Bansilal Ramnath Agarwal Charitable Trust's

Vishwakarma Institute of Information Technology, Pune-48

(An Autonomous Institute affiliated to Savitribai Phule Pune University)

Curriculum for

M. Tech.

(Mechanical – Design Engineering)

Department of Mechanical Engineering

VISION:

- Excellence in Mechanical Engineering for Global Acceptance

MISSION:

- Make spirited mechanical engineers with morals, values and principles for sustainable development of society
- Strive continuously to impart knowledge and skills of the highest standards
- Our engineers will respond to the current and future needs of the industry, higher studies as well as research

First Year M. Tech. (FYMT) Design Engineering (Mechanical Engineering)
Semester I (Pattern 2018)

Course Code	Course	Course Type	Teaching Scheme		Examination Scheme					Total	Credits
					Formative Assessment			Summative Assessment			
			L	P	ISE T1	ISE T2	CE	ESE	OR		
MEPA11181	Advanced Stress Analysis	TH	3	-	20	10	20	50	-	100	3
MEPA11182	Advanced Vibrations and Acoustics	TH	3	-	20	10	20	50	-	100	3
MEPA11183	Program Elective – I	TH	3	-	20	10	20	50	-	100	3
MEPA11184	Program Elective – II	TH	3	-	20	10	20	50	-	100	3
MEPA11185	Laboratory – I	CE-OR	-	4	-	-	50	-	50	100	2
MEPA11186	Laboratory – II	CE-OR	-	4	-	-	50	-	50	100	2
MEPA11187	Research Methodology and IPR	CE	2	-	-	-	50	-	-	50	2
AP1	Audit Course I	-	-	-	-	-	-	-	-	-	-
	Total		**14**	**8**	**80**	**40**	**230**	**200**	**100**	**650**	**18**

Elective-I

MEPA11183A	Advanced Machine Design
MEPA11183B	Design for Manufacturing and Assembly
MEPA11183C	Mathematical Methods in Engineering

Elective-II

MEPA11184A	Advanced Engineering Materials
MEPA11184B	Mechanics of Composite Materials
MEPA11184C	Tribology in Design

Audit Courses

1. English for Research Paper Writing
2. Disaster Management
3. Sanskrit for Technical Knowledge
4. Value Education
5. Constitution of India
6. Pedagogy Studies
7. Stress Management by Yoga
8. Personality Development through Life Enlightenment Skills.

BoS Chairman Dean Academics Director

First Year M. Tech. (FYMT) Design Engineering (Mechanical Engineering)
Semester II (Pattern 2018)

Course Code	Course	Course Type	Teaching Scheme		Examination Scheme					Total	Credits
					Formative Assessment			Summative Assessment			
			L	P	ISE		CE	ESE	OR		
					T1	T2					
MEPA12181	Finite Element Method	TH	3	-	20	10	20	50	-	100	3
MEPA12182	Computer Aided Design	TH	3	-	20	10	20	50	-	100	3
MEPA12183	Program Elective – III	TH	3	-	20	10	20	50	-	100	3
MEPA12184	Program Elective - IV	TH	3	-	20	10	20	50	-	100	3
MEPA12185	Laboratory – III	CE-OR	-	4	-	-	50	-	50	100	2
MEPA12186	Laboratory – IV	CE-OR	-	4	-	-	50	-	50	100	2
MEPA12187	Mini Project	CE-OR	-	4	-	-	50	-	50	100	2
AP2	Audit Course II	-	-	-	-	-	-	-	-	-	-
	Total		**12**	**12**	**80**	**40**	**230**	**200**	**150**	**700**	**18**

Elective-III

MEPA12183A	Analysis and Synthesis of Mechanism
MEPA12183B	Robotics
MEPA12183C	Fracture Mechanics

Elective-IV

MEPA12184A	Multi-body Dynamics
MEPA12184B	Condition Based Monitoring
MEPA12184C	Optimization Techniques in Design

Audit Courses

1.English for Research Paper Writing
2. Disaster Management
3. Sanskrit for Technical Knowledge
4. Value Education
5. Constitution of India
6. Pedagogy Studies
7. Stress Management by Yoga
8.Personality Development through Life Enlightenment Skills.

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INDEX

Advanced Stress Analysis (MEPA11181)

Teaching Scheme
Credits : 3
Lectures : 3Hrs/week

Examination Scheme
Formative Assessment: 50 Marks
Summative Assessment: 50 Marks

Prerequisite:

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

Course Objectives:

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

Course Outcomes:

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

1. Determine stress distribution along a component under different loading conditions.
2. Understand behavior of walled sections.
3. Solve real time problems subjected under bending.
4. Prepare composite material sample.
5. Investigate components subjected to Hartezian contact stresses
6. 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 : 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 III : Unsymmetrical Bending and Shear Centre

Concept of shear center in symmetrical and unsymmetrical bending, stress and deflections in beams subjected to unsymmetrical bending, shear center for thin wall beam cross section, open section with one axis of symmetry, general open section, and closed section.

Unit IV : 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 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 and 2 – Timoshenko, CBS publisher 4. Advanced Mechanics of Materials – Boresi, Schmidt, Sidebottom, Willey 5. Mechanics of Materials - vol 1 and 2 - E J Hearn , Butterworth- Heinemann

Advanced Vibrations and Acoustics (MEPA11182)

Teaching Scheme
Credits : 3
Lectures : 3Hrs/week

Examination Scheme
Formative Assessment: 50 Marks
Summative Assessment: 50 Marks

Prerequisite:

1. Dynamics of machinery
2. Engineering Mathematics

Course Objectives :

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

Course Outcomes :

At the end of the course students will be able yo:

1. Predict response of a SDOF system, damped, undamped or force excited.
2. Write differential equations of motion for MDOF systems.
3. Obtain the Eigen-values and mode shapes of natural vibrations.
4. Obtain natural frequencies and mode shapes of MDOF and continuous systems using
5. Know various terminologies used in acoustics and acoustic wave transmission.
6. Understand the basics of psychoacoustics.

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.Transient Vibrations, Response of a single degree of freedom system to step and any arbitrary excitation,

Unit II : Multi Degree of Freedom Systems

Multi degree of freedom systems, Free, damped and forced vibrations of two degree of freedom systems, Eigen values and Eigen vectors, normal modes,Rayleigh, Rayleigh-Ritz and Dunkerley's methods, matrix iteration method for Eigen-value calculations, Holzer's method

Unit III : Continuous Systems

Continuous Systems, vibrations of bars, torsion vibration of shafts/rod and lateral vibration of beams., forced vibration of simply supported beam subjected to concentrated harmonic force at a point, Mode summation method, discretized models of continuous systems and their solutions using Rayleigh – Ritz method

Unit IV : Vibration Control

Vibration Control, Methods of vibration control, Vibration Absorber, Vibration isolation, FFT analyzer, vibration exciters, signal analysis, time domain and frequency domain analysis of signals, experimental modal analysis, Examples of vibration tests - Industrial case studies.

Unit V : Acoustic Waves

Plane acoustic waves, Sound speed, characteristic acoustic impedance of elastic media, sound intensity, dB scale, Transmission Phenomena, transmission from one fluid medium to another, normal incidence, reflection at the surface of a solid, standing wave patterns, Symmetric Spherical waves, near and far fields, simple models of sound sources, sound power, determination of sound power.

Unit VI : Introduction to Psychoacoustic

Psychoacoustics, Speech, mechanism of hearing, thresholds of the ear – sound intensity and frequency, loudness, equal loudness levels, loudness, pitch and timbre, beats, masking by pure tones, masking by noise.

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. Robert D. Finch, "Introduction to acoustics", PHI., 2008
5. S.N.Sen "Acoustics waves and Oscillations" New Age International Publication,2010.

