## ANNA UNIVERSITY, CHENNAI

### AFFILIATED INSTITUTIONS

### REGULATIONS 2013

### M.E. PRODUCT DESIGN AND DEVELOPMENT

### I TO IV SEMESTERS (FULL TIME) CURRICULUM AND SYLLABUS

### SEMESTER I

<table>
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<tr>
<th>SL. NO</th>
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**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)

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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)

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)

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)

REFERENCES
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

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

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


UNIT IV


UNIT V


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

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.

UNIT III NURBS AND SOLID MODELING  9
NURBS- Basics- curves , lines, arcs, circle and bi linear surface.

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
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, $2^k$ factor 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:
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

UNIT II  WORK PLACE AND EQUIPMENT DESIGN
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
Vision and illumination design – Climate, Noise, Motion, Sound, Vibration.

UNIT IV  BIOMECHANICS, BIOThERMODYNAMICS, BIOENERGETICS
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 - Biothermal 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
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
PD7111      CAD AND CAM LABORATORY       L T P C
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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
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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
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  FINE ELEMENT ANALYSIS OF ONE DIMENSIONAL PROBLEMS  11+3

UNIT II  FINE 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

UNIT III  ISO-PARAMETRIC FORMULATION  8+3

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

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:
PD7201 INTEGRATED PRODUCT DESIGN AND PROCESS DEVELOPMENT

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
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

UNIT III PRODUCT ARCHITECTURE
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

UNIT V  DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT

- 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


REFERENCES:

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


UNIT II  TOOLS FOR PROCESS IMPROVEMENT

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

UNIT IV  BENCHMARKING AND ESTABLISHING ENGINEERING SPECIFICATIONS  

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

TEXT BOOK:  

REFERENCES:  

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  

UNIT II  PROCESS MODELING AND PRODUCT DESIGN  

UNIT III  NON METALS AND MANUFACTURING  
UNIT IV PRODUCT DESIGN AND ASSEMBLY REQUIREMENTS  
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  
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

REFERENCES
2. Sami Franssile- Introduction to Micro Fabrication- John Wiley and Sons-UK 2004
3. Harfold Belofsky- Plastic design and processing hand book, Hanser publication- 2005

PD7211 DESIGN PROJECT

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.
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 cardboard 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)

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

UNIT II EXPLORATORY RESEARCH DESIGN
UNIT III  MEASUREMENT AND SCALING
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
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
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

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

UNIT II  MECHANISM OF THINKING AND VISUALIZATION
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
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
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

TOTAL: 45 PERIODS

REFERENCES
2. Geoffrey Petty," how to be better at Creativity", The Industrial Society 1999

PD7002 ENTERPRISE RESOURCE PLANNING

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

UNIT II TECHNOLOGY AND ARCHITECTURE

UNIT III ERP SYSTEM PACKAGES
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.
ED7004  DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS

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

UNIT II  CONTROL AND REGULATION ELEMENTS
Pressure - direction and flow control valves - relief valves, non-return and safety valves - actuation systems.

UNIT III  HYDRAULIC CIRCUITS

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

REFERENCES:

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
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
Optimization with equality and inequality constraints - Direct methods – Indirect methods using penalty functions, Lagrange multipliers - Geometric programming

UNIT III ADVANCED OPTIMIZATION TECHNIQUES
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

UNIT V DYNAMIC APPLICATIONS
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

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:  

UNIT II REVERSE ENGINEERING AND CAD MODELING:  

UNIT III LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS:  
Solid Ground Curing (SGC): working principle, process, strengths, weaknesses and applications.

UNIT IV POWDER BASED ADDITIVE MANUFACTURING SYSTEMS:  

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), Ballistic Particle Manufacturing (BPM), Selective Laser Melting, Electron Beam Melting.

