BansilalRamnathAgarwal Charitable Trust's

Vishwakarma Institute of Information Technology, Pune-48

(An Autonomous Institute affiliated to SavitribaiPhule Pune University)

Curriculum for

M. Tech.

(Mechanical – Design Engineering)

Department of

Mechanical Engineering

BansilalRamnathAgarwal *Charitable Trust's*
VISHWAKARMA INSTITUTE OF INFORMATION TECHNOLOGY
Department of Mechanical Engineering

Vision: Excellence in Mechanical Engineering for Global Acceptance

Ref.: VIIT/Mech./BOS/2017-18/ July 21, 2017

List of Members of Board of Studies of Mechanical Engineering (BOS)

Sr. No.	Name of Member Board of Studies of Mechanical Engineering	Subject expert	Signature
1	Dr. Atul P. Kulkarni. Associate Professor and Head Mechanical, VIIT, Pune	Chairman	
2	Dr. Satish S. Chinchanikar Professor and Dean Academics, VIIT	Member	
3	Dr. D. N. Kambale Associate Professor, VIIT	Senior Teacher	
4	Prof. Ashok R. Mache. Assistant Professor. VIIT, Pune	Subject Expert	
5	Dr. D. N. Kambale Associate Professor, VIIT	Subject Expert	
6	Prof. (Mrs.) Sampada V. Dravid. Assistant Professor. VIIT, Pune	Subject Expert	
07	Dr. S. N. Sapali. Professor, Department of Mechanical Engineering, College of Engineering, Pune	V.C. Nominee	
08	Dr. D. G. Thakur Associate Professor, Department of Mechanical Engineering, Defense Institute of Advanced Technology, Pune	Professional Expert	
09	Dr. Arun Chavan Senior Software Technical Consultant , PTC Software , Pune	Professional Expert	
10	Dr. Hitendra Patel (Philips Electronics (I) Ltd)	Industry Representative	
11	Mr. Shridhar Manda	Meritorious Alumnus	21/7/17

Department of Mechanical Engineering

Structure for First Year M. Tech Design Engineering
Mechanical Engineering
with effect from academic year 2017 – 2018

First Year - Semester I

Course Code	Course	Teaching Scheme		Examination Scheme					Total	Credits
				Formative Assessment			Summative Assessment			
				ISE		CE	ESE	PR/OR		
		L	P	T1	T2					
MEPA11171	Advanced Stress Analysis*	4	-	15	15	20	50	-	100	4
MEPA11172	Computational Methods *	4	-	15	15	20	50	-	100	4
MEPA11173	Research Methodology*	4	-	15	15	20	50	-	100	4
	Elective – I* (Program Specific)	4	-	15	15	20	50	-	100	4
	Elective – II (Department Specific)	4	-	15	15	20	50	-	100	4
MEPA11176	Seminar - I	-	2	-	-	50	-	50	100	1
MEPA11177	Lab practice – I*	-	8	-		50	-	50	100	4
MEPA11178	Audit Course	-	-	-	-	-	-	-	-	-
	Total	20	10	75	75	200	250	100	700	25

*Lab Practice I comprises of courses with course code MEPA11171, MEPA11172, MEPA11173, Elective – I, MEPA11177

	Elective-I		**Elective-II**
MEPA11174A	Process Equipment and Piping Design	MEPA11175A	Engineering System Modeling and Simulation
MEPA11174B	Industrial Tribology	MEPA11175B	Performance Modeling of Automated Manufacturing Systems
MEPA11174C	Introduction to Composite Material	MEPA11175C	Concurrent Engineering
MEPA11174D	Fracture Mechanics	MEPA11175D	Reliability Engineering

Audit Course : No Credits

Department of Mechanical Engineering

First Year – Semester II

Course Code	Course	Teaching Scheme		Examination Scheme					Total	Credits
				Formative Assessment			Summative Assessment			
		L	P	ISE		CE	ESE	PR/OR		
				T1	T2					
MEPA12171	Advanced Mechanical Vibrations *	4	-	15	15	20	50	-	100	4
MEPA12172	Advanced Finite Element Analysis*	4	-	15	15	20	50	-	100	4
MEPA12173	Analysis and Synthesis of Mechanisms*	4	-	15	15	20	50	-	100	4
	Elective – III (Program Specific)	4	-	15	15	20	50	-	100	4
	Elective - IV (Program Specific)	4	-	15	15	20	50	-	100	4
MEPA12176	Seminar – II	-	2	-	-	50	-	50	100	1
MEPA12177	Intellectual Property Rights	1	-	-	-	50	-	-	50	1
MEPA12178	Lab practice – II*	-	6	-	-	50	-	50	100	3
MEPA12179	Audit Course	-	-	-	-	-	-	-	-	
	Total	21	8	75	75	250	250	100	750	25

*Lab Practice II comprises of courses with course codeMEPA12171, MEPA12172, MEPA12173

Elective-III

MEPA12174A	Vehicle Dynamics
MEPA12174B	Mechanics of Composites
MEPA12174C	Design of Material Handling Equipment
MEPA12174D	Computer Aided Engineering

Elective-IV

MEPA12175A	Design of Experiments
MEPA12175B	Optimization Techniques
MEPA12175C	Advanced Material Science
MEPA12175D	Computational Fluid Dynamics

Audit Course: No Credits

Department of Mechanical Engineering

Second Year – Semester I

Course Code	Course	Teaching Scheme		Examination Scheme					Total	Credits
				Formative Assessment			Summative Assessment			
		L	P	ISE		CE	ESE	PR/OR		
				T1	T2					
	Open Elective (Institute)	3	-	15	15	20	-	-	50	3
MEPA21172	Foreign Language (German/French)/Business English	2	-	-	-	50	-	-	50	2
MEPA21173	Internship# / Value added course# / In-house Project#	-	8	-	-	100	-	100	200	8
MEPA21174	Project Stage I#	-	12	-	-	100	-	100	200	12
MEPA21175	Audit Course	-	-	-	-	-	-	-	-	-
	Total	5	20	15	15	270	-	200	500	25

Open Elective (Institute)

MEPA21171A: Ergonomic and Aesthetic in Product Design

Audit Course: No Credits

Second Year – Semester II

Course Code	Course	Teaching Scheme		Examination Scheme					Total	Credits
				Formative Assessment			Summative Assessment			
		L	P	ISE		CE	ESE	PR/OR		
				T1	T2					
ETPA22171	Project Stage II#	-	25	-	-	100	-	100	200	25
MEPA22172	Audit Course	-	-	-	-	-	-	-	-	-
	Total	-	25	-	-	100	-	100	200	25

Audit Course: No Credits

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Semester – I

Advanced Stress Analysis (MEPA11171)

Teaching Scheme
Credits : 4
Lectures : 4Hrs/week
Practical : 2 Hrs/week

Examination Scheme
F. A. : 50 Marks
S. A. : 50 Marks

Prerequisite:

1. Engineering Mathematics
2. Engineering Physics
3. Engineering Mechanics
4. Strength of Materials

Course Objectives:

1. To understand concept of three dimensional stress and strain at a point.
2. To understand stress distribution in component subjected to unsymmetrical bending and torsional loading.
3. To study methods of computing contact stresses and deflections
4. To study different techniques of experimental stress analysis

Course Outcomes:

Upon learning the course the student will be able to

1. Determine stress distribution along a component under different loading conditions
2. Able to apply of failure theories to solve real time problems.
3. Able to measure stress strain through experiments.

Unit I : Theory of Elasticity

Elasticity problems in two dimensions - stress strain relationship for brittle materials, ductile materials. Compatibility equations in two and three dimensions, free body diagram of complicated structures and stress calculations, stress functions in rectangular and cylindrical coordinate systems, evaluation of stresses in flat rectangular plates with different clamp and load conditions evaluation of the stresses in the flat and circular plate with center hole/holes using stress function.

Unit II : Plate Bending

Bending of plate to cylindrical surface, bending of a long uniformly loaded rectangular plate, pure bending in two perpendicular directions, bending of circular plates loaded symmetrically w.r.t. center, bending of circular plates of variable thickness, circular plate with circular hole at center symmetrically loaded and load distributed along inner and outer edges.

Unit III : Stress Analysis of Engineering Plastics and Composites

Types of engineering plastics (Nylon, ABS, PP) failure modes, failure phenomenon in two and three dimensional stress analysis, wear and tear of plastics, impact properties of plastics, types of composites (fiber reinforced plastics), evaluation of elastic properties of composites.

Unit IV : Theory of Torsion

Torsion of general prismatic bars of solid section, Membrane Analogy, Torsion of Thin walled tubes, Torsion of Thin walled Multiple-Cell closed sections, Torsion of rolled sections.

Unit V : Contact Stresses
Geometry of contact surfaces, method of computing contact stresses and deflection of bodies in point contact, stress for two bodies in line contact with load normal to contact area and load normal and tangent to contact area, gear contacts, contacts between cam and follower, ball bearing contacts.
Unit VI : Experimental Stress Analysis
Dimensional analysis, analysis techniques, strain gauges, types of strain gauges, materials, configuration, instrumentation, characteristics of strain gauge measurement, theory of photo elasticity.
Reference Books :
1. Advanced Mechanics of Materials - Cook and Young , Prentice Hall 2. Theory of elasticity - Timoshenko and Goodier , McGraw Hill 3.Advance Strength of Materials- vol 1 & 2 – Timoshenko, CBS publisher 4. Advanced Mechanics of Materials – Boresi, Schmidt, Sidebottom, Willey 5. Mechanics of Materials - vol 1 & 2 - E J Hearn , Butterworth- Heinemann
List of Practicals :
1. Advanced strength and Applied stress analysis - Richard G Budynas, McGraw Hill 2. Advanced Mechanics of solids - L S Srinath , McGraw Hill
Term Work :
1. Determination of full range stress-strain curve for mild steel and aluminum specimen as per ASTM-E8M 2. Measurement of strain in cantilever beam using strain gauges 3. Contact stress analysis using FEM Software 4. Determining shear center of asymmetric section (any two problems)

Prepared by :

Mr. A. R. Deshpande

BOS Chairman :

BOS Member :

Computational Method (MEPA11172)

Teaching Scheme
Credits : 4
Lectures : 4Hrs/week
Practical : 2 Hrs/week

Examination Scheme
F. A. : 50 Marks
S. A. : 50 Marks

Prerequisite:

Engineering Mathematics

Course Objectives:

1. To introduce students to some of the basic computational methods that emphasizes in analyzing problems arising in engineering and physical sciences.
2. To enhance computational skills using MATLAB

Course Outcomes:

Upon learning the course the student will be able to

1. Analyze the problems connected with data analysis and solution to ordinary and partial differential equations that arise in the respective engineering courses
2. Apply optimization, statistical methods to solve engineering problems using MATLAB

Unit I : Solution of Equations and Eigen value Problems

Solution of linear system of equations – Iterative methods of Gauss Jacobi and Gauss Seidel; Eigen values of a matrix by Power method and by Jacobi's method. Solution of algebraic and transcendental equations –Newton Raphson method & Secant Method

Unit II : Data Analysis & Interpolation

Newton's divided difference interpolation; Lagrange interpolation; Interpolation using Cubic Splines; Curve fitting – General Least squares principle – Linear, polynomial and multiple linear fit – Goodness of a fit; Fourier Analysis for sinusoidal variation.

Unit III : Optimization

Introduction to optimization, Classification, Constrained optimization: Graphical and Simplex method. One Dimensional unconstrained optimization: Newton's Method. Modern Optimization Techniques: Genetic Algorithm (GA), Simulated Annealing (SA).

Unit IV : Initial value & Boundary value problems for Ordinary Differential Equations

Euler's & Modified Euler methods; Fourth order Runge Kutta method for solving first order ODE; Runge Kutta method for a system of first order ODE and higher order systems; Multi-step methods & Stiffness – Milne's and Adams-Bashforth predictor-corrector methods for solving first order equations.