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. Michael Rettinger, "Acoustic Design and Noise Control", Vol. I and II. , Chemical Publishing Co., New York, 1977

Advanced Machine Design (MEPA11183A)

Teaching Scheme
Credits : 3
Lectures : 3Hrs/week

Examination Scheme
Formative Assessment: 50 Marks
Summative Assessment: 50 Marks

Prerequisite:

1. Strength of Material
2. Machine Design

Course Objectives :

- To familiarize students with design for different manufacturing processes.
- To study the advanced concepts of risk, reliability and safety and the methodologies to define reliability in a quantitative manner to aid to design for reliability
- To gain knowledge by formulating design intentions that include emotional and happiness effects.
- To expose different types of Rapid prototyping processes and materials used in Rapid prototyping systems.

Course Outcomes :

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

1. Realize that creativity, manufacturability, assembly, maintainability, emotions, reliability are also important aspects of design other than finding dimensions and stresses in the highly competitive, dynamic and customer centered market.
2. Demonstrate the ability to identify needs of the customer and convert them in to technical specifications of a product.
3. Generate different ideas after identifying the need and determining the specifications and constraints of a product for a particular purpose.
4. Understand the principals used while designing for manufacture, assembly, emotions and maintenance.
5. Know various methods of rapid prototyping the products to test and modify the designs.
6. Design the components considering strength based reliability.

Unit I :

Development processes and organizations, Product Planning

Unit II :

Need Identification and problem definition, product specification, concept generation and selection, evaluation, creativity methods, Concept testing

Unit III :

Design for manufacture, assembly, maintenance, casting, forging,

Unit IV :

Design for Reliability, strength based reliability, parallel and series systems, robust design,

Unit V :
Industrial design: Design for Emotion and experience, Introduction to retrofit and Eco design, Human behavior in design
Unit VI : Special Topics
Rapid Prototyping
Text Books : 1. George E Dieter, "Engineering Design", McGraw Hill Company, 00. 2. Prashant Kumar, "Product Design, Creativity, Concepts and Usability", Eastern Economy Edition, PHI New Delhi. 12 3. Woodson T.T., "Introduction to Engineering Design", McGraw Hill Book Company, 1966.
References: 4. John J.C. "Design Methods", Wiley Inter science, 1970. 5. Averill M. Law and W. David Kelton "Simulation, modelling and analysis", McGraw Hill Book Company, 1991. 6. Pahl, G.and W.Beitz, *Engineering Design–A Systematic Approach* – Springer, 2nd Ed., 1996. 7. Product Design and development Karl T. Ulrich, Steven Eppinger

Design for Manufacturing and Assembly (MEPA11183B)

Teaching Scheme
Credits : 3
Lectures : 3Hrs/week

Examination Scheme
Formative Assessment: 50 Marks
Summative Assessment: 50 Marks

Prerequisite:

Course Objectives:

- To introduce the concept and application for design for manufacturing and assembly to practicing designers and manufacturing engineers as well as design students.
- To discuss various fundamentals of assembly and design recommendations for product development.

Course Outcomes:

At the end of the course, the student should be able to

1. Understand various types of materials, its classification, suitable materials for product design and various methods of material selection, various mechanical properties of material.
2. Know various casting design, machining design, designing of formed components
3. Understand various design recommendations for cleaning, design for polishing, plating and coating, and Heat treatment and various design recommendations
4. Know various design recommendation for permanent joining such as welding, soldering, brazing,
5. Know various design recommendation for riveting, screw fastening etc.
6. Able to understand introduction to CAD, various types of geometric model, different types of features, procedure for feature extraction from part and assembly model

Unit I : Introduction to DFMA

Introduction, History of DFMA, Steps for applying DFMA during product design, Advantages of applying DFMA during product design, Reasons for not implementing DFMA, Introduction to Manufacturing Process: Classification of manufacturing process, Basic manufacturing processes, Mechanical properties of material: Tensile properties, Engineering stress-strain, True stress strain, Compression properties, Shear properties, Introduction to materials and material selection: Classification of engineering materials, Material selection for product design

Unit II : Unit 2: Sand Casting

Introduction to sand casting, Design consideration for sand casting, investment casting: Introduction, Steps, Typical characteristics and applications, Die casting: Introduction, Advantages, Disadvantages, Applications, Suitable material consideration, General design consideration, Specific design recommendation, Injection moulding :Introduction, Typical characteristics of injection moulded parts, Effect of shrinkage, Suitable materials, Design recommendations, Design for powder metal processing: Introduction to powder metal processing, Typical characteristics and applications, Limitations, Design recommendations.

Unit III : Design for machining

Introduction to machining, Recommended materials for machinability, Design recommendations, Design for tuning, milling, planning, shaping and slotting operations: Process description, Typical characteristics and applications, Suitable materials, Design recommendations, Design for machining round holes: Introduction, Suitable materials, Design recommendations, Recommended tolerances, Design for broached parts: Process description, Typical characteristics of broached parts, Suitable materials for broaching, Design recommendations.

Unit IV : Metal Extrusion

Metal extrusion process, Suitable material for extrusion, Design recommendation for metal extrusion, Metal stamping, Fine blanked parts and Rolled formed section: Process, Characteristics and applications, Suitable materials, Design Recommendations Impact or cold extrusion: Process, Design recommendations for backward extrusion, Forward extrusion: Process, Design recommendations for forward extrusion, Design for Forging: Forging processes, Forging nomenclature, Suitable materials for forging, Design recommendations, Metal injection moulded parts:Process, Materials suitable, Design recommendations for metal injection-molded parts.

Unit V : Design for cleaning and joining processes

Introduction to cleaning and polishing processes: Design recommendations, Design for plated surface: Electroplating process, Typical characteristics, Design recommendations for plating, Thermal sprayed coating: Process, Design recommendations for thermal sprayed coating, Design for heattreatment, Design for welding, soldering and brazing: Design recommendations, Typical characteristics, Suitable materials, Design for adhesively bonded assemblies: Introduction, characteristics, Suitable materials, Design recommendations for adhesive joint.

Unit VI : Introduction to Assembly and CAD

The assembly process, Characteristics and applications, Economic significance of assembly, General taxonomies of assembly operation and systems, Design for Assembly: Introduction, Design consideration, Design for Fasteners: Introduction, Design recommendation for fasteners. Introduction to CAD: Geometric Representation in CAD, Extraction of part feature information from CAD Model: Introduction, Feature recognition techniques, Free Form Features, Hybrid Techniques, Extraction of assembly feature information from CAD Model: Introduction, Assembly features, Definition of assembly feature attributes, Characterization of assembly feature, Examples of Assembly feature, Overview of procedure to extract assembly features from CAD model of Assembly, Description of steps in the assembly feature extraction procedure, Examples of assembly feature extraction.

Text Books:

1. Geoffrey Boothroyd, Peter Dewhurst and Winston Knight (2002) Product Design for Manufacture and Assembly, Third Edition, CRC press, Taylor and Francis, Florida, USA
2. O. Molloy, S. Tilley and E.A. Warman (1998) Design for Manufacturing and assembly, First Edition, Chapman and Hall, London, UK.

A.K. Chitale and R.C. Gupta, (1999) Product design and Manufacturing, Prentice Hall of India, New Delhi.

Reference Books :

1. J. Lesko, (1999) Industrial Design, Materials and Manufacture Guide, John Willy and Sons, Inc
2. George E. Dieter and Linda C. Schmidt (2009), Engineering Design, Fourth edition, McGraw-Hill companies, New York, USA
3. D. E. Whitney, (2004) Mechanical Assemblies: Their Design, Manufacture, and Role in Product Development, Oxford University Press, New York
4. James G. Bralla (1998) Design for Manufacturability Handbook, Second Edition, McGraw-Hill companies, New York, USA

Mathematical Methods in Engineering (MEPA11183C)

Teaching Scheme
Credits : 3
Lectures : 3Hrs/week

Examination Scheme
Formative Assessment: 50 Marks
Summative Assessment: 50 Marks

Prerequisite:

1. Engineering Mathematics
2. Numerical Methods and Optimization

Course Objectives:

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

Course Outcomes:

At the end of the course, students will to:

1. Apply statistical techniques to analyze multivariate functions.
2. Identify and solve engineering problems by applying the knowledge of ordinary differential equations.
3. Identify nature of a given wave equation and solve by applying D'Alembert solution and/or method of solution of method of separation of variables
4. Solve engineering problems by applying the knowledge of partial differential equations.
5. Optimization technique to solve engineering problems
6. Analyze problems arising in engineering and physical sciences.

Unit I : Introduction to Probability Theory

Probability Theory and Sampling Distributions. Basic probability theory along with examples. Standard discrete and continuous distributions like Binomial, Poisson, and Normal, Exponential etc. Central Limit Theorem and its significance. Some sampling distributions like □2, t, F.

Unit II :Data Analysis and 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 : Ordinary Differential Equations:

Ordinary linear differential equations solvable by direct solution methods; solvable nonlinear ODE's;

Unit IV : Partial Differential Equations and Concepts in Solution to Boundary Value Problems

First and second order partial differential equations; canonical forms

Unit V : Optimization

Introduction to optimization, Classification, Constrained optimization: Graphical and Simplex method. One Dimensional unconstrained optimization: Newton's Method. Modern Optimization Techniques:

Unit VI : Major Equation Types Encountered in Engineering and Physical Sciences

Solution methods for wave equation, D'Alembert solution, potential equation, properties of harmonic functions, maximum principle, solution by variable separation method

Text Books :

1. Ronald E, Walpole, Sharon L. Myers, Keying Ye, Probability and Statistics for Engineers
2. and Scientists (8th Edition), Pearson Prentice Hall, 07 (for Units I)
3. J. B. Doshi, Differential Equations for Scientists and Engineers, Narosa,NewDelhi Unit (IIIandIV)
4. Steven C. Chapra, Raymond P. Canale, Numerical Methods for Engineers, 4/e, Tata McGraw Hill Editions Dr. B. S. Garewal, Numerical Methods in Engineering and Science, Khanna Publishers,.
5. Steven C. Chapra, Applied Numerical Methods with MATLAB for Engineers and Scientist, Tata Mc-GrawHill Publishing Co-Ltd
6. Rao V. Dukkipati, Applied Numerical Methods using Matlab, New Age International Publishers

Reference Books :

1. Douglas C. Montgomery, Design and Analysis of Experiments (7th Edition), Wiley Student
1. Edition, 09.
2. S. P. Gupta, Statistical Methods, S. Chand and Sons, 37th revised edition, 08
3. William W. Hines, Douglas C. Montgomery, David M. Goldsman, Probability and
4. Statistics for Engineering, (4th Edition), Willey Student edition, 06.
5. Advanced Engineering Mathematics (9th Edition), Erwin Kreyszig, Wiley India (13).
6. E. Balagurusamy, Numerical Methods, Tata McGraw Hill

Advanced Engineering Materials (MEPA11184A)

Teaching Scheme
Credits : 3
Lectures : 3Hrs/week

Examination Scheme
Formative Assessment: 50 Marks
Summative Assessment: 50 Marks

Prerequisite :

Material Science and engineering metallurgy

Manufacturing process

Course Objectives :

- To study different strengthening mechanisms and their applications.
- Describe importance fracture mechanics to the student
- 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. Apply the basic concepts of plastic deformation
2. Describe importance of mechanical properties in plastic behaviour of metals.
3. Apply the fundamentals of types of fractures in studying the fracture mechanic
4. Identify microstructure and property changes in iron-carbon system
5. Select types of material for particular applications
6. Identify applicability of materials in different conditions

Unit I : Introduction, Atomic Structure, Interatomic Bonding and Structure of Crystalline Solids:

Historical perspective of Materials Science. Why study properties of materials? Classification of materials. Advanced Materials, Future materials and modern materials, Atomicstructure. Atomic bonding in solids, Crystal structures, Crystalline and noncrystalline materials. Anisotropic elasticity. Material Testing under Complex Loading Tensile testing – uni-axial and biaxial tension test.

Unit II : Imperfections in Solids and Mechanical Properties of Metals, Diffusion, Dislocations and Strengthening Mechanisms:

Point defects. Theoretical yield point. Line defects and dislocations. Interfacial defects. Bulk or volume defects. Atomic vibrations; Elastic deformation. Plastic deformation. Interpretation of tensile stress-strain curves Yielding under multiaxial stress. Dislocation and plastic deformation. Mechanisms of strengthening in metals. Recovery, recrystallization and grain growth. Particle strengthening by precipitation

Unit III : Phase Diagrams:

Equilibrium phase diagrams Kinetics of nucleation and growth. The iron-carbon system. Phase transformations. Transformation rate effects and TTT diagrams. Microstructure and property changes in iron-carbon system

Unit IV: Fracture.

Ductile and brittle fracture. Fracture mechanics. Impact fracture. Ductile brittle transition. Fatigue. Crack initiation and propagation. Crack propagation rate. Creep. Generalized creep behaviour. Stress and temperature effects

Unit V : Applications and Processing of Metals and Alloys, Polymers, Ceramics, and composites:

Types of metals and alloys. Fabrication of metals. Thermal processing of metals. Types and applications of ceramics. Fabrication and processing of ceramics, Mechanical behaviour of polymers. Mechanisms of deformation and strengthening of polymers. Crystallization, melting and glass transition. Polymer types. Polymer synthesis and processing, Particle reinforced composites. Fibre reinforced composites. Structural composites

Unit VI : Electrical, Thermal and Magnetic Properties and economic Considerations:

Electrical conduction. Semi conductivity. Super conductivity. Electrical conduction in ionic ceramics and in polymers. Dielectric behavior. Ferroelectricity. Piezoelectricity Heat capacity. Thermal expansion. Thermal conductivity. Thermal stresses Diamagnetism and Para magnetism. Ferromagnetism, Anti-ferromagnetism and ferrimagnetism. Influence of temperature on magnetic behavior Economic, Environmental and Social Issues of Material Usage - Economic considerations. Environmental and societal considerations. Recycling issues. Life cycle analysis and its use in design

Text Books :

1. Willam D. Callister, Jr., "Material Science and Engineering: An introduction", John Wiley and Sons, Inc, 2003.
2. Willam F. Smith, "Principles of Materials Science and Engineering", 3rd edition, McGraw Hill,2002
3. Flinn, R.A. and Trojan, P.K., "Engineering Materials and their Applications ", (4th Edition), Jaico, 1999.
4. Modern Physical Metallurgy and Material Engineering, Science, Process, application, Smallman R.E., Bishop R J, Butterworth Heinemann, Sixth Ed., 1999.
5. George E. Dieter, "Mechanical Metallurgy ", McGraw Hill, 1988.

Reference Books :

1. Metals Hand Book, Vol.10, "Failure Analysis and Prevention ", (10th Edition), 1994.
2.Foundations of Theory of Plasticity, L.M. Kachanov, Dover Publications, 2004
3.Mechanical Behaviour of Materials, Dominique Francois, Andre Pineau, Andre Zaoui, Springer
4.Mechanical Behaviour of Materials, W. F. Hosford, Cambridge University Press, 2005
5.Thomas H. Courtney, " MechanicalBehavior of Materials ", McGraw-Hill, 2000

Mechanics of Composite Materials (MEPA11184B)

Teaching Scheme
Credits : 3
Lectures : 3 Hrs/week

Examination Scheme
Formative Assessment: 50 Marks
Summative Assessment: 50 Marks

Prerequisite:

1. Strength of Material
2. Machine Design
3. Material Science

Course Objectives :

- To understand importance of composite materials in various applications such as aerospace, automotive
- To understand various fabrication methods of composite material
- To develop an understanding of the linear elastic analysis of composite materials

Course Outcomes :

By the end of the course, students will able to

1. Student will be able to understand the basic concepts and difference between composite materials with conventional materials.
2. Students will be able to understand role of constituent materials in defining the average properties and response of composite materials on macroscopic level.
3. Students will be able to apply knowledge for finding failure envelopes and stress-strain plots of laminates.
4. Students will be able to develop a clear understanding to utilize subject knowledge using computer programs to solve problems at structural level.
5. To develop an ability to predict the failure strength of a laminated composite plate
6. To design composite structure

Unit I : Introduction

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 : Basic Concepts and Characteristics

Structural performance of conventional material, Geometric and physical definition, Material response, Scale of analysis; Micromechanics, Basic lamina properties, Constituent materials and properties, Properties of typical composite materials, Volume fraction, Void content

Unit III : Elastic Behavior of Unidirectional Lamina

Stress-strain relations, Evaluation of Elastic Moduli, Relation between mathematical and engineering constants, Rule of Mixture, transformation of stress, strain and elastic parameters

Unit IV : Strength of Unidirectional Lamina

Micromechanics of failure; failure mechanisms, Macro-mechanical strength parameters, Macromechanical failure theories, Applicability of various failure theories

Unit V : Elastic Behavior of Laminate

Basic assumptions, Strain-displacement relations, Stress-strain relation of layer within a laminate, Force and moment resultant, General load–deformation relations, Analysis of different types of laminates

Unit VI : Stress and Failure Analysis of Laminates

Types of failures, Stress analysis and safety factors for first ply failure of symmetric laminates, Micromechanics of progressive failure; Progressive and ultimate laminate failure, Design methodology for structural composite materials

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. Madhujit Mukhopodhyay , Mechanics of Composite Materials and Structures , University Press (India) PVT Ltd, 2009, ISBN: 9788173714771
4. Mallick PK, Fiber-reinforced composites: materials, manufacturing, and design. CRC press, Taylor and Francis Group 2007; ISBN: 13: 978-0-8493-4205-9.

Reference Books :

1. Isaac M. Daniels, Ori Ishai, "Engineering Mechaincs of Composite Materials", Oxford University Press, 1994.
2. Bhagwan D. Agarwal, Lawrence J. Broutman, "Analysis and Performance of fiber composites", John Wiley and Sons, Inc. 1990.
3. Mathews, F. L. and Rawlings, R. D., "Composite Materials: Engineering and Science", CRC Press, Boca Raton, 03.
4. Mazumdar S. K., "Composaite Manufacturing – Materials, Product and Processing Engineering", CRC Press, Boca Raton, 02.

Tribology in Design (MEPA11184C)

Teaching Scheme
Credits : 3
Lectures : 3Hrs/week

Examination Scheme
Formative Assessment: 50 Marks
Summative Assessment: 50 Marks

Prerequisite:

1. Engineering Mechanics
2. Strength of Material
3. Machine Design
4. Introduction to Tribology

Course Objectives :

- To know about properties of lubricants, modes of lubrication, additives etc.
- To study the film lubrication theory, sommerfield
- To study the design concept in hydrostatic and elasto-hydrodynamic lubrications
- To apply the design concept in surface friction, wear and lubrications about frictional behavior commonly encountered sliding surfaces.

Course Outcomes :

By the end of the course, students will able to

1. Apply theories of friction and wear to various practical situations by analyzing the physics of the process.
2. Understand the various surface measurement techniques and effect of surface texture on tribological behavior of a surface.
3. Select materials and lubricants to suggest a tribological solution to aparticular situation.
4. Design a hydrodynamic bearing using various bearing charts.
5. Design a hydrostatic bearing using various bearing charts.
6. Understand the recent developments in the field and understand modern research material.

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 : Wear

Wear, theories of 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, wear prevention

Unit III : Advances in rolling and sliding contact bearing

Reynolds's equation and its limitations, idealized bearings, infinitely long plane pivoted and fixed show sliders, infinitely long and infinitely short (narrow) journal bearings, lightly loaded infinitely long journal bearing (Petroff's solution), Finite Bearings, Design of hydrodynamic journal bearings.

Unit IV : Design in hydrostatic bearing
Hydrostatic, squeeze film Circular and rectangular flat plates, variable and alternating loads, piston pin lubrications, application to journal bearings.
Unit V : Design in Elasto-hydrodynamic lubrication
Elasto-hydrodynamic lubrication – pressure viscosity term in Reynolds's equation, Hertz' theory, Ertel-Grubin equation, lubrication of spheres, gear teeth and rolling element bearings, Air lubricated bearings, Tilting pad bearings,
Unit VI : Surfaces and Friction
Topography of Engineering surfaces- Contact between surfaces –Various tribological problems and solutions- Sources of sliding Friction – Adhesion, ploughing Friction, theories of friction, Friction control, Surface texture and measurement, genesis of friction, instabilities and stick-slip motion.
Text Books :
1. Cameron, "Basic Lubrication Theory", Ellis Horwood Ltd, 1981. 2. Principles in Tribology, Edited by J. Halling, 1975 3. Introduction to Tribology of Bearings –B. C. Majumdar, A. H. Wheeler andco. pvt. Ltd 1985. 4. T.A. Stolarski, "Tribology in Machine Design".
Reference Books :
1. Fundamentals of Fluid Film Lubrication – B. J. Hamrock, McGraw Hill International, 1994. 2. D.D. Fuller, "Theory and Practice of Lubrication for Engineers", John Wiley and Sons, 1984. 3. "Fundamentals of Friction and wear of Materials" American Society of Metals.

Laboratory I (Advanced Stress Analysis) (MEPA11185)

Teaching Scheme
Credits: 2
Practical : 4 Hrs/week

Examination Scheme
Formative Assessment. : 50 Marks
Summative Assessment : 50 Marks

Course Objectives:

- To provide practical exposure with the real life situation

Course Outcomes:

At the end of the course

1. Students will be able to use various experimental techniques relevant to the subject.
2. Students will acquire hands on experience on the various test-rigs, Experimental set up.
3. Students will be able to function as a team member
4. Students will develop communication skills.
5. Students will be able to write technical reports.
6. Students will be able to use different software's

Syllabus Contents:

1. Determination of full range stress-strain curve for mild steel specimen as per ASTM-E8M
2. Determination of full range stress-strain curve for aluminum specimen as per ASTM-E8M
3. Determination of full range stress-strain curve for composite specimen
4. Determination of deflection and angle of twist for a thin section.
5. Determining shear center of asymmetric section (any two problems)
6. CE component-presentation preparation
7. CE component-presentation conduction
8. Preparation of composite sample using hand lay-up supported by compression molding
9. Contact stress analysis of gear pair using FEM Software
10. Contact stress analysis of cam and follower using FEM Software
11. Study of different strain gauge rosettes
12. CE component- Assignment 1
13. CE component- Assignment 2
14. Measurement of strain in cantilever beam using strain gauges
15. Model analysis of mechanical component
16. Study of Photo-elasticity for static analysis
17. CE component- open book test
18. CE component- open book test

Laboratory II (Advanced Vibration and Acoustics) (MEPA11186)

Teaching Scheme
Credits: 2
Practical : 4 Hrs/week

Examination Scheme
Formative Assessment. : 50 Marks
Summative Assessment : 50 Marks

Course Objectives:
To provide practical exposure with the real life situation

Course Outcomes:
At the end of the course:

1. Students will be able to use various experimental techniques relevant to the subject.
2. Students will acquire hands on experience on the various test-rigs, Experimental set up.
3. Students will be able to function as a team member
4. Students will develop communication skills.
5. Students will be able to write technical reports.
6. Students will be able to use different software's

Syllabus Contents:

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1. Determine natural frequency and damping coefficient of damped vibration of single degree freedom system.
2. Plot frequency response curves of single degree freedom system with variable damping
3. Determine total response of single degree damped system to harmonic excitation using suitable software.
4. Determine natural frequency of torsional vibration of two rotor system and position of node.
5. Experimental verification of Dunkerleys formula.
6. CE component-presentation preparation
7. CE component-presentation conduction
8. Plot forced vibration response of continuous system using MATLAB Programming. (
9. Study of numerical methods for solving Eigen values.
10. Computer program to find Eigen values using numerical method
11. Determination of Natural Frequencies of cantilever beam using FFT Analyzer.
12. Experimental study of vibration absorber
13. CE component- Assignment 1
14. CE component- Assignment 2
15. Noise measurement and analysis using FFT Analyzer.
16. Study of noise measurement techniques
17. Industrial visit for demonstration on psychoacoustic.
18. Industrial visit for demonstration on measurement and control of psychoacoustic.
19. CE component- open book test
20. CE component- open book test

Research Methodology and IPR (MEPA11187)

Teaching Scheme
Credits : 2
Lectures : 2Hrs/week

Examination Scheme
Formative Assessment: 50 Marks

Prerequisite:

Engineering Mathematics

Course Objectives:

- To understand concepts of hypothesis.
- Able to formulate a research problem with the methodology.
- 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. Understand the concept of literature survey, plagiarism and research ethics
3. Understand the concept related to research proposal and its presentation
4. Understand concept and terms related to IPR
5. Understand the process of Patent filing
6. Understand latest trends in IPR

Unit I :

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

Unit II :

Effective literature studies approaches, analysis Plagiarism, Research ethics,

Unit III :

Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

Unit IV :

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Unit V :

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

Unit VI :

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.
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 Nathand co.
Reference Books :
1. Research methodology: an introduction for science and engineering students, Stuart Melville and Wayne Goddard 2. Research Methodology: An Introduction, Wayne Goddard and Stuart Melville

Finite Element Method (MEPA12181)

Teaching Scheme
Credits : 3
Lectures : 3Hrs/week

Examination Scheme
Formative Assessment: 50 Marks
Summative Assessment: 50 Marks

Prerequisite:

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

Course Objectives :

- To familiarize students with the displacement-based finite element method for displacement and stress analysis and to introduce related analytical and computer tools.
- 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.
- To study approximate nature of the finite element method and convergence of results are examined.
- To study non-linear Finite element analysis to solve problems involving different types of nonlinearities.

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.
6. Solve real life mechanical engineering problems

Unit I :

Introduction-Brief history of FEM, general FEA procedure, applications of FEA, advantages and disadvantages of FEM

Introduction to different approaches used in FEA: Variational formulation- Principal of Minimum Potential Energy (PMPE), Galerkin weighted residual method and Principal of virtual work.

Formulation of elemental stiffness matrix and load vector for bar, truss and beam, Formulation of load vector due to uniform temperature change (for bar only), treatment of boundary conditions- elimination

approach, stress calculations

Unit II :

Two-Dimensional Stress Analysis: Plane Stress/Strain problems in 2D elasticity, constitutive relations, Constant Strain Triangle(CST), Liner Strain Rectangle (LSR), displacement function, Pascal's triangle, compatibility and completeness requirement, geometric isotropy, convergence requirements, strain filed, stress filed, Formulation of element stiffness matrix and load vector for Plane Stress/Strain problems

Unit III :

Concept of isoparametric elements, Terms isoparametric, super parametric and subparametric,
Coordinate mapping - Natural coordinates, Area coordinates (for triangular elements), higher order triangular and quadrilateral elements (Lagrangean and serendipity elements), mesh refinement- p vs h refinements, Numerical integration –Gauss Quadrature in 1 and 2 dimension, Order of Gauss integration, full and reduced integration

Unit IV :

Formulation of dynamic problems, consistent and lumped mass matrices Solution of eigenvalue problems, Forced vibration – steady state and transient vibration analysis, modeling of damping, direct integration methods – implicit and explicit numerical integration

Unit V :

Introduction to non-linear analysis, Finite element formulations, Nonlinear equation solving procedure - direct iteration, Newton-Raphson method, modified Newton-Raphson method, incremental techniques.

Unit VI :

Types of Analysis (Introduction): Linear static analysis, Non-linear analysis, Dynamic analysis, Linear buckling analysis, Thermal analysis, Fatigue analysis, Crash analysis, Noise, Vibration and Harshness (NVH) analysis
Computer implementation of the finite element method: pre-processing, meshing techniques, processing post processing. Static condensation ,Submodelling and substructuing ,Patch test and incompatible element, h and p refinements.

Text Books :

8. Daryl L. Logan , A First Course in the Finite Element Method,. ISBN-10:81-315-0217-1
9. R. D. Cook, et al. , Concepts and Applications of Finite Element Analysis, Wiley, India. ISBN-0-471-10774-3.
10. Seshu P., Text book of Finite Element Analysis, PHI Learning Private Ltd. New Delhi, 2010.ISBN:978-81-203-2315-5.
11. 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 Procedures‖, 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.

Computer Aided Design (MEPA12182)

Teaching Scheme
Credits: 3
Lectures:3Hrs/week
Practical : 2 Hrs/week

Examination Scheme
Formative Assessment. : 50 Marks
Summative Assessment : 50 Marks

Prerequisite:

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

Course Objectives:

- To introduce the concept of CAD hardware, software and network system involved in CAD system for understanding computer graphics transformations.
- To discuss and understand the different projections used for modeling and concepts of analysis

Course Outcomes:

At the end of the course:, students will able to

1. Have a conceptual understanding of the principles of CAD systems, the implementation of these principles, and its connections to CAM and CAE systems
2. Understand the concept of networking
3. Understand 2D, 3D transformations and projection transformations
4. Get knowledge of various approaches of geometric modeling
5. Understand mathematical representation of 2D and 3D entities
6. Understand basic fundamentals of FEM

Unit I : CAD Hardware and Software

Introduction, Types of systems and system considerations, input and output devices, hardware integration and networking, hardware trends, Software modules,

Unit II : Computer Communications

Principle of networking, classification networks, network wring, methods, transmission media and interfaces, network operating systems.

Unit III : Computer Graphics

Introduction, transformation of geometric models: translation, scaling, reflection, rotation, homogeneous representation, concatenated transformations; mappings of geometric models, translational mapping rotational mapping, general mapping, mappings as changes of coordinate system; inverse transformations and mapping

Unit IV: Projections of Geometric Models

Projections of geometric models, orthographic projections, Geometric Modeling, curve representation: Parametric representation of analytic curves, parametric representation of synthetic curves, curve manipulations. Surface representation

Unit V : Fundamentals of solid modeling

Fundamentals of solid modeling, boundary representation (B-rep), Constructive Solid Geometry

(CSF), sweep representation, Analytic Solid Modeling (ASM), other representations; solid manipulations, solid modeling based applications: mass properties calculations, mechanical tolerancing, etc

Unit VI :Finite Element Modeling and Analysis

Finite Element Modeling and Analysis, Finite Element Analysis, finite element modeling, mesh generation mesh requirements, semiautomatic methods, fully automatic methods, design and engineering applications, System Simulation, Need of simulation, areas of applications, when simulation is appropriate tool / not appropriate, concept of a system, components of a system, discrete and continuous systems, model of a system, types of models, types of simulation approaches

Text Books :

1. Ibrahim Zeid, 'Mastering CAD/CAM', Tata McGraw Hill Co. Ltd. 2007
2. P.N. Rao, "CAD / CAM principles and applications", Tata Mcraw-Hill, 02.
3. T R Chandraupatla, A D Belegundu, 'Introduction to Finite Elements in Engineering', Pearson Education, 3rd Ed. 2004.

Reference Books :

1. Jim Browne, "Computer Aided Engineering and Design".
2. P. Radhakrishnan / V. Raju / S. Subramanyam, "CAD / CAM / CIM".
3. Rogers / Adams, "Mathematical Elements for Computer Graphics".
4. Rooney and Steadman, "Principles of Computer Aided Design", Aug. 1993.