TOTAL: 45 PERIODS

REFERENCES
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

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

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:

REFERENCES
2. Charles E. Ebeling, Reliability and Maintainability Engineering, TMH, 2000
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
Introduction, Materials-substrates, Additive materials. Fabrication techniques-Deposition, Lithography, etching, Surface micro machining, Thick film screen-printing and electroplating

UNIT II MECHANICAL SENSOR PACKAGING
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
Piezo resistivity, Piezoelectricity, Capacitive Techniques, Optical techniques, Resonant techniques. Actuation techniques, Smart Sensors.MEMS Simulation and Design tools-Behavioral modeling simulation tools and Finite element simulation tools.

UNIT IV PRESSURE SENSORS
Introduction.Techiques 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

TOTAL:45PERIODS

TEXT BOOK:

REFERENCE

ED 7071 INDUSTRIAL ROBOTICS AND EXPERT SYSTEMS
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

UNIT II ROBOT DRIVES AND CONTROL 9

UNIT III ROBOT SENSORS 9

UNIT IV ROBOT CELL DESIGN AND APPLICATION 9

UNIT V ROBOT PROGRAMMING, ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS 8

TOTAL: 45 PERIODS

REFERENCES
MODAL ANALYSIS OF MECHANICAL SYSTEMS

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

UNIT II THEORETICAL BASIS

UNIT III MOBILITY MEASUREMENT TECHNIQUES

UNIT IV MODAL PARAMETER EXTRACTION METHODS

UNIT V DERIVATION OF MATHEMATICAL MODELS

REFERENCE

DESIGN FOR MANUFACTURE, ASSEMBLY AND ENVIRONMENTS

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
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
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

UNIT IV  COMPONENT DESIGN – CASTING CONSIDERATION
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

TOTAL: 45 PERIODS

REFERENCES:

IC7072  COMPUTATIONAL FLUID DYNAMICS

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

UNIT IV CONVECTION HEAT TRANSFER AND FEM 10

UNIT V TURBULENCE MODELS 5
Algebraic Models – One equation model, K - $\varepsilon$ Models, Standard and High and Low Reynolds number models, Prediction of fluid flow and heat transfer using standard codes.

TOTAL: 45 PERIODS

REFERENCES

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

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

UNIT III CONCEPTS
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

UNIT V INTEGRATION
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

REFERENCES

PD7006 PRODUCT DESIGN FOR ENERGY AND ENVIRONMENT

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

UNIT II SOLAR PRODUCTS – DESIGN AND DEVELOPMENT
UNIT III  BIO ENERGY PRODUCTS – DESIGN  

UNIT IV TESTING  

UNIT V ECONOMICS  
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:
2. David Boyles, Bio Energy Technology Thermodynamics and costs, Ellis HooknoodChichester, 1984.

REFERENCES

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
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

UNIT III INDUSTRIAL DESIGNS
UNIT IV  COPY RIGHT AND TRADEMARKS

UNIT V  INTELLECTUAL PROPERTY MANAGEMENT
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:

REFERENCES

ED7010 TRIBOLOGY IN DESIGN

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
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

UNIT III  LUBRICANTS AND LUBRICATION REGIMES
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

REFERENCES:

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

UNIT II  NON-LINEAR PROBLEMS  10

UNIT III  DYNAMIC PROBLEM  8
UNIT IV FLUID MECHANICS AND HEAT TRANSFER

UNIT V ERROR ESTIMATES AND ADAPTIVE REFINEMENT
Error norms and Convergence rates – h-refinement with adaptivity – Adaptive refinement.

REFERENCES

PD7008 MAINTENANCE ENGINEERING

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
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
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
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
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

TOTAL: 45 PERIODS

TEXT BOOK:

REFERENCES:

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

UNIT III   SELECTION AND DESIGN OF ROLLING BEARINGS  10
Contact Stresses in Rolling bearings- Centrifugal stresses-Elasto hydrodynamic lubrication- Fatigue 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

TOTAL: 45 PERIODS

REFERENCES:

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

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

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: