

COURSE OUTCOMES

At the end of this course, the students will be able to

- understand the accuracy of technical computations and describe the relevance of answers, with its appropriateness.
- acquire knowledge in solving a first order explicit initial value problem using Runge – Kutta 4th order.
- understand the application of iterative techniques, explicit and implicit techniques, ADI methods used in finite difference algorithms.
- analyze the techniques, involved in constructing approximate polynomial and determining the intermediate values.
- implement the finite element method efficiently in order to solve a particular equation.

REFERENCES

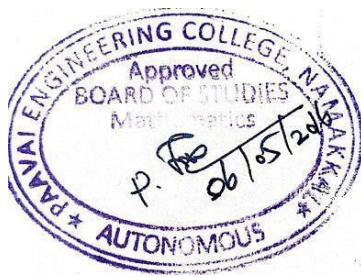
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2. Gupta S.K., —Numerical Methods for Engineers, New Age Publishers, 1995.
3. Burden, R.L., and Faires, J.D., —Numerical Analysis – Theory and Applications, Cengage Learning, India Edition, New Delhi, 2009
4. Jain M. K., Iyengar S. R., Kanchi M. B.,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

WEB LINKS

1. <https://www.youtube.com/watch?v=QTQ8bO1F-Dg>
2. <https://www.youtube.com/watch?v=AT7Olelic8U>

CO-PO Mapping

Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	-	-	-	-	-	-	-	1	3	2
CO2	3	3	2	3	-	-	-	-	-	-	-	1	3	2
CO3	3	3	2	3	-	-	-	-	-	-	-	1	3	2
CO4	3	3	2	3	-	-	-	-	-	-	-	1	3	2
CO5	3	3	3	2	-	-	-	-	-	-	-	1	3	2



COURSE OUTCOMES

At the end of this course, the students will be able to

- understand the fundamentals of design process and designing codes and standards.
- familiarize the product design specifications, ergonomics and aesthetics.
- identify the suitable design methods for problem solving.
- understand the proper material selection processing
- apply the probability concepts in design for reliability

REFERENCES

1. Dieter, George E., —Engineering Design - A Materials and Processing Approach, McGraw Hill, International Editions, Singapore, 2000.
2. Pahl, G, and Beitz, W., Engineering Design, Springer – Verlag, NY. 1984.
3. Ray, M.S., —Elements of Engg. Design, Prentice Hall Inc. 1985.
4. Suh, N.P., -The principles of Design, Oxford University Press, NY. 1990.
5. Karl T. Ulrich and Steven D. Eppinger —Product Design and Development, McGraw Hill Edition 2000.

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CO3	1	2	3	-	-	-	-	1	-	-	-	2	2	3
CO4	1	2	3	-	-	-	-	1	-	-	-	2	2	3
CO5	1	2	3	-	-	-	-	1	-	-	-	2	2	3



COURSE OBJECTIVES

- To impart knowledge in computer graphics used routinely in the field of science engineering medicine etc.
- To get familiarized with the application computer graphics in designing.
- To understand the overall learning curves to solve CAE problems that arise in engineering
- To know the concepts of visuals realism to parametric and variational geometry by using software's
- To impart knowledge in the assembly of part and product data exchange.

UNIT I INTRODUCTION TO COMPUTER GRAPHICS FUNDAMENTALS 17

Output primitives (points, lines, curves etc.), 2-D & 3-D transformation (Translation, scaling, rotators) windowing - view ports - clipping transformation. Representation of curves – Bezier curves - cubic spline curve - B – Spline curves -Rational curves –Surface Modeling techniques - surface patch – Coons patch- bicubic patch – Bezier and B-spline surfaces – Volume modeling – Boundary models – CSG- other modeling techniques.

UNIT II INTRODUCTION TO CAD SOFTWARE 14

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 NURBS AND SOLID MODELING 14

NURBS- Basics- curves , lines, arcs, circle and bi linear surface. Regularized Boolean set operations - primitive instancing – sweeprepresentations - boundary representations - constructive solid Geometrycomparison of representations - user interface for solid modeling. Graphics and computing standards– Open GL Data Exchange standards – IGES, STEP etc– Communication standards.

UNIT IV VISUAL REALISM 15

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 15

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

TOTAL: 75 PERIODS

COURSE OUTCOMES

At the end of this course, the students will be able to

- familiarized with the computer graphics application in design.
- understand the reinforces to solve CAE problems using the learning curves.

- know various solid modeling Techniques and communication standards.
- apply the tolerance analysis and mass property calculations.
- analyze the optimum dimension with respect 2D and 3D

REFERENCES

1. William M Neumann and Robert F.Sproul —Principles of Computer Graphics, McGraw Hill BookCo. Singapore, 1989.
2. Donald Hearn and M. Pauline Baker —Computer Graphics, Prentice Hall, Inc.,1992.
3. Foley, Wan Dam, Feiner and Hughes – Computer graphics principles & practices,PearsonEducation – 2003.
4. Ibrahim Zeid Mastering CAD/CAM – McGraw Hill, International Edition, 2007.
5. Donald Heam and M. Pauline Baker —Computer Graphics, Prentice Hall, Inc.,1992.

WEB LINKS

1. www.adi.pt/docs/innoregio_cad-en.pdf
2. scholar.lib.vt.edu/ejournals/JCAEDE/v1n1/jones.html

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CO5	1	2	3	-	-	-	-	1	-	-	-	2	2	3



COURSE OBJECTIVES

- To impart knowledge on various concepts in engineering design and principles of implementing quality in a product or service.
- To know about the design for quality and performance metrics in design process.
- To understand the failure mode effect analysis in various mechanical aspects.
- To learn about the design of experiments in ANOVA ratio test and DOE.
- To get knowledge on design for six sigma and learn six sigma process and services.

UNIT I DESIGN FOR QUALITY**9**

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**9**

Basic methods: Refining geometry and layout, general process of product embodiment- Embodiment checklist- Advanced methods: systems modeling, mechanical embodiment principles-FMEA method- links fault states to systems modeling-Case study- computer monitor stand for a docking station.

UNIT III DESIGN OF EXPERIMENTS**9**

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**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

UNIT V DESIGN FOR SIX SIGMA**9**

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.

TOTAL: 45 PERIODS

COURSE OUTCOMES

At the end of this course, the students will be able to

- know the design cum quality engineer to get familiarized with various concepts in design, quality and reliability principles in the design of an engineering product or a service.
- understand the concepts of three dimensional stress and strain at a point as well as the stress-strain relationships for homogenous, isotropic materials.
- get awareness on appropriate experiment to evaluate a new product design or process improvement through experimentation strategy, data analysis, and interpretation of experimental results.
- study the reliability and statistics in design criticality and failure effect in various charts.
- understanding of six sigma and lean manufacturing concept in industry.

REFERENCES

1. Product Design Techniques in Reverse Engineering and New Product Development, KEVIN OTTO & KRISTIN WOOD, Pearson Education (LPE), 2001.
2. Product Design And Development, KARL T. ULRICH, STEVEN D. EPPINGER, TATA MCGRAW-HILL- 3rd Edition, 2003.
3. The Management and control of Quality-6th edition-James R. Evens, William M Lindsay Pub: south-western

WEB LINKS

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3. booksite.elsevier.com/samplechapters/.../9780750660754.PDF

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COURSE OBJECTIVES

- To acquire in depth knowledge in fundamental of mechanics
- To provide basic knowledge in elasticity and stress strain relations
- To familiar with stresses and deflections in beams subjected to unsymmetrical loading and buckling.
- To get knowledge in the practice of various loads like concentrated load and uniform load
- To know the principles and objectives of torsion in Non-circular section with various theories.

UNIT I ELASTICITY**15**

Stress-Strain relations and general equations of elasticity in Cartesian, Polar and curvilinear coordinates, differential equations of equilibrium-**compatibility-boundary conditions**-representation of three-dimensional stress of a tension generalized hook's law - St. Venant's principle - plane stress - Airy's stress function. Energy methods.

UNIT II SHEAR CENTER AND UNSYMMETRICAL BENDING AND BUCKLING**16**

Location of shear center for various thin sections – shear flows. Stresses and deflections in beamssubjected to unsymmetrical loading-kern of a section. **Buckling – Twist bend buckling of beams, Buckling of shafts** by Torsion, Twist buckling of columns

UNIT III CURVED FLEXIBLE MEMBERS AND STRESSES IN FLAT PLATES**16**

Circumference and radial stresses – deflections - curved beam with restrained ends - closed ring subjected to concentrated load and uniform load – **chain links and crane hooks**. Solution of rectangular plates – pure **bending of plates** – deflection – **uniformly distributed load** – various end conditions

UNIT IV TORSION OF NON-CIRCULAR SECTIONS**13**

Torsion of rectangular cross section - St.Venants theory - elastic membrane analogy - Prandtl's stress function - torsional stress in **hollow thin wall tubes**.

UNIT V STRESSES IN ROTARY SECTIONS AND CONTACT STRESSES**15**

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.

TOTAL: 75 PERIODS**COURSE OUTCOMES**

At the end of this course, the students will be able to

- gain knowledge in the stresses under different loading conditions.
- know the fundamental mechanics of materials through development of basic principles in elasticity
- demonstrate the application of the knowledge in fundamental mechanics of materials to practical engineering structures
- determine the stresses resulting from bending of curved beams and flat plates.
- apply energy methods for the determination of the deflections and rotations.

REFERENCES

1. Arthur P Boresi, Richard J. Schmidt, —Advanced mechanics of materials, John Wiley, 2002.
2. Timoshenko and Goodier, "Theory of Elasticity", McGraw Hill.
3. J.P Den Hartog —Advanced Strength of Materials, Courier Corporation, 1987
4. Robert D. Cook, Warren C. Young, "Advanced Mechanics of Materials", Mcmillanpub. Co., 1985.
5. Srinath. L.S., —Advanced Mechanics of solids, Tata McGraw Hill, 1992.

WEB LINKS

1. <http://www.me.mtu.edu>
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CO5	3	2	2	-	-	-	-	-	-	-	-	2	3	2



COURSE OBJECTIVES

- gain practical experience in handling 2D drafting and 3D modeling software systems
- gain knowledge about design and detailed drawing using software
- get practice to draw machine components like flange coupling, plumber block etc.,
- get exposure and practice to various techniques available in software for assembling machine elements

CAD INTRODUCTION

Sketcher

Solid modeling & 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 (Screw Jack, Universal Coupling, Tail stock, Flange Coupling, Plummer Block)

Assembly using Parametric and feature based Packages like PRO-E / SOLID WORKS /CATIA / NX etc

COURSE OUTCOME

- develop 2D and 3D models using modeling software.
- draw part diagram using various features and options available in modeling software
- use the features of design and modeling software to assemble various components of machine elements like Screw Jack, Universal Joint and Safety valve etc.
- describe ability to draw and assemble any machine components using modeling software

TOTAL: 60 PERIODS

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CO2	3	-	-	-	2	-	-	-	-	-	-	2	2	2
CO3	3	-	-	-	2	-	-	-	-	-	-	2	2	2
CO4	3	-	-	-	2	-	-	-	-	-	-	2	2	2



COURSE OBJECTIVES

- To be familiar with the concepts of structures boundary conditions, co-ordinate system and various approaches to finite element criteria.
- To get in depth knowledge in the various methods of boundary value problems and elements used in different components.
- To impart knowledge about the problems involved in heat transfer, fluid mechanics and numerical examples.
- To get clear focus in degree of freedom, modal methods and analysis of response spectra.
- To learn general formulation and computational procedure for non-linear analysis.

UNIT I GENERAL INTRODUCTION 15

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 15

Boundary value problems – integral or weak statements- weighted residual methods- Galerkin method- virtual work as weak form of equations in solid and fluid mechanics- variation principles – establishment of natural variation principles for linear self-adjoint differential equations – standard and hierarchical elements- shape functions- rectangular elements- completeness of polynomials- Lagrange family- Serendipity family- **rectangular prisms**- tetrahedral elements- **global and local finite element approximation**- mapped elements- coordinate transformations- **geometrical conformity of elements**- evaluation of element matrices- transformation and coordinates-order of convergence- **numerical integration – example problems**

UNIT III APPLICATIONS TO FIELD PROBLEMS 15

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 15

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

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- modeling considerations

TOTAL: 75 PERIODS

COURSE OUTCOMES

At the end of this course, the students will be able to

- know the concepts and approaches involved in finite element analysis
- solve the problems in various finite element concepts and element shape functions.
- perform and analysis the field problems in finite element application
- evaluate the equations and concept analysis involved in FEM.
- familiar with the procedure and formulation of non-linear analysis.

REFERENCES

1. Zienkiewicz. O.C, Taylor. R.L,& Zhu, J.Z —The Finite Element Method: Its Basis & Fundamentalsl, Butterworth-Heinemann (An imprint of Elsevier), First printed in India 2007,India Reprint ISBN: 978-81-312-1118-2, published by Elsevier India Pvt. Ltd., New Delhi.
2. Cook, R.D., Malkus, D. S., Plesha,M.E., and Witt,R.J — Concepts and Applications of Finite Element Analysisl, Wiley Student Edition, 4th Edition, First Reprint 2007, Authorized reprint by Wiley India (P) Ltd., New Delhi, ISBN-13 978- 81-265-1336-9

WEB LINKS

1. <https://www.osc.edu/education/si/projects/MechEng>
2. www.topajka-shaw.co.nz/pdf/UFEMD1.pdf
3. <https://www.osc.edu/education/si/projects/MechEng>

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CO5	3	3	3	-	2	-	-	-	-	-	-	2	3	3



COURSE OBJECTIVES

- To understand the Fundamentals of Vibration and its practical applications.
- To learn the working principle and operations of various vibration measuring instruments.
- To identify the various Vibration control strategies.
- To know various vibration measurement techniques.
- To analyze the various experimental methods in vibration analysis.

UNIT I FUNDAMENTALS OF VIBRATION**10**

Introduction -Sources Of Vibration-Mathematical Models- Displacement, velocity and Acceleration- Review Of Single Degree Freedom Systems -Vibration isolation Vibrometers and accelerometers - Response To Arbitrary and non- harmonic Excitations – Transient Vibration –Impulse loads-Critical SpeedOf Shaft- Rotor systems.

UNIT II TWO DEGREE FREEDOM SYSTEM**7**

Introduction-Free Vibration of Undamped and Damped- Forced Vibration with Harmonic Excitation System –Coordinate Couplings and Principal Coordinates

UNIT III MULTI-DEGREE FREEDOM SYSTEM AND CONTINUOUS SYSTEM**9**

Multi Degree Freedom System –Influence Coefficients (Stiffness and Flexibility), Generalized Coordinates, and Co-ordinate Coupling. Lagrangian's and Hamilton Equations – Eigen Values and Eigen Vectors-Matrix Iteration Method –Approximate Methods: Dunkley, Rayleigh's, and Holzer Method - Geared Systems-Eigen Values & Eigen vectors for large system of equations using sub space, Lanczos method - Continuous System: Vibration of String, Shafts and Beams

UNIT IV VIBRATION CONTROL**9**

Specification of Vibration Limits –Vibration severity standards- Vibration as condition Monitoring tool- Vibration Isolation methods- -Dynamic Vibration Absorber, Torsional and Pendulum Type Absorber-Damped Vibration absorbers-Static and Dynamic Balancing-Balancing machines-Field balancing – Vibration Control by Design Modification- - Active Vibration Control, Basics, Piezoelectric materials, electro rheological fluids, magneto rheological fluids, shape memory alloys.

UNIT V EXPERIMENTAL METHODS IN VIBRATION ANALYSIS**10**

Vibration Analysis Overview - Experimental Methods in Vibration Analysis.-Vibration Measuring Instruments -FFT analyzer, vibration exciters, signal analysis. Selection of Sensors- Accelerometer Mountings. –Vibration Exciters-Mechanical, Hydraulic, Electromagnetic and Electrodynamics –Frequency Measuring Instruments-. System Identification from Frequency Response -Testing for resonance and mode shapes.

TOTAL: 45 PERIODS**COURSE OUTCOMES**

At the end of this course, the students will be able to

- understand the basics of vibration, its importance in engineering field.

- apply the working operations of various vibration measuring instruments.
- gain knowledge in the Concepts of multi-degree freedom system and continuous system .
- impart the various Vibration control and analysis techniques in the engineering field.
- demonstrate various Experimental Methods in Vibration Analysis

REFERENCES

1. Rao, S.S.,|| Mechanical Vibrations,|| Addison Wesley Longman, 1995.
2. Thomson, W.T. – -Theory of Vibration with Applications||, CBS Publishers and Distributors, New Delhi, 1990
3. Ramamurti. V, —Mechanical Vibration Practice with Basic Theory||,Narosa, New Delhi, 2000
4. S. Graham Kelly & Shashidar K. Kudari, —Mechanical Vibrations||, Tata McGraw –Hill Publishing Com. Ltd New Delhi,2007.
5. Singh. V.P., —Mechanical Vibrations||, Dhanpat Rai & Sons.

WEB LINKS

1. <http://www.sciencedirect.com/science/book/9780340631836>
2. <http://www.intechopen.com/books/vibration-analysis-and-control-new-trends-and-developments>

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CO5	3	3	3	-	2	-	-	-	-	-	-	2	3	3



COURSE OBJECTIVES

- To understand the various mechanisms and its design.
- To learn the kinematic analysis and its applications.
- To identify mechanisms based on the strategies of motion, degrees of freedom and elements.
- To use of the simulation software in the mechanism design process.
- To apply the analysis and synthesis method to design a mechanism for a robot.

UNIT I INTRODUCTION 15

Review of fundamentals of kinematics-classifications of mechanisms-components of mechanisms – mobility analysis – formation of one D.O.F. multi loop kinematic chains, Network formula – Gross motion concepts- Basic kinematic structures of serial and parallel robot manipulators-Compliant mechanisms- Equivalent mechanisms.

UNIT II KINEMATIC ANALYSIS 15

Position Analysis – Vector loop equations for four bar, slider crank, inverted slider crank, geared five bar and six bar linkages. Analytical methods for velocity and acceleration Analysis– four bar linkage jerk analysis. Plane complex mechanisms auxiliary point method. Graphical synthesis - Displacement – Velocity and acceleration analysis of simple mechanisms-Goodman analysis-Auxiliary point method.

UNIT III PATH CURVATURE THEORY, COUPLER CURVE 15

Fixed and moving centrodes -inflection points and inflection circle -Euler Savary equation -Bobillier's construction-Hartmann's construction-Graphical constructions-Cubic of stationary curvature. Four bar coupler curve-cusp-crunode-coupler driven six-bar mechanisms-straight line mechanisms.

UNIT IV SYNTHESIS OF FOUR BAR MECHANISMS 15

Type synthesis – Number synthesis – Associated Linkage Concept. Dimensional synthesis – function generation, path generation, motion generation. Graphical methods-Pole technique-inversion technique-point position reduction-two, three and four position synthesis of four- bar mechanisms. Analytical methods-Freudenstein's Equation-Bloch's Synthesis.

UNIT V KINEMATICS OF ROBOT 15

Introduction -topology arrangements of robotics arms -Kinematic analysis of spatial RSSR mechanism – Denavit -Hartenberg parameters -Forward and inverse kinematics of robotic manipulators. Study and use of Mechanism using Simulation Software packages.

TOTAL: 75 PERIODS

COURSE OUTCOMES

At the end of this course, the students will be able to

- familiarized with the advanced mechanism design and simulation.
- apply the kinematic analysis for different mechanism.
- gain knowledge in path curvature theory and concepts of coupler curve
- know the Synthesis of Four Bar Mechanisms, Graphical methods and Analytical methods.

- get acquaint knowledge in the Synthesis of Coupler Curve Based Mechanisms & Cam Mechanisms ideas.

REFERENCES

1. Robert L.Norton., —Design of Machinery, Tata McGraw Hill, 2005.
2. Sandor G.N., and Erdman A.G., —Advanced Mechanism Design Analysis and Synthesis, Prentice Hall, 1984.
3. Uicker, J.J., Pennock, G. R. and Shigley, J.E., -Theory of Machines and Mechanisms, Oxford University Press, 2005.
4. Amitabha Ghosh and Asok Kumar Mallik, -Theory of Mechanism and Machines, EWL P, Delhi, 1999.
5. Kenneth J, Waldron, Gary L. Kinzel, -Kinematics, Dynamics and Design of Machinery, John Wiley-sons, 1999.

WEB LINKS

1. <https://www.design-simulation.com/ddm/inventor/ddmp/index.php>
2. blog.rectorsquid.com/linkage-mechanism-designer-and-simulator/

CO-PO Mapping

Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
Cos	Programme Outcomes(Pos)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	-	2	-	-	-	-	-	-	2	3	3
CO2	3	3	3	-	2	-	-	-	-	-	-	2	3	3
CO3	3	3	3	-	2	-	-	-	-	-	-	2	3	3
CO4	3	3	3	-	2	-	-	-	-	-	-	2	3	3
CO5	3	3	3	-	2	-	-	-	-	-	-	2	3	3



COURSE OBJECTIVES

- To introduce the basic concepts and principles behind materials deformation, fracture, fatigue and creep.
- To learn about the mechanical behavior of structures and materials under different loading condition.
- To be focused in design and processing the materials from the atomic micro scale.
- To know the mechanical behavior metallic materials under different loading and temperature conditions.
- To provide an understanding of the mechanics and micro mechanisms of elastic and plastic deformation.

