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) - Semester I (Pattern 2020)

Mechanical – Design Engineering

Course Code	Course		Teaching Scheme		Examination Scheme					Total	Credits
			L	P	CIE	ISE	SCE	ESE	TW/ OR		
MEPA11201	Advanced Stress Analysis	TH	3	-	20	30	20	30	-	100	3
MEPA11202	Advanced Vibrations and Acoustics	TH	3	-	20	30	20	30	-	100	3
MEPA11203	Mechanics of Composite Materials	TH	3	-	20	30	20	30	-	100	3
MEPA11204	Program Elective I	TH	3	-	20	30	20	30	-	100	3
MEPA11205	Program Elective II	TH	3	-	20	30	20	30	-	100	3
MEPA11206	Open Elective I	CE	2	-	-	-	-	-	50	50	2
MEPA11207	Research Methodology	CE	2	-	-	-	-	-	50	50	2
MEPA11208	Laboratory I	CE-OR	-	4	-	-		-	50	50	2
AP 1	Audit Course I	-	-	-	-	-		-	-	-	-
	Total		19	4	100	150	100	150	150	650	21

Course Code	Program Elective I
MEPA11204A	Advanced Machine Design
MEPA11204B	Design for Manufacturing & Assembly
MEPA11204C	Mathematical Methods in Engineering

Course Code	Program Elective II
MEPA11205A	Advanced Engineering Materials
MEPA11205B	Reliability Engineering
MEPA11205C	Tribology in Design

Course Code	Open Elective I
IOEP11206A	Soft Computing Techniques
IOEP11206B	Ethical Hacking
IOEP11206C	Product Design Engineering

List of 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.

First Year M. Tech. (FYMT) - Semester II (Pattern 2020)

Mechanical – Design Engineering

Course Code	Course		Teaching Scheme		Examination Scheme					Total	Credits
			L	P	CIE	ISE	SCE	ESE	TW /OR		
MEPA12201	Finite Element Method	TH	3	-	20	30	20	30	-	100	3
MEPA12202	Computer Aided Design	TH	3	-	20	30	20	30	-	100	3
MEPA12203	Analysis and Synthesis of Mechanism	TH	3	-	20	30	20	30	-	100	3
MEPA12204	Program Elective III	TH	3	-	20	30	20	30	-	100	3
MEPA12205	Program Elective IV	TH	3	-	20	30	20	30	-	100	3
MEPA12206	Open Elective II	CE	2	-	-	-	-	-	50	50	2
MEPA12207	Intellectual Property Rights	CE	2	-	-	-	-	-	50	50	2
MEPA12208	Laboratory II	CE-OR	-	4	-	-	-	-	50	50	2
AP II	Audit Course II	-	-	-	-	-					
	Total		19	4	100	150	100	150	150	650	21

Course Code	Program Elective III
MEPA12204A	Robotics
MEPA12204B	Fracture Mechanics
MEPA12204C	Process Equipment Design

Course Code	Program Elective IV
MEPA12205A	Multi-body Dynamics
MEPA12205B	Condition Based Monitoring
MEPA12205C	Optimization Techniques in Design

Course Code	Open Elective II
IOEP12206A	Project Planning and Management
IOEP12206B	Blockchain Technologies
IOEP12206C	Data Science for Engineers

List of 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.

Dean Academics

Director

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Semester I

Advanced Stress Analysis (MEPA11201)

Teaching Scheme
Credits : 3
Lectures : 3Hrs/week

Examination Scheme
CIE: 20
ISE: 30
SCE: 20
ESE: 30
PR/OR/ TW: NA

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 : Introduction

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

Unit II :Theory of Elasticity

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 III : 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 IV : Introduction to Fracture Mechanics

Introduction to Linear Elastic Fracture Mechanics, Modes of fractures, Stress intensity factor, crack initiation and Crack opening phenomenon, stress distribution around crack tip under various loading conditions, Fracture toughness

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 (MEPA11202)

Teaching Scheme
Credits : 3
Lectures : 3Hrs/week

Examination Scheme
CIE: 20
ISE: 30
SCE: 20
ESE: 30
PR/OR/ TW: NA

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 to:

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

Mechanics of Composite Materials (MEPA11203)

Teaching Scheme	**Examination Scheme**
Credits - 3	CIE: 20
Lectures - 3 Hrs/week	ISE: 30
	SCE: 20
	ESE: 30
	PR/OR/ TW: NA

Prerequisite:

1. Strength of Material
2. Design of Machine Elements
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 know various composite testing methods and standards of testing
- To develop an understanding of the micro and macro mechanical analysis of composite materials