Unit V : Partial Differential Equations

Finite difference methods for first order boundary value problems; Finite difference techniques for the solution of two dimensional Laplace's and Poisson's equations on rectangular domain – One dimensional heat, flow equation by explicit and implicit (Crank Nicholson) methods, One dimensional wave equation by explicit method.

Unit VI : Transforms

Concept of transforms, Fourier transforms, Applications to partial differential equations, Dis Fourier transform, Laplace transforms and its inverse, Laplace transform of special functions: Unit Unit impulse, Periodic and Error. Applications to initial value problem and wave equation transform techniques

Text Books :

1. Steven C. Chapra, Raymond P. Canale, Numerical Methods for Engineers, 4/e, Tata McGraw Editions Dr. B. S. Garewal, Numerical Methods in Engineering and Science, Khanna Publisher
2. Steven C. Chapra, Applied Numerical Methods with MATLAB for Engineers and Scientist, Mc-GrawHill Publishing Co-Ltd
3. Rao V. Dukkipati, Applied Numerical Methods using Matlab, New Age International Publishe

Reference Books :

1. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley India
2. Gerald and Wheatley, Applied Numerical Analysis, Pearson Education Asia
3. E. Balagurusamy, Numerical Methods, Tata McGraw Hill
4. P. Thangaraj, Computer Oriented Numerical Methods, PHI 4. S. S. Sastry, Introductory Me of Numerical Analysis, PHI
5. Gupta S.K.(1995) Numerical Methods for Engineers, New Age International.

List of Practicals :

Student should use MATLAB for below practicals

1. Develop a program for Newton Raphson & Secant Method
2. Develop a program for Gauss Siedel Method
3. Develop a program for Numerical Differentiation & Integration
4. Develop a program for Lagrangian Interpolation
5. Use of optimization tool using any one technique (GA, SA)
6. Numerical investigation of a real problem using any two method of Computational Method

Prepared by :

Mr. M. N. Jagdale

BOS Chairman :

BOS Member :

Research Methodology (MEPA11173)

Teaching Scheme
Credits : 4
Lectures : 4 Hrs/week
Practical : 2 Hrs/week

Examination Scheme
F. A. : 50 Marks
S. A. : 50 Marks

Prerequisite:

Engineering Mathematics

Course Objectives:

1. To understand concepts of hypothesis.
2. Able to formulate a research problem with the methodology.
3. To study statistical techniques and its applications in research.

Course Outcomes:

Upon successful completion of this course, students will be able to

1. Impart fundamentals of concepts, construct and theory.
2. Develop capability to undertake empirical and quantitative research with software using scientific methods.
3. To write technical reports in standard format.

Unit I : Introduction to Research Methodology

Meaning and purpose of research, Objective of research, Types of research, Significance and approaches for research, Research Process and criteria, Scientific methods, Meaning of Research problem, Identification, selection and formulation of Research Problem, Meaning of Research Design, Need of Research Design, Features of a Good Research Design, Different types Research Design

Unit II : Hypothesis

What is Hypothesis? Concept and procedure of Hypothesis Testing, Flow diagram and test for Hypothesis.

Unit III : Basic Instrumentation

Instrumentation schemes, Static and dynamic characteristics of instruments used in experimental set up, Performance under flow or motion conditions, Data collection using a digital computer system, Linear scaling for receiver and fidelity of instrument, Role of DSP is collected data contains noise.

Unit IV : Applied Statistics

Regression analysis, Parameter estimation, Multivariate statistics, Principal component analysis, Moments and response curve methods, State vector machines and uncertainty analysis, Probable errors in the research, Error analysis

Unit V : Modelling and Prediction of Performance

Setting up a computing model to predict performance of experimental system, Multi-scale modelling and verifying performance of process system, Nonlinear analysis of system and asymptotic analysis, Verifying if assumptions hold true for a given apparatus setup, Plotting family of performance curves to study trends and tendencies, Sensitivity theory and applications.

Unit VI : Developing a Research Proposal
Format of research proposal, Individual research proposal, Institutional proposal, Proposal of a student – a presentation and assessment by a review committee consisting of Guide and external expert only, Other faculty members may attend and give suggestions relevant to topic of research
Text Books :
1. Research Methodology: A Step by Step Guide for Beginners, Ranjit Kumar, 2nd Edition 2. Research Methodology: Methods and Trends, Dr. C. R. Kothari 3. Operational Research, Dr. S.D. Sharma, Kedar Nath Ram Nath& co.
Reference Books :
1. Research methodology: an introduction for science & engineering students, Stuart Melville and Wayne Goddard 2. Research Methodology: An Introduction, Wayne Goddard and Stuart Melville
Term Work :
1. Write Sample research proposal of the planned research topic giving details of topic, significance, funding required etc. 2. Write a research paper on review of at least 5 research papers for a research topic (Language, formatting and authors guidelines to be strictly followed from standard Springer or Elsevier Journals and referred journal details to be mentioned in the Lab practice file) and verify the research article for plagiarism and attach the plagiarism report.

Prepared by :

Dr. A. P. Kulkarni

BOS Chairman :

BOS Member :

Elective I : Process Equipment and Piping Design (MEPA11174A)

Teaching Scheme
Credits : 4
Lectures : 4 Hrs/week
Practical : 2 Hrs/week

Examination Scheme
F. A. : 50 Marks
S. A. : 50 Marks

Prerequisite:

1. Engineering Mathematics
2. Machine Design
3. Mechanical System Design.

Course Objectives :

1. Understand the content of process flow diagrams (PFD)
2. Understand the content of piping and instrument diagrams (P&ID)
3. Introducing students to various design codes
4. To enable students to apply the requirements of the relevant industry standards to the mechanical design of equipment used in the process industry and above ground atmospheric storage

Course Outcomes :

Upon completion of the course, students should be able to:

1. Students will be able to understand the calculation of line sizes and pressure drops, flow measurement sizing and develop a flow measurement process data sheet.
2. Students will have understanding of several design codes used in the design.
3. Students will have understanding of the principles of process equipment design, the mechanical aspects of the design and operation of process equipment, including safety considerations.
4. Students will be able to complete detailed designs of several process equipment.

Unit I : Introduction to Process Design

Basic concepts in process design, block diagrams for flow of processes, material flow balance.

Unit II : Design Parameters

Design pressures and temperatures, design stresses, factory of safety, minimum shell thickness and corrosion allowance, weld joint efficiency, design loading, stress concentration and thermal stresses, failure criteria, optimization technique such as Lagrange's multiplier and golden section method, cost and profitability estimation

Unit III : Design of Cylindrical and Spherical Vessels

Thin and thick walled cylinder analysis, design of end closers, local stresses due to discontinuity or change of shape of vessel, vessel opening compensation, design of standard and non-standard flanges, design of vessels and pipes under external pressure, design of supports for process vessels.

Unit IV : Introduction to Piping Design

Piping design and procedure for process plant.

Unit V : Process Piping Design Considerations

Flow diagrams and pipe work symbols, Types of valves used on pipe line design of piping support, valves and fittings, standards, stress analysis, operation and maintenance aspects in piping design

Unit VI : Process Control and CAD Application

Fundamentals of process measurements and control modern control devices and other controls of majo unit operation and processes. Applications of CAD to process Equipment Design.

Text Books :

1. Joshi M V; Mahajani V V., "Process Equipment Design", New Delhi, Macmillan India Ltd. 1996., ISBN: 0333-92418-5
2. Browell and Young, Process Equipment Design, John Wiley, ISBN 0471113190
3. Design of Piping Systems, M. W. Kellogg Company 2
4. Pipe Stress Engineering, Liang-ChuanPeng and Tsen-LoongPeng, ASME Press
5. Engineering Optimization : Theory and Practice : By Rao S.S., New Age Publishing Co., New Delhi.

Reference Books :

1. Kellen Heward, Handbook of Instrumentation and Control, McGraw Hill.
2. B.C.Bhattacharya, "Introduction to Chemical Equipment Design: Mechanical Aspects", CBS ISBN: 9788123909455.
3. D.N.W. Kentish, Industrial Pipe Work, McGraw Hill. ISBN: 9780070845572
4. Piping Design Handbook by John J. Mcketta, by Marcel Dekker, Inc, New York.
5. Piping Handbook, Edited by MohinderNayyar, McGraw-Hill Education.
6. Process System Analysis and Control : By D.R. Coughanowr, McGraw Hill, New York.

List of Practicals :

1. Preparing flow diagrams of processes, piping layout, etc.
2. Assignment on standard codes for pressure vessel design
3. Report based on visit to industries such as sugar, cement, chemical industries.
4. Industrial case study on process measurement and control

Prepared by :

Dr. D. N. Kamble

BOS Chairman :

BOS Member :

Elective I : Industrial Tribology (MEPA11174B)

Teaching Scheme
Credits : 4
Lectures : 4 Hrs/week
Practical : 2 Hrs/week

Examination Scheme
F. A. : 50 Marks
S. A. : 50 Marks

Prerequisite:

1. Fluid Mechanics
2. Engineering Mathematics
3. Strength of Materials
4. Material Science and Metallurgy

Course Objectives :

1. To know about properties of lubricants, modes of lubrication, additives etc.
2. To study the film lubrication theory, sommerfield
3. To select lubrication and lubrication type
4. To apply the basic theories of surface friction, wear and lubrications about frictional behavior commonly encountered sliding surfaces.

Course Outcomes :

1. The students will understand various theories of friction and wear and will be able to apply them to various practical situations.
2. They will understand the various surface measurement techniques and effect of surface texture on Tribological behavior of a surface
3. They will be able to select lubrication and lubrication type.
4. The students will learn the basics of surface engineering and materials for bearings.

Unit I : Introduction To Tribology

Tribology definition. Tribology in design- bearing material its properties and construction Tribological design of oil seals and gasket. Tribology in industry (Maintenance). Lubrication-Definition, basic modes of lubrication, properties of lubricants, additives, EP lubricants.
Self-Learning: Comparison between sliding and rolling contact bearing. (Theoretical treatment only)

Unit II : Film Lubrication Theory

Coefficient of viscosity, Fluid film in simple shear , Viscous flow between very close parallel plates – Lubricant supply- Lubricant flow rate-Cold jacking-Couette flow Cavitation- Film rupure-oil whirl-Shear stress variation with in the film- Lubrication theory by Osborne Reynolds – Pressure fields for full sommerfeld- Half sommerfeld, Reynolds boundary conditions.

Unit III : Lubricants and Lubrication Types

Types and properties of Lubricants – Lubricant additives – Lubricant impurities and contaminants-Testing methods - Hydrodynamic Lubrication - Elasto hydrodynamic lubrication- Boundary Lubrication - Solid Lubrication, Hydrostatic Lubrication.

Unit IV : Surface Engineering and Materials for Bearings

Surface modifications - Transformation hardening - Surface fusion - Thermo chemical processes - Surface coatings - Plating and anodizing - Materials for rolling element bearings - Materials for fluid film bearings - Materials for marginally lubricated and dry bearings.

Unit V : Surfaces and Friction

Topography of Engineering surfaces- Contact between surfaces –Various tribological problems and solutions- Sources of sliding Friction – Adhesion, ploughing- Friction characteristics of metals - Friction of non-metals- Friction of ceramic materials and polymers - Rolling friction - Source of rolling friction - Stick slip motion - Measurement of friction.

Unit VI : Wear

Types of wear - Simple theory of sliding wear mechanism -Abrasive wear - Materials for adhesive and abrasive wear - Corrosive wear - Surface fatigue wear - Wear of ceramics and polymers - Wear measurements

Text Books :

1. Hutchings.I.M, "Tribology, Friction and Wear of Engineering Material", Edward Arnold. London, 1992
2. Williams.J.A, "Engineering Tribology", Oxford University Press, 2005.
3. GwidonStachowiak, Andrew W Batchelor., "Engineering tribology", Elsevier Butterworth – Heinemann, USA, 2005

Reference Books :

1. Stolarski.T.A, "Tribology in Machine Design", Industrial Press Inc., 1991.
2. Bowden.F.P, and Tabor.D, "Friction and Lubrication", Heinemann Educational Books Ltd., 2001.
3. Cameron.A, "Basic Lubrication theory", Longman, U.K., 1981.
4. Neale.M.J, (Editor), "Tribology Handbook", Newnes Butter worth, Heinemann, U.K., 1999.