UNIT I BASIC CONCEPTS OF MATERIAL BEHAVIOR**9**

Elasticity in metals and polymers– Strengthening mechanisms, work hardening, solid solutioning, grain boundary strengthening, poly phase mixture, precipitation, particle, fibre and dispersion strengthening. Effect of temperature, strain and strain rate on plastic behaviour – Super plasticity – Griffith's theory,– Ductile, brittle transition in steel – High temperature fracture, creep, Hot working of metals – Larson Miller parameter – Deformation and fracture mechanism maps.

UNIT II BEHAVIOR UNDER DYNAMIC LOADS AND DESIGN APPROACHES**9**

Stress intensity factor and fracture toughness – Fatigue, low and high cycle fatigue test, crack initiation and propagation mechanisms and Paris law.- Safe life, Stresslife, strain-life and fail - safe design approaches - Effect of surface and metallurgical parameters on fatigue – Fracture of non metallic materials – Failure analysis, sources of failure, procedure of failure analysis.

UNIT III SELECTION OF MATERIALS**9**

Motivation for selection, cost basis and service requirements – Selection for mechanical properties, strength, toughness, fatigue and creep – Selection for surface durability corrosion and wear resistance – Relationship between materials selection and processing – Case studies in materials selection with relevance to aero, auto, marine, machinery and nuclear applications – Computer aided materials selection. Electrochemical Nature of Corrosion in Metals

UNIT IV MODERN METALLIC MATERIALS**9**

Dual phase steels, High strength low alloy (HSLA) steel, Transformation induced plasticity (TRIP) Steel, Maraging steel, Nitrogen steel – Intermetallics, Ni and Ti aluminides – smart materials, shape memory alloys – Metallic glass and nano crystalline materials.

UNIT V NON METALLIC MATERIALS**9**

Polymeric materials – Formation of polymer structure – Production techniques of fibers, foams, adhesives and coating – structure, properties and applications of engineering polymers – Advanced structural ceramics, WC, TiC, TaC, Al₂O₃, SiC, Si₃N₄ CBN and diamond – properties, processing and applications. Mechanical Behavior of Composites.

TOTAL: 45 PERIODS

At the end of this course, the students will be able to

- ## REFERENCES

- ## WEB LINKS

-

Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	-	2	-	-	-	-	-	-	2	3	3
CO2	3	3	3	-	2	-	-	-	-	-	-	2	3	3
CO3	3	3	3	-	2	-	-	-	-	-	-	2	3	3
CO4	3	3	3	-	2	-	-	-	-	-	-	2	3	3
CO5	3	3	3	-	2	-	-	-	-	-	-	2	3	3

COURSE OBJECTIVES

- give exposure to software tools needed to analyze engineering problems.
- expose the students to different applications of simulation and analysis tools
- give practise to solve real time problems in air conditioning, hydraulic/pneumatic systems and cam mechanisms through simulation software C / MAT lab
- expose to stress analysis(Mechanical, thermal) and heat transfer analysis through simulation software

LIST OF EXPERIMENTS

1. Analysis of Mechanical Components – Use of FEA Packages like ANSYS/NASTRAN etc.,
2. Exercises shall include analysis of
3. Machine elements under Static loads
4. Thermal Analysis of mechanical systems
5. Modal Analysis
6. Stress Analysis of an Axis -Symmetric Component
7. Machine elements under Dynamic loads
8. Harmonic Response Analysis
9. Non-linear systems
10. Use of kinematics and dynamics simulation software like ADAMS, MATLAB. Analysis of velocity and acceleration for mechanical linkages of different mechanisms.

TOTAL: 60 PERIODS**COURSE OUTCOME**

- simulate components like Air conditioning system, Hydraulic and pneumatic cylinder and camfollower mechanism.
- do simple analysis in both structural and non-structural problems.
- Solve thermal conductivity and thermal stress related problems using simulation software
- do model, analyse and simulate experiments to meet realworld system and evaluate the performance.

CO-PO Mapping

Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	2	-	-	-	-	-	-	2	2	2
CO2	3	-	-	-	2	-	-	-	-	-	-	2	2	2
CO3	3	-	-	-	2	-	-	-	-	-	-	2	2	2
CO4	3	-	-	-	2	-	-	-	-	-	-	2	2	2



COURSE OBJECTIVES

- give an opportunity to the student to get hands on training in the fabrication of one or more components of a complete working model, which is designed by them
- make a revision of the fundamental knowledge acquired during earlier semesters and apply to real life problems.
- form a small team and execute a simple project in the area of design, analysis, fabrication, and thermal engineering
- identify, formulate and solve engineering problems

GUIDELINE FOR REVIEW AND EVALUATION

Each student 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: 30 PERIODS**COURSE OUTCOMES**

At the end of this course, the students will be able to

- learn elements of various modeling software for modeling and analyzing real time components in a part or assembly and study their Static and dynamic characteristics
- learn the uses of design principles and develop conceptual and engineering design elements of any components.
- fabricate any components using proper manufacturing tools.
- design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political safety, manufacturability and sustainability aspects.

CO-PO Mapping

Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
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CO1	3	-	2	-	-	-	-	-	3	3	3	2	2	2
CO2	3	-	2	-	-	-	-	-	3	3	3	2	2	2
CO3	3	-	2	-	-	-	-	-	3	3	3	2	2	2
CO4	3	-	2	-	-	-	-	-	3	3	3	2	2	2



PED16151 DESIGN FOR MANUFACTURE, ASSEMBLY AND ENVIRONMENTS 3 0 0 3

- To know the concept of design for manufacturing, assembly and environment.
- To gain knowledge in computer application in design for manufacturing and assembly.
- To understand the selection of materials , methods, fit and tolerance concepts to design a product.
- To familiarize the basic concept of design for castings, welding, sheet metal, forging and manufacturing processes.
- To learn about the basic procedure of design for assembly and environments.

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.

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

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

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

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

COURSE OUTCOMES

- get acquainted with the design for manufacturing, assembly and environment.
- select the materials, methods, fit and tolerance to design a product.

- demonstrate the design procedure for castings, welding, forging, sheet metal and manufacturing processes.
- integrate the knowledge of compliance analysis and interference analysis for assembly.
- apply a systematic understanding of knowledge in the environmental objectives and techniques to reduce environmental impact.

REFERENCES

1. Boothroyd, G, 1980 Design for Assembly Automation and Product Design. New York, Marcel Dekker.
2. Bralla, Design for Manufacture handbook, McGraw hill, 1999.
3. Boothroyd, G, Heartz and Nike, Product Design for Manufacture, Marcel Dekker, 1994.
4. Dickson, John. R, and Corroda Poly, Engineering Design and Design for Manufacture and Structural
5. Approach, Field Stone Publisher, USA, 1995.

WEB LINKS

1. web.mit.edu/meeker/Public/DFMAandIPDP.pdf
2. <https://www.vidyarthiplus.com/.../Thread-CC7201-Design-for-Manufact...>
3. montalee.ie.engr.tu.ac.th/ch8english.pdf

CO-PO Mapping

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COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	-	2	-	-	-	-	-	-	2	3	3
CO2	3	3	3	-	2	-	-	-	-	-	-	2	3	3
CO3	3	3	3	-	2	-	-	-	-	-	-	2	3	3
CO4	3	3	3	-	2	-	-	-	-	-	-	2	3	3
CO5	3	3	3	-	2	-	-	-	-	-	-	2	3	3



COURSE OBJECTIVES

- To understand the rapid tooling software for rapid prototyping and rapid prototyping in manufacturing industries.
- To learn about the liquid and solid based RPT systems.
- To get knowledge of power based RPT systems.
- To understand about the techniques used in CAD modelling and reverse engineering.
- To study about the various application of rapid tooling.

UNIT I INTRODUCTION

7

Need - Development of RP systems – RP process chain - Impact of Rapid Prototyping and Tooling on Product Development – Benefits- Applications – Digital prototyping - Virtual prototyping.

UNIT II LIQUID BASED AND SOLID BASED RAPID PROTOTYPING SYSTEMS 10

Stereo lithography Apparatus, Fused deposition Modeling, Laminated object manufacturing, three dimensional printing: Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies.

UNIT III POWDER BASED RAPID PROTOTYPING SYSTEMS 10

Selective Laser Sintering, Direct Metal Laser Sintering, Three Dimensional Printing, Laser Engineered Net Shaping, Selective Laser Melting, Electron Beam Melting: Processes, materials, products, advantages, applications and limitations – Case Studies.

UNIT IV REVERSE ENGINEERING AND CAD MODELING 10

Basic concept- Digitization techniques – Model Reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data Requirements – geometric modeling techniques: Wire frame, surface and solid modeling – data formats – Data interfacing, Part orientation and support generation, Support structure design, Model Slicing and contour data organization, direct and adaptive slicing, Tool path generation.

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: 45 PERIODS**COURSE OUTCOMES**

At the end of this course, the students will be able to

- learn about benefits and applications of rapid prototyping and tooling.
- understand about different types of dimensional printing.
- know about various types of laser sintering methods
- get knowledge about various CAD modeling and Digitization techniques.
- get awareness about various types of tools for rapid prototyping

REFERENCES

1. Rapid prototyping: Principles and applications, second edition, Chua C.K., Leong K.F., and Lim C.S.,
World Scientific Publishers, 2003.
2. Rapid Tooling: Technologies and Industrial Applications, Peter D.Hilton,Hilton/Jacobs, Paul F.Jacobs, CRC press, 2000.
3. Rapid prototyping, Andreas Gebhardt, Hanser Gardener Publications, 2003.
4. Rapid Prototyping and Engineering applications : A tool box for prototype development, Liou W.Liou, Frank W.Liou, CRC Press, 2007.
5. Rapid Prototyping: Theory and practice, Ali K. Kamrani, Emad Abouel Nasr, Springer, 2006

WEB LINKS

1. [nptel.ac.in/courses/112102103//Module%20G/Module%20G\(4\)/p1.htm](http://nptel.ac.in/courses/112102103//Module%20G/Module%20G(4)/p1.htm)
2. www.garpa.org/assets/CS2007_india_material.pdf

CO-PO Mapping

Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	2	-	1	-	-	-	-	2	3	2
CO2	3	-	-	-	2	-	1	-	-	-	-	2	3	2
CO3	3	-	-	-	2	-	1	-	-	-	-	2	3	2
CO4	3	-	-	-	2	-	1	-	-	-	-	2	3	2
CO5	3	-	-	-	2	-	1	-	-	-	-	2	3	2



COURSE OBJECTIVES

- To know the principles of objectives of production systems and manufacturing strategies.
- To acquire in depth knowledge in the concepts of group technologies and process planning techniques.
- To be familiar with planning and control in shop floor and data collection systems.
- To get clear focus in the objectives of production monitoring, process control and inspection techniques.
- To get knowledge in the practice of various manufacturing systems, rapid prototyping and artificial intelligence through CIM.

