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\*\* a Term Project must be given for Assessment – 3 (Compulsory)  
(Total number of credits: 22 + 23 + 15 + 12 = 72)

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### UNIVERSITY DEPARTMENTS

**ANNA UNIVERSITY CHENNAI : : CHENNAI 600 025**

**REGULATIONS - 2009**

**CURRICULUM I TO VI SEMESTERS (PART TIME)**

**M.E. PRODUCT DESIGN & DEVELOPMENT**

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</table>
UNIT I  D RANDOM VARIABLES  9

UNIT II  COMPUTATIONAL METHODS IN ENGINEERING  9

UNIT III  TENSOR ANALYSIS  9
Summation convention – Contravariant and covariant vectors – contraction of tensors – inner product – quotient law – metric tensor – Christoffel symbols – covariant differentiation – gradient, divergence and curl

UNIT IV  CALCULUS OF VARIATION  9
Variation and its properties – Euler's equation – functionals dependent on first and higher order derivatives – functionals dependent on functions of several independent variables – problems with moving boundaries – direct methods – Ritz and Kantorovich methods

UNIT V  FAST FOURIER TRANSFORMS  9

Total: L: 45 + T: 15 = 60

REFERENCES:
UNIT I DESIGN FUNDAMENTALS 9

UNIT II CUSTOMER ORIENTED DESIGN & SOCIETAL CONSIDERATIONS 9


UNIT III DESIGN METHODS 9

UNIT IV MATERIAL SELECTION PROCESSING AND DESIGN 9

UNIT V PROBABILITY CONCEPTS IN DESIGN FOR RELIABILITY 9

TEXT BOOKS:

REFERENCES:

Total 45
UNIT I  INTRODUCTION TO COMPUTER GRAPHICS FUNDAMENTALS  11

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


UNIT II  INTRODUCTION TO CAD SOFTWARE  8

Writing interactive programs to solve design problems and production of drawings - using any languages like Auto LISP/C/FORTRAN etc.- creation of surfaces - solids etc. using solid modeling packages (prismatic and revolved parts).

UNIT III  SOLID MODELING  8


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  9

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

Note: Lab Practice of 30 hrs. Total 45 + 30 = 75 Hours

REFERENCES:
AIM
To study about robust design, embodiment principles, various methods in design of experiments, reliability charts and histograms and six sigma techniques.

UNIT I DESIGN FOR QUALITY
Quality Function Deployment -House of Quality-Objectives and functions-Targets-Stakeholders-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 MODE EFFECT ANALYSIS
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-Case study- computer monitor stand for a docking station.

UNIT III DESIGN OF EXPERIMENTS
Design of experiments-Basic methods- Two factorial experiments-Extended method-reduced tests and fractional experiments, orthogonality, base design method, higher dimensional fractional factorial design-Statistical analysis of experiments: Degree of freedom, correlation coefficient, standard error of the residual t-test, ANOVA-ratio test, other indicators-residual plots, Advanced DOE method for product testing-Product applications of physical modeling and DOE, Blender panel display evaluation, coffee grinder experimental optimization-Taguchi method.

UNIT IV STATISTICAL CONSIDERATION AND RELIABILITY
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 distributions

UNIT V DESIGN FOR SIX SIGMA
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

REFERENCES:
PD9112 DIGITAL PRODUCT DEVELOPMENT LAB –I

- 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

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

Total - 45 hr

PD9113 DIGITAL PRODUCT DEVELOPMENT LAB-III

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 45 Hrs
OBJECTIVE:
At the end of this course the students would have developed 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.

UNIT-I: GENERAL INTRODUCTION *
Introduction- structural element and system- assembly and analysis of a structure- boundary conditions- general pattern- standard discrete system- transformation of coordinates- examples – direct physical approach to problems in elasticity- direct formulation- displacement approach – minimization of total potential- convergence criteria – discretization error- nonconforming elements and patch test- solution process- numerical examples

UNIT-II: GENERALIZATION OF FINITE ELEMENT CONCEPTS AND ELEMENT SHAPE FUNCTIONS*

UNIT-III: APPLICATIONS TO FIELD PROBLEMS *
Solution to problems in linear elasticity- plane problems in elasticity- plates and shells- solution of problems in heat-transfer and fluid mechanics- numerical examples- discussion on error estimates

UNIT-IV: FINITE ELEMENTS IN STRUCTURAL DYNAMICS AND VIBRATIONS **
Dynamic equations- stiffness, mass and damping matrices- consistent and diagonal mass matrices- Extraction of natural frequencies and modes- Reduction of number of degrees of freedom - modal methods - component mode synthesis- harmonic analysis- response history- explicit and implicit direct integration- stability and accuracy- analysis of response spectra- example problems

UNIT-V: NON-LINEAR ANALYSIS ***
Non-linear problems in elasticity- some solution methods- plasticity: introduction, general formulation for small strains- formulation for von Mises theory- computational procedure- problems of gaps and contact- geometric non-linearity- modelling considerations
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


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

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.