List of Practicals :

Any one case study from 1 to 3 and any one assignment from 4 to 6 of the following:

1. Lubrication and lubrication type.
2. Surface friction
3. Surface engineering and materials for bearing
4. Assignment based on the Tribological design of the system like I C Engine, Machine Tool, Rolling Mill.
5. Industrial visit: students should visit the industry to study the lubrication systems or to study the techniques of surface coating.
6. Seminar on recent trends in Tribology or related areas: A seminar on recent trends in Tribology or related areas shall be given by the student. A seminar report shall be submitted as a part of term work.

Prepared by :

Mr. A. V. Salve

BOS Chairman :

BOS Member :

Elective I: Introduction to Composite Material (MEPA11174C)

Teaching Scheme
Credits : 4
Lectures : 4Hrs/week
Practical : 2 Hrs/week

Examination Scheme
F. A. : 50 Marks
S. A. : 50 Marks

Prerequisite:

1. Material Science
2. Metallurgy
3. Manufacturing Process

Course Objectives :

1. To understand importance of composite materials in various applications such as aerospace, automotive etc.
2. To understand various fabrication methods of composite material
3. An exposure to various experimental testing required for characterizing the composite material.

Course Outcomes :

Upon learning the course the student will be able to

1. Identify the properties of fiber and matrix materials used in commercial composites, as well as some common manufacturing.
2. Analysis stress and strength in the design of composite materials and structures.
3. Know the recent developments in composites

Unit I : Introduction to Composite Material

Introduction to Composite Materials, Constituent materials for composites-Fiber materials(Artificial And Natural), Matrix and Filler materials, Thermoset and thermoplastic matrix, Classification of composite materials, Lamina and Laminate, Potential advantages of composite materials, Applications of composite materials- Aircraft and Military Applications, Space Applications, Automotive Applications, Sporting Goods Applications, Marine Applications, Infrastructure.
Self-Learning: List/Study various types of synthetic and natural fibers.

Unit II : Pretreatment of Composite Constituents

Fiber Surface Treatments, Fillers and Other Additives, Incorporation of Fibers into Matrix (Prepregs Sheet-Molding Compounds, Incorporation of Fibers into Thermoplastic Resins) , Fiber Content, Density, and Void Content, Fiber Architecture, Cost Issues.

Unit III : Fabrication Techniques for Polymer Composites

Fundamentals (like Degree of Cure , Viscosity , Resin Flow, Consolidation, Time Test, Shrinkage, Voids.), Hand Layup, Bag-Molding Process, Compression Molding, Pultrusion, Filament Winding, Liquid Composite Molding Processes, Resin Transfer Molding, Structural Reaction Injection Molding, Other Manufacturing Processes, Manufacturing Processes for Thermoplastic Matrix Composites, Joint Design, Mechanical Joints, Bonded Joints, Cost Issues

Unit IV : Fabrication Techniques for Metal, Ceramic Matrix Composites

Metal Composites :

Squeeze Infiltration, Stir Casting, Spray Deposition, Powder Blending and Consolidation, Diffusion Bonding of Foils, Physical Vapour Deposition (PVD)

Ceramic Composites :

Powder-Based Routes, Reactive Processing, Layered Ceramic Composites, Carbon/Carbon Composites

Self-Learning: Study additional manufacturing process available

Unit V : Polymer Nano-composites

Nanoclay, Carbon Nanofibers, Carbon Nanotubes: Structure, Production of Carbon Nanotubes, Functionalization of Carbon Nanotubes, Mechanical Properties of Carbon Nanotubes, Carbon Nanotube–Polymer Composites, Properties of Carbon Nanotube–Polymer Composites

Unit VI : Mechanical Testing of Composites and their Constituents

Measurement of constituents material properties, Measurement of Basic composite properties-tensile tests, compression tests, shear tests, flexure tests, measurement of visco-elastic and dynamic properties-creep tests, vibration tests.

Self-Learning: Transverse Shear Strength.

Text Books :

1. Autar K. Kaw, Mechanics of Composite Materials, , CRC, Taylor and Francis 2006, ISBN:10:0-8493-1343-0.
2. Robert M. Jones, Mechanics of Composite Materials, Taylor and Francis 2010, ISBN:10:1-56032-712-X.
3. MadhujitMukhopodhyay , Mechanics of Composite Materials and Structures , University Press (India) PVT Ltd, 2009, ISBN: 9788173714771

Reference Books :

1. Ronald F. Gibson, Principles of Composite material Mechanics, , CRC Press, Taylor and Francis Group, 2010, ISBN-13: 978-0-8247-5389-4.
2. Mallick PK, Fiber-reinforced composites: materials, manufacturing, and design. CRC press, Taylor & Francis Group 2007; ISBN: 13: 978-0-8493-4205-9.

List of Practicals :

1. Demonstration on manufacturing of synthetic fiber reinforced composite laminate using compression molding machine.
2. Demonstration on manufacturing of natural fiber reinforced composite laminate using compression molding machine
3. Demonstration on manufacturing of synthetic fiber reinforced composite laminate using vacuum bagging technique
4. Demonstration on manufacturing of natural fiber reinforced composite laminate using vacuum bagging technique
5. Demonstration on Manufacturing of Fiber Metal Laminate
6. Tensile testing of composite coupon specimen

Prepared by :

Dr. A. R. Mache **BOS Chairman** **BOS Member**

Elective I : Fracture Mechanics (MEPA11174D)

Teaching Scheme
Credits : 4
Lectures : 4 Hrs/week
Practical : 2 Hrs/week

Examination Scheme
F. A. : 50 Marks
S. A. : 50 Marks

Prerequisite :

1. Engineering Mathematics
2. Strength of Materials
3. Material Science and Metallurgy
4. Machine Design

Course Objectives :

1. To know the fundamentals of elastic and plastic behaviors of solids etc.
2. To know the brittle fracture and modes of failure
3. To know the linear elastics fracture mechanics, crack tip plasticity
4. To apply the basic theories of elasto-plastics fracture mechanics.

Course Outcomes :

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

1. The students will understand various theories of elastic and plastic behaviors of solids
2. They will understand the brittle fracture and modes of failure
3. They will be able to learn linear elastics fracture mechanics, crack tip plasticity
4. The students will learn the basics of theories of elasto-plastics fracture mechanics

Unit I : Fundamentals of Elastic and Plastic Behaviors of Solids

The stress Tensor, Equations of Equilibrium, Strain Displacement Relations, Compatibility of Strain,The Stain Tensor, The Stress and Strain Invariants, Constitutive Laws for Elastic Solids, Two-Dimensional Problems, Displacement and Stress in Terms of Complex Potentials, An Overview of Plasticity Theory, Stress and Strain Deviator Tensors, Criteria for Yielding, Subsequent, Yield Surface, Hardening Rules, Plastic Stress Strain Relations.

Unit II : Modes of Failure

Failure and Fracture, Plastic Collapse, Ductile Failure, Brittle Fracture, Plastic Instability, Buckling and bifurcation, Fatigue Failure (Crack Initiation, Crack Propagation: Stages I & II and Crack Arrest), Creep and Creep Rupture and Corrosion. Emphases will be Given to Brittle Fracture and Fatigue.

Unit III : Brittle Fracture

Ductile Fracture, Brittle Fracture, Case History: Liberty Ships, Griffith Thermodynamic Energy Balance, The Griffith Crack, Irwin-Orowan Postulate, Design Against Brittle Fracture.

Unit IV : Linear Elastic Fracture Mechanics (LEFM)

Modes of Crack-Tip Deformation, Elastic Stress Field Equations: Westergaard Stress Function, Opening Mode Analysis, Sliding Mode Analysis, Tearing Mode Analysis, Superposition of Stress Intensity Factors, Effect of Finite Size of Component, Mixed Mode Problem, Determination of Stress Intensity Factors, Analytical Methods, Numerical Methods, Experimental Methods

Unit V : Crack-Tip Plasticity

Memory Plastic Zone Size Due to Irwin, Plastic Zone Size Due to Dugdale, Plastic Zone Size Using Classical Yield Criteria, Plastic Zone Shape and Size, Effect of Material Thickness Upon the Plastic Zone Size and Shape, Plane Strain and Plane Stress Fracture Toughness, Measurement of Plane Strain Toughness.

Unit VI : Elasto-Plastic Fracture Mechanics

The J-Integral, Path Independence of the J-Integral, The J-Integral: A Fracture Criterion, or a Characterizing Parameter, Experimental Determination of the J-Integral, The Crack Opening Displacement, Crack Opening Displacement (COD), Experimental Determination of COD

Text Books :

1. Timoshenko, S.P. and J.N. Goodier, "Theory of Elasticity", McGraw Hill (1970).
2. Broek, D., "Elementary Engineering Fracture Mechanics", 4th edition, MartinusNijhoff (1987).
3. Rolfe, S.T. and J.M. Barsom, "Fracture and Fatigue Control in Structures, Applications of Fracture Mechanics", Prentice Hall (1977).
4. Kobayashi, A.S. Editor, "Experimental Techniques in Fracture Mechanics", Vol. 1-2, The Iowa State University Press and SESA (1975).
5. "A General Introduction to Fracture Mechanics", The Journal of Strain Analysis,vol. 10, (1975).

Reference Books :

1. Tada, H., Paris, P. and Irwin, G., "The stress Analysis of Cracks Handbook" 3rd edition, ASME Pren (2000).
2. Rooke, D.P. and Cartwright, D.J., "Compedium of Stress Intensity Factors", Her Majestys Stationery Office, London (1976).
3. Murakami, Y. Editor in Chief, "Stress Intensity Factors Handbook", Pergamon Press (1988) (3 Volumes).
4. "Damage Tolerant Design Handbook", WL-TR-94-4052, CINDAS/USAF Handbooks Operation, Purdue University (1994) (5 Volumes).

List of Practicals :

Example Case Studies:

1 Failure of aero engine discs
2 Mechanically induced residual stresse
3 Liberty ships
4 Space shuttle "Challenger
5 Elements of Fracture Mechanics
6 Cyclic Stress and Strain Fatigue
7 Fatigue Crack Propagation

Fracture Mechanics Projects: In support of the above syllabus, students will be assigned failure analysis projects. OR Demonstration and measurement of material failure on fatigue testing machine set up.

Prepared by :

Mr. A.V.Salve **BOS Chairman :** **BOS Member :**

Elective II: Engineering System Modelling and Simulation (MEPA11175A)

Teaching Scheme
Credits : 4
Lectures : 4 Hrs/week

Examination Scheme
F. A. : 50 Marks
S. A. : 50 Marks

Prerequisite:

1. Turbo Machines
2. Engineering Mathematics
3. Hydraulics and Pneumatics

Course Objectives :

1. Understand what is a model, types of models, purpose of models
2. Apply problem-driven light-weight simulations and understand their value and purpose in early design decisions

Course Outcomes :

1. Model electro-mechanical, hydraulic & pneumatic systems using analytical & computational skills
2. Analyze steady state and transient response and investigate system stability

Unit I : Introduction

Course overview, Fundamental simulation modeling concepts, model development principles and methods, Modeling and simulation concepts, application domains, and tools.

Unit II : Modelling of Mechanical Elements and Systems

Mathematical modeling of mechanical elements – inertia, stiffness and damper.
Mathematical modeling of Mechanical systems – articulated vehicle and other mechanical systems. Modelling of Electro- Mechanical systems.