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 PLANNING 5

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

UNIT III COMPUTER AIDED PLANNING AND CONTROL 10

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

UNIT IV COMPUTER MONITORING 10

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

UNIT V INTEGRATED MANUFACTURING SYSTEM 15

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

TOTAL: 45 PERIODS

COURSE OUTCOMES

At the end of this course, the students will be able to

- know concepts of manufacturing strategy and analysis
- study the principles of group technology and computer aided process planning.
- be familiar with production planning and cost controlling techniques.
- understand the concepts of computer controlling and monitoring systems.
- acquire knowledge in Flexible manufacturing systems

REFERENCES

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

WEB LINKS

1. www.emeraldinsight.com/loi/ims
2. https://en.wikipedia.org/wiki/Computer-integrated_manufacturing
3. elearning.vtu.ac.in/11/enotes/CompIntManf/unit1-KM.pdf

CO-PO Mapping

Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	2	-	1	2	-	-	-	1	1	1
CO2	2	-	-	-	2	-	1	2	-	-	-	1	1	1
CO3	2	-	-	-	2	-	1	2	-	-	-	1	1	1
CO4	2	-	-	-	2	-	1	2	-	-	-	1	1	1
CO5	2	-	-	-	2	-	1	2	-	-	-	1	1	1



COURSE OBJECTIVES

- To acquire knowledge in the various types of bearings used in industries.
- To know about the basic design consideration for various bearings.
- To get clear focus in the concepts behind rolling bearings and its selections.
- To familiar with the principles of dynamics of hydrodynamic bearings.
- To know the principles of rotors under various dynamic conditions.

UNIT I CLASSIFICATION AND SELECTION OF BEARINGS 6

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

UNIT II DESIGN OF FLUID FILM BEARINGS 10

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

UNIT III SELECTION AND DESIGN OF ROLLING BEARINGS 10

Contact Stresses in Rolling bearings- Centrifugal stresses-Elasto hydrodynamic lubrication- 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

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

TOTAL: 45 PERIODS

COURSE OUTCOMES

At the end of this course, the students will be able to

- know about the classification and selection of bearings
- design procedures in fluid film bearings.

- understand the concepts of dynamic and vibration analysis and trouble shooting techniques.
- analysis the bearings under dynamic conditions.
- familiar with concepts of rotor balancing and design configuration.

REFERENCES

1. Neale, M.J. -Tribology Hand Bookl, Butterworth Heinemann, United Kingdom 2001.
2. Cameron, A. —Basic Lubrication Theoryl, Ellis Herward Ltd., UK, 1981
3. Halling, J. (Editor) – —Principles of Tribology —, Macmillian – 1984.
4. Williams J.A. — Engineering Tribologyl, Oxford Univ. Press, 1994.

WEB LINKS

1. nptel.ac.in/courses/112105125/pdf/mod14les1.pdf
2. accessengineeringlibrary.com/.../fundamentals-of-fluid-film-lubrication

CO-PO Mapping

Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	1	2	3	-	-	-	-	1	-	-	-	2	2	3
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CO3	1	2	3	-	-	-	-	1	-	-	-	2	2	3
CO4	1	2	3	-	-	-	-	1	-	-	-	2	2	3
CO5	1	2	3	-	-	-	-	1	-	-	-	2	2	3



ELECTIVE II

PED16251

COMPOSITE MATERIALS AND MECHANICS

3 0 0 3

COURSE OBJECTIVES

- To study the fundamentals of composite material strength and the rule of mixtures.
- To understand the reinforced laminate for different combinations of plies with different orientations of the fiber.
- To analyze the stress, strain and failure criteria of the composite laminate.
- To know the equation of motion and analyze the bending, buckling and frequency of the composite laminate.
- To learn the thermo-mechanical behavior and isotropic and orthotropic layered structure of the laminate.

UNIT I LAMINA CONSTITUTIVE RELATIONS

12

Definition –Need – General Characteristics, Applications. Fibers – Glass, Carbon, Ceramic and Agamid fibers. Matrices – Polymer, Graphite, Ceramic and Metal Matrices – Characteristics of fibers and matrices. Lamina Constitutive Equations: Lamina Assumptions – Macroscopic Viewpoint. Generalized Hooke's Law. Reduction to Homogeneous Orthotropic Lamina –Isotropic limit case, Orthotropic Stiffness matrix (Q_{ij}), Typical Commercial material properties, Rule of Mixtures. Generally Orthotropic Lamina – Transformation Matrix, Transformed Stiffness. Manufacturing: Bag Molding – Compression Molding – Pultrusion –Filament Winding – Other Manufacturing Processes.

UNIT II FLAT PLATE LAMINATE CONSTITUTIVE RELATIONS

10

Definition of stress and Moment Resultants. Strain Displacement relations. Basic Assumptions of Laminated anisotropic plates. Laminate Constitutive Equations –Coupling Interactions, BalancedLaminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Laminate Structural Moduli. Evaluation of Lamina Properties from Laminate Tests. Quasi-Isotropic Laminates. Determination of Lamina stresses within Laminates.

UNIT III LAMINA STRENGTH ANALYSIS

5

Introduction - Maximum Stress and Strain Criteria. Von-Misses Yield criterion for Isotropic Materials. Generalized Hill's Criterion for Anisotropic materials. Tsai-Hill's Failure Criterion for Composites. Tensor Polynomial (Tsai-Wu) Failure criterion. Prediction of laminate Failure

UNIT IV ANALYSIS OF LAMINATED FLAT PLATES

10

Equilibrium Equations of Motion. Energy Formulations. Static Bending Analysis. Buckling Analysis. Free Vibrations – Natural Frequencies

UNIT V EFFECT OF THERMAL PROPERTIES

8

Modification of Hooke's Law due to thermal properties - Modification of Laminate Constitutive Equations. Orthotropic Lamina - special Laminate Configurations – Unidirectional, Off-axis, Symmetric Balanced Laminates - Zero C.T.E laminates, Thermally Quasi-Isotropic Laminates.

TOTAL: 45 PERIODS

COURSE OUTCOMES

At the end of this course, the students will be able to

- study the fundamentals and properties of composite materials and the rule of mixtures.
- understand the reinforcement of laminate for different combinations of plies and the stress-strain displacement.
- analyze the residual stress-strain and failure of the composite materials.
- study the equation of motion and analyze the laminated plate in bending and buckling.
- gain knowledge in thermo-mechanical behavior, isotropic and orthotropic structure.

REFERENCES

1. Gibson, R.F., Principles of Composite Material Mechanics, McGraw-Hill, 1994, Second Edition – CRC press in progress.
2. Hyer, M.W., —Stress Analysis of Fiber – Reinforced Composite Materials, McGraw-Hill, 1998
3. Issac M. Daniel and Ori Ishai, —Engineering Mechanics of Composite Materials, Oxford University Press-2006, First Indian Edition - 2007
4. Mallick, P.K., Fiber, Reinforced Composites: Materials, Manufacturing and Design, Manel Dekker Inc, 1993.
5. Halpin, J.C., —Primer on Composite Materials, Analysis, Technomic Publishing Co., 1984.

WEB LINKS

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2. www.springer.com > ... > Characterization & Evaluation of Materials

CO-PO Mapping

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CO4	3	-	-	-	2	-	1	-	-	-	-	2	3	2
CO5	3	-	-	-	2	-	1	-	-	-	-	2	3	2



COURSE OBJECTIVES

- To understand the basic concepts associated with the design and functioning and applications of Robots
- To study about the drives and End of tooling in Robots
- To study about the sensors used in robotics.
- To learn about analyzing robot kinematics and robot programming
- To study about the safety requirement associated with installation testing and maintenance.

UNIT I INTRODUCTION AND ROBOT KINEMATICS 10

Definition need and scope of Industrial robots – Robot anatomy – Work volume – Precision movement – End effectors – **Sensors. Robot Kinematics** – Direct and inverse kinematics – Robot trajectories – Control of robot manipulators – **Robot dynamics** – Methods for orientation and location of objects.

UNIT II ROBOT DRIVES AND CONTROL 9

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

UNIT III ROBOT SENSORS 9

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

UNIT IV ROBOT CELL DESIGN AND APPLICATION 9

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

UNIT V ROBOT PROGRAMMING, ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS 8

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

TOTAL: 45 PERIODS

COURSE OUTCOMES

At the end of this course, the students will be able to

- learn the fundamentals of robot working, Robot characteristics, subsystems.
- identity the drives and control systems used for different application in industrial purpose.
- find out the sensors for specific applications.

- draw the layout of robot cell at different working environment.
- explore the application of artificial intelligence techniques.

REFERENCES

1. K.S.Fu, R.C. Gonzalez and C.S.G. Lee, —Robotics Control, Sensing, Vision and Intelligence, Mc Graw Hill, 1987.
2. Yoram Koren, Robotics for Engineers' Mc Graw-Hill, 1987.
3. Kozyrey, Yu. -Industrial Robots, MIR Publishers Moscow, 1985.
4. Richard. D, Klafter, Thomas, A, Chmielewski, Michael Negin, —Robotics Engineering – An Integrated Approach, Prentice-Hall of India Pvt. Ltd., 1984.
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1. <https://www.vidyarthiplus.com/vp/Thread-ED7071-Industrial-Robotics-and-Expert-Systems-Question-Bank-VEC-Edition>
2. <https://books.google.co.in/books?isbn=9401167680>

CO-PO Mapping

Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	2	-	-	-	-	-	-	2	2	2
CO2	3	-	-	-	2	-	-	-	-	-	-	2	2	2
CO3	3	-	-	-	2	-	-	-	-	-	-	2	2	2
CO4	3	2	-	-	2	-	-	-	-	-	-	2	2	2
CO5	3	-	-	-	2	-	-	-	-	-	-	2	2	2



COURSE OBJECTIVES

- To study fundamental concepts of mechatronics systems
- To acquire knowledge sensors and Transducers
- To understand the mechanisms of actuators used fundamentally in mechatronics systems
- To gain knowledge on basic concepts of programmable controllers and signal conditioning
- To impact the principles of Computer Numerical Control Systems (CNC) and microcontroller

UNIT I INTRODUCTION 5

Introduction to Mechatronics - Systems- Need for Mechatronics - Emerging area of Mechatronics - Classification of Mechatronics - Measurement Systems – Control Systems.

UNIT II SENSORS AND TRANSDUCERS 12

Introduction - Performance Terminology – Potentiometers - LVDT – Capacitance sensors - Strain gauges - Eddy current sensor - Hall Effect sensor – Temperature sensors - Light sensors - Selection of sensors - Signal processing.

