development with focus on the front end processes. At the end of this course the student is expected to demonstrate an understanding of the overview of all the product development processes and knowledge of concept generation and selection tools.

UNIT I **9**

Need for developing products – the importance of engineering design – types of design –the design process – relevance of product lifecycle issues in design –designing to codes and standards- societal considerations in engineering design –generic product development process – various phases of product development-planning for products –establishing markets- market segments- relevance of market research

UNIT II **9**

Identifying customer needs –voice of customer –customer populations- hierarchy of human needs-need gathering methods – affinity diagrams – needs importance- establishing engineering characteristics-competitive benchmarking- quality function deployment- house of quality- product design specification-case studies

UNIT II **9**

Creative thinking –creativity and problem solving- creative thinking methods- generating design concepts-systematic methods for designing –functional decomposition – physical decomposition – functional representation –morphological methods-TRIZ- axiomatic design

UNIT IV **9**

Decision making –decision theory –utility theory –decision trees –concept evaluation methods – Pugh concept selection method- weighted decision matrix –analytic hierarchy process – introduction to embodiment design –product architecture – types of modular architecture –steps in developing product architecture

UNIT V **9**

Industrial design – human factors design –user friendly design – design for serviceability – design for environment – prototyping and testing – cost evaluation –categories of cost –overhead costs – activity based costing –methods of developing cost estimates – manufacturing cost –value analysis in costing

TOTAL: 45 PERIODS

Note: Since the idea is to provide an overview of the design process, the questions in the examination should have more number of sub-divisions leading to not more than 4 or 5 marks each and need to be generic in the Part-B part.

REFERENCES

1. George E.Dieter, Linda C.Schmidt, “Engineering Design”, McGraw-Hill International Edition, 4th Edition, 2009, ISBN 978-007-127189-9
2. Anita Goyal, Karl T Ulrich, Steven D Eppinger, “Product Design and Development “, 4th Edition, 2009, Tata McGraw-Hill Education, ISBN-10-007-14679-9
3. Kevin Otto, Kristin Wood, “Product Design”, Indian Reprint 2004, Pearson Education,ISBN 9788177588217
4. Yousef Haik, T. M. M. Shahin, “Engineering Design Process”, 2nd Edition Reprint, Cengage Learning, 2010, ISBN 0495668141
5. Clive L.Dym, Patrick Little, “Engineering Design: A Project-based Introduction”, 3rd Edition, John Wiley & Sons, 2009, ISBN 978-0-470-22596-7

ED7102 COMPUTER APPLICATIONS IN DESIGN L T P C
3 0 2 4

OBJECTIVE:

- To impart knowledge on computer graphics which are used routinely in diverse areas as science, engineering, medicine, etc.

OUTCOME:

- With laboratory classes in conjunction, It helps the students to get familiarized with the computer graphics application in design. This understanding reinforces the knowledge being learned and shortens the overall learning curves which are necessary to solve CAE problems that arise in engineering.

UNIT I INTRODUCTION TO COMPUTER GRAPHICS FUNDAMENTALS 8

Output primitives (points, lines, curves etc.,), 2-D & 3-D transformation (Translation,scaling,rotators) windowing - view ports - clipping transformation.

UNIT II CURVES AND SURFACES MODELLING 10

Introduction to curves - Analytical curves: line, circle and conics – synthetic curves: Hermite cubic spline- Bezier curve and B-Spline curve – curve manipulations.

Introduction to surfaces - Analytical surfaces: Plane surface, ruled surface , surface of revolution and tabulated cylinder – synthetic surfaces: Hermite bicubic surface- Bezier surface and B-Spline surface- surface manipulations.

UNIT III NURBS AND SOLID MODELING 9

NURBS- Basics- curves , lines, arcs, circle and bi linear surface.

Regularized Boolean set operations - primitive instancing - sweep representations - boundary representations - constructive solid Geometry - comparison of representations - user interface for solid modeling.

UNIT IV VISUAL REALISM 9

Hidden – Line – Surface – solid removal algorithms shading – coloring. Introduction to parametric and variational geometry based software's and their principles creation of prismatic and lofted parts using these packages.

UNIT V ASSEMBLY OF PARTS AND PRODUCT DATA EXCHANGE 9

Assembly modeling - interferences of positions and orientation - tolerances analysis - mass property calculations - mechanism simulation.

Graphics and computing standards– Open GL Data Exchange standards – IGES, STEP etc– Communication standards.

T= 30, TOTAL: 75 PERIODS

Laboratory session: Writing interactive programs generate graphics and to solve design problems - using any languages like Auto LISP/ C / FORTRAN etc. Each assessment should contain a component of Laboratory session.

REFERENCES

1. William M Neumann and Robert F.Sproul "Principles of Computer Graphics", Mc Graw Hill Book Co. Singapore, 1989.
2. Donald Hearn and M. Pauline Baker "Computer Graphics", Prentice Hall, Inc., 1992.
3. Ibrahim Zeid Mastering CAD/CAM – McGraw Hill, International Edition, 2007.
4. Foley, Wan Dam, Feiner and Hughes – Computer graphics principles & practices, Pearson Education – 2003.
5. David F. Rogers, James Alan Adams " Mathematical elements for computer graphics" second edition, Tata McGraw-Hill edition.

PD7102 QUALITY CONCEPTS IN PRODUCT DEVELOPMENT L T P C
3 0 0 3

OBJECTIVE:

To impart knowledge on various principles of implementing quality in a product or service through tools such as quality houses, control charts, statistical process control method, failure mode effect analysis and various strategies of designing experiments, methods to uphold the status of six sigma and improve the reliability of a product.

OUTCOME:

It helps the design cum quality engineer to get familiarized with various concepts in quality and reliability principles in the design of an engineering product or a service.

UNIT I DESIGN FOR QUALITY 9

Quality-Objectives and functions-Targets- Measures and Matrices-Design of Experiments –design process-Identification of control factors, noise factors, and performance metrics - developing the experimental plan- experimental design –testing noise factors- Running the experiments – Conducting the analysis-Selecting and conforming factor-Set points-reflecting and repeating.

UNIT II FAILURE MODES & EFFECT ANALYSIS 9

Basic methods: Refining geometry and layout, general process of product embodiment - Embodiment checklist- Advanced methods: systems modeling, mechanical embodiment principles-FMEA method- linking fault states to systems modeling

UNIT III DESIGN FOR SIX SIGMA 8

Basis of SIX SIGMA –Project selection for SIX SIGMA- SIX SIGMA problem solving- SIX SIGMA in service and small organizations - SIX SIGMA and lean production –Lean SIX SIGMA and services

UNIT IV DESIGN OF EXPERIMENTS 10

Importance of Experiments, Experimental Strategies, Basic principles of Design, Terminology, ANOVA, Steps in Experimentation, Sample size, Single Factor experiments - Completely Randomized design, Randomized Block design, Statistical Analysis, Multifactor experiments - Two and three factor full Factorial experiments, 2^K factorial Experiments, Confounding and Blocking designs, Fractional factorial design, Taguchi's approach - Steps in experimentation, Design using Orthogonal Arrays, Data Analysis, Robust Design- Control and Noise factors, S/N ratios

UNIT V STATISTICAL CONSIDERATION AND RELIABILITY 9

Frequency distributions and Histograms- Run charts –stem and leaf plots- Pareto diagrams-Cause and Effect diagrams-Box plots- Probability distribution-Statistical Process control–Scatter diagrams –Multivariable charts –Matrix plots and 3-D plots.-Reliability-Survival and Failure-Series and parallel systems-Mean time between failure-Weibull distribution

TOTAL: 45 PERIODS

REFERENCES:

1. Product Design Techniques in Reverse Engineering and New Product Development, KEVIN OTTO & KRISTIN WOOD, Pearson Education (LPE), 2001.
2. The Management and control of Quality-6th edition-James R. Evens, William M Lindsay Pub:son south-western(www.swlearning.com)
3. Fundamentals of Quality control and improvement 2nd edition, AMITAVA MITRA, Pearson Education Asia, 2002.
4. Montgomery, D.C., Design and Analysis of experiments, John Wiley and Sons, 2003.
5. Phillip J.Rose, Taguchi techniques for quality engineering, McGraw Hill, 1996.

PD7103 **INDUSTRIAL DESIGN** **L T P C**
3 0 2 4

OBJECTIVE:
To expose the students to the various aspects of Industrial Design so as to develop new products considering aesthetics, ergonomics, environment and other human factors.

OUTCOME:
Upon completion of the course, the students will be able to
- understand the importance of ergonomics in the design of new products
- learn the effect of biomechanics, biothermodynamics, bioenergetics on the design and development of new products
- understand the effects of other human factors

UNIT I INTRODUCTION 9
Definition – Human & Machine system – Manual; Mechanical; Automated system, Input of Information - Auditory, Visual, Oral, Olfactory display & Communication. Human Output and Control – Physical work, Manual material handling, Physiological performance : Motor Skill, human control of systems, controls & data entry devices, hand tools & devices.

UNIT II WORK PLACE AND EQUIPMENT DESIGN 9
Applied anthropometry, Workspace design and seating, arrangement of components within a physical space, interpersonal aspects of work place design, and design of repetitive task, design of manual handling activity task, work capacity, stress, and fatigue. Design of Equipment : Ergonomic factors to be considered in the design of displays and control, design for maintainability, design of human computer interaction.

