PAAVAI ENGINEERING COLLEGE, NAMAKKAL – 637 018
(AUTONOMOUS)
M.E. ENGINEERING DESIGN
REGULATIONS 2015
CURRICULUM

SEMESTER I

Course Code	Course Title	L	T	P	C
PMA 15106	Advanced Numerical Methods	3	2	0	4
PED 15102	Concepts of Engineering Design	3	2	0	4
PED 15103	Computer Applications in Design	3	2	0	4
PED 15104	Quality Concepts in Design	3	0	0	3
PED 15105	Advanced Mechanics of Materials	3	2	0	3
PEDE 151**	Elective I	3	0	0	3
PED 15106	CAD Lab	0	0	4	2

SEMESTER II

Course Code	Course Title	L	T	P	C
PED 15201	Finite Element Methods in Mechanical Design	3	2	0	4
PED 15202	Vibration Analysis and Control	3	0	0	4
PED 15203	Mechanisms Design and Simulation	3	2	0	4
PED 15204	Mechanical Behavior of Materials	3	0	0	4
PEDE 152**	Elective-II	3	0	0	3
PEDE 152**	Elective-III	3	0	0	3
PED 15205	Analysis and Simulation Lab	0	0	4	2
PED 15206	Design Project	0	0	2	1

LIST OF ELECTIVES

SEMESTER I

Course Code	Course Title	L	T	P	C
PEDE 15101	Design for Manufacture, Assembly & Environments	3	0	0	3
PEDE 15102	Rapid Prototyping and Tooling	3	0	0	3
PEDE 15103	Integrated Manufacturing Systems	3	0	0	3
PEDE 15104	Bearing Design and Rotor Dynamics	3	0	0	3

SEMESTER II

Course Code	Course Title	L	T	P	C
PEDE 15201	Composite Materials and Mechanics	3	0	0	3
PEDE 15202	Industrial Robotics and Expert systems	3	0	0	3
PEDE 15203	Mechatronics in Manufacturing	3	0	0	3
PEDE 15204	Advanced Optimization Techniques in Design	3	0	0	3
PEDE 15205	Engineering Fracture Mechanics	3	0	0	3
PEDE 15206	Tribology in Design	3	0	0	3
PEDE 15207	Design of Heat exchanger	3	0	0	3
PEDE 15208	Applied Engineering Acoustics	3	0	0	3

PMA 15106 ADVANCED NUMERICAL METHODS 3 2 0 4

COURSE OBJECTIVES

- To deveop stable solution algorithm for solving linear system of equations.
- To understand the linkage between accuracy,stability and convergence.
- To understand the fundamental principles of finite difference method and finite element method.
- To enable students to understand numerical methods and gain solid foundation to apply it to solve problems related to engineering and technology.
- To impart knowledge that is adaptable to changing technologies and research works.

UNIT I ALGEBRAIC EQUATIONS 9+6

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

UNIT II ORDINARY DIFFERENTIAL EQUATIONS 9+6

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

UNIT III FINITE DIFFERENCE METHOD FOR TIME DEPENDENT PARTIAL DIFFERENTIAL EQUATION 9+6

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

UNIT IV FINITE DIFFERENCE METHODS FOR ELLIPTIC EQUATIONS 9+6

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

UNIT V FINITE ELEMENT METHOD 9+6

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

TOTAL (45+30): 75 PERIODS

COURSE OUTCOME

- The study of the subject will prepare the students to use numerical methods to solve engineering problems and understand its application to related fields.
- It helps the students to get familiarized with the numerical method which are necessary to solve the problems numerically.
- The students will become familiar with fundamentals of various science and technology subjects and thus acquire the capability to apply them.
- To find the application of finite difference method and finite element method in Engineering field.
- To find application of numerical stability analysis and Wave 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.

WEBLINK

- http://mathworld.wolfram.com/OrdinaryDifferentialEquation.html
- http://www.nptel.ac.in/courses/111104031/
- https://mat.iitm.ac.in/home/sryedida/public_html/caimna/lae/Iterative.html

PED 15102 CONCEPTS OF ENGINEERING DESIGN 3 2 0 4

COURSE OBJECTIVES

At the end of the course, the students should be able

- to understand the basic concepts associated with morphology of design and market requirements.
- to identify customer needs and understand ergonomics and Aesthetics .
- to provide knowledge on product development technique through TRIZ.
- to gain knowledge in the selection of materials and manufacturing processes.
- to impart knowledge on probability concepts and Reliability like Failure, Design of reliable system and Reliability testing.

UNIT I DESIGN FUNDAMENTALS 9+6

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 9+6

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 9+6

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 9+6

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 9+6

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

TOTAL(45+30):75 PERIODS

COURSE OUTCOMES

- Understand the fundamentals of design process and designing to codes and standards.
- Helps to familiarize the Product Design Specifications, Ergonomics and Aesthetics.
- Capability of solving inventive or non- routine technical problems within the framework of TRIZ
- Understand the selection of material based on manufacturing process.
- 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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- http://www-materials.eng.cam.ac.uk/mpsite/
- http://www2.warwick.ac.uk/fac/sci/wmg/ftmsc/modules/modulelist/peuss/slides/section_6a_qfd_notes.pdf
- http://www.additive3d.com/rm_c.htm

PED 15103 COMPUTER APPLICATIONS IN DESIGN 3 2 0 4

COURSE OBJECTIVES

At the end of the course, the students should be able

- to have an introduction to fundamentals of computer graphics
- to learn various CAD software's like Auto LISP/C/Fortron etc.
- to understand solid modeling
- to learn various Visual Realism software
- to learn assembly of parts with mass property calculations and mechanical simulation.

UNIT I INTRODUCTION TO COMPUTER GRAPHICS FUNDAMENTALS 11+6

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 8+6

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 8+6

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 9+6

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

UNIT V ASSEMBLY OF PARTS 9+6

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

TOTAL(45+30):75 PERIODS

COURSE OUTCOMES

The study of the subject will prepare the students to:

- Get familiarized with the computer graphics application in design.
- Understanding reinforces the knowledge being learned and shortens the overall learning curves which are necessary to solve CAE problems that arise in engineering.
- Familiarize various solid modeling Techniques and communication standards.
- Apply the tolerance analysis and mass property calculations
- Acquiring knowledge on Computer Assisted Assembly & modeling and simulation mechanism.

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.

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- www.adi.pt/docs/innoregio_cad-en.pdf
- scholar.lib.vt.edu/ejournals/JCAEDE/v1n1/jones.html
- http://www.opencascade.org/occt/overview/compocc3/

PED 15104 QUALITY CONCEPTS IN DESIGN 3 0 0 3

COURSE OBJECTIVES

At the end of the course, the students should be able

- to identify control factors, noise factors, performance metrics, etc.
- to learn failure mode effect analysis
- to understand Design of Experiments involving basic methods, statistical analysis, experimental optimization etc.
- to apply the Pareto diagrams-Cause and Effect diagrams-Box plots-Scatter diagrams in real case problems
- to understand Design for Six Sigma

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

The study of the subject will prepare the students:

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

REFERENCES

1. Kevin Otto & Kristin Wood "Product Design Techniques in Reverse Engineering and New Product Development" , Pearson Education (LPE), 2001.
2. Karl t. Ulrich, Steven D. Eppianger 'Product Design And Development' , Tata Mcgraw-hill- 3rd Edition, 2003.
3. James R. Evens, William M Lindsay 'The Management and control of Quality" 6th edition- Pub:son south-western

4. Amitava Mitra “Fundamentals of Quality control and improvement” 2nd edition, , Pearson Education Asia, 2002.
5. Eugene C. Nelson, Paul B. Batalden, Marjorie M. Godfrey “Quality By Design: A Clinical Microsystems Approach” John Wily and Sons Inc.2007

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- http://www.webducate.net/qfd/qfd.html
- https://www.moresteam.com/toolbox/design-of-experiments.cfm#preparation
- http://www.tutorialspoint.com/six_sigma/six_sigma_methodology.htm

PED 15105 ADVANCED MECHANICS OF MATERIALS 3 2 0 3

COURSE OBJECTIVES

- to impart knowledge on simple stresses, strains and deformation in components due to external loads and their relations**.**
- to provide knowledge in shear centre and unsymmetrical bending through advanced mathematical models.
- to impart knowledge on stress induced in curved flexible and flat plates by using industrial equipments.
- to study various stresses induced in torsional sections and the theories of non circular sections.
- to understand the concepts of stresses due to rotary sections and contact stresses

UNIT I ELASTICITY 9+6

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 10+6

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 10+6

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 7+6

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 9+6

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(45+30):75 PERIODS

COURSE OUTCOMES

At the end of this course students should be able

- to understand stresses under different loading conditions and also relate the mechanical properties of materials to their structure.
- to select suitable materials for structural applications.
- to solve realistic or fundamental problems relating to mechanical behavior of materials for individual solutions and tests.
- to estimate the design strength of various industrial needs.
- to work in teams for the materials selection in design aspects.

REFERENCES

1. Arthur P Boresi, Richard J. Schmidt, “Advanced mechanics of materials”,John Wiley, 2002.
2. J.P Den Hartog “Advanced Strength of Materials”, Courier Corporation, 1987
3. Robert D. Cook, Warren C. Young, "Advanced Mechanics of Materials", Mcmillanpub. Co., 1985.
4. Srinath. L.S., “Advanced Mechanics of solids”, Tata McGraw Hill, 1992.
5. G H Ryder Strength of Materials Macmillan, India Ltd, 2007.

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- http://classes.mst.edu/civeng120/lessons/flexure/elastic/saint_venant/index.html
- https://ecourses.ou.edu/cgi-bin/ebook.cgi?doc=&topic=me&chap_sec=06.0
- http://www.me.mtu.edu.

PED 15106 CAD 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. To give practice on solid and surface modeling and make familiar with various commands involved in modeling and drafting of Mechanical components.

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 usingParametric and feature based Packages like PRO-E / SOLID WORKS /CATIA / NX etc.

COURSE OUTCOMES

The students get familiarized with the computer applications in design and preparing drawings for various mechanical components they will have good practice in modeling and drafting activities and familiar with commands used in various operations like Surface modeling –Extrude, Sweep, Trim ..etc and Mesh of curves, Free form,Feature manipulation – Copy, Edit, Pattern, Suppress, History operations and also clearly understand and draw Assembly-Constraints, Exploded Views, Interference check ,Drafting-Layouts, Standard & Sectional Views, Detailing & Plotting.

TOTAL: 60 PERIODS

PED 15201 FINITE ELEMENT METHODS IN MECHANICAL DESIGN 3 2 0 4

COURSE OBJECTIVES

At the end of the course, the students should be able

- to understand assembly and analysis of a structure and boundary
- to learn generalization of Finite Element concepts and shape functions conditions
- to solve problems in elasticity, heat transfer and fluid mechanics
- to understand harmonic analysis, response history, etc.
- to learn geometric non linearity and modeling considerations.

UNIT I GENERAL INTRODUCTION 9+6

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 9+6

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 9+6

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 9+6

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 9+6

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(45+30):75 PERIODS

COURSE OUTCOMES

- To understand the different approaches and numerical techniques available to model physical systems.
- Ability to select and apply discretisation and boundary conditions for 1D, 2D problems
- Knowledge to solve plane problems and problems involving heat transfer fluid mechanics
- Clear understanding of FEA methods to solve structural dynamics and vibration problems
- Ability to analyze non linear problem in elasticity and solve problems

REFERENCES

1. Zienkiewicz.O.C, Taylor.R.L,& Zhu,J.Z "The Finite Element Method: Its Basis & Fundamentals", Butterworth-Heinemann (An imprint of Elsevier), First printed in India 2007, India Reprint ISBN:978- 8 1-312-1118-2, published by Elsevier India Pvt. Ltd., New Delhi.

2. Cook, R.D., Malkus, D. S., Plesha,M.E., and Witt,R.J " Concepts and Applications of Finite Element Analysis", Wiley Student Edition, 4th Edition, First Reprint 2007, Authorized reprint by Wiley India(P) Ltd., New Delhi, ISBN-13 978-81-265-1336-9.

3. Zienkiewicz.O.C, Taylor.R.L "The Finite Element Method" McGraw Hill International Editions, Fourth Edition, 1991, Volume 2 (Chapters 7&8)

4. Reddy, J.N., “Introduction to Non-Linear Finite Element Analysis”, Oxford Uniiversity Press, 2008

5. Rao,S.S., “The Finite Element Method in Engineering”, Butterworth-Heinemann(An imprint of Elsevier), reprinted 2006,2007, Published by Elsevier India Pvt. Ltd., New Delhi, Indian Reprint ISBN: 978-81-8147-885-6

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- http://www.colorado.edu/engineering/CAS/courses.d/Structures.d/IAST.Lect22.d/IAST.Lect22.pdf
- http://web.mae.ufl.edu/nkim/eml5526/Lect06.pdf

PED 15202 VIBRATION ANALYSIS AND CONTROL 3 0 0 4

COURSE OBJECTIVES

- To impart knowledge on the sources of vibration and noises in various Mechanical components
- To learn about damped and un-damped vibration
- To learn about Eigen values and Eigen vectors
- To learn about various vibration control techniques
- To understand various vibration analysis method

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

The study of the subject will prepare the students to:

- Understand the basics of vibration, its importance in engineering field.
- Gain knowledge on vibration and working operations of various vibration measuring instruments.
- Understand the Concepts of multi-degree freedom system and continuous system .
- The various Vibration control and analysis techniques in the engineering field.
- Understand overview of the 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. Haym benaroya and Mark .L.Nagurka, " Mechanical Vibrations", CRC Press, 2010

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- http://www.sciencedirect.com/science/book/9780340631836
- http://www.intechopen.com/books/vibration-analysis-and-control-new-trends-and-developments
- http://www.ni.com/tutorial/7111/en/

PED 15203 MECHANISMS DESIGN AND SIMULATION 3 2 0 4

COURSE OBJECTIVES

- To develop a thorough understanding of the various mechanisms and its design
- To understand the layout of linkages in the assembly of a system/machine**.**
- To study the principles involved in assessing the displacement, velocity and acceleration at any point in a link of a mechanism.
- To analyze the motion resulting from a specified set of linkages in a mechanism.
- Study and use of Mechanism using Simulation Software packages.

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UNIT I INTRODUCTION 9+6

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 9+6

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 9+6

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 9+6

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 9+6

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(45+30):75 PERIODS

COURSE OUTCOMES

- Designing the linkages for particular applications.
- Analyze the velocity and acceleration of various mechanisms.
- Selecting the topological arrangements of robotic arm for specific applications
- Interpret interrelationship between forces of various members and mechanisms
- Synthesis of Coupler Curve Based Mechanisms & Cam Mechanisms ideas.

REFERENCES

1. Robert L.Norton., "Design of Machinery",Tata McGraw Hill, 2005.
2. Uicker, J.J., Pennock, G. R. and Shigley, J.E., "Theory of Machines and Mechanisms", Oxford University Press, 2005.
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PED 15204 MECHANICAL BEHAVIOR OF MATERIALS 3 0 0 4

COURSE OBJECTIVES

- To understand the basic concepts of elasticity, strengthen mechanisms in metals and polymers.
- To learn the phenomena of material deformation and fracture in dynamic loading conditions.
- To impart knowledge in basic requirements of materials and methodology involved in selection of materials for different working conditions.
- To acquire knowledge on modern materials like dual phase steel, smart materials and shape memory alloy.
- To learn the production techniques involved in manufacturing polymers and ceramic materials.

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

- Gain knowledge in the area of material behavior under different loading and selection of materials for the design of engineering structures.
- Understand material behavior under dynamic loads and design approaches.
- Identify and select materials for different applications and service requirements.
- Update knowledge on modern metallic materials, smart materials, shape memory alloys.
- Distinguish between different types of polymers, ceramics and learn various aspects of composites.

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PED 15205 ANALYSIS AND SIMULATION LAB 0 0 4 2

COURSE OBJECTIVES

The end of this course the students would have developed a thorough understanding of the computer aided finite element analysis packages and their applicability to different mechanical structures .The Student will acquire ability to effectively use the tools of the analysis software for solving practical problems arising in engineering design.

LIST OF EXPERIMENTS

Analysis of Mechanical Components – Use of FEA Packages like ANSYS/NASTRAN etc.,

Exercises shall include analysis of Machine elements under Static loads.

Thermal Analysis of mechanical systems.

Modal Analysis.

Stress Analysis of an Axis -Symmetric Component.

Machine elements under Dynamic loads.

Harmonic Response Analysis.

Non-linear systems.

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 OUTCOMES

The students get familiarized with the computer aided finite element analysis software packages which are necessary to solve the engineering problems numerically .The exposure would help them to improve their project works and future research works.

PED 15206 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

Students to get familiarize the design principles and develop Engineering conceptual design of any components and ability to integrate the parts design with assembly and ability to prepare manufacturing drawings.

PEDE 15101 DESIGN FOR MANUFACTURE, ASSEMBLY AND ENVIRONMENT 3 0 0 3

COURSE OBJECTIVES

- To gain knowledge on the concept of design for manufacturing, assembly and environment.
- To develop skills of the computer application in design for manufacturing and assembly.
- To introduce the basic concepts and design guidelines of different manufacturing processes.
- To make the student familiar with solving different problems in design modifications of the product related to various manufacturing techniques.
- To develop design techniques to minimize material usage, recyclability, energy efficiency and eco-friendly approach.

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

- Selection of material based on manufacturing process, design and assembly
- Usage of DFMA tools for minimizing effort and cost in manufacturing
- Designing of components based on environmental issues
- Considerations in casting and machining to facilitate easy manufacturing
- Knowledge to modify the design techniques to improve productivity

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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.
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PEDE 15102 RAPID PROTOTYPING AND TOOLING 3 0 0 3

COURSE OBJECTIVES

- To gain in depth knowledge about applications and benefits of Digital,Virtual and Rapid prototyping.
- To make the students in understanding the concepts of various rapid prototyping systems and their materials and applications.
- To develop knowledge on principles, products and advantages of various power based RP systems.
- To impart knowledge of data processing, CAD modeling and reverse engineering concepts.
- To know about the classifications of rapid tooling and applications towards various industries.

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

Upon the completion of the course students will

- know the benefits of RP and tooling
- Prepare to learn about types of dimensional printing.
- distinguish various laser sintering methods.
- Solve the problems in CAD modeling and reverse engineering,
- Classify the rapid toolings.

REFERENCES

1. Chua C.K., Leong K.F., and Lim C.S., Rapid prototyping: Principles and applications, second edition, World Scientific Publishers, 2003.
2. Peter D.Hilton,Hilton/Jacobs, Paul F.Jacobs, Rapid Tooling: Technologies and Industrial Applications, CRC press, 2000.
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4. Liou W.Liou, Frank W.Liou, Rapid Prototyping and Engineering applications : A tool box for prototype development, CRC Press, 2007.
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PEDE 15103 INTEGRATED MANUFACTURING SYSTEMS 3 0 0 3

COURSE OBJECTIVES

At the end of the course, the students should be able

- to know about manufacturing systems and their analysis in operations.
- to impart knowledge on techniques of group technology and computer aided process planning.
- to make the students familiar about concepts of NC, CNC, MRP and data collection systems
- to know well about various monitoring systems and concepts of QC and inspection methods..
- to develop knowledge on applications and principles of various manufacturing systems.

UNIT I INTRODUCTION 5

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

UNIT II GROUP TECHNOLOGY AND COMPUTER AIDED PROCESS 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- Numerical Control (NC), Concepts of Computer Numerical Control (CNC)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

Upon the completion of the course students will

- Classify and analyze the manufacturing systems
- Prepare to learn about various production planning and control cost.
- Solve challenges in CNC and data collection systems.
- Be clear in computers in QC and inspection methods.
- Learn about 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.
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- http://www.pera.net/Methodologies/Cimosa/CIMOSA.html
- http://www.cimosa.de/CoAssoc/NewWebS/Frame1/About_us.htm

PEDE 15104 BEARING DESIGN AND ROTOR DYNAMICS 3 0 0 3

COURSE OBJECTIVES

- To know about different types of bearings available for machine design and their operating principles.
- To design hydrodynamic/ hydrostatic / rolling bearing for given specifications and analyze the bearings for their performance.
- To understand the bearing behavior under dynamic conditions.
- To understand the loading and analysis using finite difference approach
- To understand the rotor dynamics and measurement computation with frequency and resonance whip.

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

Upon completion of this course, the students will learn :

- Analysis of all types of bearings.
- The Skill for conducting dynamic / vibration analysis and trouble shooting of bearings.
- The analysis of short bearings under dynamic conditions.
- About rotor balancing.
- Computation and measurements of journal bearings.

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.
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5. J. S. Rao “Rotor Dynamics” New Age International, 1996

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- accessengineeringlibrary.com/.../fundamentals-of-fluid-film-lubrication
- http://www.iitg.ernet.in/engfac/rtiwari/resume/rtiwari01.pdf

PEDE 15201 COMPOSITE MATERIALS AND MECHANICS 3 0 0 3

COURSE OBJECTIVES

- To understand the fundamentals of composite material like strength and its mechanical behavior and understanding of the analysis of fiber reinforced Laminate design for different combinations of plies with different orientations of the fiber.
- To understand the Thermo-mechanical behavior and study of residual stresses in Laminates during processing, Implementation of Classical Laminate Theory (CLT).
- To gain knowledge on the analysis of residual stresses in an isotropic layered structure such as electronic chips.
- To Understand the code for laminate stacking sequence and to Develop relationships of mechanical loads applied to a laminate to strains and stresses in each lamina
- To Understand the significance of stiffness and mechanical response of special cases of laminates and to Establish the failure criteria for laminates based on failure of individual lamina in a 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

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

- Analyze the fiber reinforced Laminate for optimum design.
- Apply classical laminate theory to study and analyze the residual stresses in Laminate.
- Analyze a laminated plate in bending, including finding laminate properties from lamina properties and find residual stresses from curing and moisture.
- Predict the elastic properties of both long and short fiber composites based on the constituent properties.
- Understand the recent developments in composites, including metal and ceramic matrix composites, the ideas developed in the analysis of composites towards using composites in aerospace design.

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. Agarwal, B.D., and Broutman L.J., “Analysis and Performance of Fiber Composites”, John Wiley and Sons, New York, 1990.

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PEDE 15202 INDUSTRIAL ROBOTICS AND EXPERT SYSTEMS 3 0 0 3

COURSE OBJECTIVES

- To gain in depth knowledge about the concepts and needs of robot kinematics.
- To make the students in understanding the concepts of robot drives, control systems and designs associated.
- To develop knowledge on principles and working of robot sensors.
- To impart knowledge of design and layout of robot cell and its applications.
- To know about the robot programming, artificial intelligence and expert system.

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

Upon the completion of the course students will

- Gain knowledge about robot kinematics and joints & Cartesian space.
- Understand the working of links, valves, and grippers.
- Understand the concepts of sensing methodology and types of sensors.
- Design the robot work cell and its working layout.
- Prepare the program and work with artificial intelligence systems.

REFERENCES

1. 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.
   Deb, S.R." Robotics Technology and Flexible Automation", Tata Mc Graw-Hill,1994.
5. Mikell, P. Groover, Mitchell Weis, Roger, N. Nagel, Nicholas G. Odrey," Industrial Robotics Technology, Programming and Applications", Mc Graw-Hill, Int. 1986.

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PEDE 15203 MECHATRONICS IN MANUFACTURING 3 0 0 3

COURSE OBJECTIVES

- To study the concepts of mechatronics systems.
- To acquire knowledge about the sensors and transducers.
- To understand the working of the actuators.
- To prepare the program and work on PLC.
- To understand the working of CNC and micro controller.

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

Upon the completion of the course students will

- Have exposure on mechatronics systems and overview of control systems & actuators.
- Gain knowledge about the sensors and transducers and its applications.
- Understood the working of various actuators and its applications.
- Gain knowledge on various signal conditioning units in PLC.
- Understood the programming and working of CNC and micro controller.

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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.
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5. Nitaigour Premchand Mahalik, “Mechatronics Principles, Concepts and Applicatlions”Tata McGraw-Hill Publishing company Limited, 2003.

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- http://www.toolingu.com/class-470220-robotic-drives-hardware-and-components-220.html
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PEDE 15204 ADVANCED OPTIMIZATION TECHNIQUES IN DESIGN 3 0 0 3

COURSE OBJECTIVES

- To understand the basic unconstrained optimization techniques and methods.
- To gain knowledge about constrained optimization techniques and geometric programming.
- To study about logic principles and genetic algorithms used in advanced optimization techniques.
- To familiarize about the design of shaft, structural and spring loaded members.
- To know the dynamic applications of mechanism and optimum of degree of freedom.

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

- Understanding basic unconstrained optimization techniques and methods.
- Gain the knowledge of geometric programming and constrained optimization techniques.
- Learn the logic principles and genetic algorithms advanced optimizations techniques.
- Develop ability for designing of shaft, structural and spring loaded members.
- Familiarized the dynamic application of mechanism and optimum of degree of freedom.

REFERENCES

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2. Johnson Ray, C., "Optimum design of mechanical elements", Wiley, John & Sons, 1990.
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5. R.Venkatarao, Vimal .J. Savsani, Mechanical design optimization using advanced optimization in techniques, 2012.

WEB LINKS

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- http://nptel.iitk.ac.in/courses/Webcourse-contents/IISc-BANG/OPTIMIZATION%20METHODS/pdf/Module_1/ M1L1_LN.pdf
- http://www.esa.int/gsp/ACT/doc/MAD/pub/ACT-RPR-MAD-2007-BenchmarkingDifferentGlobalOptimisation Techniques.pdf

PEDE 15205 ENGINEERING FRACTURE MECHANICS 3 0 0 3

COURSE OBJECTIVES

- To know the basic knowledge of geometry of stress, strain and deformation of the element of solid mechanics.
- To learn the analytical of yielding and integral relation in stationary crack under static loading.
- To study about the energy balance and crack growth through griffith analysis and K1C method.
- Understand basic crack growth law and load calculation in fatigue crack growth curve.
- To familiarize the application of fracture mechanics through large scale yielding and stresses.

UNIT I ELEMENTS OF SOLID MECHANICS 9

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

UNIT II STATIONARY CRACK UNDER STATIC LOADING 9

Two dimensional elastic fields – Analytical solutions yielding near a crack front – Irwin's approximation – plastic zone size – Dugdaale model – determination of J integral and its relation to crack opening displacement.

UNIT III ENERGY BALANCE AND CRACK GROWTH 9

Griffith analysis – stable and unstable crack growth –Dynamic energy balance – crack arrest mechanism –K1c test methods - R curves - determination of collapse load.

UNIT IV FATIGUE CRACK GROWTH CURVE 9

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

UNIT V APPLICATIONS OF FRACTURE MECHANICS 9

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

TOTAL : 45 PERIODS

COURSE OUTCOMES

- Know the basic knowledge of geometry of stress, strain and deformation of solid mechanism.
- Learn the analytical of yielding and J.Integral relations in stationary crack under static loading.
- Study about the energy balance and crack growth through Griffith analysis and K1C method.
- Understand basic crack growth law and load calculation in fatigue crack growth curve.
- Familiarize the application of fracture mechanics through large scale yielding and stresses.

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1. David Broek, ”Elementary Engineering Fracture Mechanics “, Fifthoff and Noerdhoff International Publisher, 1978.
2. Kare Hellan, “Introduction of Fracture Mechanics”, McGraw-Hill Book Company, 1985.
3. Preshant Kumar, “Elements of Fracture Mechanics”, Wheeler Publishing, 1999.
4. John M.Barson and Stanely T.Rolfe Fatigue and fracture control in structures Prentice hall Inc. Englewood cliffs. 1977
5. Ted L.Anderson, T.L. Anderson, Fracture mechanics: fundamental and application, second edition, 2005.

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- nptel.ac.in/courses/112106065/1
- textofvideo.nptel.iitm.ac.in/112106065/lec1.pdf

PEDE 15206 TRIBOLOGY IN DESIGN 3 0 0 3

COURSE OBJECTIVES

- To Understand the principles for selecting compatible materials for minimizing friction and wear in machinery.
- To Understand the principles of bearing selection and bearing arrangement in machines. Learn the computations required for selecting and designing bearings in machines.
- To Understand the fundamental principles of lubrication for reduction of friction and wear.
- To Understand the fundamental principles of high contact stresses (Hertz stresses), fatigue-failure, and Elastohydrodynamic (EHD) lubrication in rolling bearings and gears.
- To Recognise the laws of friction, mechanics of friction, friction space, and surface temperature.

UNIT I SURFACE INTERACTION AND FRICTION 7

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

UNIT II WEAR AND SURFACE TREATMENT 8

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

UNIT III LUBRICANTS AND LUBRICATION REGIMES 8

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

UNIT IV THEORY OF HYDRODYNAMIC AND HYDROSTATIC LUBRICATION 12

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

UNIT V HIGH PRESSURE CONTACTS AND ELASTO HYDRODYNAMIC LUBRICATION 10

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

TOTAL : 45 PERIODS

COURSE OUTCOMES

Upon the completion of the course

- To Have a knowledge of surface topography and know how to model a rough engineering surface.
- Have a clear overall picture about the basics of tribology and related sciences, theoretical background about processes in tribological system, mechanisms and forms of interaction of friction surfaces.
- To Understand Hertz contact and rough surface contact.
- To Be familiar with adhesion theories and the effect of adhesion on friction and wear.
- Have a mastery of the friction/lubrication mechanisms and know how to apply them to the practical engineering problem.

REFERENCES

1. Rabinowicz.E, “Friction and Wear of materials”, John Willey &Sons ,UK,1995
2. Cameron, A. “Basic Lubrication Theory”, Ellis Herward Ltd., UK, 1981
3. Halling, J. (Editor) – “Principles of Tribology “, Macmillian – 1984.
4. Tribology in Machine Design T.A. Stolarski Butterworth-Heinemann, 1990 - Technology & Engineering
5. Applied Tribology Michael M. Khonsari, E. Richard Booser John Wiley & Sons, 19-Feb-2001

WEB LINKS

- https://www.me.gatech.edu
- www.mccormick.northwestern.edu
- web.mit.edu

PEDE 15207 DESIGN OF HEAT EXCHANGER 3 0 0 3

COURSE OBJECTIVES

- To expose the student about the classification of heat exchangers their advantages and limitations.
- To train the students to perform heat transfer analysis using LMTD and NTU methods.
- To develop the skill of the student to quickly evaluate the size and main parameters of Shell and Tube heat exchangers to meet the process parameters.
- To introduce the basic aspects of Fouling, Pressure drop and pumping power requirements.
- To Impart the knowledge about phase changes-Special application to Condensers and Evaporators

UNIT I FUNDAMENTALS OF HEAT EXCHANGER 9

Temperature distribution and its implications types – shell and tube heat exchangers – regenerators and recuperates – analysis of heat exchangers – LMTD and effectiveness method.

UNIT II FLOW AND STRESS ANALYSIS 9

Effect of turbulence – friction factor – pressure loss – stress in tubes – header sheets and pressure vessels – thermal stresses, shear stresses, types of failures.

UNIT III DESIGN ASPECTS 9

Heat transfer and pressure loss – flow configuration – effect of baffles – effect of deviations from ideality – design of double pipe, finned tube, shell and tube heat exchangers, simulation of heat exchangers.

UNIT IV COMPACT AND PLATE HEAT EXCHANGERS 9

Types – merits and demerits – design of compact heat exchangers, plate heat exchangers – performance influencing parameters, limitations.

UNIT V CONDENSERS & COOLING TOWERS 9

Design of surface and evaporative condensers – cooling tower – performance characteristics.

TOTAL : 45 PERIODS

COURSE OUTCOMES

Upon the completion of the course

- The student will be able to do heat transfer analysis using LMTD or NTU method depending on the nature of problem and available data.
- The student will be able to perform thermal design of heat exchanger (Including heat exchangers with phase change).
- Ability to understand and solve conduction, convection and radiation problems.
- Ability to design and analyze the performance of heat exchangers and evaporators.
- Analyze heat exchanger performance by using the method of log mean temperature difference..

REFERENCES

1. Sadik Kakac, Hongtan Liu,Heat Exchangers Selection, Rating and Thermal Design,CRC Press,2002.
2. P Arthur. Frass, Heat Exchanger Design, John Wiley & Sons, 1988.
3. Taborek.T, Hewitt.G.F and Afgan.N, Heat Exchangers, Theory and Practice,McGraw-Hill Book Co. 1980.
4. Kuppan Thulukkanam, Heat Exchanger Design Handbook CRC Press, 23-Feb-2000 - Technology & Engineering.
5. Ramesh K. Shah, Dusan P. Sekulic, Fundamentals of Heat Exchanger Design, John Wiley & Sons, 11-Aug-2003 - Technology & Engineering

WEB LINK

- http://nptel.ac.in/courses/103103027/pdf/mod1.pdf
- www3.imperial.ac.uk
- web.iitd.ac.in

PEDE 15208 APPLIED ENGINEERING ACOUSTICS 3 0 0 3

COURSE OBJECTIVES

At the end of the course, the students should be able

- to familiarize students with basic concepts of acoustics like sound intensity, wave motion
- to gain knowledge on velocity of plane waves and 1Dimensional and 2Dimensional wave equations
- to analyze the transmission of fluid phenomena and transmission through three media
- to understand the measurements of sound and noise in various levels and frequency & amplitude measurements
- to impart knowledge on basics of noise control, noise reduction procedures and methods

UNIT I BASIC CONCEPTS OF ACOUSTICS 9

Scope of Acoustics – Sound pressure – Sound intensity – Sound power level Sound power – Wave motion – Alteration of wave paths –Measurement of sound waves –sound spectra – Sound fields – Interference – Standing waves – Acoustic energy density and intensity – Specific acoustic impedance.

UNIT II CHARACTERISTICS OF SOUND 10

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

UNIT III TRANSMISSION PHENOMENA 6

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

UNIT IV INTRODUCTION TO THE ASSESSMENT AND MEASUREMENT OF SOUND 10

Introduction – Decibel scale for the measurement of sound power – Sound level meter – Weighted sound pressure level – Equal Loudness contours – Perceived noisiness – Loudness, Loudness level, perceived noise, perceived noise level –Equivalent sound level – Identified level – Frequency and Amplitude measurement.

UNIT V BASICS OF NOISE CONTROL 10

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

TOTAL : 45 PERIODS

COURSE OUTCOMES

- Upon completion of the course the student will have good knowledge of acoustics and noise control to design robust systems.
- Gain knowledge on basics of acoustics, medium of sound, wave equations involved to solve problems in this area.
- Understanding of transmission of sound through different media.
- Attaining thorough knowledge of decibal scale for measurement of sound.
- Learning noise control by acoustical treatment and these knowledge would give him good grounding in acoustics.

REFERENCES

1. Lawrence E. Kinsler, Austin R. Frey, "Fundamentals of Acoustics "– John Wiley and Sons Inc., 1986.
2. Bies, David, A. and Hansen, Colin H., "Engineering Noise Control – Theory and Practice", E and FN Spon, Chapman-Hall, Second Edition, 1996.
3. Hansen C.H. and Snyder, S.D., "Active Control of Sound and Vibration", E and FN Spon, London 1996.
4. Trevor J.Cox and Peter D' Antonio "Acoustic absorbers and diffusers-Theory , Design and applications" Hard Cover Publication, 2005.
5. Frank J. Fahy, Foundatin of Engineering Acoustics, Academic Press, 2000

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- www.soundspec.info/resourses/acoustics-reference-book.html
- www.ancentech.com/resouses/fundamentals.html