UNIT III ACTUATORS 12

Actuators – Mechanical - Electrical - Fluid Power - Piezoelectric – Magneto strictive - 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 PERIODS

COURSE OUTCOMES

At the end of this course, the students will be able to

- have a brief idea of the mechatronic systems and overview of control systems & actuators
- learn about various sensors and transducers
- understand the usage of various type actuators and their applications
- gather knowledge about various signal conditioning units, amplifiers, logic gates and their role in programmable logic controllers
- know about CNC systems structure and their application and also to know about microcontrollers

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4. Godfrey C. Onwubolu, "Mechatronics Principles and Applications", Elsevier, 2006.
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CO-PO Mapping

Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	2	-	1	-	2	-	-	-	-	-	-	-	2	2
CO2	2	-	1	-	2	-	-	-	-	-	-	-	2	2
CO3	2	-	1	-	2	-	-	-	-	-	-	-	2	2
CO4	2	-	1	-	2	-	-	-	-	-	-	-	2	2
CO5	2	-	1	-	2	-	-	-	-	-	-	-	2	2



COURSE OBJECTIVES

- To ability to apply knowledge in optimization design techniques
- To understand basic optimization methods and its techniques.
- To familiarize about the recent trends in optimization techniques
- To study the application of static and dynamic optimization techniques
- To gain knowledge dynamic applications of various linkage mechanisms.

UNIT I UNCONSTRAINED OPTIMIZATION TECHNIQUES 10

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

UNIT II CONSTRAINED OPTIMIZATION TECHNIQUES 10

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

UNIT III ADVANCED OPTIMIZATION TECHNIQUES 10

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

UNIT IV STATIC APPLICATIONS 8

Structural applications – Design of simple truss members - Design applications – Design of simple axial, transverse loaded members for minimum cost, weight – Design of shafts and torsionally loaded members – Design of springs.

UNIT V DYNAMIC APPLICATIONS 7

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

TOTAL: 45 PERIODS

COURSE OUTCOMES

At the end of this course, the students will be able to

- understand the basic principles and classification of optimization of optimization
- know the use of optimization techniques for geometric programming.
- solve the various constrained optimization problems.
- implement the static and dynamic optimization techniques.
- familiarise the optimization techniques in dynamic problems.

REFERENCES

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

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2. http://nptel.iitk.ac.in/courses/Webcourse-contents/IISc-BANG/OPTIMIZATION%20METHODS/pdf/Module_1/M1L1_LN.pdf

CO-PO Mapping

Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
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CO1	3	3	3	2	2	-	-	-	1	-	-	2	3	3
CO2	3	3	3	2	2	-	-	-	1	-	-	2	3	3
CO3	3	3	3	2	2	-	-	-	1	-	-	2	3	3
CO4	3	3	3	2	2	-	-	-	1	-	-	2	3	3
CO5	3	3	3	2	2	-	-	-	1	-	-	2	3	3



COURSE OBJECTIVES

- To provide students an exposure to disasters, their significance and types.
- To understand approaches to the classifications, cause and impacts of disaster.
- To gain a basic knowledge in the approaches to Disaster Risk Reduction (DRR).
- To enhance awareness of disaster management by institutional arrangements in the county.
- To develop rudimentary ability to respond to their surroundings with potential disaster management.

UNIT I INTRODUCTION TO DISASTERS 9

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Disasters: Types of disasters –Earthquake, Landslide, Flood, Drought, Fire etc. - Classification, Causes, Impacts including social, economic, political, environmental, health, psychosocial, etc.- Differential impacts- in terms of caste, class, gender, age, cation, disability - Global trends in disasters: urban disasters, pandemics, complex emergencies, Climate change- Dos and Don'ts during various types of Disasters.

UNIT II APPROACHES TO DISASTER RISK REDUCTION (DRR) 9

Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community based DRR, Structural- nonstructural measures, Roles and responsibilities of- community, Panchayat Raj Institutions/Urban Local Bodies (PRIs/ULBs), States, Centre, and other stake-holders- Institutional Processes and Framework at State and Central Level- State Disaster Management Authority(SDMA) – EarlyWarning System – Advisories from Appropriate Agencies.

UNIT III INTER-RELATIONSHIP BETWEEN DISASTERS AND DEVELOPMENT 9

Factors affecting Vulnerabilities, differential impacts, impact of Development projects such as dams, embankments, changes in Land-use etc.- Climate Change Adaptation- IPCC Scenario and Scenarios in the context of India - Relevance of indigenous knowledge, appropriate technology and local resources.

UNIT IV DISASTER RISK MANAGEMENT IN INDIA 9

Hazard and Vulnerability profile of India, Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, Disaster Management Act and Policy - Other related policies, plans, programmes and legislation – Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment.

UNIT V DISASTER MANAGEMENT: APPLICATIONS AND CASE STUDIES AND FIELD WORKS 9

Landslide Hazard Zonation: Case Studies, Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made

COURSE OBJECTIVES

- To provide knowledge on information systems, related issues and use of information technology.
- To make aware of global information technology and solving issues related to social challenges.
- To introduce and understand various models of e-business for application.
- To impart knowledge on consumer oriented e-commerce.
- To give input on EDI concepts and their applications in business.

UNIT I FUNDAMENTALS OF INFORMATION SYSTEMS 12

Information systems in business, fundamentals of information systems solving business problems with information systems. Business Information systems, Transaction processing systems, management information systems and decision support systems. Artificial intelligence technologies in business, information system for strategic applications and issues in information technology.

UNIT II ISSUES IN MANAGING INFORMATION TECHNOLOGY 12

Managing information resources and technologies global information technology, management, planning and implementing change, integrating business change with IT, security and ethical challenges in managing IT, social challenges of information technology.

UNIT III INTRODUCTION TO E-BUSINESS 8

E-commerce frame work, Media convergence, Consumer applications, Organization applications. EBUSINESS MODEL: Architectural frame work for E-commerce, Application services and transaction Models – B2C Transactions, B2B Transactions, Intra- Organisational Transactions. WWW Architecture: Client server structure of the web, e-Commerce architecture, Technology behind the web.

UNIT IV CONSUMER-ORIENTED E-COMMERCE 7

Consumer oriented Application: Finance and Home Banking, Home shopping, Home Entertainment, Mercantile Process Models, Consumers perspective, Merchants perspective.

UNIT V ELECTRONICS DATA INTERCHANGE (EDI) 6

EDI Concepts, Applications in business – components of international trade, Customs Financial EDI, Electronic fund transfer, Manufacturing using EDI, Digital Signatures and EDI.

TOTAL: 45 PERIODS

COURSE OUTCOMES

At the end of this course, the students will be able to

- understand fundamentals of information system and its commercial applications for solving problems.
- develop an integrative knowledge of the Information Technology applied for management in organization
- gain knowledge on e-business models and web-technologies involved in organisational and commercial transactions.

- apply e-commerce models for banking, shopping, entertainment etc.
- identify components of EDI like international trade and digital signature.

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1. Sadogopan. S., -Management Information Systems" 1998Edition, PHI ISBN 81-20311809
2. Murdick. G.R., —Information systems for modern management", 2ndEdition. PHI.
3. Jams. A O'Brien., —Management Information systems- managing information technology in the internet worked enterprisel Tata McGraw Hill publishing company limited, 2002.
4. Laaudon & Laudon, —Management Information Systems", PHI ISBN 81-203-1282-1.1998.
5. Turban, McLean and Wether, Information Technology for Management –Transforming Organisations in the Digital Economy, John Wiley, 2008.

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2. www.nptel.ac.in/courses/122105022/

CO-PO Mapping

Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	2	-	-	-	-	-	-	2	2	2
CO2	3	3	3	2	2	-	-	-	-	-	-	2	2	2
CO3	3	3	3	2	2	-	-	-	-	-	-	2	2	2
CO4	3	3	3	2	2	-	-	-	-	-	-	2	2	2
CO5	2	2	2	2	3	-	-	-	-	-	-	3	2	2



COURSE OBJECTIVE

- To impart knowledge in reliability concepts, reliability estimation methods and reliability improvement methods
- To familiarize Data collection, distribution and plotting methods involved in reliability engineering
- To understand various reliability assessment systems
- To gain knowledge in Life testing methods involved in reliability engineering
- To understand various reliability improvement techniques

UNIT I RELIABILITY CONCEPTS 9

Reliability definition – Quality and Reliability– Reliability mathematics – Reliability functions – Hazard rate – Measures of Reliability – Design life –A priori and posteriori probabilities – Mortality of a component – Mortality curve – Useful life.

UNIT II LIFE DATA ANALYSIS 11

Data collection –Non Parametric methods: Ungrouped/Grouped, Complete/Censored data – Time to failure distributions: Exponential, Weibull – Probability plotting – Goodness of fit tests.

UNIT III RELIABILITY ASSESSMENT 10

Different configurations – Redundancy – k out of n system – Complex systems: RBD – Baye's approach – Cut and tie sets – Fault Trees – Standby systems.

UNIT IV RELIABILITY MONITORING 8

Life testing methods: Failure terminated – Time terminated – Sequential Testing –Reliability growth monitoring – Reliability allocation – Software reliability-Human reliability.

UNIT V RELIABILITY IMPROVEMENT 7

Analysis of downtime – Repair time distribution – System repair time – Maintainability prediction – Measures of maintainability – Inspection decisions –System Availability.

TOTAL: 45 PERIODS

COURSE OUTCOMES

At the end of this course, the students will be able to

- understand the quality, reliability and other concepts of products.
- gain knowledge in data analysis through distribution methods.
- know the various systems involved in reliability assessment.
- apply reliability monitoring methods and software reliability.
- gain Knowledge on reliability improvement systems.

REFERENCES

1. Patrick D T o'connor, —Practical Reliability Engineeringll, John-Wiley and Sons inc, 2002.
2. David J Smith, —Reliability, Maintainability and Risk: Practical Methods for Engineersl, Butterworth, 2002
3. Way kuo, Rajendra Prasad V, Frank A and Tillman, ching- lai Hwang —Optimal Reliability Design and Applicationsl, Cambridge University Press P ltd., 2001.
4. Srinath I.S, Engineering Design and Reliability, ISTE, 1999.
5. Oleg Vinogradov, —Introduction to Mechanical Reliability: A Designers Approach", Hemisphere Publications, 1991.