UNIT III ENVIRONMENTAL DESIGN 9
Vision and illumination design – Climate, Noise, Motion, Sound, Vibration.

UNIT IV BIOMECHANICS, BIOTHERMODYNAMICS, BIOENERGETICS 9
Biostatic mechanics, statics of rigid bodies, upper extremity of hand, lower extremity and foot, bending, lifting and carrying, biodynamic mechanics, human body kinematics, kinetics, impact and collision, human activity analysis, ergonomic tools, RULA, REBA, NOISH lifting equation - Bio-thermal fundamentals, human operator heat transfer, human system bioenergetics, thermoregulatory physiology, human operator thermo regularity, passive operator, active operator, heat stress.

UNIT V COGNITIVE ERGONOMICS & HUMAN FACTOR APPLICATION 9
Information Theory Information processing, Signal detection theory, Human response, human errors, cognitive task analysis. Human factors applications : Human error, accidents, human factors and the automobile, organizational and social aspects, steps according to ISO.DIS6385, OSHA's approach, virtual environments.

T= 30, TOTAL: 75 PERIODS

REFERENCES

1. Chandler Allen Phillips, "Human Factors Engineering", John Wiley and sons, New York, 2000
2. Mark S Sanders, "Human Factors in Engineering and Design", McGraw Hill, New York, 1993.
3. Bridger R S, "Introduction to Ergonomics", Taylor and Francis, London, 2003.
4. MeCormik, J., Human Factors Engineering and Design, McGraw Hill, 1992.
5. Martin Helander, A guide to Human Factors and Ergonomics, 2nd Edition, CRC, Taylor & Francis Group 2006.

PD7111 **CAD AND CAM LABORATORY** **L T P C**
0 0 2 1

OBJECTIVE:

- To impart knowledge on how to prepare drawings for various mechanical components using any commercially available 3D modeling software's

OUTCOME:

- With laboratory classes, it helps the students to get familiarized with the computer applications in design and preparing drawings for various mechanical components.

- **CAD** Introduction.
- **Sketcher**
- **Solid modeling** –Extrude, Revolve, Sweep, etc and Variational sweep, Loft ,etc
- **Surface modeling** –Extrude, Sweep, Trim...etc and Mesh of curves, Free form etc
- **Feature manipulation** – Copy, Edit, Pattern, Suppress, History operations etc.
- **Assembly**-Constraints, Exploded Views, Interference check
- **Drafting**-Layouts, Standard & Sectional Views, Detailing & Plotting.

Exercises in Modeling and drafting of Mechanical Components - Assembly using Parametric and feature based Packages like PRO-E / SOLID WORKS /CATIA / NX etc

- Introduction to Rapid Prototyping – Conversion of PRT file to STL file -Slicing Software
- CNC Machines – Features, Tooling
- **CNC program** simulation in **FANUC/SINUMERIC** systems.
- CAD/CAM connection & DNC link.
- **Cutter path generation** for Planar machining, Surface Machining, Cavity machining, Fixed & variable contour machining, Drilling,Turning, tool&die and mould machining
- Practical in Production CNC **Machining & Turning Centres** and **Rapid Prototyping** Machine
- Post processing & CNC code Generation for advanced machining.

Exercises in tool path and NC code generation using software such as NX

TOTAL: 30 PERIODS

PD7112 **PRODUCT DATA ANALYSIS** **L T P C**
0 0 2 1

OBJECTIVE:

- To impart knowledge on the use of Finite Element Analysis software to solve various field problems in mechanical engineering to optimize and verify the design of machine elements.

OUTCOME:

Upon conclusion of this course the student will be able to

- Model and analyze various physical problems
- Select appropriate elements and give boundary conditions
- Solve structural, thermal, modal and dynamics problems.

Analysis of Mechanical Components – Use of FEA Packages like ANSYS/ NASTRAN etc., Exercises shall include analysis of

i) Machine elements under Static loads
ii) Thermal Analysis of mechanical systems
iii) Modal Analysis
iv) Machine elements under Dynamic loads
v) Non-linear systems

- Rapid Prototyping – Making RP component – Study on RP tooling

TOTAL: 30 PERIODS

ED7201 FINITE ELEMENT METHODS IN MECHANICAL DESIGN L T P C
3 1 0 4

OBJECTIVE:

To develop a thorough understanding of the basic principles of the finite element analysis techniques with an ability to effectively use the tools of the analysis for solving practical problems arising in engineering design

OUTCOME:

Upon understanding this course the students will be able to

- Understand how to mathematically model physical systems and solve using numerical techniques.
- Select appropriate element and boundary conditions for various 1D, 2D Boundary problems.
- Apply various solution techniques to solve Boundary value problems and Eigen value problems

UNIT I FINITE ELEMENT ANALYSIS OF ONE DIMENSIONAL PROBLEMS 11+3

Historical Background – Weighted Residual Methods - Basic Concept of FEM – Variational Formulation of B.V.P. – Ritz Method – Finite Element Modelling – Element Equations – Linear and Quadratic Shape functions – Bar, Beam Elements – Bars and beams of arbitrary orientation - Applications to Heat Transfer problems.

UNIT II FINITE ELEMENT ANALYSIS OF TWO DIMENSIONAL PROBLEMS 10+3

Basic Boundary Value Problems in two-dimensions – Triangular, quadrilateral, higher order elements – Poisson's and Laplace's Equation – Weak Formulation – Element Matrices and Vectors – Application to scalar variable problem

Introduction to Theory of Elasticity – Plane Stress – Plane Strain and Axisymmetric Formulation – Principle of virtual work – Element matrices using energy approach – Examples related to one-dimensional and two-dimensional problems.

UNIT III ISO-PARAMETRIC FORMULATION 8+3

Natural Co-ordinate Systems – Lagrangian Interpolation Polynomials – Isoparametric Elements – Formulation – Numerical Integration – Gauss quadrature – one-, two- and three-dimensional triangular elements formulation – rectangular elements – Serendipity elements - Illustrative Examples.

UNIT IV SOLUTION TECHNIQUES 8+3

Inversion Method, Decomposition Method, Banded Solver method, Skyline procedure method, Band width reduction Techniques, Front width Methods, Free meshing and Mapped Meshing

UNIT V SPECIAL TOPICS 8+3

Dynamic Analysis – Equation of Motion – Mass & damping matrices – Free Vibration analysis – Natural frequencies of Longitudinal, Transverse and torsional vibration – Introduction to transient field problems. Non-linear analysis. Use of softwares – h & p elements – special element formulation – Solution techniques – Explicit & Implicit methods

T= 15, TOTAL: 60 PERIODS

NOTE

At the post-graduate level of instruction the contact hours are to be supplemented by self study by students. As for the examination, modelling considerations, choice of elements, boundary conditions, loading conditions, and basic procedures only need to be emphasized without expecting a complete numerical solution to practical problems.

REFERENCES:

1. *Zienkiewicz.O.C, Taylor.R.L,& Zhu,J.Z "The Finite Element Method: Its Basis & Fundamentals", Butterworth-Heinemann (An imprint of Elsevier), First printed in India 2007, India Reprint ISBN:978-81-312-1118-2, published by Elsevier India Pvt. Ltd., New Delhi.

2. **Cook, R.D., Malkus, D. S., Plesha,M.E., and Witt,R.J " Concepts and Applications of Finite Element Analysis", Wiley Student Edition, 4th Edition, First Reprint 2007, Authorized reprint by Wiley India(P) Ltd., New Delhi, ISBN-13 978-81-265-1336-9
3. *** Zienkiewicz.O.C, Taylor.R.L "The Finite Element Method" McGraw Hill International Editions, Fourth Edition, 1991, Volume 2 (Chapters 7&8)
4. Reddy, J.N., "Introduction to Non-Linear Finite Element Analysis", Oxford Uniiversity Press, 2008
5. Rao,S.S., "The Finite Element Method in Engineering", Butterworth-Heinemann(An imprint of Elsevier), reprinted 2006,2007, Published by Elsevier India Pvt. Ltd., New Delhi, Indian Reprint ISBN: 978-81-8147-885-6
6. Huebner,K.H., Dewhirst,D.L.,Smith,D.E & Byron,T.G., "The Finite Element Method for Engineers", Wiley Student Edition, Fourth Edition 2004,John Wiley&Sons (Asia)Pve.Ltd., ISBN: 9812-53-154-8
7. Ramamurthi, V., "Finite Element Method in Machine Design", Narosa Publishing House, January 2009, ISBN: 978-81-7319-965-3

PD7201 INTEGRATED PRODUCT DESIGN AND PROCESS DEVELOPMENT** L T P C 3 1 0 4**

OBJECTIVE

The course aims at providing the basic concepts of product design, product features and its architecture so that student can have a basic knowledge in the common features a product has and how to incorporate them suitably in product.

OUTCOME:

On completion of the course the student will be able to

- understand the integration of customer requirements in product design
- Apply structural approach to concept generation, selection and testing
- Understand various aspects of design such as industrial design , design for manufacture , economic analysis and product architecture

UNIT I INTRODUCTION 8

Need for IPPD-Strategic importance of Product development - integration of customer, designer, material supplier and process planner, Competitor and customer - behavior analysis. Understanding customer-promoting customer understanding-involve customer in development and managing requirements - Organization process management and improvement

UNIT II CONCEPT GENERATION, SELECTION AND TESTING 10

Plan and establish product specifications. Task - Structured approaches - clarification - search-externally and internally-Explore systematically - reflect on the solutions and processes - concept selection - methodology - benefits. Implications - Product change - variety - component standardization - product performance - manufacturability – Concept Testing Methodologies.