Unit III : Modeling of Hydraulic and Pneumatic - Elements and Systems

Mathematical modeling of hydraulic elements and system – Pneumatic elements and system. Transfer function representation, block diagram, State variable representation, matrix equation.

Unit IV : Advanced Modeling and Simulation Techniques

Introduction to Lyapunov Stability and Modeling via Lyapunov, Nonlinear Modeling Techniques such as consideration of Structural Nonlinearity and Material Nonlinearity.

Unit V : System

Transient response of first and second order system, Steady state response, Step Response, ramp response, impulse response, sinusoidal response, input – convolution integral, stability of system.

Unit VI : Simulation using Matlab

Introduction to Simulink, building blocks, Simulation of simple and compound pendulums, Simulation of planar mechanisms, Simulation of wheeled mobile robots, Validation and Verification of Simulation Models

Text Books :

1. Nicola Bellomoand Luigi Preziosi, "Modeling Mathematical Methods & Scientific Computations", 1995, CRC Press.
2. I.J. Nagarathand M. Gopal, "Systems Modeling & Analysis", Tata McGraw Hill, New Delhi.
3. Ogata, "System Dynamics", Pearson Education.

Reference Books :

1. Hung V Vu & R.S. Esfandi, "Dynamics Systems - Modeling and Analysis", ThecGraw-Hill Companies Inc.
2. Ogata, "System Dynamics", Pearson Education

Prepared by :

Mr. F.A.Shaikh

BOS Chairman :

BOS Member :

Elective II : Performance Modeling of Automated Manufacturing Systems (MEPA11175B)

Teaching Scheme
Credits : 4
Lectures : 4 Hrs/week

Examination Scheme
F. A. : 50 Marks
S. A. : 50 Marks

Prerequisite:

Course Objectives :

1. To learn about the various automation principles for factory/industrial.
2. To develop research skills and enhance knowledge in the field in innovative ways.

Course Outcomes :

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

1. Design automation technique
2. Apply innovative methods for industrial process

Unit I : Modeling Automated Manufacturing Systems

Introduction, Role of Performance Modeling, Performance Measures, Introduction to Performance Modeling Tools: Simulation Models, Analytical Models

Unit II : Automated Manufacturing Systems

Introduction, Manufacturing Systems, Performance Measures, Computer Controlled Machines, Material Handling Systems, Plant Layout, Flexible Manufacturing Systems, Computer Controlled Systems

Unit III : Markov Chain Models

Stochastic processes in manufacturing: Examples of Stochastic processes, Discrete time Markov chain models, Continuous time Markov chain models

Unit IV : Markov model of a transfer line

Birth and death processes in manufacturing, time reversible Markov chains in manufacturing, Absorbing states and modeling of deadlocks, Semi-Morkov processes in manufacturing, Transfer analysis of manufacturing systems, Computational issues in Markov analysis

Unit V : Queuing Models

Queues: Notation for queues, the M/M/1 queue, the M/M/m queue, Batch arrival queuing systems

Unit VI : Petri Net Models

Classical Petri nets, Stochastic Petri nets, Generalized Stochastic Petri nets, GSPN modeling of Kanban Systems

Text Books :

1. Ronald. G. Askin, Modeling and Analysis of Manufacturing Systems, John Wiley and Sons, Inc.
2. N. Viswanadham, Y. Narahari, Performance Modeling of Automated Manufacturing Systems, PHI.
3. Mikell.P.Groover, Automation , Production systems & computer integrated manufacturing, PHI
4. S.S.Rao, Engineering optimization, New Age International Publications.

Reference Books :

1. P. Brandimarte, A Villa, Modeling Manufacturing Systems, Springer Verlag, Berlin.
2. Richard Crowson, Factory Operations: Planning and Instructional Methods- Ed2, CRC Press, Second Edition.
3. Phillip. F. Ostwald, Jairo Munoz, Manufacturing Processes and Systems, John Wiley and Sons

Prepared by:

Dr.S.S.Chinchanikar

BOS Chairman :

BOS Member :

Elective II : Concurrent Engineering (MEPA11175C)

Teaching Scheme
Credits : 4
Lectures : 4 Hrs/week

Examination Scheme
F. A. : 50 Marks
S. A. : 50 Marks

Prerequisite:

1. Quality Control
2. Research Methodology

Course Objectives :

1. The current trends in CE.
2. The potential scope of CE within an organization.
3. The importance of rapid inter-departmental communication.
4. The role of computers in implementing CE.

Course Outcomes :

Upon learning the course the student will be able to

1. Understand the need for adopting CE methodology in their own organisation
2. Understand the importance of such factors as the right corporate culture, multi-disciplinary teams and their empowerment for successful implementation of CE
3. Be able to undertake an evaluation of their company's present communication infrastructure and recommend suitable changes to support the CE environment
4. Become familiar with a range of computer based tools for modelling engineering processes and information
5. Understand various factors and techniques required to optimize the product development process

Unit I : Introduction to Concurrent engineering

Introduction, Definition and requirement, meaning of CE, objectives of CE, benefits of CE, Life cycle design of products, life cycle costs. Support for CE: Classes of support for CE activity, CE organizational structure, CE team composition and duties, Computer based Support, CE Implementation Process.

Unit II : Design Product for Customer

Industrial Design, Quality Function Deployment, house of quality, Translation process of quality function deployment (QFD). Modeling of Concurrent Engineering Design: Compatibility approach, Compatibility index, implementation of the Compatibility model, integrating the compatibility Concerns.

Unit III : Design for Manufacture (DFM)

Introduction, role of DFM in CE, DFM methods, e.g. value engineering, DFM guidelines, design for assembly, creative design methods, product family themes, design axioms, Taguchi design methods, Computer based approach to DFM. Evaluation of manufacturability and assemblability.

Unit IV : Quality by Design

Quality engineering & methodology for robust product design, parameter and Tolerance design, Quality loss function and signal to noise ratio for designing the quality, experimental approach.
Unit V : Design for X-ability
Design for reliability, life cycle serviceability design, design for maintainability, design for economics, decomposition in concurrent design, concurrent design case studies.
Unit VI : Artificial Intelligence in Concurrent Engineering
Application of expert systems to engineering design, a knowledge-based approach to design for manufacturing using features, Concurrent accumulation of knowledge: a view of concurrent engineering, Integrated knowledge systems for adaptive, concurrent design.
Text Books :
1. Concurrent Engineering- Kusiak - John Wiley & Sons 2. Concurrent Engineering-menon, Chapman & Hall 3. Concurrent Engineering, shortening lead times, raising quality & lowering costs, John. R. Hartley, Susmu Okamato.
Reference Book :
1. Concurrent Engineering- Hamid Parsaei and William Sullivan, Chapman & Hall

Prepared by :

Dr. S. S. Chinchanikar

BOS Chairman :

BOS Member :

Elective II : Reliability Engineering (MEPA11175D)

Teaching Scheme
Credits : 4
Lectures : 4 Hrs/week

Examination Scheme
F. A. : 50 Marks
S. A. : 50 Marks

Prerequisite:

1. Engineering Mathematics
2. Probability
3. Statistics.

Course Objectives :

1. Understanding the basic reliability aspects of mechanical components and systems.
2. Understanding the modes of failures of mechanical components and the failure aspects of ductile and brittle materials.
3. Understanding of various statistical models and distribution functions which govern the behaviour of mechanical components.
4. Understanding aspects of redundancy, reliability of repairable systems and system availability functions.

Course Outcomes :

On completion of the course the student will be able to:

1. Understand and analyse different modes of failure of mechanical components.
2. Apply the statistical models and appropriate distribution function to obtain the reliability of mechanical components.
3. Evaluate the reliability of mechanical systems Statistically estimate reliability parameters, sample size and confidence interval.

Unit I : Reliability Concepts and Statistical models

Reliability terminologies, life characteristic phases, failure density, failure Rate, hazard rate, pdfandcdf. Causes and modes of failures, Mean Time To Failure (MTTF) and Mean Time Between Failure (MTBF), Relations among reliability, hazard rate and failure density, Discrete and continuous probability distributions - binomial, normal, lognormal, Poisson, Weibull and exponential.

Unit II : System Reliability

Series configuration with Normal Load Distribution and its modified approach, Series configuration with Exponential Reliability Functions, Parallel configuration, Parallel configuration with exponential distribution, Mixed configuration systems, Conditional probability method, Tie-set and Cut Set methods.

Unit III : Redundancy Aspects and Reliability Apportionment Techniques

Redundant systems, Active Redundancy, Standby Redundancy, Markov process, Element redundancy, Unit redundancy, Reliability apportionment techniques - AGREE, ARINC and Minimum effort method

Unit IV : Reliability Techniques and Management

Maintainability and availability (inherent, achieved and operational availability) functions, Repairable systems, Maintainability parameters, Reliability techniques- Failure mode, effects analysis (FMEA) and Failure mode, effects and criticality analysis (FMECA)-Case Studies, Fault Tree construction and analysis, Monte Carlo Simulation.

Unit V : Reliability of Mechanical Components for Strength

General expressions for reliability, Reliability expressions for specific distributions, Reliability of bolted joints, Shafts, Antifriction bearings and Welded joints..

Unit VI : Statistical Estimation of Reliability Parameters

Introduction and need of multi-biometric Reliability parameters and distribution function, Reliability parameter estimation, Confidence level with unknown variance, sample size for μ estimation, Confidence level for failure probability, Solution through Beta and Normal function, Chi-Square distribution and Goodness-of-Fit tests.

Text Books :

1. Kapur, Reliability in engineering Design, Wiley India
2. S S. Rao, Reliability Based Design, McGraw Hill Inc. 1992.

Reference Books :

1. L.S.Srinath, Reliability Engineering, EWP, 4th Edition 2011
2. Alessandro Birolini, Reliability Engineering Theory and Practice, Springer
3. L.S.Srinath, Mechanical Reliability, EWP, 2002.

Prepared by :

Dr.S. S. Chinchanikar

BOS Chairman :

BOS Member :

Seminar I (MEPA11176)

Teaching Scheme
Credits : 1
Practical : 2 hrs/week

Examination Scheme
F. A. (CE) : 50 Marks
S. A. (Oral) : 50 Marks

Guidelines:

Shall be on state of the art topic of student's own choice approved by an authority. The student shall submit the duly certified seminar report in standard format, for satisfactory completion of the work by the concerned Guide and head of the department/institute.

Lab Practice I (MEPA11171)

Teaching Scheme
Credits : 4
Practical : 8Hrs/week

Examination Scheme
F. A. (CE) : 50 Marks
S. A. (Oral) : 50 Marks

List of Experiments:

Advanced Stress Analysis (Practical) :

1. Determination of full range stress-strain curve for mild steel and aluminum specimen as per ASTM-E8M
2. .Measurement of strain in cantilever beam using strain gauges
3. Contact stress analysis using FEM Software
4. Determining shear center of asymmetric section (any two problems)

Computational Method (Practical) :

1. Program on Roots of Equation
2. Program on ODE
3. Theory assignment on Modern Optimization techniques.
4. Solving Application oriented Numerical from each unit with algorithm & flow char
5. Matlab as an engineering tool, applications to telecommunications, biomedical engineering, embedded systems, electricity market, robotics, and other fields of engineering as appropriate

Research Methodology (Assignment) :

1. Write Sample research proposal of the planned research topic giving details of topic, significance, funding required etc.
2. Write a research paper on review of at least 5 research papers for a research topic (Language, formatting and authors guidelines to be strictly followed from standard Springer or Elsevier Journals and referred journal details to be mentioned in the Lab practice file) and verify the research article for plagiarism and attach the plagiarism report.

