PAAVAI ENGINEERING COLLEGE

(AUTONOMOUS)

M.E. ENGINEERING DESIGN

REGULATIONS 2016

CURRICULUM

(CHOICE BASED CREDIT SYSTEM)

SEMESTER I

Course Code	Course Title	L	T	P	C
PMA16106	Advanced Numerical Methods	3	2	0	4
PED16101	Concepts of Engineering Design	3	2	0	4
PED16102	Computer Applications in Design	3	2	0	4
PED16103	Quality Concepts in Design	3	0	0	3
PED16104	Advanced Mechanics of Materials	3	2	0	4
PED1615*	Elective I	3	0	0	3
PED16105	Computer Aided Design Lab	0	0	4	2

SEMESTER II

Course Code	Course Title	L	T	P	C
PED16201	Finite Element Methods in Mechanical Design	3	2	0	4
PED16202	Vibration Analysis and Control	3	2	0	4
PED16203	Mechanisms Design and Simulation	3	2	0	4
PED16204	Mechanical Behavior of Materials	3	0	0	3
PED1625*	Elective II	3	0	0	3
PED1635*	Elective III	3	0	0	3
PED16205	Analysis and Simulation Lab	0	0	4	2
PED16206	Design Project	0	0	2	1

LIST OF ELECTIVES

ELECTIVE I

Course Code	Course Title	L	T	P	C
PED16151	Design for Manufacture, Assembly & Environments	3	0	0	3
PED16152	Rapid Prototyping and Tooling	3	0	0	3
PED16153	Integrated Manufacturing Systems	3	0	0	3
PED16154	Bearing Design and Rotor Dynamics	3	0	0	3
ELECTIVE II					
PED16251	Composite Materials and Mechanics	3	0	0	3
PED16252	Industrial Robotics and Expert systems	3	0	0	3
PED16253	Mechatronics in Manufacturing	3	0	0	3
PED16254	Optimization Techniques In Design	3	0	0	3

ELECTIVE III (OPEN ELECTIVE)

Course Code	Course Title	L	T	P	C
PED16351	Disaster Management	3	0	0	3
PED16352	Management Information System	3	0	0	3
PED16353	Reliability Engineering	3	0	0	3
PED16354	Fundamentals of Nanoscience	3	0	0	3

PMA16106 ADVANCED NUMERICAL METHODS 3 2 0 4

COURSE OBJECTIVE

- To explain the ideas of mathematical operations involved, accuracy requirements, and available computational resources.
- To Illustrate the dealing between reducing the step size and using a Runge – Kutta method of higher order
- To develop finite difference algorithm techniques for elliptic, parabolic and hyperbolic partial differential equations.
- To enhance sound knowledge in characaterizing, analyzing and solving a wide range of problems using finite different schemes.
- To discuss about the finite element methods and arrangement of collocation points at boundaries between elements and domain.

UNIT I ALGEBRAIC EQUATIONS 15

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

UNIT II ORDINARY DIFFERENTIAL EQUATIONS 15

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

UNIT III FINITE DIFFERENCE METHOD FOR TIME DEPENDENT PARTIAL DIFFERENTIAL EQUATION 15

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

UNIT IV FINITE DIFFERENCE METHODS FOR ELLIPTIC EQUATIONS 15

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

UNIT V FINITE ELEMENT METHOD 15

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

TOTAL: 75 PERIODS

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 4^{th} 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

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

WEB LINKS

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

PED16101 CONCEPTS OF ENGINEERING DESIGN 3 2 0 4

COURSE OBJECTIVES

- To impart the fundamentals designing cost effective, preservation and productive.
- To familiarize with the customer oriented design and societal considerations.
- To understand reinforces the knowledge being learned and shortens the overall learning of design methods.
- To know the concepts of materials for the design process.
- To acquire the knowledge in the design of reliability of failure mode effect analysis and probability concepts.

UNIT I DESIGN FUNDAMENTALS 15

Importance of design- The design process-Considerations of Good Design – Morphology of Design – Organization for design– Computer Aided Engineering –Designing to codes and standards – Concurrent Engineering – Product and process cycles – Technological Forecasting – Market Identification – Competition Bench marking.

UNIT II CUSTOMER ORIENTED DESIGN & SOCIETAL CONSIDERATIONS 15

Identification of customer needs- customer requirements- Quality Function Deployment- Product Design Specifications- Human Factors in Design – Ergonomics and Aesthetics. Societal consideration - Contracts – Product liability – Protecting intellectual property – Legal and ethical domains – Codes of ethics – Ethical conflicts – Environment responsible design-future trends in interaction of engineering with society.

UNIT III DESIGN METHODS 15

Creativity and Problem Solving –Creativity methods-Theory of Inventive Problem Solving (TRIZ) – Conceptual decomposition-Generating design concepts-Axiomatic Design – Evaluation methods-Embodiment Design-Product Architecture- Configuration Design- Parametric Design. Role of models in design-Mathematical Modeling – Simulation – Geometric Modeling –Rapid prototyping- Finite Element Analysis– Optimization – Search Methods.

UNIT IV MATERIAL SELECTION PROCESSING AND DESIGN 15

Material Selection Process – Economics – Cost Vs Performance – Weighted property Index – Value Analysis – Role of Processing in Design – Classification of Manufacturing Process – Design for Manufacture – Design for Assembly –Designing for castings, Forging, Metal Forming, Machining and Welding – Residual Stresses – Fatigue, Fracture and Failure.

UNIT V PROBABILITY CONCEPTS IN DESIGN FOR RELIABILITY 15

Probability – Distributions – Test of Hypothesis – Design of Experiments – Reliability Theory – Design for Reliability – Reliability centered Maintenance-Robust Design- Failure mode Effect Analysis.

TOTAL: 75 PERIODS

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 foe 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.

PED16102 COMPUTER APPLICATIONS IN DESIGN 3 2 0 4

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 Book Co. 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,Pearson Education – 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

PED16103 QUALITY CONCEPTS IN DESIGN 3 0 0 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 MLindsay Pub:son south-western

WEB LINKS

1. www.swlearning.com
2. https://www.vidyarthiplus.com/.../Thread-PD-9211-—-QUALITY-CONC.
3. booksite.elsevier.com/samplechapters/.../9780750660754.PDF

PED16104 ADVANCED MECHANICS OF MATERIALS 3 2 0 4

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.
- To be familiar with radial and tangential stresses in both uniform and varying thickness.

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 beams subjected 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
2. www.slideshare.net/.../advanced-mechanics-of-materials-by-arthur-p-bor...

PED16105 COMPUTER AIDED DESIGN LAB 0 0 4 2

COURSE OBJECTIVES

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

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

At the end of this course, the students will be able to design the computer applications and sketch various mechanical components.

TOTAL: 60 PERIODS

SEMESTER II

PED16201 FINITE ELEMENT METHODS IN MECHANICAL DESIGN 3 2 0 4

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- Gale kin method- virtual work as weak form of equations in solid and fluid mechanics- variation principles – establishment of natural variation principles for linear self-adjoin 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

UNIT V NON-LINEAR ANALYSIS 15

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 & Fundamentals", Butterworth-Heinemann (An imprint of Elsevier), First printed in India 2007, India Reprint ISBN: 978-81-312-1118-2, published by Elsevier India Pvt. Ltd., New Delhi.
2. Cook, R.D., Malkus, D. S., Plesha,M.E., and Witt,R.J " Concepts and Applications of Finite Element Analysis", Wiley Student Edition, 4th Edition, First Reprint 2007, Authorized reprint by Wiley India (P) Ltd., New Delhi, ISBN-13 978- 81-265-1336-9

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

PED16202 VIBRATION ANALYSIS AND CONTROL 3 0 0 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 Speed Of Shaft-Rotor systems.

UNIT II TWO DEGREE FREEDOM SYSTEM 7

Introduction-Free Vibration of Undammed 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 Co-ordinates,and Co-ordinate Coupling. Lagrangian's and Hamilton Equations – Eigen Values and Eigen Vectors-Matrix Iteration Method –Approximate Methods: Drunkenly, 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

PED16203 MECHANISMS DESIGN AND SIMULATION 3 2 0 4

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",EWLP, Delhi, 1999.
5. Kenneth J, Waldron, Gary L. Kinzel, "Kinematics, Dynamics and Design ofMachinery", 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/

PED16204 MECHANICAL BEHAVIOR OF MATERIALS 3 0 0 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**

COURSE OUTCOMES

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

- familiarize the area of material behaviour under different loading and selection of materials for the design of engineering structures.
- develop the ideas of behavior under dynamic loads and design approaches.
- know selection of materials and the service requirements for various mechanical applications.
- study the Modern metallic materials, smart materials, shape memory alloys.
- understand high temperature mechanical behavior of materials.

REFERENCES

1. George E.Dieter, Mechanical Metallurgy, McGraw Hill, 1988
2. Thomas H. Courtney, Mechanical Behavior of Materials, (2nd edition),McGraw Hill, 2000
3. Charles, J.A., Crane, F.A.A. and Fumess, J.A.G., Selection and use ofengineering materials, (34rd edition), Butterworth-Heiremann, 1997.
4. Flinn, R.A., and Trojan, P.K., Engineering Materials and their Applications,(4th Edition) Jaico, 1999.
5. Deformation and fracture mechanics of engineering materials, 3rd Edition, R,W, Hertzbey Wiley,1989.

WEB LINKS

1. http://ocw.mit.edu/courses/materials-science-and-engineering/3-22-mechanical-behavior-of-materials-spring-2008/
2. http://bama.ua.edu/~mweaver/courses/MechBeh/N27.pdf

PED16205 ANALYSIS AND SIMULATION LAB 0 0 4 2

COURSE OBJECTIVES

- To gain practical knowledge and to get hands on experience in various analysis and simulation techniques by using mechanical software tools.

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

At the end of this course, the students will be able to gain basis knowledge of analysis and simulation tools, and understand thermal analysis of various mechanical systems.

PED16206 **DESIGN PROJECT** **0 0 2 1**

COURSE OBJECTIVES

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

GUIDELINE FOR REVIEW AND EVALUATION

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

TOTAL: 30 PERIODS

COURSE OUTCOMES

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

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

ELECTIVE I

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

COURSE OBJECTIVES

- 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.

UNIT I INTRODUCTION 5

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

UNIT II FACTORS INFLUENCING FORM DESIGN 13

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

UNIT III COMPONENT DESIGN - MACHINING CONSIDERATION 8

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

UNIT IV COMPONENT DESIGN – CASTING CONSIDERATION 10

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

UNIT V DESIGN FOR THE ENVIRONMENT 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

- 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.NewYork, 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 forManufacture 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

PED16152 RAPID PROTOTYPING AND TOOLING 3 0 0 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
2. www.garpa.org/assets/CS2007_india_material.pdf

PED16153 INTEGRATED MANUFACTURING SYSTEMS 3 0 0 3

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

PED16154 BEARING DESIGN AND ROTOR DYNAMICS 3 0 0 3

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 Book”, Butterworth Heinemann, United Kingdom 2001.
2. Cameron, A. “Basic Lubrication Theory”, Ellis Herward Ltd., UK, 1981
3. Halling, J. (Editor) – “Principles of Tribology “, Macmillian – 1984.
4. Williams J.A. “ Engineering Tribology”, Oxford Univ. Press, 1994.

WEB LINKS

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

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 orthortropic 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 (Qij), 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, Balanced Laminates, 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", Maneel Dekker Inc, 1993.
5. Halpin, J.C., "Primer on Composite Materials, Analysis", Technomic Publishing Co., 1984.