UNIT III PRODUCT ARCHITECTURE 8

Product development management - establishing the architecture - creation - clustering - geometric layout development - Fundamental and incidental interactions - related system level design issues - secondary systems -architecture of the chunks - creating detailed interface specifications-Portfolio Architecture.

UNIT IV INDUSTRIAL DESIGN 8

Integrate process design - Managing costs - Robust design - Integrating CAE, CAD, CAM tools – Simulating product performance and manufacturing processes electronically - Need for industrial design-impact – design process - investigation of customer needs - conceptualization - refinement - management of the industrial design process - technology driven products - user - driven products - assessing the quality of industrial design.

UNIT V DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT 11

Definition - Estimation of Manufacturing cost-reducing the component costs and assembly costs – Minimize system complexity - Prototype basics - Principles of prototyping - Planning for prototypes - Economic Analysis - Understanding and representing tasks-baseline project planning - accelerating the project-project execution.

T= 15, TOTAL: 60 PERIODS

****a Term Project/Presentation must be given for Assessment – 3 (Compulsory)**

TEXT BOOK

1. Product Design and Development, Karl T.Ulrich and Steven D.Eppinger, McGraw –Hill International Edns.1999

REFERENCES:

1. Concurrent Engg./Integrated Product Development. Kemnneth Crow, DRM Associates, 6/3,ViaOlivera, Palos Verdes, CA 90274(310) 377-569,Workshop Book
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. www.me.mit/2.7444

PD7202 PRODUCT AND PROCESS ENGINEERING TOOL L T P C
3 0 0 3

OBJECTIVES

To study about the tools used for concept development, optimization, design verification, process improvement and process control, bench marking and project management.

OUTCOME:

On completion of the course the student will be able to

- understand and apply the various tools used for design development analysis and optimization.
- Learn about the various methodology for process improvement
- Use various statistical process control methods and control charts
- Appreciate the need for bench marking and project management

UNIT I TOOLS FOR CONCEPT DEVELOPMENT 9

Products division, Quality function Deployment, concept engineering –Tools for Design Development: design failure mode and design analysis, Reliability prediction- Tools for Design Optimization: The Taguchi Loss Function, Optimizing Reliability- Tools for Design Verification: Reliability Testing.

UNIT II TOOLS FOR PROCESS IMPROVEMENT 9

Process improvement methodologies, The Deming Cycle-FADE-Basic tools for process improvement: flow charts, run charts and control charts, check sheets, histograms, Pareto diagrams, Cause and Effect Diagrams-Scatter Diagrams-Other tools for process improvement: Kaizen Blitz, Poka-yoke (mistake proofing), process simulation-Engaging the work force in process improvement.

UNIT III STATISTICAL PROCESS CONTROL 9

Quality control measurements-SPC Methodology-Process capacity evaluation- Control charts for variables data-Special Control charts for variables data- Process Capability Evaluation- Control Charts for Attributes- Summary of control charts construction chart, np-charts,c& u charts – Designing control charts: sampling , size, frequency-SPC,ISO 9000:2000, AND SIX SIGMA-Pre control- Measurement system Evaluation.

UNIT IV BENCHMARKING AND ESTABLISHING ENGINEERING SPECIFICATIONS 9

A Benchmarking Approach – Support tools for the benchmarking process: intended assembly cost analysis, form diagram, trend analysis- Setting product specifications: Basic & Advanced method.

UNIT V PROJECT MANAGEMENT 9

Understanding and representing tasks: Tasks, charts- Baseline project planning –Accelerating projects-project execution- Postmortem execution.

TORAL: 45 PERIODS

TEXT BOOK:

1. Product Design & Development, KARL T. ULRICH, STEVEN D. EPPINGER, TATA McGRAW-HILL- 3rd Edition, 2003

REFERENCES:

1. Product Design Techniques in Reverse Engineering and New Product Development, KEVIN OTTO & KRISTIN WOOD, Pearson Education (LPE), 2001.
2. The Management and control of Quality-6th edition-James R. Evens, William M Lindsay Pub:son south-western(www.swlearning.com)

PD7203 MATERIALS FOR PRODUCT DESIGN L T P C
3 1 0 4

OBJECTIVES

To expose the students to the material aspects of Product design, Process modeling, design for assembly and new material processing techniques.

OUTCOME:

On completion of the course the student will be able to

- understand the behavior of various metals and non-metals
- Learn about the selection of material for different applications
- Appreciate design for assembly
- Get exposure to the manufacturing processes in micro fabrication

UNIT I MATERIAL BEHAVIOR AND SELECTION 12

Elastic and Plastic deformation- Mechanism of Plastic deformation-yield stress and shear strength- Perfect and Real crystals- Effect of strain rate and temperature on plastic behaviour- Super plasticity- Deformation of non crystalline materials- Material selection- Cost and service requirement- Recycling- Selection of material for mechanical properties- Strength, toughness and fatigue- Material selection for durability and surface wear and Corrosion resistance- Functional relation between materials and processing- Manufacturing characteristics of metals- Material selection charts and other aids- material selection for aero, auto and nuclear application-Structural Product analysis-End Use behavior – Tooling in product design- Case studies in material selection .

UNIT II PROCESS MODELING AND PRODUCT DESIGN 9

Methods of analysis- Slab, slip line and upper bound solutions- Numerical methods- Effect of Friction- Contact problem- Basic analysis of process- Forging, Drawing and sheet metal forming- machining- Turning- modern materials- micro alloyed and dual phase steel- High strength low alloy metals- Smart materials- Shape memory metals- Metallic Glasses- Nano Materials- Metal foams- Properties and applications for product design.

UNIT III NON METALS AND MANUFACTURING 9

General properties and its importance of polymers- Thermal and electrical properties- mechanical properties- Criteria for selection- Composite materials- fibers- Boron, glass, carbon, organic- Ceramic and metallic fibres- - Matrix materials- Polymer, metal and ceramics- properties and applications- Manufacturing methods of plastic products-Injection and blow moulding –Rotational moulding-Compression moulding-Transfer moulding- layering of composites

UNIT IV PRODUCT DESIGN AND ASSEMBLY REQUIREMENTS 8

Structural product analysis- End use behaviour- Effect of tooling in product design- Design for joining and assembling- Design for live hinges- Snap fits, design of corners, bushes and ribs- Design considerations- New product design-Methods of decoration- Bonding and cementing techniques- Thermal bonding- Machining of plastics- Parameters and effect- Case studies in material selection with relevance to product design and development

UNIT V DEVELOPMENT IN MATERIALS PROCESSING 7

Micro fabrication technologies- Tool for micro fabrication- Diamond and high speed machining- LIGA micro fabrication process- Multilayer X-ray lithography- Wire bonding packaging- Etching- Wet and dry etching techniques- Typical application

T= 15, TOTAL: 60 PERIODS

****a Term Project must be given for Assessment – 3 (Compulsory)**

TEXT BOOK

1. SeropeKalpakjian and Schmid- Manufacturing process for Engineering materials Pearson- 2005.

REFERENCES

1. Paul Degarmo, Black and Kohsher- Materials and processes in Manufacturing- Wiley Student Edition- 9th Edition- 2005
2. Sami Franssile- Introduction to Micro Fabrication- John Wiley and Sons-UK 2004
3. HarfoldBelofsky- Plastic design and processing hand book, Hanser publication- 2005
4. Beck- Plastic Product Design- van NostrandReignhold 2nd Edition
5. Asbhay, Selection of Materials, El Sevier Publications, 2006

PD7211 DESIGN PROJECT L T P C
0 0 3 2

OBJECTIVES:

- The main objective is to give an opportunity to the student to achieve integrated mechanical design of a product through parts design assembly preparation of manufacturing drawings.

GUIDELINE FOR REVIEW AND EVALUATION

Each students works under a project supervisor. The product system /component(s) to be designed may be decided in consultation with the supervisor and if possible with an industry. A project report to be submitted by the student which will be reviewed and evaluated for internal assessment by a Committee constituted by the Head of the Department. At the end of the semester examination the project work is evaluated based on oral presentation and the project report jointly by external and internal examiners

TOTAL : 45 PERIODS

OUTCOMES:

- Use of design principles and develop conceptual and engineering design of any components.
- Ability to integrate the parts design with assembly and ability to prepare manufacturing drawings.

PD7212 NEW PRODUCT DESIGN STUDIO LABORATOY L T P C
0 0 2 1

OBJECTIVE:

- To impart knowledge on the use of various media such as clay, wood and RP techniques for development of prototypes

OUTCOME:

Upon conclusion of this course the student will be able to

- appreciate the use of physical prototype models for evaluating product concept
- apply theoretical knowledge to design and development of physical products using clay, wood, sheet metal and RP techniques

The students in a group have to develop digital and physical prototype models using RP machine / clay models of a new product/ existing product with enhanced feature involving the following areas:

- Automotive components
- Tool and die components
- Press tool components
- Consumer product
- Injection moulded products.

The fabricated models may be in the form of RP models, clay models, sheet metal models or card-board models etc… The design and development of the product will be reviewed in two stages for awarding internal marks. The end semester examination mark will be based on the demonstration of the new product developed and oral examination on the same by internal examiners.