Elective I : Process Equipment and Piping Design (Practical):

1. Preparing flow diagrams of processes, piping layout, etc.
2. Assignment on standard codes for pressure vessel design
3. Report based on visit to industries such as sugar, cement, chemical industries.
4. Industrial case study on process measurement and control

Elective I : Industrial Tribology (Practical):

Any one case study from 1 to 3 and any one assignment from 4 to 6 of the following:

1. Lubrication and lubrication type.
2. Surface friction
3. Surface engineering and materials for bearing
4. Assignment based on the Tribological design of the system like I C Engine, Machine Tool, Rolling Mill.
5. Industrial visit: students should visit the industry to study the lubrication systems or to study the techniques of surface coating.
   Seminar on recent trends in Tribology or related areas: A seminar on recent trends in Tribology or related areas shall be given by the student. A seminar report shall be

submitted as a part of term work.

Elective I : Fracture Mechanics (Practical)

The Term Work shall consist of:

Example Case Studies:

1. Failure of aero engine discs
2. Mechanically induced residual stresses
3. Liberty ships
4. Space shuttle "Challenger"
5. Elements of Fracture Mechanics
6. Cyclic Stress and Strain Fatigue
7. Fatigue Crack Propagation
8. Fracture Mechanics Projects

In support of the above syllabus, students will be assigned failure analysis projects.

OR

Demonstration and measurement of material failure on fatigue testing machine set up.

Elective I : Introduction to Composite Material (Practical)

1. Demonstration on manufacturing of synthetic fiber reinforced composite laminate using compression molding machine.
2. Demonstration on manufacturing of natural fiber reinforced composite laminate using compression molding machine.
3. Demonstration on manufacturing of synthetic fiber reinforced composite laminate using vacuum bagging technique.
4. Demonstration on manufacturing of natural fiber reinforced composite laminate using vacuum bagging technique.
5. Demonstration on Manufacturing of Fiber Metal Laminate

Tensile testing of composite coupon specimen

Semester - II

Advanced Mechanical Vibration (MEPA12171)

Teaching Scheme
Credits : 4
Lectures : 4 Hrs/week
Practical : 2 Hrs/week

Examination Scheme
F. A. : 50 Marks
S. A. : 50 Marks

Prerequisite:

1. Dynamics of machinery
2. Engineering Mathematics

Course Objectives :

1. To develop analytical competency in solving vibration problems.
2. To study vibration characteristics of the multi degrees of freedom system
3. To study the vibration measuring instruments.

Course Outcomes :

By the end of the course, students will able to

1. Able to determine natural frequencies,. Eigen values and mode shapes of MDOF.
2. Measure and analyse vibration of machine components.
3. Design machine components and analyse system response from vibration point of view.

Unit I : Fundamentals of Vibration

Review on basics of vibration, single degree freedom systems with free un-damped and damped system, and forced damped vibrations system.

Unit II : Two-degree of Freedom Systems

Free vibration of Undamped system, Principal modes of vibration, Spring coupled and mass coupled systems. Bending variation of two degree freedom system, Forced vibration, Vibration Absorber, Vibration isolation.

Unit III : Multi Degree of Freedom Systems

Equation of motion, Normal mode of vibration, Eigen value and Eigen Vector, Orthogonal properties, Modal analysis, stiffness and flexibility influence coefficients, Approximate methods for fundamental frequency- Matrix iteration methods, Rayleigh's, Stodola and Holzer.

Unit IV : Continuous Systems

Continuous Systems, longitudinal vibrations of bars, torsion vibration of shafts/rod and lateral vibration of beams.

Unit V : Non-linear Vibrations

Non-linear systems, Undamped and forced vibration with non-linear spring forces, Introduction of self-excited vibrations and examples like tool-chatter phenomenon etc.

Unit VI : Vibration Measurement Experimental Methods in Vibration Analysis

FFT analyzer, vibration exciters, signal analysis, time domain and frequency domain analysis of signals, experimental modal analysis, Examples of vibration tests - Industrial case studies.

Text Books :

1. S. S. Rao, "Mechanical Vibrations", 4th Edition, Pearson Education Inc. New Delhi, ISBN: 9788177588743
2. G. K.Grover, "Mechanical Vibrations", 8th Edition, New Chand and Bros,Roorkee, ISBN:978-81-85240-56-5
3. V. P.Singh, " Mechanical Vibrations", DhanpatRai and Sons, New Delhi, ISBN: 1234567150209
4. S. G. Kelly, "Mechanical Vibrations", Schaum's outlines, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 0070340412
5. V. Ramamurti, "Mechanical Vibration Practice and Noise Control", Narosa Publishing House, ISBN: 978-81-8487-199-9

Reference Books :

1. W.T. Thomson, Marie Dillon Dahleh, "Theory of vibrations with applications", 5th Edition, Pearson Education Pvt. Ltd., ISBN: 9788131704820
2. W. Weaver, Jr., S. P. Timoshenko, D. H. Young, "Vibration Problems in Engineering", 5th Edition ISBN: 978-0-471-63228-3.
3. Leonard Meirovitch, "Fundamentals of vibrations", Waveland PrInc; Reissue edition, ISBN-10: 1577666917
4. J. P. Den Hartog, "Mechanical Vibrations", Dover Publications INC, New York, ISBN: 0-486-64785-4

List of Practicals :

1. Determination of the free response of single degree damped system with amount of damping using suitable software
2. Determine total response of single degree damped system to harmonic excitation using suitable software.
3. Determination of Natural Frequencies of cantilever beam using any software package.
4. Determination of Natural Frequencies of cantilever beam using FFT Analyzer.
5. Computer program to find Eigen values using numerical method
6. Assignment on solving vibration problems by numerical Methods.

Prepared by :

Mr. N. H. Ambhore

BOS Chairman :

BOS Member :

Advanced Finite Element Analysis (MEPA12172)

Teaching Scheme
Credits : 4
Lectures : 4Hrs/week
Practical : 2 Hrs/week

Examination Scheme
F. A. : 50 Marks
S. A. : 50 Marks

Prerequisite:

1. Engineering Mechanics
2. Strength of Material
3. Machine Design
4. Mechanical Vibrations
5. Numerical Methods and Optimization
6. Fundamentals of Programming Language

Course Objectives :

1. To familiarize students with the displacement-based finite element method for displacement and stress analysis and to introduce related analytical and computer tools.
2. It provides a bridge between hand calculations based on mechanics of materials and machine design and numerical solutions for more complex geometries and loading states.
3. To study approximate nature of the finite element method and convergence of results are examined.
4. To study non-linear Finite element analysis to solve problems involving different types of nonlinearities.
3. It provides some experience with a commercial FEM code and some practical modeling exercises

Course Outcomes :

Upon learning the course the student will be able to

1. Derive and use 1-D and 2-D element stiffness matrices and load vectors from various methods to solve for displacements and stresses.
2. Apply mechanics of materials and machine design topics to provide preliminary results used for testing the reasonableness of finite element results.
3. Explain the inner workings of a finite element code for linear stress, displacement, temperature and modal analysis.
4. Use professional-level finite element software to solve engineering problems in solid Mechanics
5. Interpret the results of finite element analyses and make an assessment of the results in terms of modeling (physics assumptions) errors, discretization (mesh density and refinement toward convergence) errors, and numerical (round-off) errors.

Unit I : Fundamental Concepts

Finite element method, basic steps, advantages and disadvantages, energy principles, work and energy, principles of virtual work and stationery potential energy, variational methods of approximation –

Rayleigh-Ritz methods, weak formulation, Galerkin weighted residuals methods, Variational formulation of 1D bar and beam elements (Euler Bernoulli and Timoshenko beam) – governing equation, domain discretization, elemental equations, assembly and element connectivity, application of boundary condition, solution of equations, postprocessing of the results.Self-Learning: Review of Matrix Algebra (Vectors, Matrices, Symmetric banded matrix, Determinants, Inverses)

Unit II : Isoperimetric Elements and Formulation of Plane Stress and Plane Strain Elements

Introduction, shape functions – linear & quadratic, displacement function – criteria for the choice of the displacement function, polynomial displacement functions, triangular and quadrilateral isoparametric elements, higher order elements, characteristics of Jacobian, strain-nodal parameter relationship, stress-strain relationship, element stiffness matrix, convergence of isoparametric elements, numerical integration –Gauss Quadrature formula, Gauss Quadrature in one and two dimensions, remarks on order of Gauss integration, FEM convergence requirements-consistency and stability, reduced integration and spurious zero energy modes..

Unit III : Nonlinear Problems – Geometric, Material and Contact Problems

Introduction to non-linear analysis, formulation for geometrical, material and contact nonlinear problems, Nonlinear equation solving procedure - direct iteration, Newton-Raphson method, modified Newton-Raphson method, incremental techniques

Unit IV : Dynamic Problems – Eigen value and Time Dependent Problems

Formulation of dynamic problems, consistent and lumped mass matrices Solution of eigenvalue problems – transformation methods, Jacobi method, Vector Iteration methods, subspace iteration method , Forced vibration – steady state and transient vibration analysis, modeling of damping, the mode superposition scheme, direct integration methods – implicit and explicit numerical integration

Unit V : Types of Finite Element Analysis

Introduction to Linear static analysis, non-linear analysis, dynamic analysis, linear buckling analysis, thermal analysis, fatigue analysis, optimization, crash analysis, noise, vibration and harshness (NVH)

Unit VI : Special Topics

Computer implementation of the finite element method: pre-processing, meshing techniques, processing post processing. Static condensation ,Submodelling and substructuing ,Patch test and incompatible element, error estimation, h & p refinements.

Text Books :

4. Daryl L. Logan , A First Course in the Finite Element Method,. ISBN-10:81-315-0217-1
5. R. D. Cook, et al. , Concepts and Applications of Finite Element Analysis, Wiley, India. ISBN-0-471-10774-3.
6. Seshu P., Text book of Finite Element Analysis, PHI Learning Private Ltd. New Delhi, 2010.ISBN:978-81-203-2315-5.
7. Chandrupatla T. R. and Belegunda A. D., —Introduction to Finite Elements in Engineering‖, Prentice Hall India.ISBN-978-81-203-2106-9.

Reference Books :

1. Bathe K. J., —Finite Element Proceduresǁ, Prentice-Hall of India (P) Ltd., New Delhi. 42106. ISBN-0-13-301458.
2. S. Moaveni, —Finite element analysis, theory and application with Ansys. ISBN-0-13-785098-0
3. Fundamental of Finite Element Analysis, David V. Hutton, Tata McGraw-Hill. ISBN-0-07-239536-2
4. Gokhale N. S., Deshpande S. S., Bedekar S. V. and Thite A. N., —Practical Finite Element Analysis, Finite to Infinite, Pune. ISBN-978-81-906195-0-9
5. Gupta S.K.(1995) Numerical Methods for Engineers, New Age International.

List of Practicals :

1. Stress and deflection analysis of any machine component consisting of 3-D elements using FEA software.
2. Modal analysis of any machine component using FEA software.
3. Elasto-Plastic analysis of tensile test specimen using FEM Software.
4. Non-linear dynamic analysis of any component using FEM Software
5. Fatigue Analysis of any machine component using FEA software

Prepared by:

Dr.A. R. Mache

BOS Chairman :

BOS Member :

Analysis and Synthesis of Mechanisms (MEPA12173)

Teaching Scheme
Credits : 4
Lectures : 4 Hrs/week
Practical : 2 Hrs/week

Examination Scheme
F. A. : 50 Marks
S. A. : 50 Marks

Prerequisite:

1. Engineering Mathematics
2. Engineering Physics
3. Engineering Graphics
4. Engineering Mechanics
5. Basic Mechanical Engineering
6. Theory of Machines

Course Objectives: 1. To study basic of simple and complex mechanism analysis 2. To study kinematics of synthesis of mechanism
Course Outcomes: 1. Able to synthesize a mechanism for specified output 2. Able to evaluate and analyze complex mechanisms
Unit I : Introduction
Basic definitions, criterions, degree of freedom, equivalent linkages. Mechanical advantage and transmission angle kinematic analysis of mechanism.
Unit II : Kinematic Analysis of Complex Mechanisms
Velocity and acceleration analysis of complex mechanisms by the normal acceleration and auxiliary point methods.
Unit III : Force Analysis of Planar Mechanisms
Static force analysis, Dynamic force analysis of planar mechanisms, inertia forces linkages, Kineto-static analysis of mechanisms by matrix method. Analysis of elastic mechanisms, elastic linkage model, equations of motions.
Unit IV : Curvature Theory
Fixed and moving centrodes, inflection circle, Euler- Savy equation, Bobillier constructions, cubic of stationary curvature, Ball's point, Applications in dwell Mechanisms
Unit V : Synthesis of Planar Mechanisms:
Graphical Method: Types, number and dimensional synthesis, function generation, path generation and rigid body guidance problems, Chebychev spacing, graphical synthesis for function generation and rigid body guidance with two, three and four accuracy points using pole method, center point and circle point curves, Bermester points, synthesis for path generation.Analytical Method: Freudenstein's equation, synthesis for four accuracy points, synthesis of four-bar for prescribed angular velocities and accelerations using complex numbers, dyad, Robert Chebychev theorem, Cognates
Unit VI : Kinematics of Spatial Mechanisms

Transformations describing planar finite displacements, planar finite transformations, identity transformation, rigid-body transformations, spatial transformations Denavit-Hartenberg parameters, matrix method of analysis of spatial mechanisms.