WEB LINKS

1. www.composites.ugent.be/links.html
2. www.springer.com › ... › Characterization & Evaluation of Materials

PED16252 INDUSTRIAL ROBOTICS AND EXPERT SYSTEMS 3 0 0 3

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.
5. Deb, S.R.” Robotics Technology and Flexible Automation”, Tata Mc Graw-Hill,1994.

WEB LINKS

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

PED16253 MECHATRONICS IN MANUFACTURING 3 0 0 3

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

REFERENCES

1. Bolton.W, “Mechatronics” , Pearson education, second edition, fifth Indian Reprint, 2003
2. Smaili.A and Mrad.F , "Mechatronics integrated technologies for intelligent machines", Oxford university press, 2008.
3. Devadas Shetty and Richard A.Kolk, “Mechatronics systems design”, PWS Publishing company,2007
4. Godfrey C. Onwubolu, "Mechatronics Principles and Applications", Elsevier, 2006.
5. Nitaigour Premchand Mahalik, “Mechatronics Principles, Concepts and Applicatlions”Tata McGraw-Hill Publishing company Limited, 2003.

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1. nptel.ac.in/downloads/112103174/
2. https://www.vidyarthiplus.com/vp/Thread-ME2401-Mechatronics-Lecture-Notes-R-M-K-Edition

PED16254 OPTIMIZATION TECHNIQUES IN DESIGN 3 0 0 3

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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1. nptel.ac.in/courses/105108127/pdf/Module_1/M1L2_LN.pdf
2. http://nptel.iitk.ac.in/courses/Webcourse-contents/IISc-BANG/OPTIMIZATION%20METHODS/pdf/ Module_1/ M1L1_LN.pdf

ELECTIVE III

PED16351 DISASTER MANAGEMENT 3 0 0 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) – Early Warning 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

disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management. **TOTAL: 45 PERIODS**

COURSE OUTCOMES

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

- differentiate the types of disasters, causes and their impact on environment and society
- assess vulnerability and various methods of risk reduction measures as well as mitigation.
- draw the hazard and vulnerability profile of India, Scenarios in the Indian context, Disaster damage assessment and management.
- identify the roles and responsibilities of community, Panchayat Raj Institutions/Urban local bodies
- analyze case studies and to devise appropriate management techniques for handling disasters in the future.

REFERENCES

1. Singhal J.P. "Disaster Management", Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN-13: 978-9380386423
2. Tushar Bhattacharya, "Disaster Science and Management", McGraw Hill India Education Pvt.Ltd., 2012. ISBN-10: 1259007367, ISBN-13: 978-1259007361]
3. Gupta Anil K, Sreeja S. Nair. Environmental Knowledge for Disaster Risk Management,NIDM, New Delhi, 2011
4. Kapur Anu Vulnerable India: A Geographical Study of Disasters, IIAS and Sage Publishers,New Delhi, 2010.
5. Govt. of India: Disaster Management Act , Government of India, New Delhi, 2005

WEB LINKS

1. cbse.nic.in/natural%20hazards%20&%20disaster%20management.pdf
2. www.unisdr.org/2005/mdgs-drr/national-reports/India-report.pdf
3. www.disasterready.org/

PED16352 MANAGEMENT INFORMATION SYSTEMS 3 0 0 3

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 impact 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.

REFERENCES

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 enterprise” 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.

WEB LINKS

1. https://en.wikipedia.org/wiki/Management_information_system
2. www.nptel.ac.in/courses/122105022/

PED16353 RELIABILITY ENGINEERING 3 0 0 3

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 Engineringt", John-Wiley and Sons inc, 2002.
2. David J Smith, "Reliability, Maintainability and Risk: Practical Methods for Engineers", Butterworth, 2002
3. Way kuo, Rajendra Prasad V, Frank A and Tillman, ching- lai Hwang "Optimal Reliability Design and Applications", 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.

WEB LINKS

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

PED16354 FUNDAMENTALS OF NANOSCIENCE 3 0 0 3

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 idea"., 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