TOTAL: 30PERIODS

PD7301 MARKETING RESEARCH (Compulsory Elective) L T P C
3 0 0 3

OBJECTIVE:

To provide the student with an overview of marketing research techniques. At the end of this course the student will gain a fundamental knowledge marketing research and its application in the front end of product development.

RECOMMENDED:

Students should be encouraged to have hands on experience on the use of any of the software packages like SPSS, SAS, etc.

UNIT I INTRODUCTION TO MARKETING RESEARCH 9

Introduction – definition of marketing research – classification of MR –MR process –role of MR in decision making – defining the problem – developing an approach – Research design- definition – classification –exploratory research –descriptive research – causal research –potential sources of error –research proposal

UNIT II EXPLORATORY RESEARCH DESIGN 9

Exploratory research– primary and secondary data –classification of secondary data –sources of secondary data – qualitative research – primary data –classification of qualitative research procedures- focus groups –advantages & disadvantages –depth interviews – projective techniques –analysis of qualitative data- Descriptive research design – survey methods –observations- causal research design – experimentation

UNIT III MEASUREMENT AND SCALING 9

Measurement and scaling –scale characteristics and levels of measurement –comparative scales – paired comparison, rank order, constant sum- non-comparative scales- continuous rating, itemized rating-questionnaire and form design –sampling design –sampling techniques – non-probability and probability techniques-sample size determination- sampling distribution-confident interval approach

UNIT IV FREQUENCY DISTRIBUTION 9

Data analysis – univariate techniques- multivariate techniques –frequency distribution- measures of location- measures of variability- measures of shape- hypothesis testing-cross tabulations- Chi-square distribution- hypothesis testing related to differences-parametric tests- nonparametric tests-analysis software

UNIT V DATA ANALYSIS 9

Analysis of variance and covariance- one way analysis of variance – analysis of covariance-correlation and regression- product moment correlation- partial correlation- regression analysis-bivariate regression- basic concepts of cluster analysis-very brief introduction to multi-dimensional scaling and conjoint analysis **(not for examination purposes)**

TOTAL: 45 PERIODS

REFERENCE BOOKS

1. Naresh K.Malhotra, Satyabhushan Dash, "Marketing Research: An Applied Orientation",6th Edition, Pearson, ISBN 978-81-317-3181-9
2. Donald S.Tull, Del I.Hawkins, "Marketing Research: Measurement and Method",6th Edition,Eastern Economy Edition, Prentice Hall India, ISBN-978-81-203-0961-6
3. Paul E.Green, Donald S.Tull, Gerald Albaum, "Research for Marketing Decisions", Eastern Economy Edition,5th Edition, Prentice Hall India, ISBN-978-81-203-0757-5

PD7001 CREATIVITY IN DESIGN L T P C

3 0 0 3

OBJECTIVE:

- To highlight the importance of creativity for new product development and impart the skills needed for enhancing creative thinking and encouraging innovation.

OUTCOME:

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

- understand the various techniques adopted for stimulating creativity and innovation
- apply the techniques to the design and development of new products

UNIT I INTRODUCTION 4

Need for design creativity – creative thinking for quality – essential theory about directed creativity –

UNIT II MECHANISM OF THINKING AND VISUALIZATION 11

Definitions and theory of mechanisms of mind heuristics and models : attitudes, Approaches and Actions that support creative thinking - Advanced study of visual elements and principles- line, plane, shape, form, pattern, texture gradation, color symmmetry.Spatial relationships and compositions in 2 and 3 dimensional space - procedure for genuine graphical computer animation – Animation aerodynamics – virtual environments in scientific Visualization – Unifying principle of data management for scientific visualization – Unifying principle of data management for scientific visualization - Visualization benchmarking

UNIT III CREATIVITY 11

Methods and tools for Directed Creativity – Basic Principles – Tools of Directed Creativity – Tools that prepare the mind for creative thought – stimulation of new ideas – Development and Actions: -

Processes in creativity ICEDIP – Inspiration, Clarification, Distillation, Perspiration, Evaluation and Incubation – Creativity and Motivation The Bridge between man creativity and the rewards of innovativeness – Applying Directed Creativity to the challenge of quality management

UNIT IV DESIGN 9

Process Design, Emotional Design – Three levels of Design – Viceral, Behavioral and Reflective-Recycling and availability-Creativity and customer needs analysis – Innovative product and service designs, future directions in this application of creativity thinking in quality management

UNIT V INNOVATION 10

Achieving Creativity – Introduction to TRIZ methodology of Inventive Problem Solving - the essential factors – Innovator's solution – creating and sustaining successful growth – Disruptive Innovation model – Segmentive Models – New market disruption - Commoditation and DE-commoditation – Managing the Strategy Development Process – The Role of Senior Executive in Leading New Growth – Passing the Baton

TOTAL: 45 PERIODS

REFERENCES

1. Rousing Creativity: Think New NowFloydHurr, ISBN 1560525479, Crisp Publications Inc. 1999
2. Geoffrey Petty," how to be better at Creativity", The Industrial Society 1999
3. Donald A. Norman," Emotional Design", Perseus Books Group New York , 2004
4. Clayton M. Christensen Michael E. Raynor," The Innovator's Solution", Harvard Business School Press Boston, USA, 2003
5. Semyon D. Savransky," Engineering of Creativity – TRIZ", CRC Press New YorkUSA," 2000

PD7002 ENTERPRISE RESOURCE PLANNING L T P C
3 0 0 3

OBJECTIVE:

- To impart to students the basic concepts of Enterprise Resource Planning and its role in improving the business dynamics

OUTCOME:

Upon completion of the course, the students will be able

- To provide an integrated view of the various facets of business, including planning, manufacturing, sales, finance and marketing.
- To understand the development of software to integrate business activities such as inventory management and control, order tracking, customer service, finance and human resources.
- To become aware of the software applications and tools that are available to business to use to drive out costs and improve efficiency.

UNIT I ENTERPRISE RESOURCE PLANNING 10

Principle – ERP framework – BusinessBlue Print – Business Engineeringvs Business process Re-Engineering – Tools – Languages – Value chain – Supply and Demand chain – Extended supply chain management – Dynamic Models –Process Models

UNIT II TECHNOLOGY AND ARCHITECTURE 10

Client/Server architecture – Technology choices – Internet direction – Evaluation framework – CRM – CRM pricing – chain safety – Evaluation framework.

UNIT III ERP SYSTEM PACKAGES 10

SAP,.People soft, Baan and Oracle – Comparison – Integration of different ERP applications – ERP as sales force automation – Integration of ERP and Internet – ERP Implementation strategies – Organisational and social issues.

UNIT IV **7**

Overview – Architecture – AIM – applications – Oracle SCM. SAP : Overview – Architecture – applications -Before and after Y2k – critical issues – Training on various modules of IBCS ERP Package-Oracle ERP and MAXIMO, including ERP on the NET

UNIT V ERP PROCUREMENT ISSUES **8**

Market Trends – Outsourcing ERP – Economics – Hidden Cost Issues – ROI – Analysis of cases from five Indian Companies.

TOTAL: 45 PERIODS

REFERENCES:

1. Sadagopan.S , ERP-A Managerial Perspective, Tata Mcgraw Hill, 1999.
2. Jose Antonio Fernandez , The SAP R/3 Handbook, Tata Mcgraw Hill, 1998.
3. Vinod Kumar Crag and N.K.Venkitakrishnan ,Enterprise Resource Planning –Concepts and Practice, Prentice Hall of India, 1998.
4. ERPWARE , ERP Implementation Framework, Garg&Venkitakrishnan, Prentice Hall, 1999.
5. Thomas E Vollmann and BeryWhybark , Manufacturing and Control Systems, Galgothia Publications, 1998.

ED7004 DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS **L T P C**
3 0 0 3

OBJECTIVE:

- To impart students on the science, use and application of hydraulics and pneumatics as fluid power in Industry. Also to impart knowledge on the methodology of basic and advanced design of pneumatics and hydraulics systems.

OUTCOME:

- It helps students to get knowledge on the need, use and application of fluid power and make them familiar to industrial design that lead to automation.

UNIT I OIL HYDRAULIC SYSTEMS AND HYDRAULIC ACTUATORS **5**

Hydraulic Power Generators – Selection and specification of pumps, pump characteristics. Linear and Rotary Actuators – selection, specification and characteristics.

UNIT II CONTROL AND REGULATION ELEMENTS **12**

Pressure - direction and flow control valves - relief valves, non-return and safety valves - actuation systems.

UNIT III HYDRAULIC CIRCUITS **5**

Reciprocation, quick return, sequencing, synchronizing circuits - accumulator circuits - industrial circuits - press circuits - hydraulic milling machine - grinding, planning, copying, - forklift, earth mover circuits- design and selection of components - safety and emergency mandrels.

UNIT IV PNEUMATIC SYSTEMS AND CIRCUITS **16**

Pneumatic fundamentals - control elements, position and pressure sensing - logic circuits - switching circuits - fringe conditions modules and these integration - sequential circuits - cascade methods - mapping methods - step counter method - compound circuit design - combination circuit design.

UNIT V INSTALLATION, MAINTENANCE AND SPECIAL CIRCUITS **7**

Pneumatic equipments- selection of components - design calculations – application -fault finding - hydro pneumatic circuits - use of microprocessors for sequencing - PLC, Low cost automation - Robotic circuits.

TOTAL: 45 PERIODS

REFERENCES:

1. Antony Espossito, “Fluid Power with Applications”, Prentice Hall, 1980.
2. Dudleyt, A. Pease and John J. Pippenger, “Basic fluid power”, Prentice Hall, 1987.