Text Books :

1. Shigley Joseph Edward and Vicker John Joseph. "Theory of Machines and Mechanisms", 3rd., 1995, Oxford University Press. ISBN 0-19-515598-x.
2. Ghosh Amitabh and Malik Ashok Kumar, "Theory of mechanisms and Machines", 3ed, Affiliated East West press, 2000, ISBN 81-85938-93-8

Reference Books :

1. Allen Strickland, Jr. Hall, "Kinematics and Linkage Design", Waveland PrInc (1986) ISBN 10: 0881332720
2. Wilson C.E., Sandler J. P. "Kinematics and Dynamics of Machinery", Person Education. ISBN 020135099-8
3. Erdman A.G. and Sandor G.N., "Mechanism Design, Analysis and Synthesis" Volume-I, Prentice –Hall of India.

List of Practicals :

1. Coupler curve synthesis for a mechanism using computer software
2. Analysis of inertia forces in slider crank mechanism using any software
3. Simulation of planer mechanism using any software
4. Velocity and acceleration analysis of complex mechanism (any two problem)

Prepared by :

Mr.A.R.Deshpande

BOS Chairman :

BOS Member :

Elective III : Vehicle Dynamics (MEPA12174A)

Teaching Scheme
Credits : 4
Lectures : 4 Hrs/week

Examination Scheme
F. A. : 50 Marks
S. A. : 50 Marks

Prerequisite:

1. System Dynamics
2. Automobile Engineering
3. Kinematics of Machine
4. Dynamics of Machinery

Course Objectives :

1. To understand the principle and performance of vehicle in various modes such as longitudinal, vertical and lateral directions.
2. The student will be able to study the various forces and loads and performance under acceleration, ride and braking.

Course Outcomes :

Upon learning the course the student will be able to

1. Discuss the important elements in vehicle system dynamics and chassis design.
2. Derivate the dynamic equations governing a road vehicle.
3. Solve the fundamental problems in vehicle dynamics.

Unit I : Performance Characteristics of Vehicle

SAE Vehicle axis system, Forces & moments affecting vehicle, Earth Fixed coordinate system, Dynamic axle loads, Equations of motion, transmission characteristics, vehicle performance, power limited and traction limited acceleration, braking performance, Brake proportioning, braking efficiency.
Self-study: Prediction of vehicle response to braking

Unit II : Dynamic Suspension System

Requirements of suspension system. Spring mass frequency, wheel hop, Wheel wobble, wheel shimmy, choice of suspension spring rate. Calculation of effective spring rate. Hydraulic dampers and choice of damping characteristics. Compensated suspension systems. Human response to vibration, vehicle ride model. Load distribution. Stability on a curved track, banked road and on a slope.
Self-study: Deign Suspension System of Passenger car

Unit III : Mechanics of Tires

Tire forces and moments, rolling resistance of tires, relationship between tractive effort and longitudinal slip of tires, cornering properties of tires, ride properties of tire.
Self-study: Find free vibration of tires using FFT analyzer.

Unit IV : Aerodynamics of Vehicle

Mechanics of Air Flow Around a Vehicle, Pressure Distribution on a Vehicle, Aerodynamic Forces, Drag Components, Aerodynamics Aids.
Self-study: Find the drag coefficient of truck.

Unit V : Stability of Vehicle System

Load distribution. Stability on a curved track and on a slope. Gyroscopic effects, weight transfer durin acceleration and braking, overturning and sliding, Steady state handling characteristics.

Self-study: Transient response characteristics. Directional stability of vehicle.

Unit VI : Rollover& Vehicle handling

Quasi-Static Rollover of a Rigid Vehicle, Quasi-Static Rollover of a Suspended Vehicle, Transie Rollover, Over steer, under steer, steady state cornering, Directional stability of vehicles.

Text Books :

1. Kirpal Sing Vol 1 & 2 Automobile Engineering, Standard Publications.
2. Thomas D. Gillespie, Fundamentals of Vehicle Dynamics, SAE, 1992.

Reference Books :

1. J. G. Giles, 'Steering Suspension and Tyres, Iliffe Books Ltd,. 1968.
2. J. Y. Wong, 'Theory of Ground Vehicles', John Wiley & Sons Inc., New York, 2001.
3. Hans Pacejka, Tire and Vehicle Dynamics, Elsevier, 2012
4. Rajesh Rajamani, Vehicle Dynamics & control, Springer.
5. R. V. Dukkipati, Vehicle Dynamics, Narsova Publications.

List of Practicals :

1. Whirling of Shaft.
2. Finding Natural Frequency of Automotive Component using FFT analyser
3. Wheel Balancing
4. Simulation of Quarter Car Model Using Matlab.
5. Configuration of Passenger car using veDYNE software

Prepared by :

Mr.Pravin Rathod

BOS Chairman :

BOS Member :

Elective III : Mechanics of Composites (MEPA12174B)

Teaching Scheme
Credits : 4
Lectures : 4Hrs/week

Examination Scheme
F. A. : 50 Marks
S. A. : 50 Marks

Prerequisite:

1. Advanced Stress Analysis Composite
2. Material Science
3. Strength of Material

Course Objectives :

1. To develop an understanding of the linear elastic analysis of composite materials
2. To develop an ability to predict the failure strength of a laminated composite plate
3. To design composite structure

Course Outcomes :

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

1. Predict the elastic properties of fiber reinforced composites based on the constituent properties
2. Analysis stress and strength in the design of composite materials and structures.
3. Design composite structure as per application .

Unit I : Introduction to Composite Material

Introduction to Composite Materials, Classification of composite materials, Manufacturing methods of composite material, Characterization of composite material, Advantages , disadvantages and applications of composite materials, Lamina and Laminate

Unit II : Macromechanical Behaviour of a Lamina

Review of Definitions: Stress, Strain, Elastic Moduli, Strain Energy
Hooke's Law for Different Types of Materials - Anisotropic Material, Orthotropic Material (Orthogonally Anisotropic)/Specially Orthotropic, Transversely Isotropic Material, Isotropic Material
Hooke's Law for a Two-Dimensional Unidirectional Lamina- Plane Stress Assumption, Reduction of Hooke's Law in Three Dimensions to Two Dimensions, Relationship of Compliance and Stiffness Matrix to Engineering Elastic Constants of a Lamina

Unit III : Failure Theories of Lamina

Strength Failure Theories of an Angle Lamina - Strength Ratio, Failure Envelopes, Tsai–Wu Failure Theory, Maximum Stress Failure Theory, Tsai–Hill Failure Theory , Maximum Strain Failure Theory, Practical examples of orthotropic materials

Unit IV : Micromechanical Behaviour of a Lamina

Volume and Mass Fractions, Density, and Void Content ,Evaluation of the Four Elastic Moduli by Strength of Materials Approach, Semi-Empirical Models and Elasticity Approach , Elastic Moduli of Lamina with Transversely Isotropic Fibers , Ultimate Strengths of a Unidirectional Lamina , Longitudinal Tensile Strength, Longitudinal Compressive, Transverse Tensile Strength, Transverse Compressive Strength, In-Plane Shear Strength

Unit V : Damage Mechanics of Composite Materials

Basic Principles, Damage characterization, Damage evaluation in laminates, Inelastic strains and damage, Damage accumulation, Matrix microcracking, Interfacial damage
Unit VI : Design of Composite Structures
Laminate Design consideration-Laminate Design for Strength & Stiffness, Joint Design - Mechanical Joints, Bonded Joints, Failure Prediction, Design Examples-Design of a Tension Member, Design of a Compression Member, Design of a Beam, Design of a Torsional Member Application Examples-(any one): Inboard Ailerons on Lockheed L-1011 Aircraft, Composite Pressure Vessels, Corvette Leaf Springs, Tubes for Space Station Truss Structure
Text Books :
1. Autar K. Kaw, Mechanics of Composite Materials, , CRC, Taylor and Francis 2006, ISBN:10:0-8493-1343-0. 2. Robert M. Jones, Mechanics of Composite Materials, Taylor and Francis 2010, ISBN:10:1-56032-712-X. 3. MadhujitMukhopodhyay , Mechanics of Composite Materials and Structures , University Press (India) PVT Ltd, 2009, ISBN: 9788173714771
Reference Books :
1. Ronald F. Gibson, Principles of Composite material Mechanics, , CRC Press, Taylor and Francis Group, 2010, ISBN-13: 978-0-8247-5389-4. 2. Mallick PK, Fiber-reinforced composites: materials, manufacturing, and design. CRC press, Taylor & Francis Group 2007; ISBN: 13: 978-0-8493-4205-9.

Prepared by :

Dr.A.R.Mache

BOS Chairman :

BOS Member :

Elective III : Design of Material Handling Equipment (MEPA12174C)

Teaching Scheme
Credits : 4
Lectures : 4 Hrs/week

Examination Scheme
F. A. : 50 Marks
S. A. : 50 Marks

Prerequisite:

1. Strength of Machine Elements
2. Machine Design
3. Dynamics of machinery
4. Theory of machines

Course Objectives :

1. Understand the requirements of material handling systems and their design.
2. Be able to apply design procedure and methods as well as tooling for material handling system and its design.
3. Learn to apply automation techniques for material handling equipments.

Course Outcomes :

By the end of the course, students will able to

1. To take decisions based on the knowledge for a new design of equipments
2. Evaluate alternatives for any particular system which is to be designed.
3. Face a new problem under a scientific perspective.

Unit I : Material Handling System

Principles and features of material handling system, importance, terminology, objectives and benefits of better material handling, classification of material handling equipment.

Unit II :Selection Of Material Handling Equipment

Choice of material handling equipment, factors affecting for selection, general analysis procedures, basic analytical techniques, the unit load concept.

Unit III : Design of Cranes

2D Hand-propelled and traveling mechanisms of cantilever and monorail cranes, design considerations for structures of rotary cranes with fixed radius, fixed post and overhead traveling cranes, brakes, motor selection, safety arrangements, electrical control system.