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1. <https://www.palisade.com/.../pdf/EngineeringReliabilityConcepts.pdf>
2. www.nptel.ac.in/downloads/105108128/

CO-PO Mapping

Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	2	-	-	-	-	-	-	2	2	2
CO2	3	3	3	2	2	-	-	-	-	-	-	2	2	2
CO3	3	3	3	2	2	-	-	-	-	-	-	2	2	2
CO4	3	3	3	2	2	-	-	-	-	-	-	2	2	2
CO5	2	2	2	2	3	-	-	-	-	-	-	3	2	2



COURSE OBJECTIVES

- To learn about the basis of nanomaterial science, properties and applications in different fields.
- To understand the methods of preparation of nanomaterials.
- To learn about nanoforms of carbon, nanometaloxides, their properties and applications
- To gain knowledge on characterization techniques like SEM,AFM,STM for analysis of nanomaterials
- To learn the significance and impact of nanoscience in various fields

UNIT I INTRODUCTION**8**

Nanoscale Science and Technology- Implications for Physics, Chemistry, Biology and Engineering- Classifications of nanostructured materials- nano particles- quantum dots, nanowires-ultra-thinfilms multilayered materials. Length Scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic and Thermal properties. Introduction to properties and motivation for study (qualitative only).

UNIT II GENERAL METHODS OF PREPARATION**9**

Bottom-up Synthesis-Top-down Approach: Co-Precipitation, Ultrasonication, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE.

UNIT III NANOMATERIALS**12**

Nanoforms of Carbon - Buckminster fullerene- graphene and carbon nanotube, Single wall carbon Nanotubes (SWCNT) and Multi wall carbon nanotubes (MWCNT)- methods of synthesis(arc-growth, laser ablation, CVD routes, Plasma CVD), structure-property Relationships applications- Nanometal oxides- ZnO, TiO₂,MgO, ZrO₂, NiO, nanoalumina, CaO, AgTiO₂, Ferrites, Nanoclays functionalization and applications-Quantum wires, Quantum dots-preparation, properties and applications

UNIT IV CHARACTERIZATION TECHNIQUES**9**

X-ray diffraction technique, Scanning Electron Microscopy - environmental techniques, Transmission Electron Microscopy including high-resolution imaging, Surface Analysis techniques- AFM, SPM, STM, SNOM, ESCA, SIMS-Nano indentation

UNIT V APPLICATIONS**7**

Nano InfoTech: Information storage- nano computer, molecular switch, super chip, nanocrystal, Nano bio techlogy: nano probes in medical diagnostics and biotechnology, Nano medicines, Targetted drug delivery, Bioimaging - Micro Electro Mechanical Systems (MEMS), Nano Electro Mechanical Systems (NEMS)- Nanosensors, nano crystalline silver for bacterial inhibition, Nanoparticles for sunbarrier products - In Photostat, printing, solar cell, battery

TOTAL: 45 PERIODS

COURSE OUTCOMES

At the end of this course, the students will be able to

- familiarize with the basics of nanomaterials science
- develop knowledge on the preparation methods of nanomaterials
- gain knowledge on the types of nanomaterials available
- acquire knowledge on various characterization techniques for analyzing nanomaterials
- know the application of nanomaterials in various fields

REFERENCES

1. Edelstein. A.S., and R.C. Cammearata, eds., -Nanomaterials: Synthesis, Properties and Applications, Institute of Physics Publishing, Bristol and Philadelphia, 1996.
2. Mark Ratner and Daniel Ratner —Nanotechnology: A gentle introduction to the next big ideal., Pearson Education Inc., 2003, Printice Hall/PTR, New Jersy, USA
3. John Dinardo. N, —Nanoscale charecterisation of surfaces & Interfaces, 2nd edition,
4. Weinheim Cambridge, Wiley-VCH, 2000
5. Timp. G, —Nanotechnology, AIP press/Springer, 1999.

WEB LINKS

1. <https://en.wikipedia.org/wiki/Nanotechnology>
2. www.nanoscience.com

CO-PO Mapping

Mapping of Course Outcomes with Programme Outcomes														
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
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CO4	3	3	3	2	2	-	-	-	-	-	-	2	2	2
CO5	2	2	2	2	3	-	-	-	-	-	-	3	2	2



COURSE OBJECTIVES

- develop ability to identify problems to solve through project works.
- get exposure to literature review related to project problem and how to find the gap.
- get exposure to required design procedure, experimental setup, analysis package to solve the identified problem.
- Prepare project reports, practice to face viva- voce examination

The student works on a topic approved by the head of the department under the guidance of a faculty member and prepares a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

COURSE OUTCOMES

At the end of this course ,the students will be able to

- identify feasible problems to solve through project works
- Collect literature through research journals and identify the gap in selected area
- Devise the methodology to find solution through gathering complete knowledge on materials/design procedure/analysis and optimisation techniques/ availability of experimental setup/ company permission and other documentation procedures to execute the project
- Prepare project report as per format and confidently face viva voce with proper PPT for presentation

CO-PO Mapping

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CO3	3	-	2	-	-	-	-	-	3	3	3	2	2	2
CO4	3	-	2	-	-	-	-	-	3	3	3	2	2	2

- drive mathematical models of modal analysis for display, response, spatial and system models.

REFERENCES

1. Ewins D J, “Modal Testing: Theory and Practice “, John Wiley & Sons Inc., 1984.
2. Gaetan.Kerchen, “Modal analysis of non linear mechanical system”, CISM International system,2014
3. Singiresu S.RAO, “Vibration of Continuous System”,2007
4. S.K.Dwivedy, “Analysis of mechanical System”, 2008
5. Nuno Manuel Mendes Maia et al,” Theoretical and Experimental Modal Analysis”, Wiley John & sons, 1998.

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2. www.springer.com/gp/book/9783709117903
3. <https://hal.inria.fr/docs/00/56/17/57/PDF/paper.pdf>

CO-PO Mapping

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CO4	2	2	2	-	-	-	-	-	-	-	-	2	2	2
CO5	2	2	2	-	-	-	-	-	-	-	-	2	2	2



COURSE OBJECTIVES

To enable the students to

- get trained in preparing project reports and how to face reviews and viva voce examinations.
- develop ability to identify problems to solve through project works.
- acquire knowledge on literature review related to project problem and how to find the gap.
- gain exposure to required design procedure, experimental setup, analysis package to solve the identified problem.

COURSE OUTCOMES

At the end of this course, the students will be able to

- to take up any challenging practical problems and find solution by formulating proper methodology.
- collect literature through research journals and identify the gap in selected area
- devise the methodology to find solution through gathering complete knowledge on materials/design procedure/analysis and optimisation techniques/ availability of experimental setup/ company permission and other documentation procedures to execute the project.
- prepare project report as per format and confidently face viva voce with proper PPT for presentation

CO-PO Mapping

Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
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CO3	3	-	2	-	-	-	-	-	3	3	3	2	2	2
CO4	3	-	2	-	-	-	-	-	3	3	3	2	2	2



COURSE OBJECTIVES

- To understand the concepts of productivity and analyze its factors and models.
- To learn the concepts of management by objectives (MBO) and performance objective Productivity (POP).
- To study the elements of organizational transformation, reengineering principles and models.
- To familiarize the reengineering process improvement and its models like LMICIP and NPRDC.
- To gain the knowledge about reengineering tools, techniques and implementation.

UNIT I PRODUCTIVITY**9**

Productivity Concepts – Macro and Micro factors of productivity – Dynamics of Productivity - Productivity Cycle Productivity Measurement at International, National and Organization level - Productivity measurement models

UNIT II SYSTEMS APPROACH TO PRODUCTIVITY MEASUREMENT**9**

Conceptual frame work, Management by Objectives (MBO), Performance Objectivities Productivity (POP) – Methodology and application to manufacturing and service sector.

UNIT III ORGANIZATIONAL TRANSFORMATION**9**

Elements of Organizational Transformation and Reengineering-Principles of organizational transformation and re-engineering, fundamentals of process reengineering, 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 PERIODS**COURSE OUTCOMES**

After completion of the course the students will be able to

- gain knowledge on macro and micro factors of productivity and measurement models.
- understand the system approach to productivity measurement.
- familiarise the process of organizational transformations .
- become knowledgeable about re-engineering process improvement models.
- learn re-engineering tools ,implementation techniques and analyze the problems involved.

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1. Sumanth, D.J., 'Productivity Engineering and Management', TMH, New Delhi, 1990.
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CO-PO Mapping

Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2	3	1	-	-	-	-	-	2	1	2
CO2	2	2	2	2	3	1	-	-	-	-	-	2	1	2
CO3	2	2	2	2	3	1	-	-	-	-	-	2	2	2
CO4	2	2	2	2	3	1	-	-	-	-	-	2	2	2
CO5	2	2	2	2	3	1	-	-	-	-	-	2	2	2



COURSE OBJECTIVES

- To familiarize the students to know the various hydraulic systems and hydraulic actuators.
- To understand the control valve and actuation systems.
- To learn to design Hydraulic circuits effectively.
- To acquire knowledge to design the pneumatic systems and circuits.
- To know about pneumatic equipments, design calculation and use of microprocessors.

UNIT I OIL HYDRAULIC SYSTEMS AND HYDRAULIC ACTUATORS 5
Hydraulic Power Generators – Selection and specification of pumps, pump characteristics. Linear and Rotary Actuators – selection, specification and characteristics.

UNIT II CONTROL AND REGULATION ELEMENTS 12
Pressure - direction and flow control valves - relief valves, non-return and safety valves - actuation systems.

UNIT III HYDRAULIC CIRCUITS 5
Reciprocation, quick return, sequencing, synchronizing circuits - accumulator circuits - industrial circuits - press circuits - hydraulic milling machine - grinding, planning, copying, - forklift, earth mover circuits- design and selection of components – safety and emergency mandrels.

UNIT IV PNEUMATIC SYSTEMS AND CIRCUITS 16
Pneumatic fundamentals - control elements, position and pressure sensing – logic circuits - switching circuits - fringe conditions modules and these integration -sequential circuits - cascade methods - mapping methods - step counter method -compound circuit design - combination circuit design.

UNIT V INSTALLATION, MAINTENANCE AND SPECIAL CIRCUITS 7
Pneumatic equipments- selection of components - design calculations – application -fault finding - hydro pneumatic circuits - use of microprocessors for sequencing -PLC, Low cost automation - Robotic circuits.

TOTAL: 45 PERIODS

COURSE OUTCOMES

After learning the course, the students will be able to

- have thorough knowledge of hydraulic power generator, pumps and various actuators.
- gain knowledge of control and regulation elements.
- design an appropriate hydraulic circuits for various Engineering applications.
- acquire knowledge on designing of pneumatic circuits.
- select the components for designing hydro pneumatic circuits.

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2. Dudley, A. Pease and John J. Pippenger, “Basic fluid power”, Prentice Hall, 1987.

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4. Bolton. W., "Pneumatic and Hydraulic Systems ", Butterworth –Heinemann, 1997.
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CO-PO Mapping

Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	1	-	-	-	-	2	3	2
CO2	3	-	-	-	-	-	1	-	-	-	-	2	3	2
CO3	3	-	2	-	-	-	1	-	-	-	-	2	3	2
CO4	3	-	-	-	-	-	1	-	-	-	-	2	3	2
CO5	3	-	2	-	-	-	1	-	-	-	-	2	3	2



COURSE OBJECTIVES

- To introduce the basic concepts, tools, data management and integration process of re-engineering
- To know the different types of Reverse Engineering tools.
- To study the reverse engineering concepts and their implementations.
- To understand the strategies, software components and evaluation models of data management.
- To learn the reuse tools, coordinate measurement and feature capturing for integration of reverse engineering.