3. Andrew Parr, “Hydraulic and Pneumatics” (HB), Jaico Publishing House, 1999.
4. Bolton. W., “Pneumatic and Hydraulic Systems “, Butterworth –Heinemann, 1997.
5. K.Shanmuga Sundaram, “Hydraulic and Pneumatic Controls: Understanding made Easy" S.Chand & Co Book publishers, New Delhi, 2006 (Reprint 2009)

ED7001 OPTIMIZATION TECHNIQUES IN DESIGN L T P C
3 0 0 3

OBJECTIVE:
To impart knowledge on various categories of existing engineering problems and solutions to such problems through different optimization techniques and approaches.

OUTCOME:
It helps the engineers to get familiarized with the different approaches of optimizing (maximizing or minimizing) an engineering problem or a function which is essentially required in industries today.

UNIT I UNCONSTRAINED OPTIMIZATION TECHNIQUES 10
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.

UNIT II CONSTRAINED OPTIMIZATION TECHNIQUES 10
Optimization with equality and inequality constraints - Direct methods – Indirect methods using penalty functions, Lagrange multipliers - Geometric programming

UNIT III ADVANCED OPTIMIZATION TECHNIQUES 10
Multi stage optimization – dynamic programming; stochastic programming; Multi objective optimization, Genetic algorithms and Simulated Annealing techniques; Neural network & Fuzzy logic principles in optimization.

UNIT IV STATIC APPLICATIONS 8
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.

UNIT V DYNAMIC APPLICATIONS 7
Dynamic Applications – Optimum design of single, two degree of freedom systems, vibration absorbers. Application in Mechanisms – Optimum design of simple linkage mechanisms.

TOTAL: 45 PERIODS

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.

CM7001 ADDITIVE MANUFACTURING L T P C
3 0 0 3

OBJECTIVE:

- To educate students with fundamental and advanced knowledge in the field of Additive manufacturing technology and the associated Aerospace, Architecture, Art, Medical and industrial applications.

OUTCOME:

- On completion of this course, they will learn about a variety of Additive Manufacturing (AM) technologies, their potential to support design and manufacturing, case studies relevant to mass customized manufacturing, and some of the important research challenges associated with AM and its data processing tools

UNIT I INTRODUCTION: 8

Need - Development of AM systems – AM process chain - Impact of AM on Product Development - Virtual Prototyping- Rapid Tooling – RP to AM -Classification of AM processes-Benefits-Applications.

UNIT II REVERSE ENGINEERING AND CAD MODELING: 10

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, Model Slicing, Tool path generation-Software for AM- Case studies.

UNIT III LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS: 10

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

Solid Ground Curing (SGC): working principle, process, strengths, weaknesses and applications. Fused deposition Modeling (FDM): Principle, details of processes, process variables, types, products, materials and applications. Laminated Object Manufacturing (LOM): Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies.

UNIT IV POWDER BASED ADDITIVE MANUFACTURING SYSTEMS: 10

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

UNIT V OTHER ADDITIVE MANUFACTURING SYSTEMS 7

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. Shape Deposition Manufacturing (SDM), Ballastic Particle Manufacturing (BPM), Selective Laser Melting, Electron Beam Melting.

TOTAL: 45 PERIODS

REFERENCES

1. Gibson, I., Rosen, D.W. and Stucker, B., “Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing”, Springer, 2010.
2. Chua, C.K., Leong K.F. and Lim C.S., “Rapid prototyping: Principles and applications”, second edition, World Scientific Publishers, 2010.
3. Gebhardt, A., “Rapid prototyping”, Hanser Gardener Publications, 2003.
4. Liou, L.W. and Liou, F.W., “Rapid Prototyping and Engineering applications : A tool box for prototype development”, CRC Press, 2011.
5. Kamrani, A.K. and Nasr, E.A., “Rapid Prototyping: Theory and practice”, Springer, 2006.
6. Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications, CRC press, 2005.

PD7003 **DESIGN PARADIGM** **L T P C**
3 0 0 3

OBJECTIVE:

- To impart knowledge on the various design methodologies for manufacture and assembly, value engineering and the economics of product development

OUTCOME:

Upon completion of the course, the students will be able

- To gain an exposure to the interrelation between design and manufacture.
- To understand the various design aspects to be considered for manufacturing the products using different processes.

UNIT I DESIGN FOR MANUFACTURE 8

General design principles for manufacturability - strength and mechanical factors, mechanisms selection, evaluation method, Process capability - Feature tolerances - Geometric tolerances - Assembly limits – Datum features - Tolerance stacks.

UNIT II FORM DESIGN OF CASTINGS AND WELDMENTS 9

Redesign of castings based on parting line considerations - Minimizing core requirements - Redesigning a cast members using weldments-factors influencing form design-Working principle, Material, Manufacture, Design - Possible solutions - Materials choice - Influence of materials-on from design - form design of welded members, forgings and castings.

UNIT III DESIGN FOR ASSEMBLY 6

Assembly processes-Handling and insertion process-Manual ,automatic and robotic assembly-Cost of Assembly-Number of Parts-DFA guidelines

UNIT IV VALUE ENGINEERING 12

Value –types –functional –operational –aesthetic –cost- –material – Design process – value and worthiness –procedure -brainstorming sessions –evaluation –case studies –value estimation-Value analysis - Design for value - Selection of alternatives - optimization – Implementation

UNIT V PRODUCT DEVELOPMENT ECONOMICS 10

Elements of Economics analysis-Quantitative and qualitative analysis-Economic Analysis process-Estimating magnitude and time of future cash inflows and out flows-Sensitivity analysis-Project trade-offs-Trade-offs rules-Limitation of quantitative analysis-Influence of qualitative factors on project success

TOTAL :45 PERIODS

TEXT BOOK:

1.Harry Peck, Designing for Manufacture, Pitman Publications, 1983.
2. George E Dieter, Engineering Design,McGraw-Hill Int Editions, 2000

REFERENCES

1. S.S.Iyer ,Value Engineering, New Age International, 2000
2. Charles E. Ebeling, Reliability and Maintainability Engineering, , TMH, 2000

PD7004 MICRO ELECTRO MECHANICAL SYSTEMS L T P C
3 0 0 3

OBJECTIVE:
To impart knowledge to the students about the design and fabrication of Micro Electro Mechanical systems used in various products (MEMS).

OUTCOME:
Upon completion of the course, the students will be able to
- select the suitable manufacturing processes for MEMS
- adopt suitable strategies for the production and integration with sensors for MEMS.

UNIT I INTRODUCTION 8
Introduction, Materials-substrates, Additive materials. Fabrication techniques-Deposition, Lithography, etching, Surface micro machining, Thick film screen-printing and electroplating

UNIT II MECHANICAL SENSOR PACKAGING 8
Introduction, Standard IC packages-ceramic, plastic and metal packages. Packaging process-Electrical interconnects, Methods of die attachment, sealing techniques. MEMS mechanical sensor packaging

UNIT III MECHANICAL TRANSDUCTION TECHNIQUES 9
Piezo resistivity, Piezoelectricity, Capacitive Techniques, Optical techniques, Resonant techniques. Actuation techniques, Smart Sensors.MEMS Simulation and Design tools-Behavioral model ling simulation tools and Finite element simulation tools.

UNIT IV PRESSURE SENSORS 12
Introduction.Techniques for sensing.Physics of pressure sensing-Pressure sensor specifications.Dynamic pressure sensing.Pressure sensor types. MEMS technology pressure sensors-Micro machined silicon diaphragms,

UNIT V FORCE, TORQUE AND INERTIAL SENSORS 8
Introduction-Silicon based devices-Optical devices-capacitive devices-Magnetic devices-Atomic force microscope and scanning probes- micro machined accelerometer-Micro machined Gyroscope-Future inertial micro machined sensors

TOTAL:45PERIODS

TEXT BOOK:
1. Nadim Maluf and Kirt Williams,' An introduction to Micro electro mechanical System Engineering, Artech House, Inc. Boston.2003

REFERENCE
1. Stephen Beeby, Graham Ensell, Michael Kraft and Neil White,' MEMS Mechanical sensors' Artech House, Inc. Boston 2003

ED 7071 INDUSTRIAL ROBOTICS AND EXPERT SYSTEMS L T P C
3 0 0 3

OBJECTIVES:
- To teach students the basics of robotics, construction features, sensor applications, robot cell design, robot programming and application of artificial intelligence and expert systems in robotics.

OUTCOME:

- The student will be able to design robots and robotic work cells and write program for controlling the robots. The student will be able to apply artificial intelligence and expert systems in robotics.

UNIT I INTRODUCTION AND ROBOT KINEMATICS 10

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.

UNIT II ROBOT DRIVES AND CONTROL 9

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.

UNIT III ROBOT SENSORS 9

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.

UNIT IV ROBOT CELL DESIGN AND APPLICATION 9

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

UNIT V ROBOT PROGRAMMING, ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS 8

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.

TOTAL: 45 PERIODS

REFERENCES

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

ED7007 MODAL ANALYSIS OF MECHANICAL SYSTEMS L T P C
3 0 0 3

OBJECTIVE:
To impart knowledge on modal testing, modal analysis of single and multi- degree of freedom systems.

OUTCOME:
It helps the students to get familiarized with the modal testing, modal analysis of single and multi-degree of freedom systems.