Unit IV : Load Lifting Attachments

Load chains and types of ropes used in material handling system, forged, standard and Ramshorn hooks, crane grabs and clamps; grab buckets; electromagnet; design consideration for conveyor belts

Unit V : Study Of Bulk Material Handling Systems

Objectives of storage; bulk material handling; gravity flow of solids through slides and chutes; storage in bins and hoppers; screw conveyor, vibratory conveyor, pneumatic & hydraulic conveyor (classification, types, principles of operation)

Unit VI : Automation In Material Handling

Control of hoisting & conveying machinery, material handling in direct-line production and automated lines, safety and design; safety regulations and discipline

Text Books :

1. N.Rudenko, 'Material Handling Equipment', Peace Publishers , OCLC number 15354981
2. James M. Apple, 'Material Handling System Design', John-Wiley and Sons ,*ISBN* 10: 0471066524
3. John R. Immer, 'Material Handling' McGraw Hill, *ISBN* 9780070316775
4. Colin Hardi, 'Material Handling in Machine Shops'. Machinery Publication Co. Ltd., ISBN 9780853332077

Reference Books :

1. M .P. Nexandrn, 'Material Handling Equipment', MIR Publication,*ISBN*: 0471968218
2. C. R. Cock and J. Mason, 'Bulk Solid Handling', Leonard Hill Publication Co. Ltd.,*ISBN* 81-203-2308-4
3. Spivakovsy, A.O. and Dyachkov, V.K., 'Conveying Machines', Volumes I and II, MIR Publishers
4. Kulwiac R. A., 'Material Handling Hand Book', John Wiley Publication

List of Practicals :

1. Study of bottle filling plant and linear conveyor.
2. Design of belt conveyor system.
3. . Design of crane hook.
4. Failure mode and effect analysis of one product/component in a system.
5. Design review of any product/system for aesthetic and ergonomic considerations.
6. A report on plant visit.

Prepared by :

Mr. C. R. More

BOS Chairman :

BOS Member :

Elective III : Computer Aided Engineering (MEPA12174D)

Teaching Scheme
Credits : 4
Lectures : 4 Hrs/week

Examination Scheme
F. A. : 50 Marks
S. A. : 50 Marks

Prerequisite :

1. Computer Aided Machine Drawing
2. CAD/CAM
3. Finite Element Method

Course Objectives :

1. Understand the fundamental ideas of the solid modeling.
2. Understand the fundamental ideas of the FEM.
3. Understand the fundamental ideas of the Computational Fluid Dynamics
4. Can interpret and evaluate the quality of the results.
5. Learn how the finite element method is implemented (both algorithmically and numerically) by developing simple finite element computer code
6. Develop finite element formulations of engineering problems from a variety of application areas including stress, heat transfer, and vibration analysis.
7. Be aware of the limitations of the FEM. Learn to use any Commercial finite element programs

Course Outcomes :

By the end of the course, students will able to

1. 1. Knowledge of the governing equations for commonly encountered mechanical engineering problems.
2. Students will learn the mathematical formulation of the finite element method and how to apply it to basic (linear) ordinary and partial differential equations
3. Modeling and simulation of complex engineering problems by proper selection of finite element and boundary conditions.

1. Ability to solve linear, nonlinear and dynamic analysis problems using 1D, 2D and 3D FE models.
2. Ability to think laterally and originally, conceptualise and solve engineering problems, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering all necessary factors.
3. Usage of commercial FE softwares to solve complex engineering problems with an understanding of their limitations.

Using any Commercial finite element package perform stress, thermal, and modal analysis

Unit I : Solid Modeling

Geometry & Topology, Solid representation, Techniques of volume modeling, Feature based modeling: Feature representation, Parametrics, Relations, Constraints, Feature Manipulation. Mass properties calculations, Assembly modeling and Assembly analysis. Product Data Exchange.

Unit II : Rapid Prototyping

Introduction to Rapid Prototyping, classification of RP Processes, Working principle, models & specification process, application, advantages & disadvantages & case study of Stereo Lithography Apparatus (SLA), Laminated Object Manufacturing (LOM), Selective Laser Sintering (SLS), 3D Printing, Fused Deposition Modeling [FDM], Rapid Tolling and STL format.

Unit III : Two Dimensional Finite Element Analysis

Three noded triangular element, six noded triangular element, four noded quadrilateral element, eight noded quadrilateral element and nine noded quadrilateral element. Development of Finite Element Models for plane stress, plane strain, Axisymmetric stress analysis applications.

Unit IV : Dynamic Analysis Using Finite Elements

Vibration problems, Equations of motion based on weak form, Equations of motion using Lagrange's approach, consistent and lumped mass matrices, Solution of Eigenvalue problems.

Unit V : Computational Flow Simulation

Meshing for flow simulation, finite volume methods, pressure-velocity coupling, numerical stability.

Unit VI :Three dimensional Finite Element Analysis

Four node tetrahedral element, six node prism element, Eight node Hexahedral element and higher order elements. Boundary conditions, Mesh Generation, Mesh Refinement and other practical considerations.

Text Books :

1. Ibrahim Zeid, 'Mastering CAD/CAM', Tata McGraw Hill Co. Ltd. 2007
2. Larry J. Segerlind, 'Applied Finite Element Analysis', John Wiley & Sons, New York, 1984.
3. T Sundararajan and K Muralidhar, 'Computational Fluid Flow and Heat Transfer', Alpha Science International, Ltd., 2003.
4. T R Chandraupatla, A D Belegundu, 'Introduction to Finite Elements in Engineering', Pearson Education, 3rd Ed. 2004.

Reference Books :

1. D F Roger, J Adams, 'Mathematical Elements for Computer Graphics', McGraw Hill Co. Ltd. New York, 1990.
2. J N Reddy, 'Introduction to Finite Element Method' , Tata McGraw Hill Co. Ltd, 2005
3. K H Huebner, D L Dewhirst, D E Smith, T G Byrom, 'The Finite Element Method for Engineers', John Wiley & Sons, New York, 2008.
4. P. Sheshu, Textbook of Finite Element Analysis, Prentice Hall of India, 2004.

Prepared by :

Mr.K.S.Wangikar

BOS Chairman :

BOS Member :

Elective IV : Design of Experiments (MEPA12175A)

Teaching Scheme
Credits : 4
Lectures : 4 Hrs./week

Examination Scheme
F. A. : 50 Marks
S. A. : 50 Marks

Prerequisite:

1. Design of Machine Elements-I & II
2. Strength of Material
3. Engineering Mathematics

Course Objectives :

1. Understand the importance of statistical design of experiments and benefits in R&D
2. Learn the experimental designs most widely used in practice
3. Choose an appropriate experimental design based on the study objectives
4. Construct and implement the design selected
5. Analyze the data collected based on the design used and its underlying assumptions
6. Interpret the results of the experiment and report the conclusions

Course Outcomes :

1. By the end of the course, students will able to
2. Explain the practical implications of Design of experiments
3. Adopt ANOVA techniques to identify sufficient factors
4. Apply Taguchi techniques to conduct experiments in research work

Unit I : Principles and Techniques

Introduction- Planning of experiments – Steps – Need, Terminology: Factors, levels, variables, experimental error, replication, Randomization, Blocking, Confounding.

Unit II : ANOVA

Single Factor Experiments- ANOVA - Sum of squares – Completely randomized design, Randomized block design, effect of coding, Comparison of treatment means – Newman Kuel's test, Duncan's Multiple Range test, Latin Square Design.

Unit III : Experimental Design Concepts

Factorial Experiments-Main and interaction effects –Two and three Factor full factorial Designs, 2k designs with Two and Three factors- Yate's Algorithm

Unit IV : Analysis of Variance

Analysis of Variance in Random-Effects Model and Mixed-Effects Model, Analysis of Nonorthogonal Data, General Linear Hypothesis and Analysis of Variance

Unit V: Special Experimental Designs

Special Experimental Designs- Blocking and Confounding in 2k design

Unit VI : Taguchi Techniques

Taguchi Techniques- Fundamentals of Taguchi methods, Quality Loss function, orthogonal designs, application to Process and Parameter design.

Text Books :

1. Montgomery, D.C. "Design and Analysis of Experiments", John Wiley and Sons, 5th Edition,2002

Reference Books :

1. Hicks,C.R. "Fundamental concepts in Design of Experiments", Holt, Rinehort and Winston,
2. Bagchi, T.P. "Taguchi Methods explained", PHI, 2002.
3. Ross, P.J. "Taguchi Techniques for quality Engineering", Prentice Hall, 2000.

Prepared by :

Mr. G. K. Lambdhade

BOS Chairman :

BOS Member :

Elective IV : Optimization Techniques (MEPA12175B)

Teaching Scheme
Credits : 4
Lectures : 4Hrs/week

Examination Scheme
F. A. : 50 Marks
S. A. : 50 Marks

Prerequisite :

Engineering Mathematics

Course Objectives :

1. To understand the theory of optimization methods and algorithms developed for solving various types of optimization problems.
2. To develop and promote research interest in applying optimization techniques in problems of Engineering and Technology.
3. To apply the mathematical results and numerical techniques of optimization theory to concrete Engineering problems.

Course Outcomes :

1. Able to explain different approaches to optimize mechanical systems.
2. Able to calculate optimum solution to linear and non-linear problems.
3. Model and analyze data using interpolation and regression methods.
4. In a position to model engineering problems and pose it as an optimization problem

Unit I : Classical Optimization Technique

Need for optimization and historical development, Engineering applications of optimization, Statement of optimization problem, classification of optimization problem, single variable optimization, multi variable optimization with no constraint, equality constraint, in-equality constraint, Calculus based methods, Enumerative schemes.

Unit II : Linear Programming:

Simplex algorithm, two phases of the simplex method, applications, case studies.

Unit III : Non-Linear Programming

Need, One-dimensional minimization - exhaustive search, golden section method, Quasi-Newton method, random search methods, Powell's method

Unit IV : Optimum design of mechanical elements

Purpose and applications of optimum design, Effects of manufacturing errors, characteristics of mechanical systems, Selection of optimum configuration, critical regions materials and dimensions.

Unit V : Modern Methods of Optimization

Digital computers in optimum design, Exact and Interactive techniques, Genetic algorithms, simulated annealing, fuzzy optimization, neural-network-based methods.

Unit VI : Optimal Design of Different Elements and Topology Optimization

Optimal design of elements and systems, shafts gears, bearings, springs high speed machinery, cams etc. Case studies, Problem formulation and parameterization of design, solution methods, topology optimization as a design tool, combining topology and shape design

Text Books :

1. Engineering Optimization: Theory and Practice, Singiresu S. Rao, John Wiley & Sons. ISBN: 9780470549124.
2. Optimization: concepts and application engineering, Ashok Belegundu and Tirupathi Chandrupatla, Pearson Education Asia, Delhi, ISBN: 9781107674172.
3. Optimization: Theory and Practice, Mohan Joshi and Kannan Moudgalya, Narosa Publishing House, Bombay, ISBN: 978-81-7319-424-5.

Reference Books :

1. Structural Optimization, Raphael T. Haftka and ZaferGurdal, Kluwer Academic Publishers, ISBN: 978-0-7923-1505-6.
2. Practical Optimization Methods with Mathematical Applications, M. AsgharBhatti, Springer, ISBN: 978-1-4612-6791-1.
3. Topology Optimization – Theory, Methods and Applications, M. P. Bendse, Q. Sigmund, ISBN 978-3-662-05086-6.
4. Evolutionary Topology Optimization of Continuum Structures, Methods and Applications, X. Huang, Y.M. Xie, Wiley, 2010, ISBN: 9780470689486.

Prepared by :

Mr.K.S.Wangikar

BOS Chairman :

BOS Member :

Elective IV : Advanced Material Science (MEPA12175C)

Teaching Scheme
Credits : 4
Lectures : 4 Hrs/week

Examination Scheme
F. A. : 50 Marks
S. A. : 50 Marks

Prerequisite :

Material Science

Course Objectives :

1. Describe importance of mechanical properties in plastic behaviour of metals.
2. To study different strengthening mechanisms and their applications.
3. Describe importance fracture mechanics to the student
4. To understand different types of composites and other modern materials used in Industry

Course Outcomes :

By the end of the course, students will able to

1. Student will apply the basic concepts of plastic deformation .
2. Student will apply the fundamentals of types of fractures in studying the fracture mechanics.

Unit I :

Elastic and Plastic Behaviour Elasticity in metals and polymers - Mechanism of plastic deformation, role of dislocations, yield stress, shear strength of perfect and real crystals Material Testing under Complex Loading Tensile testing – uni-axial and biaxial tension test.