Total No of periods: 45+15=60

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

TEXT BOOK

REFERENCES:
4. www.me.mit/2.7444
OBJECTIVES
To study about the tools required for various design activities, improvement methodologies and quality control charts and other standards.

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:
UNIT I  MATERIAL BEHAVIOR AND SELECTION  12


UNIT II  PROCESS MODELING AND PRODUCT DESIGN  9


UNIT III  NON METALS AND MANUFACTURING  9


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

Total 45 + 15 = 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
• 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:** 45 Hours
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.

**Practical 45 hrs**
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.

CONSTRAINED OPTIMIZATION TECHNIQUES

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

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.

STATIC APPLICATIONS


DYNAMIC APPLICATIONS

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

REFERENCES:
OBJECTIVE

Study about the design methodologies for manufacture and assembly, value engineering techniques and analysis of product development

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 hr

TEXT BOOK:


REFERENCES:

2. Charles E. Ebeling, Reliability and Maintainability Engineering, , TMH, 2000
UNIT I  ELEMENTS OF SOLID MECHANICS  9

The geometry of stress and strain, elastic deformation, plastic and elasto-plastic deformation - limit analysis – Airy’s function – field equation for stress intensity factor.

UNIT II  STATIONARY CRACK UNDER STATIC LOADING  9


UNIT III  ENERGY BALANCE AND CRACK GROWTH  9


UNIT IV  FATIGUE CRACK GROWTH CURVE  9

Empirical relation describing crack growth law – life calculations for a given load amplitude – effects of changing the load spectrum -- rain flow method– external factors affecting the K1c values.- leak before break analysis.

UNIT V  APPLICATIONS OF FRACTURE MECHANICS  9

Crack Initiation under large scale yielding – thickness as a design parameter – mixed mode fractures - crack instability in thermal and residual stress fields - numerical methods

Total  45

REFERENCES:

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

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

REFERENCES:

Total 45
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
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
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:

Total 45
UNIT I ELASTICITY

UNIT II SHEAR CENTER AND UNSYMMETRICAL BENDING
Location of shear center for various thin sections - shear flows. Stresses and deflections in beams subjected to unsymmetrical loading-kern of a section.

UNIT III CURVED FLEXIBLE MEMBERS AND STRESSES IN FLAT PLATES

UNIT IV TORSION OF NON-CIRCULAR SECTIONS
Torsion of rectangular cross section - St.Venants theory - elastic membrane analogy - Prandtl's stress function - torsional stress in hollow thin walled tubes.

UNIT V STRESSES IN ROTARY SECTIONS AND CONTACT STRESSES
Radial and tangential stresses in solid disc and ring of uniform thickness and varying thickness allowable speeds. Methods of computing contact stress-deflection of bodies in point and line contact applications.

REFERENCES:
OBJECTIVE

i) To understand the fundamentals of composite material strength and its mechanical behavior

ii) Understanding the analysis of fiber reinforced Laminate design for different Combinations of plies with different orientations of the fiber.

iii) Thermo-mechanical behavior and study of residual stresses in Laminates during processing.

iv) Implementation of Classical Laminate Theory (CLT) to study and analysis for residual stresses in an isotropic layered structure such as electronic chips.

UNIT I LAMINA CONSTITUTIVE RELATIONS


UNIT II FLAT PLATE LAMINATE CONSTITUTIVE RELATIONS


UNIT III LAMINA STRENGTH ANALYSIS


UNIT IV ANALYSIS OF LAMINATED FLAT PLATES


UNIT V EFFECT OF THERMAL PROPERTIES


Total 45
TEXT BOOK:  

REFERENCES:  
UNIT I  BASIC CONCEPTS OF ACOUSTICS  9


UNIT II  CHARACTERISTICS OF SOUND  10

One dimensional wave equation – Solution of 1D wave equation – Velocity in gaseous medium – Velocity of plane progressive sound wave through a thin solid rod – Velocity of plane wave in a bulk of solid – Transverse wave propagation along a string stretched under tension – Wave equation in two dimension.

UNIT III  TRANSMISSION PHENOMENA  6

Changes in media – Transmission from one fluid medium to another, normal incidence, oblique incidence - Reflection at the surface of a solid, normal incidence, oblique incidence – Standing wave pattern – Transmission through three media.