UNIT I OVERVIEW 6
Introduction to Modal Testing – Applications of Modal Testing – Philosophy of Modal Testing – Summary of Theory – Summary of Measurement Methods – Summary of Analysis – Review of Test Procedure.

UNIT II THEORETICAL BASIS 12
Introduction – Single Degree of Freedom (SDOF) System Theory – Presentation and Properties of FRF Data for SDOP System – Undamped Multi-degree of freedom (MDOF) system – Proportional Damping – Hysteretic Damping – General Case – Viscous Damping – General Case – Characteristics and presentation of MDOF – FRF Data – Complete and incomplete models - Non-sinusoidal vibration and FRF Properties – Analysis of Weakly Nonlinear Structures.

UNIT III MOBILITY MEASUREMENT TECHNIQUES 10
Introduction – Basic Measurement System – Structure preparation – Excitation of the Structure – Transducers and Amplifiers – Analyzers – Digital Signal Processing – Use of Different Excitation types – Calibration – Mass Cancellation – Rotational Mobility Measurement – Measurement on Non linear structures – Multi point excitation methods.

UNIT IV MODAL PARAMETER EXTRACTION METHODS 11
Introduction – Preliminary checks of FRF Data – SDOF Modal Analysis-I – Peak-amplitude – SDOF Modal Analysis-II – Circle Fit Method – SDOF Modal Analysis III – Inverse Method – Residuals – MDOF curve-fitting procedures – MDOF curve fitting in the Time Domain – Global or Multi-Curve fitting – Non linear systems.

UNIT V DERIVATION OF MATHEMATICAL MODELS 6
Introduction – Modal Models – Display of Modal Model – Response Models – Spatial Models – Mobility Skeletons and System Models.

TOTAL: 45 PERIODS

REFERENCES

1. Ewins D J, “Modal Testing: Theory and Practice “, John Wiley & Sons Inc., 1988
2. Nuno Manuel Mendes Maia et al,” Theoretical and Experimental Modal Analysis”, Wiley John & sons, 1997.

CC7201 DESIGN FOR MANUFACTURE, ASSEMBLY AND ENVIRONMENTS L T P C
3 0 0 3

OBJECTIVE:
- To know the concept of design for manufacturing, assembly and environment.
- To know the computer application in design for manufacturing and assembly.

OUTCOME:
- To make the students get acquainted with the design for manufacturing, assembly and environment.

UNIT I INTRODUCTION 5

General design principles for manufacturability - strength and mechanical factors, mechanisms selection, evaluation method, Process capability - Feature tolerances Geometric tolerances - Assembly limits -Datum features - Tolerance stacks.

UNIT II FACTORS INFLUENCING FORM DESIGN 13

Working principle, Material, Manufacture, Design- Possible solutions - Materials choice - Influence of materials on form design - form design of welded members, forgings and castings.

UNIT III COMPONENT DESIGN - MACHINING CONSIDERATION 8

Design features to facilitate machining - drills - milling cutters - keyways - Doweling procedures, counter sunk screws - Reduction of machined area- simplification by separation - simplification by amalgamation - Design for machinability - Design for economy - Design for clampability - Design for accessibility - Design for assembly.

UNIT IV COMPONENT DESIGN – CASTING CONSIDERATION 10

Redesign of castings based on Parting line considerations - Minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design - Modifying the design - group technology - Computer Applications for DFMA

UNIT V DESIGN FOR THE ENVIRONMENT 9

Introduction – Environmental objectives – Global issues – Regional and local issues – Basic DFE methods – Design guide lines – Example application – Lifecycle assessment – Basic method – AT&T's environmentally responsible product assessment - Weighted sum assessment method – Lifecycle assessment method – Techniques to reduce environmental impact – Design to minimize material usage – Design for disassembly – Design for recyclability – Design for remanufacture – Design for energy efficiency – Design to regulations and standards.

TOTAL: 45 PERIODS

REFERENCES:

1. Boothroyd, G, 1980 Design for Assembly Automation and Product Design. New York, Marcel Dekker.
2. Bralla, Design for Manufacture handbook, McGraw hill, 1999.
3. Boothroyd, G, Heartz and Nike, Product Design for Manufacture, Marcel Dekker, 1994.
4. Dickson, John. R, and Corroda Poly, Engineering Design and Design for Manufacture and Structural Approach, Field Stone Publisher, USA, 1995.
5. Fixel, J. Design for the Environment McGraw hill., 1996.
6. Graedel T. Allen By. B, Design for the Environment Angle Wood Cliff, Prentice Hall. Reason Pub., 1996.
7. Kevien Otto and Kristin Wood, Product Design. Pearson Publication, 2004.

IC7072 COMPUTATIONAL FLUID DYNAMICS L T P C
3 0 0 3

AIM:

This course aims to introduce numerical modeling and its role in the field of heat and fluid flow, it will enable the students to understand the various discrimination methods and solving methodologies and to create confidence to solve complex problems in the field of heat transfer and fluid dynamics.

OBJECTIVES:

- To develop finite difference and finite volume discredited forms of the CFD equations.
- To formulate explicit & implicit algorithms for solving the Euler Eqns & Navier Stokes Eqns.

UNIT I GOVERNING DIFFERENTIAL EQUATION AND FINITE DIFFERENCE METHOD 10

Classification, Initial and Boundary conditions, Initial and Boundary value problems. Finite difference method, Central, Forward, Backward difference, Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test.

UNIT II CONDUCTION HEAT TRANSFER 10

Steady one-dimensional conduction, Two and Three dimensional steady state problems, Transient one-dimensional problem, Two-dimensional Transient Problems.

UNIT III INCOMPRESSIBLE FLUID FLOW 10

Governing Equations, Stream Function – Verticity method, Determination of pressure for viscous flow, SIMPLE Procedure of Patankar and spalding, Computation of Boundary layer flow, Finite difference approach.

UNIT IV CONVECTION HEAT TRANSFER AND FEM 10

Steady One-Dimensional and Two-Dimensional Convection – Diffusion, Unsteady one-dimensional convection – Diffusion, Unsteady two-dimensional convection – Diffusion – Introduction to finite element method – Solution of steady heat conduction by FEM – Incompressible flow – Simulation by FEM.

UNIT V TURBULENCE MODELS 5

Algebraic Models – One equation model, K - $\in$ Models, Standard and High and Low Reynolds number models, Prediction of fluid flow and heat transfer using standard codes.

TOTAL: 45 PERIODS

REFERENCES

1. Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 1995.
2. Ghoshdasdidar, P.S., "Computer Simulation of flow and heat transfer" Tata McGraw Hill Publishing Company Ltd., 1998.
3. Subas, V.Patankar "Numerical heat transfer fluid flow", Hemisphere Publishing Corporation, 1980.
4. Taylor, C and Hughes, J.B. "Finite Element Programming of the Navier Stock Equation", Pineridge Press Limited, U.K., 1981.
5. Anderson, D.A., Tannehill, J.I., and Pletcher, R.H., "Computational fluid Mechanic and Heat Transfer " Hemisphere Publishing Corporation, Newyork, USA, 1984.
6. Fletcher, C.A.J. "Computational Techniques for Fluid Dynamics 1" Fundamental and General Techniques, Springer – Verlag, 1987.
7. Fletcher, C.A.J. "Computational Techniques for Fluid Dynamics 2" Specific Techniques for Different Flow Categories, Springer – Verlag, 1987.
8. Bose, T.X., "Numerical Fluid Dynamics" Narosa Publishing House, 1997.

PD7005 REVERSE ENGINEERING L T P C
3 0 0 3

OBJECTIVE:

To impart knowledge to the students about the need for and the various tools required for reverse engineering with exposure to the software needed for implementing reverse engineering.

OUTCOME:

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

- Understand the basic principles of reverse engineering
- Select the suitable tools and methodology for reverse engineering any product

UNIT I INTRODUCTION 5

Scope and tasks of RE - Domain analysis- process of duplicating

UNIT II TOOLS FOR RE 8

Functionality- dimensional- developing technical data - digitizing techniques - construction of surface model - solid-part material- characteristics evaluation -software and application- prototyping - verification

UNIT III CONCEPTS 12

History of Reverse Engineering – Preserving and preparation for the four stage process – Evaluation and Verification- Technical Data Generation, Data Verification, Project Implementation

UNIT IV DATA MANAGEMENT 10

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

UNIT V INTEGRATION 10

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

TOTAL: 45 PERIODS

REFERENCES

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

PD7006 PRODUCT DESIGN FOR ENERGY AND ENVIRONMENT L T P C

3 0 0 3

OBJECTIVE:

- To expose the students to the design and development of sustainable products using emerging renewable sources of energy such as solar, wind and bio energy

OUTCOME:

Upon completion of the course, the students will be able

- To appreciate the need for energy efficient and environmental friendly products
- To use new and renewable energy sources for new product development
- To gain the knowledge about the standards and testing procedures

UNIT I INTRODUCTION 9

Energy and Environment - Scenario – Global and Indian perspectives – Necessity for promotion of Energy generation and Environment friendly products – Creativity and Innovation.

UNIT II SOLAR PRODUCTS – DESIGN AND DEVELOPMENT 9

Solar energy Conversion – Types, Solar Products – Solar water heater, Solar Lantern, Solar Cooker & storage devices (Solar PV modules, Battery, Charge Controller, Investors), Existing Designs, Avenues for Improvements, Creativity and Innovation – Eco-friendly concepts.