Analysis and Synthesis of Mechanisms (MEPA12183A)

Teaching Scheme
Credits : 3
Lectures : 3Hrs/week

Examination Scheme
Formative Assessment: 50 Marks
Summative Assessment: 50 Marks

Prerequisite:

1. Engineering Mathematics
2. Engineering Physics
3. Engineering Graphics
4. Engineering Mechanics
5. Theory of Machines
6. Fundamentals of Programming Language

Course Objectives :

- To study basic of simple and complex mechanism analysis
- To study kinematics of synthesis of mechanism

Course Outcomes :

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

1. Understand relative position, velocity and acceleration of all moving links.
2. Use kinematic geometry to formulate and solve constraint equations to design linkages for specified tasks.
3. Analyze and animate the movement of planar and spherical four-bar linkages.
4. Apply modern computer-based techniques in the selection, analysis, and synthesis of components and their integration into complete mechanical systems.
5. Develop analytical evaluate working mechanism.
6. Understand coupler curve analysis.

Unit I : Fundamental Concepts

Basic Concepts; Definitions and assumptions; planar and spatial mechanisms; kinematic pairs; degree of freedom; equivalent mechanisms; Kinematic Analysis of Planar Mechanisms. Review of graphical and analytical methods of velocity and acceleration analysis of kinematically simple mechanisms

Unit II : Kinematic Analysis of Complex Mechanisms

Velocity and acceleration analysis of complex mechanisms by the normal acceleration and auxiliary point methods.

Unit III : Curvature Theory

Fixed and moving centrodes, inflection circle, Euler-Savary equation, Bobillier constructions, cubic of stationary curvature, Ball's point, Applications in dwell mechanisms

Unit IV : Graphical Synthesis of Planar Mechanisms

Kinematic Synthesis of planar mechanisms, accuracy (precision) points, Chebesychev spacing, types of errors, Graphical synthesis for function generation and rigid body guidance with two, three and four

accuracy points using pole method, centre and circle point curves, Analytical synthesis of four-bar and slider-crank mechanisms

Unit V : Analytical Synthesis of Planar Mechanisms

Freudenstein's equation, synthesis for four and five accuracy points, compatibility condition, synthesis of four-bar for prescribed angular velocities and accelerations using complex numbers, three accuracy point synthesis using complex numbers

Unit VI : Coupler Curves

Equation of coupler curve, Robert-Chebychev theorem, double points and symmetry.

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.

Robotics (MEPA12183B)

Teaching Scheme
Credits : 3
Lectures : 3 Hrs/week

Examination Scheme
Formative Assessment: 50 Marks
Summative Assessment: 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:

- To familiarize students with the basic terminologies and concepts associated with Robotics and Automation
- It provides a knowledge of force analysis and design aspect for gripper,.
- To study link and joint description of robot using different methods

Course Outcomes:

At the end of the course students will be able to

1. Understand basic terminologies and concepts associated with Robotics and Automation
2. Demonstrate comprehension of various Robotic sub-systems
3. Understand kinematics and dynamics to explain exact working pattern of robots
4. Aware of the associated recent updates in Robotics
5. Model and simulate manufacturing plant automation.
6. Design Industrial robot

Unit I : Introduction

Basic Concepts such as Definition, three laws, DOF, Misunderstood devices etc., Elements of Robotic Systems i.e. Robot anatomy, Classification, Associated parameters i.e. resolution, accuracy, repeatability, dexterity, compliance, RCC device, etc. Automation - Concept, Need, Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations, introduction to automation productivity.

Unit II :Robot Grippers

Types of Grippers , Design aspect for gripper, Force analysis for various basic gripper system. Sensors for Robots:- Characteristics of sensing devices, Selections of sensors, Classification and applications of sensors. Types of Sensors, Need for sensors and vision system in the working and control of a robot.

Unit III : Drives and control system

Types of Drives, Actuators and its selection while designing a robot system. Types of transmission systems, Control Systems -Types of Controllers, Introduction to closed loop control Control Technologies in Automation:- Industrial Control Systems, Process Industries Verses Discrete-Manufacturing Industries, Continuous Verses Discrete Control, Computer Process and its Forms.

Control System Components such as Sensors, Actuators and others

Unit IV : Kinematic

Transformation matrices and their arithmetic, link and joint description, Denavit - Hartenberg parameters, frame assignment to links, direct kinematics, kinematics redundancy, kinematics calibration, inverse kinematics, solvability, algebraic and geometrical methods. Velocities and Static forces in manipulators:- Jacobians, singularities, static forces, Jacobian in force domain. Dynamics:- Introduction to Dynamics , Trajectory generations

Unit V : Machine Vision System

Vision System Devices, Image acquisition, Masking, Sampling and quantisation, Image Processing Techniques , Noise reduction methods, Edge detection, Segmentation. Robot Programming :- Methods of robot programming, lead through programming, motion interpolation, branching capabilities, WAIT, SIGNAL and DELAY commands, subroutines, Programming Languages: Introduction to various types such as RAIL and VAL II etc, Features of type and development of languages for recent robot systems

Unit VI : Modeling and Simulation for manufacturing Plant Automation

Introduction, need for system Modeling, Building Mathematical Model of a manufacturing Plant, Modern Tools- Artificial neural networks in manufacturing automation, AI in manufacturing, Fuzzy decision and control, robots and application of robots for automation. Artificial Intelligence:- Introduction to Artificial Intelligence, AI techniques, Need and application of AI. Other Topics in Robotics:- Socio-Economic aspect of robotisation

Text Books :

1. John J. Craig, Introduction to Robotics (Mechanics and Control), Addison-Wesley, 2nd Edition, 04
2. Mikell P. Groover et. Al., Industrial Robotics: Technology, Programming and Applications, McGraw – Hill International, 1986.
3. Shimon Y. Nof , Handbook of Industrial Robotics , John Wiley Co, 01.
4. Automation, Production Systems and Computer Integrated Manufacturing, M.P. Groover, Pearson Education.
5. Industrial Automation: W.P. David, John Wiley and Sons.

Reference Books :

1. Richard D. Klafter , Thomas A. Chemielewski, Michael Negin, Robotic Engineering : An Integrated Approach , Prentice Hall India, 02.
2. Handbook of design, manufacturing and Automation: R.C. Dorf, John Wiley and Sons.

Fracture Mechanics (MEPA12183C)

Teaching Scheme
Credits : 3
Lectures : 3 Hrs/week

Examination Scheme
Formative Assessment: 50 Marks
Summative Assessment: 50 Marks

Prerequisite:

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

Course Objectives :

- To know the fundamentals of elastic and plastic behaviors of solids etc.
- To know the brittle fracture and modes of failure
- To know the linear elastics fracture mechanics, crack tip plasticity

Course Outcomes :

By the end of the course students will be able to

1. Apply the basic theories of elasto-plastics fracture mechanics.
2. Use any one of the four parameters for finding out damage tolerance: stress intensity factor, energy release rate, J integral, Crack tip opening displacement.
3. Manage singularity at crack tip using complex variable.
4. Understand important role played by plastic zone at the crack tip.
5. Learn modern fatigue and will able to calculate the fatigue life of a component with or without crack in it.
6. Learn modern sophisticated experimental techniques to determine fracture toughness and stress intensity factor.

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

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 and II and Crack Arrest), Creep and Creep Rupture and Corrosion. Emphases will be Given to Brittle Fracture and Fatigue.

Unit III: Linear Elastic Fracture Mechanics (LEFM)

Modes of Crack-Tip Deformation, Elastic Stress Field Equations: Westergaard Stress Function, Opening Mode Analysis, Sliding Mode Analysis,

Unit IV : 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 V: Fatigue failure

Fatigue failure: Crack propagation, effect of an overload, crack closure, variable amplitude fatigue load. Environment-assisted cracking. Dynamic mode crack initiation and growth, various crack detection techniques.

Unit VI : Test methods in fracture

Test methods for determining critical energy release rate, critical stress intensity factor, J-Integral.

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. Brook D, "Elementary engineering fracture mechanics".
2. Liebowitz H., "Fracture" Volume I to VII.
3. A Nadai, W. S. Hemp, "Theory of flow and fracture of solids", McGraw Hill Book Company, 1950.