UNIT I INTRODUCTION**5**

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

UNIT II TOOLS FOR R E**8**

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

UNIT III CONCEPTS**12**

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

UNIT IV DATA MANAGEMENT**10**

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

UNIT V INTEGRATION**10**

Cognitive approach to program understated – Integrating formal and structured methods in reverse engineering – Integrating reverse engineering, reuse and specification tool environments to reverse engineering – coordinate measurement –feature capturing – surface and solid members

TOTAL: 45 PERIODS**COURSE OUTCOMES**

At the end of the course the students will be able to

- understand the scope and tasks of re-engineering
- gain thorough knowledge of tools used for RE digitization, surface modeling, prototyping and application of software
- evaluate the process of RE, data generation ,verification and project implementation.
- find suitable reusable software components.
- acquire knowledge of integrating methods of RE.

REFERENCES

1. Design Recovery for Maintenance and Reuse, T J Biggerstaff, IEEE Corpn. July 1991
2. White paper on RE, S. Rugaban, Technical Report, Georgia Instt. of Technology, 1994
3. Reverse Engineering, Katheryn, A. Ingle, McGraw-Hill, 1994
4. Data Reverse Engineering, Aiken, Peter, McGraw-Hill, 1996
5. Reverse Engineering, Linda Wills, Kluiver Academic Publishers, 1996

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CO-PO Mapping

Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
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CO3	3	-	2	-	2	-	1	-	-	-	-	2	2	2
CO4	3	-	2	-	2	-	1	-	-	-	-	2	2	2
CO5	3	-	2	-	2	-	1	-	-	-	-	2	2	2



COURSE OBJECTIVES

- To learn the types, selection and applications of materials handling equipment.
- To familiarize the applications of the chain drives, ropes and pulleys.
- To identify the handling mechanisms which are appropriate to different types of material handling.
- To acquire knowledge about the various types of conveyors and its application based on the purpose.
- To know the design details of elevators and safety while handling various types of materials.

UNIT I MATERIALS HANDLING EQUIPMENT**5**

Types, selection and applications

UNIT II DESIGN OF HOISTS**10**

Design of hoisting elements: Welded and roller chains - Hemp and wire ropes Design of ropes, pulleys, and pulley systems, sprockets and drums, Load handling attachments. Design of forged hooks and eye hooks – crane grabs - lifting magnets -Grabbing attachments - Design of arresting gear - Brakes: shoe, band and cone types.

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 PERIODS**COURSE OUTCOMES**

After completion of the course, the students will be able

- to understand the various types of materials handling equipment, their selection and applications.
- to design the various hoisting elements like chain drive, ropes and pulley.
- to learn about the hand and power drives of hoisting gear and their mechanisms.
- to understand the different types of conveyors and their applications.
- to gain knowledge on different types of elevators and design of fork lift.

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1. Alexandrov, M., Materials Handling Equipments, MIR Publishers, 1981.

2. Boltzharol, A., Materials Handling Handbook, the Ronald Press Company, 1958.
3. P.S.G. Tech., “Design Data Book”, Kalaikathir Achchagam, Coimbatore, 2003.
4. Lingaiah. K. and Narayana Iyengar, “Machine Design Data Hand Book”, Vol.1 & 2, Suma Publishers, Bangalore, 1983.
5. ASME, “Materials Handling Handbook”, Wiley-Interscience, 1985.

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2. www.managementstudyguide.com/material-handling.htm

CO-PO Mapping

Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	-	-	-	-	-	-	-	-	2	2	2
CO2	2	2	2	-	-	-	-	-	-	-	-	2	2	2
CO3	2	2	2	-	-	-	-	-	-	-	-	2	2	2
CO4	2	2	2	-	-	-	-	-	-	-	-	2	2	2
CO5	2	2	2	-	-	-	-	-	-	-	-	2	2	2



COURSE OBJECTIVES

- To study the theory of plasticity and its behavior.
- To familiarize the concepts of constitutive relationships and plastic instability.
- To learn to analyse problems of metal forming.
- To learn sheet metal forming process and the theories involved.
- To acquire knowledge of various advancements in metal forming processes.

UNIT I THEORY OF PLASTICITY

9

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

7

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

12

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

8

Bending theory - Cold rolling theory - Hill's anisotropic theory, Hill's general yield theory - Sheet metal forming
- Elements used - Mesh generation and formulation -Equilibrium equations - Consistent full set algorithm -
Numerical solutions procedures - examples of simulation of simple parts - Bench mark tests – Forming limit
diagrams

UNIT V ADVANCES IN METAL FORMING

9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES

At the end of the course students will be able to

- learn the concepts of plasticity and its behavior.
- understand the mechanical properties of plastics and their instability.
- solve the metal forming problems for different shapes using different methods.

- gain knowledge of sheet metal forming and various theories associated with it.
- update with various advancements in metal forming processes and their techniques.

REFERENCES

1. Wagoner. R H., and Chenot. J.J., Metal Forming analysis, Cambridge University Press, 2002.
2. Slater. R A. C., Engineering Plasticity - Theory & Applications to Metal Forming, John Wiley and Sons, 1987.
3. Shiro Kobayashi, Altan. T, Metal Forming and Finite Element Method, Oxford University Press, 1989.
4. Narayanaswamy. R, Theory of Metal Forming Plasticity, Narosa Publishers, 1999.
5. Hosford. W. F and Caddell. RM., Metal Forming Mechanics and Metallurgy, Prentice Hall Eaglewood Cliffs, 1993.

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CO-PO Mapping

Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	-	-	-	-	-	-	-	-	3	3	2
CO2	3	3	3	-	-	-	-	-	-	-	-	3	3	2
CO3	3	3	3	-	-	-	-	-	-	-	-	2	3	2
CO4	3	2	3	-	-	-	-	-	-	-	-	2	3	2
CO5	3	2	2	-	-	-	-	-	-	-	-	2	3	2



COURSE OBJECTIVES

- To acquire thorough knowledge in structural mechanics, approximations of membranes, plates and shells and principals of elasticity.
- To become familiar with the concepts of classical theories, equilibrium in different coordinates, bending in various shapes of plates.
- To focus on buckling analysis of plates under different compressive and boundary conditions.
- To know about the various vibrating conditions of plates under different loads conditions.
- To analyse the shells of revolution and various aspects of cylindrical and spherical shells.

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 variation methods in elasticity- virtual work-external and internal virtual work- variation operator- functional- 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)

9

TOTAL: 45 PERIODS

At the end of the course students will be able to

- ## REFERENCES

1. Reddy,J.N., “Theory and Analysis of Elastic Plates & Shells”,C.R.C.Press,NY,USA, 2nd Edition
2. Szilard, R., Theory and Analysis of Plates, Prentice Hall Inc., 1995
3. S.Timoshenko.,”Theory of plates and shells” McGraw Hill company.
4. Eduard Ventsel Theodor Krauthammer.,” Thin Plates and Shells Theory, Analysis, and Applications”. Marcel Dekker, 2001.
5. S.S.Bhavikatti.,”Structural analysis” Vikas publication.2007.

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2. www.math.uci.edu/~fwan/pdf/65_theoryofthinelasticshellsnotes.pdf



CO-PO Mapping

Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	2	2	-	-	-	-	-	-	-	-	-	3	3	2
CO2	2	2	-	-	-	-	-	-	-	-	-	3	3	2
CO3	2	2	-	-	-	-	-	-	-	-	-	2	3	2
CO4	2	2	-	-	-	-	-	-	-	-	-	2	3	2
CO5	2	2	-	-	-	-	-	-	-	-	-	2	3	2

COURSE OBJECTIVES

- To give exposure to engineering problems involved in the design of pressure vessel.
- To learn about the tests and analysis for various components of pressure vessels.
- To know the procedure to design pressure vessels.
- To familiarize the buckling and fracture analysis of pressure vessel under various load conditions
- To acquire knowledge of piping, piping layout and designing of pipes

UNIT I INTRODUCTION**3**

Methods for determining stresses – Terminology and Ligament Efficiency –Applications.

UNIT II STRESSES IN PRESSURE VESSELS**15**

Introduction – Stresses in a circular ring, cylinder – Membrane stress Analysis of Vessel Shell components – Cylindrical shells, spherical Heads, conical heads –Thermal Stresses – Discontinuity stresses in pressure vessels.

UNIT III DESIGN OF VESSELS**15**

Design of Tall cylindrical self supporting process columns – supports for short vertical vessels – stress concentration – at a variable Thickness transition section in a cylindrical vessel, about a circular hole, elliptical openings. Theory of Reinforcement – pressure vessel Design.

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**

Introduction – Flow diagram – piping layout and piping stress Analysis.

TOTAL: 45 PERIODS**COURSE OUTCOMES**

At the end of the course the students will be able to

- understood the concepts of various types of pressure vessels and their applications
- identify various stresses in different components of pressure vessels.
- design different types of pressure vessels.
- be thorough with bucking and fracture analysis of pressure vessels and their components
- gain knowledge on the concepts of piping and stress analysis of piping.

REFERENCES

1. John F. Harvey, “Theory and Design of Pressure Vessels”, CBS Publishers and Distributors, 1987.
2. Henry H. Bedner, “Pressure Vessels, Design Hand Book, CBS publishers and Distributors, 1987.

3. Stanley, M. Wales, "Chemical process equipment, selection and Design. Butterworths series in Chemical Engineering, 1988.
4. William. J., Bees, "Approximate Methods in the Design and Analysis of Pressure Vessels and Piping", Pre ASME Pressure Vessels and Piping Conference, 1997.
5. Dennis K. Williams, James F. McCabe, Dominique Moinereau, "Pressure Vessels and Piping Division", American Society of Mechanical Engineers, 2003

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CO-PO Mapping

Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
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CO4	2	2	2	-	-	-	-	-	-	-	-	2	2	2
CO5	2	2	2	-	-	-	-	-	-	-	-	2	2	2



COURSE OBJECTIVES

- To impart knowledge on modal testing to perform model analysis and their applications.
- To apply the DOF in single and Multi systems and to study various dampings, vibrations and property analysis.
- To understand the concepts behind the mobility measurement techniques, selection and mounting of transducers, amplifiers.
- To know the concept of peak amplitude details and get an idea to draw the time domain curve.
- To gain the analytical knowledge of different modal models for display, response, spatial and system.