Course Outcomes :

By the end of the course, students will able to

1. Identify different types of composite materials and its constituents and list its applications in various fields
2. Explain various manufacturing methods of composite materials and apply ASTM testing standards for characterizing composite materials
3. Apply strength of material approach to analyze a lamina at micromechanical level
4. Analyze composite lamina at macromechanical level
5. Apply Classical Lamination Theory for the analysis of composite laminates
6. Design and Analyze composite laminates

Unit I : Introduction to Composite Materials

Introduction to Composite Materials, classification of composite materials, Matrices and Reinforcement, Types of Fiber Reinforcement, Types of matrix materials- Thermoset and Thermoplastic, Advantages and Disadvantages, Applications of composite materials, Mechanics Terminology

Unit II : Manufacturing and Characterization of Composite Materials

Composite Manufacturing Processes, Hand Lay-up process, Compression molding process, Vacuum Impregnation Methods, Resin Transfer molding, Filament winding, Pultrusion, Prepregs,
Composite testing, Need for testing, Major types of testing, Physical testing, Mechanical testing as per ASTM standards- Tensile, compression, shear, flexural, impact.

Unit III : Micromechanical Analysis of a Lamina

Volume and Mass Fractions, Density, and Void Content, Evaluation of the Elastic Moduli- Strength of material approach- Representative Volume Element (RVE), Rule of Mixtures, Inverse Rule of Mixtures. Semi-Empirical Models, Ultimate Strengths of a Unidirectional Lamina
Unit IV : Macromechanical Analysis of Lamina
Hooke's Law for Different Types of Materials- Anisotropic Material, Orthotropic/Specially Orthotropic, Hooke's Law for a Two-Dimensional Unidirectional Lamina, Plane Stress Assumption, Relationship of Compliance and Stiffness Matrix to Engineering Elastic Constants of a Lamina, Two-Dimensional Angle Lamina, Strength Failure Theories of an Angle Lamina- Tsai–Wu Failure Theory
Unit V : Macromechanical Analysis of Laminates
Laminate Code, Classical Lamination Theory- Stress–Strain and Strain-Displacement Equations, Strain and Stress in a Laminate, Force and Moment resultants related to Midplane Strains and Curvatures, extensional, coupling, and bending stiffness matrices, analyzing a laminated composite.
Unit VI : Failure, Analysis and Design of Laminates
Special Cases of Laminates- Symmetric Laminates, Cross-Ply Laminates, Angle Ply Laminates, Antisymmetric Laminates, Balanced Laminate, Quasi-Isotropic Laminates Failure criteria for laminate, Design of laminated composite
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-10-1-56032-812-X. 3. Madhujit Mukhopodhyay , Mechanics of Composite Materials and Structures , University Press (India) PVT Ltd, 2009, ISBN- 9888183814881 4. Mallick PK, Fiber-reinforced composites- materials, manufacturing, and design. CRC press, Taylor and Francis Group 2008; ISBN- 13- 988-0-8493-4205-9.
Reference Books :
1. Ronald F. Gibson, Principles of Composite Material Mechanics, CRC Press, , Taylor and Francis Group, 4th Edition , 2016 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., "Composite Manufacturing – Materials, Product and Processing Engineering", CRC Press, Boca Raton, 02.

Program Elective I
Advanced Machine Design (MEPA11204A)

Teaching Scheme
Credits : 3
Lectures : 3Hrs/week

Examination Scheme
CIE: 20
ISE: 30
SCE: 20
ESE: 30
PR/OR/ TW: NA

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

Program Elective I
Design for Manufacturing and Assembly (MEPA11204B)

Teaching Scheme
Credits : 3
Lectures : 3Hrs/week

Examination Scheme
CIE: 20
ISE: 30
SCE: 20
ESE: 30
PR/OR/ TW: NA

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

Program Elective I
Mathematical Methods in Engineering (MEPA11204C)

Teaching Scheme
Credits : 3
Lectures : 3Hrs/week

Examination Scheme
CIE: 20
ISE: 30
SCE: 20
ESE: 30
PR/OR/ TW: NA

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

Program Elective II
Advanced Engineering Materials (MEPA11205A)

Teaching Scheme
Credits: 3
Lectures: 3 Hrs./week

Examination Scheme
CIE: 20
ISE: 30
SCE: 20
ESE: 30
PR/OR/ TW: NA

Course Objectives:

- Describe importance of crystal structure
- Importance phase diagram and co-relation of different phases with different mechanical properties
- Perform various heat treatments tests for material properties and characterization of industrial samples

Course Outcomes:

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

1. Demonstrate understanding of various aspects of crystal and lattice structure and their imperfection
2. Understand importance of equilibrium diagrams and their uses in developing materials
3. Understand the process of heat treatment of different nonferrous alloys and tool steel and decide a heat treatment to acquire their desired properties
4. Demonstrate acquisition of knowledge of composites, ceramics, orthodontal and biomaterials

Unit I: Aspects of Physical Metallurgy

Crystal structure, systems and Barvias lattices, Indexing of lattice planes (Miller's Indices), Indexing of lattice directions, Co-ordination Number (Ligency), Density calculations and imperfections in crystals

Unit II : Study of Equilibrium diagrams

Fe-C systems, Cu - Bronze alloys i.e. Cu:Zn, Cu:Sn, Cu:Al etc., Developments in metallic materials like HSLA state, maraging steels, creep resisting steels, materials for high and low temperature applications, ,Inconels, Haste Alloys etc., Al, Ni alloys, Ti, alloys.

Unit III : Heat Treatment

Nonferrous alloys, strengthening mechanism , Heat Treatment of Tool steels

Unit IV : Modern Materials

Orthodental materials, Bio material, Prosthetic materials, Nano materials, super conducting materials, sports materials.

Unit V : Non Metallic Materials

Composites, ceramics, cermets, shape memory alloys their manufacturing techniques, advantages and limitations.

Unit VI : Surface coating

Surface coatings and their tribological aspects. PVD, CVD, IVD ion implantation method

Text Books :

1. Engineering Metallurgy, R. A. Higgins, Viva Books Pvt. Ltd.
2. Elements of Material Science and Engineering, Lawrence H., Van Vlack AddisonModel

Reference Books :

1. Principles of Material Science and Engineering, William F. Smith, McGraw-Hill
2. Book Co.
3. 4. Material Science, R. B. Gupta, Satya Publications, New Delhi.
4. 5. A Text Book of Material Science and Metallurgy, O. P. Khanna, Dhanpat Rai and
5. Sons, New Delhi.
6. 6. Material Science and Engineering an Introduction, William D. Callister, Jr., John Wiley and Sons Inc.
7. Smithells Metals Reference Book, E. A. Brandes and G. B. Brook, Butterworth Heinemann.
8. Biomaterials and Bioengineering Handbook, Donald L. Wise, Marcel Dekker Inc.

Program Elective II
Reliability Engineering (MEPA11205B)

Teaching Scheme
Credits: 3
Lectures: 3 Hrs./week

Examination Scheme
CIE: 20
ISE: 30
SCE: 20
ESE: 30
PR/OR/ TW: NA

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, pdf and cdf. 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 Management

Objectives and types of maintenance, Maintainability and availability (inherent, achieved and operational availability) functions, Factors affecting maintainability, Repairable systems, Maintainability parameters, Reliability Centered Maintenance, Built-in-testing.

Unit V : Reliability in Design and Development

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, General expressions for reliability, Reliability expressions for specific distributions, Introduction to Design of Experiments (DOE)

Unit VI : Reliability Testing

Reliability growth testing, Markov modeling and analysis, Accelerated life testing. Highly accelerated life testing (HALT), Highly accelerated stress screening (HASS), Reliability in manufacturing Production FRACAS,, Reliability Data – Acquisition and Graphical Analysis (Analysis of failure time and analysis of individual data)
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.

Program Elective I
Tribology in Design (MEPA11205C)

Teaching Scheme
Credits : 3
Lectures : 3Hrs/week

Examination Scheme
CIE: 20
ISE: 30
SCE: 20
ESE: 30
PR/OR/ TW: NA

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.

Open Elective I
Soft computing Techniques (IOEP11206A)

Teaching Scheme	**Examination scheme**
Credits :2	CIE: NA
Lectures :2 hrs / week	ISE: NA
	SCE: NA
	ESE: NA
	PR/OR/ TW:50

Prerequisite: UG level mathematics

Course Objectives:

1. To make students aware about soft computing techniques /AI techniques
2. To impart knowledge about working of ANN, applications of ANN
3. To impart knowledge about working of Genetic programming, applications of GP
4. To impart knowledge about working of Support vector Regression and Model Tree, applications of SVR and MT

Course Outcomes:

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

1. Understand working of ANN and design temporal and cause effect ANN models
2. Understand working of Genetic programming and design temporal and cause effect GP models
3. Understand working of Support Vector Regression and design temporal and cause effect SVR models
4. Understand working of Model Tree and design temporal and cause effect MT models