Multi-body Dynamics (MEPA12184A)

Teaching Scheme
Credits : 3
Lectures : 3 Hrs/week

Examination Scheme
Formative Assessment: 50 Marks
Summative Assessment: 50 Marks

Prerequisite:

1. Engineering Mechanics
2. Strength of Material
3. System Dynamics
4. Kinematics of Machine
5. Dynamics of Machinery

Course Objective :

- The objective of this course is to present the basic theoretical knowledge of the Foundations of Multibody Dynamics with applications to machine and structural dynamics.

Course Outcomes :

Upon learning the course the student will be able to

1. Write programs to solve constrained differential equations for analyzing multi-body systems.
2. Simulate and analyze all types of static behaviors of the multi-body systems including the kineto-static analysis.
3. Simulate and analyze all types of dynamic behaviors of the multi-body systems including the kineto-static analysis.
4. To derive equations of motion for interconnected bodies in multi-body systems with three dimensional motion.
5. To Implement and analyze methods of formulating equations of motion for interconnected bodies.
6. Solve industrial problems in the addressed domain

Unit I : Introduction

The method of constraints for planar kinematic analysis. Revolute, prismatic, gear and cam pairs are considered together with other 2 degrees-of-freedom types of constraints.

Unit II : Basic principles for analysis of multi-body systems

The automatic assembly of the systems of equations for position, velocity and acceleration analysis. Iterative solution of systems of nonlinear equations. Geometry of masses. The principle of virtual work and Lagrange's equations.

Unit III : Dynamics of Planar Systems

Dynamics of planar systems. Systematic computation and assembly of mass matrix. Computation of planar generalized forces for external forces and for actuator-spring-damper element. Simple applications of inverse and forward dynamic analysis. Numerical integration of first-order initialvalue problems. The method of Baumgarte for the solution of mixed differential-algebraic equations of motion. The use of coordinates partitioning, QR and SVD decomposition for the orthogonalization of constraints.

Unit IV : Kinematics of rigid bodies in space
Reference frames for the location of a body in space. Euler angles and Euler parameters. The formula of Rodrigues. Screw motion in space. Velocity, acceleration and angular velocity. Relationship between the angular velocity vector and the time derivatives of Euler parameters.
Unit V : Kinematic analysis of spatial systems
Basic kinematic constraints. Joint definition frames. The constraints required for the description in space of common kinematic pairs (revolute, prismatic, cylindrical, spherical). Equations of motion of constrained spatial systems.
Unit VI : Computation of Forces
Computation of spatial generalized forces for external forces and for actuator-spring-damper element. Computation of reaction forces from Lagrange's multi- pliers.
Text Books :
1. Wittenburg, J., Dynamics of Systems of Rigid Bodies, B.G. Teubner, Stuttgart, 1977. 2. Kane, T.R, Levinson, D.A., Dynamics: Theory and Applications, McGraw-Hill Book Co., 1985. 3. Nikravesh, P.E., Computer Aided Analysis of Mechanical Systems, Prentice-Hall Inc., Englewood Cliffs, NJ, 1988. 4. Roberson, R.E., Schwertassek, R., Dynamics of Multibody Systems, Springer-Verlag, Berlin, 1988. 5. Haug, E.J., Computer-Aided Kinematics and Dynamics of Mechanical Systems-Basic Methods, Allyn and Bacon, 1989. 6. Huston, R.L., Multibody Dynamics, Butterworth-Heinemann, 1990. 7. Schielen, W. ed., Multibody Systems Handbook, Springer-Verlag, Berlin, 1990. 8. de Jalo n, J.C., Bayo, E., Kinematic and Dynamic Simulation of Multibody Systems, Springer-Verlag, 1994. 9. Shabana, A.A., Computational Dynamics, John Wiley and Sons, 1994.
Reference Books :
1. "Why Do Multi-Body System Simulation?" by Rajiv Rampalli, Gabriele Ferrarotti and Michael Hoffmann, Published NAFEMS Publications, January 12 **2.** "Principles of Dynamics" by Donald T. Greenwood, 2nd ed., Prentice Hall

Condition Based Monitoring (MEPA12184B)

Teaching Scheme
Credits : 3
Lectures : 3 Hrs/week

Examination Scheme
Formative Assessment: 50 Marks
Summative Assessment: 50 Marks

Prerequisite:

1. Engineering Mechanics
2. Strength of Material
3. Mechanical Vibrations

Course Objectives :

- To provide an understanding of maintenance and Condition Monitoring (CM) and its relevance to industry.
- To study different maintenance strategies, and the instrumentation and their utilization.
- To study vibration based condition monitoring using signal (time series) analysis.

Course Outcomes :

Upon learning the course the student will be able to

1. Know and be able to explain the aim and the basics of CM
2. Aware of some methods and procedures applied for general CM;
3. Appreciate and understand the basic idea behind vibration-based structural health monitoring and vibration-based condition monitoring, know the general stages of CM;
4. Apply some basic techniques for analysis of random and periodic signals;
5. Know the basics of Vibration of Linear Systems: time and frequency response, resonance;
6. Aware of some basic instrumentation used for machinery and structural vibration-based monitoring;

Unit I :

The basic idea of health monitoring and condition monitoring of structures and machines.
Some basic techniques.

Unit II :

Basics of signal processing: Study of periodic and random signals, probability distribution, statistical properties, auto and cross correlation and power spectral density functions of commonly found systems, spectral analysis.

Unit III :

Fourier transform: the basic idea of Fourier transform, interpretation and application to real signals. Response of linear systems to stationary random signals: FRFs, resonant frequencies, modes of vibration,

Unit IV :

Introduction to vibration-based monitoring, Machinery condition monitoring by vibration analysis: Use and selection of measurements, analysis procedures and instruments,

Unit V :

Typical applications of condition monitoring using vibration analysis to rotating machines

Unit VI :

Some other health monitoring techniques, acoustic emission, oil debris and temperature analysis, Applications.

Text Books :

References:

1. M.Adams, Rotating machinery analysis - from analysis to troubleshooting, Marcel Dekker, New York, 01, ISBN 0-8247-0258-1.
2. Cornelius Scheffer Paresh Girdhar, **Practical** Machinery Vibration Analysis and Predictive Maintenance**,** Newnes, 1st Edition, 04, **Paperback ISBN:** 9780750662758
3. Robert Bond Randall Vibration-based Condition Monitoring: Industrial, Aerospace and Automotive Applications, John Wiley and Sons, Ltd ISBN: 978-0-470-74785-8
4. B. K. N. Rao, Handbook of Condition Monitoring, Elsevier, 1996

Optimization Techniques in Design (MEPA12184C)

Teaching Scheme
Credits : 3
Lectures : 3Hrs/week

Examination Scheme
Formative Assessment: 50 Marks
Summative Assessment: 50 Marks

Course Objective:
To understand the theory of optimization methods and algorithms with a view to promote research interest in applying optimization techniques in problems of Engineering and Technology.

Course Outcomes:
At the end of the course, student will be able to:
1. Apply Classical optimization techniques for constrained and unconstrained Single-variable and Multi-variable optimization.
2. Formulate Linear Programming Problems (LPP) for constrained and unconstrained optimization.
3. solve nonlinear single variable optimization problems where objective function and/or constraints are not stated as explicit functions of the design variables or are complicated to manipulate.
4. Optimize nonlinear multivariable and constrained optimization problems where objective function and/or constraints are not stated as explicit functions of the design variables.
5. Use modern methods of optimization to solve nonlinear single variable and multivariable optimization problems where objective function are complicated to manipulate.
6. Aware of nontraditional methods of optimization to optimize nonlinear single variable and multivariable optimization problems.

Unit I: Classical Optimization Techniques

Introduction, Engineering applications of optimization, Optimal Problem Formulation: Design variables, Constraints, Objective function, Variable bounds, Classification of optimization problems, Engineering Optimization Problems, Optimization Algorithms or optimization techniques, Classical Optimization techniques for single-variable and multi-variable optimization.