UNIT III BIO ENERGY PRODUCTS – DESIGN 9

Bio energy conversion – Types, Processes and Equipments, Existing Designs, Avenues for Improvements, Creativity and Innovation – Eco-friendly concepts.

UNIT IV TESTING 9

Standards and Procedures for Solar and Bio products - Design and Testing, Testing of Equipments, Safety standards, International standards and Indian scenario.

UNIT V ECONOMICS 9

Barriers involved in commercialization of Energy products, Factors under considerations - cost, payback, reliability, comfort factors, technical factors, Policy affairs.
Economics of solar and bio power generation, Quantitative and Qualitative Approach

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Garg H P., Prakash J, Solar Energy: Fundamentals & Applications, Tata McGraw Hill, 2000.
2. David Boyles, Bio Energy Technology Thermodynamics and costs, Ellis HooknoodChichester, 1984.

REFERENCES

1. Duffie J.A and Beckman W.A., solar Engineering of Thermal Processes, John Wiley & sons, 1991.
2. Roger Messenger and Jerry Vnetre, Photovoltaic Systems Engineering, CRC Press, 2004.
3. Khandelwal KC, Mahdi SS, Biogas Technology – A Practical Handbook, Tat McGraw Hill, 1986.

PD7007 INTELLECTUAL PROPERTY RIGHTS AND PATENT LAWS L T P C
3 0 0 3

OBJECTIVE:

- To impart the knowledge about the Intellectual property rights and patent registering

OUTCOME:

Upon completion of the course, the students will

- Understand the procedures involved in obtaining Patent Rights
- Understand the rules and regulations involved in Copyrights and Trade Marks and infringement of the same
- Be exposed to the legal issues involved in New Product development

UNIT I INTELLECTUAL PROPERTY (IP) FUNDAMENTALS 9

Introduction – Legal concept of Property – Kinds of properties - Movable Property - Immovable Property. IP and Classification of IP– Patents, Industrial Designs, Copy Right, Trade Mark - Importance of IP and Terms of protection

UNIT II PATENTS 12

Purpose of a Patent –Recognised conditions for Patentability – Originality of Inventions – Novelty – Non-obviousness – Utility. Exclusive rights conferred by a Patent – National Protection – International Protection. - Patent Filing Procedure and Prosecution - Infringement of Patents – Acquisition and Transfer of Patent Rights.

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UNIT III INDUSTRIAL DESIGNS 9

Subject matter of Industrial Designs - Requirements for obtaining protection for industrial Design – Differences between Patent protection and Industrial design Protection – benefits of Industrial Design protection – National and International Procedure for filing – Rights granted to ‘Design’ holders.

UNIT IV COPY RIGHT AND TRADEMARKS 9

Copyright subsists – Meaning of word 'Original' – Fair dealing - Rights of Owners of Copy Rights – Procedures - Authorities and Institutions under the Copy Right Act – Infringement and remedies.
Trademarks (TM) – Different types of Trade marks – Service Mark – Classification Mark – Collective Mark - Importance of TM – Difference between registered TM and TM in use – Basic requirements for the registration of TM – Procedure for registration – Rights of registered TM owners – Infringement and remedies

UNIT V INTELLECTUAL PROPERTY MANAGEMENT 6

Introduction to Intellectual Property Management (IPM) – Need for IP management - Interrelationships between legal advocacy and IPM – Role of Legal Practioners – Role of Managers – IP Commercialisation – IP Audit and its Importance

TOTAL: 45 PERIODS

TEXT BOOKS:

1. G.B.Reddy, "Intellectual Property Rights and the Law", Gogia Law Agency, 7th Edition - Reprint, 2009.
2. N.R.Subbaram, "Demystifying Intellectual Property Rights", Lexis NexisButterworthsWadhwa, First Edition, 2009

REFERENCES

1. N.R.Subbaram, "Patent law – Practices and Procedures", Wadhwa, Second Edition, 2007
2. N.S.Gopalakrishnan&T.G.Agitha, 'Principles of Intellectual Property", Eastern Book Company, First Edition, 2009

ED7010 TRIBOLOGY IN DESIGN L T P C
3 0 0 3

OBJECTIVE:

- To impart knowledge in the friction , wear and lubrication aspects of machine components
- To understand the material properties which influence the tribological characteristics of surfaces.
- To understand the analytical behavior of different types bearings and design of bearings based on analytical /theoretical approach

OUTCOME:

- Ability to select material / surface properties based on the tribological requirements
- Methodology for deciding lubricants and lubrication regimes for different operating conditions
- Analysis ability of different types of bearings for given load/ speed conditions.

UNIT I SURFACE INTERACTION AND FRICTION 7

Topography of Surfaces – Surface features-Properties and measurement – Surface interaction – Adhesive Theory of Sliding Friction –Rolling Friction-Friction properties of metallic and non-metallic materials – friction in extreme conditions –Thermal considerations in sliding contact

UNIT II WEAR AND SURFACE TREATMENT 8

Types of wear – Mechanism of various types of wear – Laws of wear –Theoretical wear models-Wear of Metals and Non metals – Surface treatments – Surface modifications – surface coatings methods- Surface Topography measurements –Laser methods – instrumentation - International standards in friction and wear measurements

UNIT III LUBRICANTS AND LUBRICATION REGIMES 8

Lubricants and their physical properties- Viscosity and other properties of oils –Additives-and selection of Lubricants- Lubricants standards ISO,SAE,AGMA, BIS standards – Lubrication Regimes –Solid Lubrication-Dry and marginally lubricated contacts- Boundary Lubrication-Hydrodynamic lubrication –– Elasto and plasto hydrodynamic - Magneto hydrodynamic lubrication – Hydro static lubrication – Gas lubrication.

UNIT IV THEORY OF HYDRODYNAMIC AND HYDROSTATIC LUBRICATION 12

Reynolds Equation,-Assumptions and limitations-One and two dimensional Reynolds Equation-Reynolds and Sommerfeld boundary conditions- Pressure wave, flow, load capacity and friction calculations in Hydrodynamic bearings-Long and short bearings-Pad bearings and Journal bearings-Squeeze film effects-Thermal considerations-Hydrostatic lubrication of Pad bearing-Pressure , flow , load and friction calculations-Stiffness considerations- Various types of flow restrictors in hydrostatic bearings

UNIT V HIGH PRESSURE CONTACTS AND ELASTO HYDRODYNAMIC LUBRICATION 10

Rolling contacts of Elastic solids**-** contact stresses – Hertzian stress equation- Spherical and cylindrical contacts-Contact Fatigue life- Oil film effects- Elasto Hydrodynamic lubrication Theory-Soft and hard EHL-Reynolds equation for elasto hydrodynamic lubrication- - Film shape within and outside contact zones-Film thickness and friction calculation- Rolling bearings- Stresses and deflections-Traction drives

TOTAL: 45 PERIODS

REFERENCES:

1. Rabinowicz.E, “Friction and Wear of materials”, John Willey &Sons ,UK,1995
2. Cameron, A. “Basic Lubrication Theory”, Ellis Herward Ltd., UK, 1981
3. Halling, J. (Editor) – “Principles of Tribology “, Macmillian – 1984.
4. Williams J.A. “Engineering Tribology”, Oxford Univ. Press, 1994.
5. S.K.Basu, S.N.Sengupta & B.B.Ahuja ,”Fundamentals of Tribology”, Prentice –Hall of India Pvt Ltd , New Delhi, 2005
6. G.W.Stachowiak & A.W .Batchelor , Engineering Tribology, Butterworth - Heinemann, UK, 2005

ED7013 ADVANCED FINITE ELEMENT ANALYSIS L T P C
3 0 0 3

OBJECTIVE:

To develop a thorough understanding of the advanced finite element analysis techniques with an ability to effectively use the tools of the analysis for solving practical problems arising in engineering design

OUTCOME:

- It helps the students to get familiarized with the advanced finite element analysis techniques which are necessary to solve the engineering problems.

UNIT I BENDING OF PLATES AND SHELLS 9

Review of Elasticity Equations – Bending of Plates and Shells – Finite Element Formulation of Plate and Shell Elements - Conforming and Non Conforming Elements – C_0 and C_1 Continuity Elements –Degenerated shell elements- Application and Examples.

UNIT II NON-LINEAR PROBLEMS 10

Introduction – Iterative Techniques – Material non-linearity – Elasto Plasticity – Plasticity – Visco Plasticity – Geometric Non linearity – large displacement Formulation –Solution procedure-Application in Metal Forming Process and Contact Problems.

UNIT III DYNAMIC PROBLEM 8

Direct Formulation – Free, Transient and Forced Response – Solution Procedures – Eigen solution-Subspace Iterative Technique – Response analysis-Houbolt, Wilson, Newmark – Methods – Explicit &Implict Methods- Lanchzos, Reduced method for large size system equations.

UNIT IV FLUID MECHANICS AND HEAT TRANSFER 9

Governing Equations of Fluid Mechanics – Solid structure interaction - Inviscid and Incompressible Flow – Potential Formulations – Slow Non-Newtonian Flow – Metal and Polymer Forming – Navier Stokes Equation – Steady and Transient Solution.

UNIT V ERROR ESTIMATES AND ADAPTIVE REFINEMENT 9

Error norms and Convergence rates – h-refinement with adaptivity – Adaptive refinement.