Unit I : Artificial Neural Networks

Introduction to computing, hard computing-soft computing, AI and Soft computing, ANN as a soft computing technique, Biological neural network, artificial neuron, working of an artificial neural network, network training, validation and testing, standard Back propagation algorithm, introduction of first order, second order and global training algorithms

Unit II : Neural network design and applications

important aspects of artificial network design, types of neural networks, Applications of ANN in temporal and cause effect modeling

Unit III : Genetic programming

Introduction to Genetic programming, genetic operators, variants in GP, Algorithm of GP, GP parameters Application of GP in temporal and cause effect modeling

Unit IV: Support Vector Regression and and Model Tree

Introduction to Support vector machines, Support Vector Regression, basics of SVR, Application of MT in temporal and cause effect modeling. Introduction to Model Tree, M5 Algorithm, Application of MT in temporal and cause effect modeling

Term work:

1. Design cause effect model using ANN, GP, SVR and MT for the same problem and compare their results. Students will prepare a single report of these four applications.

Text books:

1. Bose, N. K., Liang, P. (1998), "Neural Network Fundamentals with Graphs, Algorithms and Applications", Tata McGraw-Hill Publication.
2. Kosko, B., (1992), "Neural Networks and Fuzzy systems", Prentice Hall, Englewood Cliffs, NJ

3. Wasserman, P.D., (1993), " Advanced methods in neural computing", Van Nostrand Reinhold, New York

Reference Books:

1. Publications in ASCE, Science Direct, Springer, Wiley, IEEE journals and/or similar peer reviewed international unpaid journals

Open Elective I

Ethical Hacking (IOEP11206B)

Teaching Scheme
Credits :2
Lectures :2 hrs / week

Examination scheme
CIE: NA
ISE: NA
SCE: NA
ESE: NA
PR/OR/ TW:50

Course Objectives:
The course will help students
- To aware legal perspective of cybercrime including Indian IT ACT 2008
- To learn techniques of gathering network information
- To identify security tools including, but not limited to intrusion detection and firewall software
- To learn to perform different kind of attacks

Course Outcomes: By the end of the course, Students will be able to
1. **Use** basics knowledge of network security and hacking
2. **Understand** and **use** the IT Laws as and when required
3. **Gather** required information to perform an attack
4. **Use** various tools and methods for Vulnerability Assessment

Unit I : Introduction to Network and security

Basics of Computer Networks: OSI Model, TCP/IP Model, Network topology (Physical & logical), Network Hardware Components: Connectors, Repeaters, hubs, NICs, Bridges and Switches.
Basics of Computer Networks Security: Essential Terminology, Elements of Information Security, Types of Hackers, Steps for Ethical hacking, Types of Attacks.

Unit II : Legal Perspective

The Indian IT Act, Challenges to Indian law, Cybercrime scenario in India, 2008 amendments to Indian IT Act, Intellectual property in the cyberspace.

Unit III : Information Gathering Techniques

Active information gathering, passive information gathering, Trace route, Interacting with DNS Servers, SNMP and SMTP attacks.

Unit IV : Port Scanning and Vulnerability Assessment

Target Enumeration and Port Scanning Techniques: Scanning for Open Ports and Services, Types of Port Scanning, Firewall/IDS Evading Techniques
Vulnerability Assessment: Vulnerability Scanners and How Do They Work, Pros and Cons of a Vulnerability Scanner, Vulnerability Assessment with Nmap, Nessus

Term Work:
Assignments on each unit

Text books:
1. Rafay baloch, "Ethical hacking and Penetration Testing guide", CRC press, 2015, ISBN: 13: 978-1-4822-3162-5 (eBook – PDF).
2. Nina Godbole, SunitBelapure, "Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives", WILEY Publications, 2015, ISBN:978-81-265-2179-1

Reference books:

1. Behrouz Fourzon, " Data Communication and Computer Networks", Pearson Education,5th edition ISBN : 978-0070634145.
2. Andrew S. Tanenbaum, " Computer Networks", International Economy Edition, 5th edition ISBN: 10: 9332518742

Open Elective I

Product Design Engineering (IOEP11206C)

Teaching Scheme
Credits :2
Lectures :2 hrs / week

Examination scheme
CIE: NA
ISE: NA
SCE: NA
ESE: NA
PR/OR/ TW:50

Course objectives:

1. To understand basic techniques for particular phases of product development
2. Make and manage design teams for product development in a company.

Course Outcomes:

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

1. Describe an engineering design and development process
2. Employ engineering, scientific, and mathematical principles to execute a design from concept to finished product
3. Create 3D solid models of mechanical components from the perspective of aesthetic, ergonomic and functional requirement using CAD software
4. Work collaboratively on a team.
5. Create new product based on mechanical design engineering.
6. Investigate contemporary issues and their impact on provided solution.