Unit II :

Strengthening mechanisms, work hardening, solid solutioning, grain boundary strengthening, precipitation, particle, fibre and dispersion strengthening. Effect of temperature, strain and strain rate on plasticbehaviours - Super plasticity.

Unit III :

Fracture Behavior Griffith's theory, stress intensity factor and fracture toughness – Ductile, brittle transition in steel - High temperature fracture, creep - Fatigue, low and high cycle fatigue test, Effect of surface and metallurgical parameters on fatigue

Unit IV:

Composite materials its classifications. Particle strengthened and laminar composites, Production techniques used in manufacturing of fibers, properties mechanics of composites, only manufacturing of metal matrix, Ceramic matrix composite, Carbon-Carbon composite- properties .

Unit V :

Modern Metallic Materials Dual phase steels, Micro alloyed, High strength low alloy (HSLA) steel, Transformation induced plasticity (TRIP) steel, Maraging steel, smart materials, shape memory alloys, all with its application and basics

Unit VI :

Selection of Materials 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 .

Text Books :

1. Thomas H. Courtney, " MechanicalBehavior of Materials ", McGraw-Hill, 2000.
2. Charles J.A., Crane, F.A.A and Furness, J.A.G., "Selection and use of Engineering Materials ", (3rd Edition), Butterworth-Heinemann, 1977.
3. Flinn, R.A. and Trojan, P.K., "Engineering Materials and their Applications ", (4th Edition), Jaico, 1999.
4. George E. Dieter, "Mechanical Metallurgy ", McGraw Hill, 1988.

Reference Books :

1. Metals Hand Book, Vol.10, "Failure Analysis and Prevention ", (10th Edition), 1994.
2. Willam D. Callister, Jr., "Material Science and Engineering: An introduction", John Wiley & Sons, Inc, 2003.
3. Willam F. Smith, "Principles of Materials Science and Engineering", 3rd edition, McGraw Hill, 2002.
4. Foundations of Theory of Plasticity, L.M. Kachanov, Dover Publications, 2004
5. Mechanical Behaviour of Materials, Dominique Francois, Andre Pineau, Andre Zaoui, Springer
6. Mechanical Behaviour of Materials, W. F. Hosford, Cambridge University Press, 2005

Prepared by :

Mrs. S.V.Dravid

BOS Chairman :

BOS Member :

Elective IV : Computational Fluid Dynamics (MEPA12175D)

Teaching Scheme
Credits : 4
Lectures : 4 Hrs/week

Examination Scheme
F. A. : 50 Marks
S. A. : 50 Marks

Prerequisite :

1. Engineering Mathematics
2. Engineering Physics, Fluid Mechanics
3. Heat transfer
4. Numerical Methods
5. Programming Languages MATLAB & C

Course Objectives :

1. To understand the conservation laws of fluid flow, transport mechanisms, volumetric and flux terms in fluid mechanics and heat transfer.
2. To understand and develop the ability to do discretization by finite difference method and finite volume method.
3. To understand CFD application in analysis and able to understand results.

Course Outcomes :

By the end of the course, students will able to

1. Derive the governing algebraic equations,
2. Understand various CFD codes, and use the codes for CFD application and analysis of the various problems involving fluid mechanics and heat transfer phenomenon.
3. The student will learn to use CFD application tools and able to use same in research.

Unit I : Introduction to CFD

Elastic Computational approach to Fluid Dynamics and its comparison with experimental and analytical methods; Elements in CFD: development, application and analysis; basics of PDE: Elliptic, Parabolic and Hyperbolic Equations, concept of finite and infinitesimal control volumes, Concept of substantial derivative, divergence of velocity.

(Self Learning topics : Various experimental and analytical methods for validation)

Unit II : Essentials of Fluid Dynamics and Heat Transfer

Physical laws: conservation (mass, momentum and energy) and subsidiary; transport mechanisms: diffusion and advection; governing conservation equations in integral and differential forms; physical interpretation of the governing equations; initial and boundary conditions; and governing and engineering parameters.

(Self Learning topics : Various fluid Transport phenomena theories)

Unit III : Computational Heat Conduction

2D Cartesian grid generation: uniform and non-uniform; algebraic formulation by the Finite volume method; solution methodology: explicit and implicit method; example problems on 1D and 2D conduction.

(Self Learning topics : Various advanced discretization methods)

Unit IV : Computational Heat Convection
Finite volume method; convection schemes, solution methodology: explicit and implicit method; example problems on 1D and 2D convection. (Self Learning topics : with the help of any programing language try to create code for 1D and 2D convection problems)
Unit V : Computational Fluid Dynamics on a Staggered Grid
Pressure-velocity decoupling; its remedy – a staggered grid, finite volume method on a staggered grid, philosophy of pressure correction method, Semi-Explicit method, initial and boundary conditions, example problems.
Unit VI : Computational Fluid Dynamics on a Co-located Grid
Momentum interpolation method, finite volume method, Semi-Implicit method, example problems. (Self Learning topics : Various standard tool)
Text Books :
1. Versteeg, H.K. and Malalasekera W. (1995). An Introduction to Computational Fluid Dynamics: The Finite Volume Method, Longman Scientific & Technical, Harlow, ISBN *0-470-23515-2.* 2. Patankar, S.V. (1980). Numerical Heat Transfer and Fluid Flow, Hemisphere Publishing Corporation, ISBN *0-07-048740-5.* 3. Muralidhar, K. and Sundarajan, T. (Editors) (2003). Computational Fluid Flow and Heat Transfer (2nd ed.), IIT Kanpur Series, Narosa Publishing House, New Delhi,ISBN: 81-7319-522-6.
Reference Books :
1. Anderson, J.D. (1995). Computational Fluid Dynamics: The basics with applications, McGraw Hill, New York,ISBN0-07-001685-2. 2. Ferziger, J.H. and Peric M. (2002). Computational Methods for Fluid Dynamics, Springer Verlag, Berlin,ISBN *3-540-42074-6.* 3. Biringen S. and Chow C. Y. (2011), An Introduction to Computational Fluid Mechanics by Example, Wiley,ISBN*: 978-0-470-10226-8.*

Prepared by :

Mr. A.A.Manikjade

BOS Chairman :

BOS Member :

Unit IV : Computational Heat Convection
Finite volume method; convection schemes, solution methodology: explicit and implicit method; example problems on 1D and 2D convection. (Self Learning topics : with the help of any programing language try to create code for 1D and 2D convection problems)
Unit V : Computational Fluid Dynamics on a Staggered Grid
Pressure-velocity decoupling; its remedy – a staggered grid, finite volume method on a staggered grid, philosophy of pressure correction method, Semi-Explicit method, initial and boundary conditions, example problems.
Unit VI : Computational Fluid Dynamics on a Co-located Grid
Momentum interpolation method, finite volume method, Semi-Implicit method, example problems. (Self Learning topics : Various standard tool)
Text Books :
1. Versteeg, H.K. and Malalasekera W. (1995). An Introduction to Computational Fluid Dynamics: The Finite Volume Method, Longman Scientific & Technical, Harlow, ISBN *0-470-23515-2.* 2. Patankar, S.V. (1980). Numerical Heat Transfer and Fluid Flow, Hemisphere Publishing Corporation, ISBN *0-07-048740-5.* 3. Muralidhar, K. and Sundarajan, T. (Editors) (2003). Computational Fluid Flow and Heat Transfer (2nd ed.), IIT Kanpur Series, Narosa Publishing House, New Delhi, ISBN: 81-7319-522-6.
Reference Books :
1. Anderson, J.D. (1995). Computational Fluid Dynamics: The basics with applications, McGraw Hill, New York, ISBN0-07-001685-2. 2. Ferziger, J.H. and Peric M. (2002). Computational Methods for Fluid Dynamics, Springer Verlag, Berlin, ISBN *3-540-42074-6.* 3. Biringen S. and Chow C. Y. (2011), An Introduction to Computational Fluid Mechanics by Example, Wiley, ISBN: *978-0-470-10226-8.*

Prepared by :

Mr. A.A.Manikjade

BOS Chairman :

BOS Member :

Seminar II (ETPA12176)

Teaching Scheme
Credits : 1
Practical : 2 hrs/week

Examination Scheme
F. A. (CE) : 50 Marks
S. A. (Oral) : 50 Marks

Guidelines:

Shall be on the topic relevant to latest trends in the field of concerned branch, preferably on the topic of specialization based on the electives selected by him/her approved by authority. The student shall submit the seminar report in standard format, duly certified for satisfactory completion of the work by the concerned guide and head of the Department/Institute.

Intellectual Property Rights (ETPA12175)

Teaching Scheme
Credits : 1
Lectures : 1 Hr/week

Examination Scheme
F. A. (CE) : 50 Marks

Course Objectives:

1. The course is designed to introduce fundamental aspects of Intellectual property Rights.
2. The course introduces all aspects of the IPR Acts.
3. It also includes case studies to demonstrate the application

Course Outcomes:

Students will be able to demonstrate and develop awareness of the relevance and impact of IP Law on their academic and professional lives.

Unit I : Overview of Intellectual Property

Introduction and the need for intellectual property right (IPR) IPR in India – Genesis and Development IPR in abroad Some important examples of IPR

Unit II : Patents

Macro economic impact of the patent system, Patentability, Types of IP tools, Copyright, trademarks, Patent databases, Patent document and its search, Rights of a patent,

Unit III : Patent Search

Searching a patent, Patent database, Patent free database. Patent structure, Patent grants Procedure in India, Different layers of the international patent system (National, Regional and international options).

Copyright- Definition of copyright, Content of copyright, What are related rights, Rights covered by copy right

Unit IV : Trademark

Definition of trademark, Rights of trademark, Kind of signs can be used as trademarks, Types of trademark function, Protection of trademark, Trademark registration.

Text Books :

1. Resisting Intellectual Property by Halbert ,Taylor & Francis Ltd ,2007
2. Industrial Design by Mayall, McGraw Hill
3. Intellectual Property Rights Under WTO by T. Ramappa, S. Chand
4. Encyclopedia of Ethical, Legal and policy issue in Biotechnology by T. M. Murray and M. J. Mehlman, John Wiley and Sons 2000.

Reference Books :

1. Nanotechnology Intellectual Property Rights: Research, Design, and Commercialization by Dr. S. K. Jabade, CRC Press
2. Product Design by Niebel, McGraw Hill
3. Introduction to Design by Asimov, Prentice Hall
4. Intellectual Property in New Technological Age by Robert P. Merges, Peter S. Menell, Mark A. Lemley

Lab Practice II (MEPA12178)

Teaching Scheme
Credits : 4
Practical : 6Hrs/week

Examination Scheme
F. A. (CE) : 50 Marks
S. A. (Oral) : 50 Marks

List of Experiments:

Advanced Mechanical Vibration (Practical)

1. Determination of the free response of single degree damped system with amount of damping using suitable software
2. Determine total response of single degree damped system to harmonic excitation using suitable software.
3. Determination of Natural Frequencies of cantilever beam using any software package.
4. Determination of Natural Frequencies of cantilever beam using FFT Analyzer.
5. Computer program to find Eigen values using numerical method

Assignment on solving vibration problems by numerical Methods.

Advanced Finite Element Analysis (Practical)

1. Stress and deflection analysis of any machine component consisting of 3-D elements using FEA software.
2. Modal analysis of any machine component using FEA software.
3. Elasto-Plastic analysis of tensile test specimen using FEM Software.
4. Non-linear dynamic analysis of any component using FEM Software
5. Fatigue Analysis of any machine component using FEA software

Analysis and Synthesis of Mechanisms (Practical)

1. Coupler curve synthesis for a mechanism using computer software
2. Analysis of inertia forces in slider crank mechanism using any software
3. Simulation of planer mechanism using any software
4. Velocity and acceleration analysis of complex mechanism (any two problem)