UNIT IV  INTRODUCTION TO THE ASSESSMENT AND MEASUREMENT OF SOUND  10


UNIT V  BASICS OF NOISE CONTROL  10

Noise Control at source, path, receiver – Noise control by acoustical treatment – Machinery noise – Types of machinery involved – Determination of sound power and sound power level – Noise reduction procedures – Acoustic enclosures.

REFERENCES:

UNIT I  INTRODUCTION TO TOOL DESIGN  8


UNIT II  DESIGN OF CUTTING TOOLS  9

Mechanics of Metal cutting –Oblique and orthogonal cutting- Chip formation and shear angle - Single-point cutting tools – Milling cutters – Hole making cutting tools- Broaching Tools - Design of Form relieved and profile relieved cutters-Design of gear and thread milling cutters

UNIT III  DESIGN OF JIGS AND FIXTURES  10


UNIT IV  DESIGN OF PRESS TOOL DIES  10


UNIT V  TOOL DESIGN FOR CNC MACHINE TOOLS  8


Total  45

REFERENCES:

2. E.G.Hoffman,” Jig and Fixture Design”, Thomson Asia Pvt Ltd, Singapore, 2004
UNIT I  PRODUCTIVITY  9
Productivity Concepts – Macro and Micro factors of productivity – Dynamics of Productivity - Productivity Cycle Productivity Measurement at International, National and Organisation level - Productivity measurement models

UNIT II  SYSTEMS APPROACH TO PRODUCTIVITY MEASUREMENT  9
Conceptual frame work, Management by Objectives (MBO), Performance Objectivated Productivity (POP) – Methodology and application to manufacturing and service sector.

UNIT III  ORGANISATIONAL TRANSFORMATION  9
Elements of Organisational Transformation and Reengineering-Principles of organizational transformation and re-engineering, fundamentals of process re-engineering, preparing the workforce for transformation and re-engineering, methodology, guidelines, LMI CIP Model – DSMC Q & PMP model.

UNIT IV  RE-ENGINEERING PROCESS IMPROVEMENT MODELS  9
PMI models, PASIM Model, Moen and Nolan Strategy for process improvement, LMICIP Model, NPRDC Model.

UNIT V  RE-ENGINEERING TOOLS AND IMPLEMENTATION  9
Analytical and process tools and techniques – Information and Communication Technology – Implementation of Reengineering Projects – Success Factors and common implementation Problem – Cases.

Total : 45

REFERENCES

UNIT I  INTRODUCTION AND ROBOT KINEMATICS  
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  
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  
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  
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  
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.

TEXT BOOK: 
1.  K.S.Fu, R.C. Gonzalez and C.S.G. Lee, “Robotics Control, Sensing, Vision and 

REFERENCES: 
UNIT I  FUNDAMENTALS OF HEAT EXCHANGER  

UNIT II  FLOW AND STRESS ANALYSIS  

UNIT III  DESIGN ASPECTS  

UNIT IV  COMPACT AND PLATE HEAT EXCHANGERS  

UNIT V  CONDENSERS & COOLING TOWERS  
Design of surface and evaporative condensers – cooling tower – performance characteristics.

Total Periods 45

REFERENCES

ED 9171 RAPID PROTOTYPING AND TOOLING  L T P C  3 0 0 3

UNIT I INTRODUCTION  7


UNIT II LIQUID BASED AND SOLID BASED RAPID PROTOTYPING SYSTEMS  10


UNIT III POWDER BASED RAPID PROTOTYPING SYSTEMS  10


UNIT IV REVERSE ENGINEERING AND CAD MODELING  10


UNIT V RAPID TOOLING  8

Classification: Soft tooling, Production tooling, Bridge tooling; direct and indirect – Fabrication processes, Applications. Case studies - automotive, aerospace and electronic industries.

Total Periods: 45

TEXT BOOK:


REFERENCES:

UNIT I  MATERIALS HANDLING EQUIPMENT  5
Types, selection and applications

UNIT II  DESIGN OF HOISTS  10

UNIT III  DRIVES OF HOISTING GEAR  10
Hand and power drives - Traveling gear - Rail traveling mechanism - cantilever and monorail cranes - slewing, jib and luffing gear - cogwheel drive - selecting the motor ratings.

UNIT IV  CONVEYORS  10
Types - description - design and applications of Belt conveyors, apron conveyors and escalators Pneumatic conveyors, Screw conveyors and vibratory conveyors.