TOTAL: 45 PERIODS

REFERENCES

1. Zienkiewicz, O.C. and Taylor, R.L., "The Finite Element Method", Fourth Edition, Volumes 1 & 2, McGraw Hill International Edition, Physics Services, 1991.
2. Cook R.D., "Concepts and Applications of Finite Element Analysis", John Wiley and Sons Inc., Newyork, 1989.
3. Bathe K.J., "Finite Element Procedures in Engineering Analysis", Prentice Hall, 1990.

PD7008 MAINTENANCE ENGINEERING L T P C
3 0 0 3

OBJECTIVE:

- To impart knowledge on various aspects of Maintenance and condition monitoring of equipments and safety engineering.

OUTCOME:

Upon completion of the course, the students will

- Be exposed to maintenance systems and reliability based design
- Gain knowledge about the various techniques of condition monitoring of systems
- Learn about reliability based maintenance, safety engineering and Asset planning

UNIT I INTRODUCTION TO MAINTENANCE SYSTEMS 8

Introduction to repair and Maintenance -Maintenance as business - Maintenance systems such as reactive, preventive, predictive or proactive systems - Human resources management in Maintenance management -maintainability- Inherent and overall availability. - Mean time between failures, mean time to repairs and mean down time - Testability and supportability - "Design for Maintenance" - Poor maintainability aspects - Design for reliability.

UNIT II CONDITION BASED MAINTENANCE 7

Condition based monitoring of equipment and systems -condition monitoring techniques such as a) Vibration analysis, b) Ultrasonic detection techniques, c) Thermography, d) Oil and lubricant analysis, e) Motor condition monitoring (MCM) - Shaft alignments through laser - Vibration instruments -Outline on Thermography

UNIT III MAINTENANCE TECHNIQUES SUCH AS RELIABILITY CENTRED MAINTENANCE (RCM),TOTAL PRODUCTIVE MAINTENANCE (TPM) & CMMS 10

Reliability centered Maintenance-Failure Mode and Effect Analysis-Root cause Analysis- logic tree analysis-Criticality matrix - Total Productive Maintenance, Overall Equipment Effectiveness-Lean manufacturing- TPM and TPO- Relationship between OEE and world-class Maintenance- Ladder of Maintenance improvement- Computerized Maintenance management system in a business scenario- data acquisition for effective management of CMMS.

UNIT IV ASSET PLANNING AND SCHEDULING OF ACTIVITIES IN MAINTENANCE 10

Asset and spare part management, - Conventional spare Parts management techniques such as Economic Order Quantity, two bin systems - Latest trends in monitoring through bar codes, mobile

computer and wireless data transmissions -. Different aspects of planning and scheduling of Maintenance, such as shutdowns- Critical aspects of both routine and shut down Maintenance -. bar charts - PERT network during shut down -Man power Training and utilization of skilled manpower - Sequencing of activities.

UNIT V SAFETY AND OTHER ASPECTS OF MAINTENANCE FUNCTIONS 10

Safety Engineering. - Hazard analysis -General rules and guidelines in safety and hazard prevention - Analytical tools - Hazard analysis- Fault Tree Analysis - Sneak Circuit analysis - Integrated approach to Maintenance- Statistical distributions such as normal, gamma and "Weibull" in Maintenance- Maintenance effectiveness.

TOTAL: 45 PERIODS

TEXT BOOK:

1. "Maintenance Engineering and Management": K.Venkataraman-PHI Learning - 2007

REFERENCES:

1. Kelly. A and Harris, M. J, "Management of Industrial maintenance", Butter worth & Co., 1978
2. David J. Smith, "Reliability and Maintainability in Perspective", McMillan,2nd Edition, 1985.
3. Gwidon W Stachowiakand Andrew W. Batchelor, "Engineering Tribology", Butterwork-Heinmann, 2001
4. John V.Grimaldi& Rollin H.Simonds, "Safety Management", AITBS Publishers & Distributors, 2001

ED7011 BEARING DESIGN AND ROTOR DYNAMICS L T P C
3 0 0 3

OBJECTIVE:

- To know about different types of bearings available for machine design and their operating principles
- To design hydrodynamic/ hydrostatic / rolling bearing for given specifications and analyze the bearings for their performance
- To understand the bearing behavior under dynamic conditions

OUTCOME:

- Acquisition of knowledge in the analysis of all types of bearings.
- Ability to make specifications of all types of bearings
- Skill for conducting dynamic / vibration analysis and trouble shooting of bearings

UNIT I CLASSIFICATION AND SELECTION OF BEARINGS 6

Selection criteria-Dry and Boundary Lubrication Bearings-Hydrodynamic and Hydrostatic bearings-Electro Magnetic bearings-Dry bearings-Rolling Element bearings- Bearings for Precision Applications-Foil Bearings-Special bearings- Selection of plain Bearing materials –Metallic and Non metallic bearings

UNIT II DESIGN OF FLUID FILM BEARINGS 10

Design and performance analysis of Thrust and Journal bearings – Full, partial, fixed and pivoted journal bearings design procedure-Minimum film thickness – lubricant flow and delivery – power loss, Heat and temperature distribution calculations- Design based on Charts & Tables and Experimental curves-Design of Foil bearings-Air Bearings- Design of Hydrostatic bearings-Thrust and Journal bearings- Stiffness consideration - flow regulators and pump design

UNIT III SELECTION AND DESIGN OF ROLLING BEARINGS 10

Contact Stresses in Rolling bearings- Centrifugal stresses-Elasto hydrodynamic lubrication-Fatique life calculations- Bearing operating temperature- Lubrication- Selection of lubricants-Internal clearance – Shaft and housing fit- -Mounting arrangements-Materials for rolling bearings-Manufacturing methods- Ceramic bearings-Rolling bearing cages-bearing seals selection

UNIT IV DYNAMICS OF HYDRODYNAMIC BEARINGS 10

Hydrodynamic Lubrication equation for dynamic loadings-Squeeze film effects in journal bearings and thrust bearings -Rotating loads , alternating and impulse loads in journal bearings – Journal centre Trajectory- Analysis of short bearings under dynamic conditions- Finite difference solution for dynamic conditions

UNIT V ROTOR DYNAMICS 9

Rotor vibration and Rotor critical speeds- support stiffness on critical speeds- Stiffness and damping coefficients of journal bearings-computation and measurements of journal bearing coefficients -Mechanics of Hydro dynamic Instability- Half frequency whirl and Resonance whip-Design configurations of stable journal bearings

TOTAL: 45 PERIODS

REFERENCES:

1. Neale, M.J. "Tribology Hand Book", Butterworth Heinemann, United Kingdom 2001.
2. Cameron, A. "Basic Lubrication Theory", Ellis Herward Ltd., UK, 1981
3. Halling, J. (Editor) – "Principles of Tribology ", Macmillian – 1984.
4. Williams J.A. " Engineering Tribology", Oxford Univ. Press, 1994.
5. S.K.Basu, S.N.Sengupta & B.B.Ahuja ,"Fundamentals of Tribology", Prentice –Hall of India Pvt Ltd , New Delhi, 2005
6. G.W.Stachowiak & A.W .Batchelor , Engineering Tribology, Butterworth-Heinemann, UK, 2005

CD7006 INTEGRATED MANUFACTURING SYSTEMS L T P C
3 0 0 3

OBJECTIVE:

At the end of this course the students would have developed a thorough understanding of the group technology, manufacturing process planning and control, modern manufacturing systems

OUTCOME:

It helps the students to get familiarized with the computer aided process planning, group technology, process planning and control and computer integrated manufacturing systems

UNIT I INTRODUCTION 5

Objectives of a manufacturing system-identifying business opportunities and problems classification production systems-linking manufacturing strategy and systems analysis of manufacturing operations.

UNIT II GROUP TECHNOLOGY AND COMPUTER AIDED PROCESS 5

Introduction-part families-parts classification and cooling - group technology machine cells-benefits of group technology. Process planning function CAPP - Computer generated time standards.

UNIT III COMPUTER AIDED PLANNING AND CONTROL 10

Production planning and control-cost planning and control-inventory management-Material requirements planning (MRP)-shop floor control-Factory data collection system-Automatic identification system-barcode technology- automated data collection system.

UNIT IV COMPUTER MONITORING 10

Types of production monitoring systems-structure model of manufacturing process-process control & strategies- direct digital control-supervisory computer control-computer in QC - contact inspection methods non-contact inspection method - computer-aided testing - integration of CAQC with CAD/CAM.

UNIT V INTEGRATED MANUFACTURING SYSTEM 15

Definition - application - features - types of manufacturing systems-machine tools-materials handling system- computer control system - DNC systems manufacturing cell. Flexible manufacturing systems (FMS) - the FMS concept-transfer systems - head changing FMS - variable mission manufacturing system - CAD/CAM system - human labor in the manufacturing system-computer integrated manufacturing system benefits. Rapid prototyping - Artificial Intelligence and Expert system in CIM.

TOTAL: 45 PERIODS

REFERENCES:

1. Groover, M.P., "Automation, Production System and CIM", Prentice-Hall of India, 1998.
2. David Bedworth, "Computer Integrated Design and Manufacturing", TMH, New Delhi, 1998.
3. Yorem Koren, "Computer Integrated Manufacturing Systems", McGraw Hill, 1983.
4. Ranky, Paul G., "Computer Integrated Manufacturing", Prentice Hall International 1986.
5. R.W. Yeomamas, A. Choudry and P.J.W. Ten Hagen, "Design rules for a CIM system", North Holland Amsterdam, 1985.