Unit II: Linear Programming

Introduction, Application of linear programming, Formulation of Linear programming problems (L.P.P.), Canonical and standard forms of L.P.P., Simplex method, Artificial variable techniques, The Big-M method, The Two Phase method, Special cases in the Simplex method application, Sensitivity and duality, Revised and dual simplex method.

Unit III: Single-variable Optimization Algorithms

Optimality Criteria, Region-Elimination Methods: Exhaustive Search, Fibonacci Search, Golden Section Search, Dichotomous search, Interval Halving Method, Gradient-based Methods: Newton-Raphson Method, Bisection Method

Unit IV: Multivariable and Constrained Optimization Algorithms

Optimality Criteria, Unidirectional Search, Direct Search Methods, Simplex Search Method, Pattern Search Method, Gradient-based Methods, Cauchy's (Steepest Descent) Method, Newton's Method, Kuhn-Tucker Conditions, Direct Search for Constrained Minimization, Variable Elimination Method, Random Search Methods.

Unit V: Modern Methods of Optimization
Genetic Algorithms, Working Principles, Differences between GAs and Traditional Methods, Similarities between GAs and Traditional Methods, GAs for Constrained Optimization, Other GA Operators, Real-coded Gas, Multi-objective Gas, Other Advanced Gas, Simulated Annealing, Global Optimization using the Steepest Descent Method, using Genetic Algorithms and using Simulated Annealing, Particle Swarm Optimization (PSO).
Unit VI: Nontraditional Optimization Algorithms
Ant Colony Optimization, Basic Concept, Ant Searching Behavior, Path Retracing and Pheromone. Updating, Pheromone Trail Evaporation, Algorithm, Optimization of Fuzzy Systems, Fuzzy Set Theory, Optimization of Fuzzy Systems, Computational Procedure, Neural-Network-Based Optimization.
Reference Books :
1. S. S. Stricker, "Optimising performance of energy systems" Battelle Press, New York,1985. 2. R.C. Johnson, "Optimum Design of Mechanical Elements", Willey, New York, 1980. 3. J. S. Arora, "Introduction to Optimum Design", McGraw Hill, New York, 1989. 4. Kalyanmoy Deb, "Optimization for Engineering Design", Prentice Hall of India, New Delhi, 05 5. L.C.W. Dixon, "Non-Linear Optimisation - Theory and Algorithms", Birkhauser, BoSton, 1980. 6. R.J. Duffin, E.L. Peterson and C.Zener "Geometric Programming-Theory and Applications", Willey, New York, 1967. 7. G.B. Dantzig "Linear Programming and Extensions Princeton University Press", Princeton, N. J., 1963. **8.** R. Bellman "Dynamic Programming-Princeton" University Press, Princeton, N.J. 1957.

Laboratory III (Finite Element Method) (MEPA12185)

Teaching Scheme
Credits: 2
Practical : 4 Hrs/week

Examination Scheme
Formative Assessment. : 50 Marks
Summative Assessment : 50 Marks

Course Outcomes:
At the end of the course students will be able to:

1. Students will be able to use various experimental techniques relevant to the subject.
2. Students will acquire hands on experience on the various test-rigs, Experimental set up.
3. Students will be able to function as a team member
4. Students will develop communication skills.
5. Students will be able to write technical reports.
6. Students will be able to use different software's

Syllabus Contents:
The lab practice consists of experiments, tutorials and assignments decided by the course supervisors of the program core courses and program specific elective courses.

1. Computer program for stress analysis of 1D bar using linear and quadratic elements. Show the variation of stress and strain within the element for linear and quadratic bar element.
2. Computer programs for modal analysis for 1-D beam (simply supported or cantilever beams)
3. Computer programs for stress analysis for 1-D beam (simply supported or cantilever beams)
4. Stress and deflection analysis of any machine component consisting of 3-D elements using FEA software.
5. Modal analysis of any machine (Bracket) component using FEA software.
6. Modal analysis of any machine component (Pipe) using FEA software
7. CE component-presentation preparation
8. CE component-presentation conduction
9. Elasto-Plastic analysis of tensile test specimen using FEM Software.
10. Coupled Thermal-Structural Analysis using FEA software
11. Non-linear dynamic analysis of any component using FEM Software
12. CE component- Assignment 1
13. CE component- Assignment 2
14. Fatigue Analysis using FEA software
15. Fatigue Analysis of machine component using FEA software
16. Tube crash analysis under low velocity axial impact
17. CE component- open book test
18. CE component- open book test

Laboratory IV (Computer Aided Design) (MEPA12186)

Teaching Scheme
Credits: 2
Practical : 4 Hrs/week

Examination Scheme
Formative Assessment. : 50 Marks
Summative Assessment : 50 Marks

Course Outcomes:

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

1. Students will be able to use various experimental techniques relevant to the subject.
2. Students will acquire hands on experience on the various test-rigs, Experimental set up.
3. Students will be able to function as a team member
4. Students will develop communication skills.
5. Students will be able to write technical reports.
6. Students will be able to use different software's.

Computer Aided Design:

1. Study of Basics of Hardware and Software requirement for CAD

2. Program on concatenated Transformation involving Three steps.

3. Program on Orthographic and Isometric Projection.

4. Developing component using CAD features of Feature Based Modeling/ Parametric Modeling.

5. Developing CAD models of mechanical sub assembly consisting 8- 10 components

6. CE component-presentation preparation

7. CE component-presentation conduction

8. Demonstration of Application Programming Interface (API).

9. Assignment on GD and T

10. Assignment on Tolerance stack-up

11. Stress and deflection analysis of 2D truss and Beam

12. Stress and deflection analysis of plate 2D [Mechanical Component]

13. CE component- Assignment 1

14. CE component- Assignment 2

15. Stress and deflection analysis of plate 3D [Mechanical Component]

16. Assignment on Design for Manufacturing and Assembly (Software Base)

17. CE component- open book test

18. CE component- open book test

Mini Project (MEPA12187)

Teaching Scheme
Credits : 2
Practical : 4 Hrs/week

Examination Scheme
Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

Objectives:

1. To enable the students to apply fundamental knowledge for understanding state of the art information about any topic relevant to curriculum
2. To make the students aware of ethical and professional practices
3. To enhance communication skills of the students
4. To study modern tools with an understanding of their limitations

Outcomes:

By the end of the course, the students will be able to

1. Write a detailed report about the topic in the prescribed format
2. Present the contents of the topic effectively through oral presentation
3. Demonstrate project work (hardware and/or software).

Mini Project shall be on any topic of student's own choice approved by the faculty. The continuous evaluation will be based on the continuous work of the student to achieve set objectives, technical contents of the topic to assess understanding of the student about the same. Students should prepare a power point presentation for its delivery in 15 minutes. The student should submit duly certified spiral bound report having the following contents.

- Introduction
- Literature Survey
- Theoretical contents/fundamental topics
- Relevance to the present national and global scenario (if relevant)
- Merits and Demerits
- Field Applications / case studies / Experimental work / software application / Benefit cost/ feasibility studies
- Conclusions
- References

A. Report shall be typed on A4 size paper with line spacing 1.5 on one side of paper.
Left Margin : - 25 mm
Right Margin : - 25 mm
Top Margin : - 25 mm
Bottom Margin : - 25 mm

B. Size of Letters
Chapter Number: - 12 font size in Capital Bold Letters- Times New Roman
Chapter Name: - 12 Font size in Capital Bold Letters- Times New Roman
Main Titles (1.1, 3.4 etc):- 12 Font size in Bold Letters- Sentence case. Times New Roman
Sub Titles (1.1.4, 2.5.3 etc):- 12 Font size in Bold Letters-Sentence case. Times New Roman
All other matter: - 12 Font size sentence case. Times New Roman

C. No blank sheet be left in the report
D. Figure name: - 12 Font size in sentence case-Below the figure.
E. Table title -12 Font size in sentence case-Above the table.