UNIT V  ELEVATORS  10
Bucket elevators: design - loading and bucket arrangements - Cage elevators - shaft way, guides, counter weights, hoisting machine, safety devices - Design of fork lift trucks.

Total 45

TEXT BOOKS

REFERENCES
UNIT I  THEORY OF PLASTICITY

Theory of plastic deformation - Engineering stress and strain relationship – Stress tensor - Strain tensor - Yield criteria's - Plastic stress strain relationship – Plastic work - Equilibrium conditions - Incremental plastic strain

UNIT II  CONSTITUTIVE RELATIONSHIPS AND INSTABILITY

Uniaxial tension test - Mechanical properties - Work hardening, Compression test, bulge test, plane strain compression stress, plastic instability in uniaxial tension stress, plastic instability in biaxial tension stress

UNIT III  ANALYSIS OF METAL FORMING PROBLEMS

Slab analysis - Slip line method, upper bound solutions, statistically admissible stress field, numerical methods, contact problems, effect of friction, thermo elastic Elasto plasticity, elasto visco plasticity - Thermo mechanical coupling – Analysis of forging, rolling, extrusion and wire drawing processes - Experimental techniques of the evaluation of metal forming

UNIT IV  ANALYSIS OF SHEET METAL FORMING


UNIT V  ADVANCES IN METAL FORMING

Orbital forging, Isothermal forging, Warm forging, Hot and Cold isotropic pressing, high speed extrusion, rubber pad forming, micro blanking – Superplastic forming - Overview of Powder Metal techniques - Powder rolling - Tooling and process parameters

REFERENCES:

OBJECTIVE:
After undergoing this course, the students would be in a position to understand the behaviour of these commonly occurring structural elements in engineering design and would have developed the capability to design and analyze them in their normal design practice.

UNIT I  GENERAL INTRODUCTION  7
Review of equations of elasticity- kinematics, compatibility equations, stress measures- equations of motions- constitutive relations- transformation of stresses, strains and stiffness-energy principles and variational methods in elasticity- virtual work-external and internal virtual work- variational operator- functionals- Euler Lagrange equations- energy principles- Hamilton's principle- principle of minimum total potential- applications

UNIT II  CLASSICAL THEORY OF PLATES  10
Plates as structural elements- stress and moment resultants- assumptions made in the classical theory- displacement fields and strains- equations of equilibrium in Cartesian coordinates and in polar coordinates- boundary conditions – bending of rectangular plates with various boundary conditions and loading- symmetrical and asymmetrical bending of circular plates-limitations of classical theory- finite element analysis(elementary treatment only; discussion of various elements used and their capabilities- not for examination)

UNIT III  BUCKLING ANALYSIS OF RECTANGULAR PLATES  10
Buckling of simply supported plates under compressive forces- governing equations- the Navier solution- biaxial compression of a plate- uniaxial compression of a plate- buckling of plates simply supported on two opposite edges- Levy's solution- buckling of plates with various boundary conditions- general formulation- finite element analysis(elementary treatment only; discussion of various elements used and their capabilities- not for examination)

UNIT IV  VIBRATION OF PLATES  9
Governing equations for natural flexural vibrations of rectangular plates- natural vibrations of plates simply supported on all edges- vibration of plates with two parallel sides simply supported- Levy's solution- vibration of plates with different boundary conditions- Rayleigh-Ritz method- Natural vibration of plates with general boundary conditions- transient analysis of rectangular plates- finite element analysis(elementary treatment only; discussion of various elements used and their capabilities- not for examination)

UNIT V  ANALYSIS OF THIN ELASTIC SHELLS OF REVOLUTION  9
Classification of shell surfaces- geometric properties of shells of revolution- general strain displacement relations for shells of revolution- stress resultants- equations of motion of thin shells- analytical solution for thin cylindrical shells- membrane theory-flexure under axisymmetric loads- shells with double curvature- geometric considerations- equations of equilibrium- bending of spherical shells- vibration of cylindrical shells- finite element analysis(elementary treatment only; discussion of various elements used and their capabilities- not for examination)

Total: 45 periods
REFERENCES:

4. Wilhelm Flügge, stresses in shells, Springer - Verlag
7. Dr. N. Subramanian, Principles of Space Structures, Wheeler Publishing Co. 1999
UNIT I  INTRODUCTION  3

UNIT II  STRESSES IN PRESSURE VESSELS  15

UNIT III  DESIGN OF VESSELS  15

UNIT IV  BUCKLING AND FRACTURE ANALYSIS IN VESSELS  8
Buckling phenomenon – Elastic Buckling of circular ring and cylinders under external pressure – collapse of thick walled cylinders or tubes under external pressure – Effect of supports on Elastic Buckling of Cylinders – Buckling under combined External pressure and axial loading.