UNIT I OVERVIEW**6**

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

UNIT II THEORETICAL BASIS**12**

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

UNIT III MOBILITY MEASUREMENT TECHNIQUES**10**

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

UNIT IV MODAL PARAMETER EXTRACTION METHODS**11**

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

UNIT V DERIVATION OF MATHEMATICAL MODELS**6**

Introduction – Modal Models – Display of Modal Model – Response Models – Spatial Models – Mobility Skeletons and System Models.

TOTAL: 45 PERIODS

COURSE OUTCOMES

At the end of the course the student will be able to

- learn modal testing to perform modal analysis and their applications.
- know about DOF in single and multi systems and to study various dampings, vibrations and property analysis.
- have thorough knowledge on the concepts of mobility measurement techniques.,
- understand the concept of modal parameter extraction methods.
- drive mathematical models of modal analysis for display, response, spatial and system models.

REFERENCES

1. Ewins D J, “Modal Testing: Theory and Practice “, John Wiley & Sons Inc., 1988.
2. Nuno Manuel Mendes Maia et al,” Theoretical and Experimental Modal Analysis”, Wiley John & sons, 1997.
3. Gaetan.Kerchen, “Modal analysis of non linear mechanical system”, CISM International system,2014
4. Singiresu S.RAO, “Vibration of Continuous System”,2007
5. S.K.Dwivedy, “Analysis of mechanical System”, 2008

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CO5	3	3	2	3	3	-	-	-	-	-	-	2	2	2



COURSE OBJECTIVES

- To know about force and strain measuring devices and their performance.
- To understand the working principles and operations of various vibration measuring instruments.
- To study the various pressure and wind flow measuring equipment.
- To diagnose the distress, cracks and corrosion problems in structures.
- To learn different non-destructive testing methods for structures, buildings and towers.

UNIT I FORCES AND STRAIN MEASUREMENT**9**

Strain gauge, principle, types, performance and uses. Photo elasticity – Principle and applications - Moire Fringe - Hydraulic jacks and pressure gauges – Electronic load cells – Proving Rings – Calibration of Testing Machines.

UNIT II VIBRATION MEASUREMENTS**9**

Characteristics of Structural Vibrations – Linear Variable Differential Transformer (LVDT) – Transducers for velocity and acceleration measurements. Vibration meter – Seismographs – Vibration Analyzer – Display and recording of signals – Cathode Ray Oscilloscope – XY Plotter – Chart Plotters – Digital data Acquisition systems.

UNIT III ACOUSTICS AND WIND FLOW MEASURES**9**

Principles of Pressure and flow measurements – pressure transducers – sound level meter – venturimeter and flow meters – wind tunnel and its use in structural analysis – structural modeling – direct and indirect model analysis

UNIT IV DISTRESS MEASUREMENTS**9**

Diagnosis of distress in structures – crack observation and measurements – corrosion of reinforcement in concrete – Half-cell, construction and use – damage assessment – controlled blasting for demolition.

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.

TOTAL: 45 PERIODS**COURSE OUTCOMES**

At the end of the course the student will be able to

- demonstrate a basic understanding of experimental methods commonly used in solid mechanics.
- understand the basics of vibration measurement and its importance in engineering field.

- learn the principles of measurements of static and dynamic response of structures and carryout the analysis of results.
- acquire depth logical knowledge in conclusions based theoretical results and other experimental evidence.
- Gain knowledge on different non-destructive testing methods for bridges, buildings and towers.

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1. Sadhu Singh – Experimental Stress Analysis, Khanna Publishers, New Delhi, 1996.
2. JW Dalley and WF Riley, Experimental Stress Analysis, McGraw Hill Book Company, N.Y. 1991
3. L.S.Srinath et al, Experimental Stress Analysis, Tata McGraw Hill Company, New Delhi, 1984
4. R.S.Sirohi, HC Radhakrishna, Mechanical Measurements, New Age International (P) Ltd. 1997
5. F.K Garas, J.L. Clarke and GST Armer, Structural assessment, Butterworths, London, 1987

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	3	-	-	-	-	-	-	2	2	2
CO2	3	3	2	3	3	-	-	-	-	-	-	2	2	2
CO3	3	3	2	3	3	-	-	-	-	-	-	2	2	2
CO4	3	3	2	3	3	-	-	-	-	-	-	2	2	2
CO5	3	3	2	3	3	-	-	-	-	-	-	2	2	2



COURSE OBJECTIVES

- To understand the concepts of maintenance, safety and their importance in industry.
- To learn the concepts of planning and control of various maintenance engineering.
- To know about the safety aspects that will enable the students to deal effectively with various types of hazards in industry.
- To gain knowledge on bar codes, mobile computer and wireless data transmission for monitoring.
- To study different types of analysis and its rules and guidelines in safety.

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) Thermograph, d) Oil and lubricant analysis, e) Motor condition monitoring (MCM) - Shaft alignments through laser - Vibration instruments -Outline on Thermograph

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

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

UNIT IV ASSET PLANNING AND SCHEDULING OF ACTIVITIES IN MAINTENANCE**10**

Asset and spare part management, - Conventional spare Parts management techniques such as Economic Order Quantity, two bin systems - Latest trends in monitoring through bar codes, mobile computer and wireless data transmissions -Different aspects of planning and scheduling of Maintenance, such as shutdowns-Critical aspects of both routine and shut down Maintenance -. bar charts – PERTnetwork during shut down -Man power Training and utilization of skilled manpower -

Sequencing of activities.

UNIT V SAFETY AND OTHER ASPECTS OF MAINTENANCE FUNCTIONS**10**

Safety Engineering- Hazard analysis -General rules and guidelines in safety and hazard prevention –

TOTAL: 45 PERIODS

On completion of this course, student will be able to

- ## REFERENCES

- ## WEBLINKS

1. www.auupdates.com/.../me2037-maintenance-engineering-syllabus.htm
2. www.swlearning.com/quant/gaither/ninth-edition/powerpoint/ch19.ppt.



Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	2	2	2
CO2	3	-	-	-	-	-	-	-	-	-	-	2	2	2
CO3	3	-	-	-	-	-	-	-	-	-	-	2	2	2
CO4	3	-	-	-	-	-	-	-	-	-	-	2	2	2
CO5	3	-	-	-	-	-	-	-	-	-	-	2	2	2

COURSE OBJECTIVES

- To know the principles of micro fabrication for the development of micromechanical devices.
- To understand the principles of energy transduction, sensing and actuation on a microscopic scale.
- To analyze the behavior of micro electro mechanical devices through models and systems.
- To learn the fundamentals of pressure sensors used in MEMS.
- To evaluate and choose transduction principles (e.g., electrostatic or magnetic) for actuation.

UNIT I INTRODUCTION**8**

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

UNIT II MECHANICAL SENSOR PACKAGING**8**

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

UNIT III MECHANICAL TRANSDUCTION TECHNIQUES**9**

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

UNIT IV PRESSURE SENSORS**12**

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

UNIT V FORCE, TORQUE AND INERTIAL SENSORS**8**

Introduction-Silicon based devises-Optical devises-capacitive devises-Magnetic devices-Atomic force microscope and scanning probes- micro machined accelerometer-Micro machined Gyroscope-Future inertial micro machined sensors

TOTAL: 45 PERIODS**COURSE OUTCOMES**

At the end of the course the student will be able to

- understand working principle of currently available micro sensors, actuators, and motors and fluidics used in micro systems.
- think in a unified way about interdisciplinary microsystems.
- choose micro fabrication methods suited for the fabrication of a given micro system.
- select proper micro machining techniques to develop miniaturised micro-mechanical components.
- have an experience on micro systems to deal with photonics and optical applications.

REFERENCES

1. Stephen Beeby, Graham Ensell, Michael Kraft and Neil White, ' MEMS Mechanical sensors' Artech House, Inc. Boston 2003.
2. Mohamed Gad-el-Hak , "The MEMS Handbook" , CRC Press
3. G.K.AnanthaSuresh , "Micro and Smart Systems.", Wiley India
4. James J.Allen, Micro Electro Mechanical System Design, CRC Press published in 2005
5. M-H. Bao, Elsevier, Micromechanical Transducers: Pressure sensors, accelerometers, and gyroscopes, NewYork, 2000.

WEBLINKS

1. www.mae.ucla.edu/.../syllabus/REVISED%20MEMS%20Syllabus.pdf
2. <http://www.csa.com/discoveryguides/mems/overview.php>

CO-PO Mapping

Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	2	-	1	-	-	-	-	2	3	2
CO2	3	-	-	-	2	-	1	-	-	-	-	2	3	2
CO3	3	-	-	-	2	-	1	-	-	-	-	2	3	2
CO4	3	-	-	-	2	-	1	-	-	-	-	2	3	2
CO5	3	-	-	-	2	-	1	-	-	-	-	2	3	2



COURSE OBJECTIVES

- To know about the need and significance of creativity in design and quality concepts.
- To understand the different components of creative thinking and principles of animation and visualization.
- To study the various methods and tools available for generating new ideas in creativity pertaining to customer needs.
- To gain knowledge in the elements of process design, emotional design and levels of design.
- To familiarize with the different innovation methodologies, models and its essential factors.

UNIT I INTRODUCTION 4

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

UNIT II MECHANISM OF THINKING AND VISUALIZATION 11

Definitions and theory of mechanisms of mind heuristics and models: attitudes, Approaches and Actions that support creative thinking - Advanced study of visual elements and principles- line, plane, shape, form, pattern, texture gradation, color 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 11

Methods and tools for Directed Creativity – Basic Principles – Tools of Directed Creativity – Tools that prepare the mind for creative thought – stimulation of new ideas – Development and Actions: - Processes in creativity ICEDIP – Inspiration, Clarification, Distillation, Perspiration, Evaluation and Incubation – Creativity and Motivation The Bridge between man creativity and the rewards of innovativeness –Applying Directed Creativity to the challenge of quality management

UNIT IV DESIGN 9

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

UNIT V INNOVATION 10

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

TOTAL: 45 PERIODS

COURSE OUTCOMES

After completion of the course the student will be able to

- have the ability to analyze and evaluate the information critically from multiple sources and diverse perspectives.
- access information through traditional and new technologies, and synthesize this information for problem solving activities.
- design the thinking strategies in an iterative design process to achieve innovativeness.
- assess, predict and articulate the importance of graphic design issues within the human environment from social responsibility, sustainability and interdisciplinary perspectives.
- learn the existing new design by studying various levels of theories and methods for innovation.

REFERENCES

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

WEBLINKS

1. bae.uncg.edu/ecdp/files/2012/05/ENT321_Syllabus.pdf
2. <http://nptel.ac.in/courses/107108010/>

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CO3	2	3	2	2	2	-	-	-	-	-	-	2	3	3
CO4	2	3	3	3	3	-	-	-	-	-	-	2	3	3
CO5	2	3	3	3	3	-	-	-	-	-	-	2	3	3