UNIT V  PIPING  4

TEXT BOOKS


REFERENCES

OBJECTIVE
This syllabus is formed to create knowledge in Mechatronic systems and impart the source of concepts and techniques, which have recently been applied in practical situation. It gives a framework of knowledge that allows engineers and technicians to develop an interdisciplinary understanding and integrated approach to engineering.

UNIT I  INTRODUCTION  5

UNIT II  SENSORS AND TRANSDUCERS  12

UNIT III  ACTUATORS  12
Actuators – Mechanical - Electrical - Fluid Power - Piezoelectric – Magnetostrictive - Shape memory alloy - applications - selection of actuators.

UNIT IV  PROGRAMMABLE LOGIC CONTROLLERS  8
Introduction - Basic structure - Input and output processing - Programming - Mnemonics - Timers, counters and internal relays - Data handling - Selection of PLC.

UNIT V  DESIGN AND MECHATRONICS CASE STUDIES  8
Designing - Possible design solutions-Traditional and Mechatronics design concepts - Case studies of Mechatronics systems - Pick and place Robot - Conveyor based material handling system - PC based CNC drilling machine - Engine Management system - Automatic car park barrier - Data acquisition Case studies.

Total: 45

TEXT BOOK

REFERENCES
UNIT I 
OVERVIEW

UNIT II 
THEORETICAL BASIS

UNIT III 
MOBILITY MEASUREMENT TECHNIQUES

UNIT IV 
MODAL PARAMETER EXTRACTION METHODS

UNIT V 
DERIVATION OF MATHEMATICAL MODELS

REFERENCES:
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

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.

REFERENCES:
UNIT I  FORCES AND STRAIN MEASUREMENT  9


UNIT II  VIBRATION MEASUREMENTS  9


UNIT III  ACOUSTICS AND WIND FLOW MEASURES  9


UNIT IV  DISTRESS MEASUREMENTS  9


UNIT V  NON DESTRUCTIVE TESTING METHODS  9

Load testing on structures, buildings, bridges and towers – Rebound Hammer – acoustic emission – ultrasonic testing principles and application – Holography – use of laser for structural testing – Brittle coating

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<tr>
<td>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.</td>
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<td>Types of production monitoring systems-structure model of manufacturing process-process control &amp; 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.</td>
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<th>UNIT V</th>
<th>INTEGRATED MANUFACTURING SYSTEM</th>
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<td>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.</td>
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</table>
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 centred 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


Total: 45
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REFERENCES:
# UNIT I  CLASSIFICATION AND SELECTION OF BEARINGS

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


# UNIT III  SELECTION AND DESIGN OF ROLLING BEARINGS

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

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


# REFERENCES:

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 modeling 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

TEXT BOOK:

REFERENCE:
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 symmetry. 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

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

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

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UNIT I  INTRODUCTION  5

Logistics- concepts, definitions, approaches, factors affecting logistics. Supply chain -
basic tasks of the supply chain - the new corporate model.

UNIT II  SUPPLY CHAIN MANAGEMENT  10

The new paradigm, the modular company, the network relations, supply process,
procurement process - Distribution management.

UNIT III  EVOLUTION OF SUPPLY CHAIN MODELS  10

Strategy and structure - factors of supply chain - Manufacturing strategy stages, supply
chain progress - model for competing through supply chain management - PLC grid,
supply chain redesign - Linking supply chain with customer.

UNIT IV  SUPPLY CHAIN ACTIVITY SYSTEMS  10

Structuring the SC, SC and new products, functional roles in SC, SC design framework,
collaborative product commerce (CPC)

UNIT V  SCM ORGANISATION AND INFORMATION SYSTEM  10

The management task, logistics organisation, the logistics information systems- topology
of SC application- MRP, ERP, Warehouse management system, product data
management- cases.

Total = 45

REFERENCES:

1. Scharj, P.B., Lasen, T.S., Managing the global supply chain, Viva Books, New
   Delhi, 2000.
   2000.
3. Nicolas, J.N., Competitive manufacturing management- continuous improvement,
4. Steudel, H.J. and Desruelle, P., Manufacturing in the nintees- How to become a
UNIT I ENTERPRISE RESOURCE PLANNING 10

UNIT II TECHNOLOGY AND ARCHITECTURE 10

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

UNIT V ERP PROCUREMENT ISSUES 8

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<td>Algebraic Models – One equation model, K – c Models, Standard and High and Low Reynolds number models, Prediction of fluid flow and heat transfer using standard codes.</td>
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**REFERENCES**