Unit 1 – Introduction to Product Design

Characteristics of Successful Product Development, Innovative Thinking, Challenges to Product Development, Product Development Process, Concept Development, Economics – Cost Vs Performance, Design Considerations

Unit 2 – Product Development Process

Product development process- Identification of customer needs- customer requirements, product development process flows. Product specifications and concept generation, concept selection, concept screening, concept testing, reverse engineering, product architecture

Unit 3 –Product Design Tools

Creativity and Problem Solving –Creativity methods-Theory of Inventive Problem Solving (TRIZ), Product function tree, Life cycle analysis, Quality Function Deployment, Competing Product Analysis, SWOT analysis, Failure Mode Effect Analysis.

Unit 4 – Design for Manufacture and Assembly

Design for assembly, design for disassembly, design for environment, design for graphics and packaging

Term work:

1. Case study on concept development
2. Case study on life cycle analysis
3. Case study on DFMA

Text Books:

1. Product Design-Techniques in Reverse Engineering and New Product Development, Kevin Otto, Kristion Wood, Pearson Education, ISBN 978-81-7758-821-7.
2. Karl T.U. And Steven D.E., Product Design and Development, McGraw Hill, Ed 2000.

Reference Books :

1. Dieter GE, Engineering Design-Material and Processing Approach, McGraw Hill, Ed 2000

Research Methodology (MEPA11207)

Teaching Scheme
Credits :2
Lectures :2 hrs / week

Examination scheme
CIE: NA
ISE: NA
SCE: NA
ESE: NA
PR/OR/ TW:50

Prerequisite: Basic statistical tools

Course Objectives:

1. To introduce to the concept of research and research problem
2. To understand research ethics
3. Get introduced to the concept of Intellectual property rights.
4. To understand developments in IPR

Course Outcomes:

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

1. Define research and formulate a research problem
2. Discuss the importance of Research Design and Literature Review
3. Discuss classification of data and preliminary data analysis
4. Write a research proposal to a suitable funding agency

Unit I : Introduction to Research and Research problem

Meaning of research, types of research, process of research, Objectives of research, Research and Scientific Method, Sources of research problem, Criteria / Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem, defining a research problem (Real life example or case study), formulation of research hypotheses, Qualities of a good Hypothesis, Null Hypothesis & Alternative Hypothesis. Hypothesis Testing -Logic & Importance

Unit II: Research Design and Literature review

Research Design- Concept and Importance in Research, different research designs in research studies, Literature survey- Definition of literature and literature survey, need of literature survey, elements and objectives of literature survey, sources of literature-monographs-patents – web as a source, Critical literature review – Identifying gap areas from literature review and strategies of literature survey, Errors in research.

Unit III: Data and Data Analysis

Classification of data, benefits and drawbacks of data, qualitative methods of data collection, types of data analysis, Sampling, sample size, sample design, Testing of hypothesis and Goodness of Fit: Definition of null and alternative hypothesis, student's 't' distribution, Chi-square distribution, F-test, analysis of variance techniques, introduction to non-parametric tests. Regression Analysis – Simple Linear Regression, Multiple linear Regression

Unit IV: Report, Research proposal and funding agencies

Need of effective documentation, types of reports and their format. Essentials of a research proposal. Different funding agencies for research. Research briefing, presentation styles, elements of effective presentation, writing of research paper, presenting and publishing paper, patent procedure, ethical issues.

Text books:

1. Dr. C. R. Kothari, Research Methodology: Methods and Trends', New Age International Publishers.
2. Wayne Goddard and Stuart Melville, Research Methodology: An Introduction'
3. Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners'

Reference Books:

1. Deepak Chawla and Neena Sondhi, Research Methodology**:** concepts and cases, Vikas Publishing House Pvt. Ltd. (ISBN 978-81-259-5205-3)
2. Louis Cohen, Manion, Morrison , Research Methods in Education, Routledge(Taylor & Francis Group) /Cambridge University Press India Pvt. Ltd.-ISBN-978-0-415-58336-7
3. Sekaran Uma and Roger Bougie, Research Methods for Business, Wiley, India.

Laboratory I (MEPA11208)

Teaching Scheme
Credits: 2
Practical : 4 Hrs/week

Examination Scheme
CIE: NA
ISE: NA
SCE: NA
ESE: NA
PR/OR/ TW:50

Course Objectives:

- To provide practical exposure with the real life situation

Course Outcomes:

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

1. Analyze the behavior of material under different loading conditions.
2. Compute ill acquire hands on experience on the various test-rigs, Experimental set up.
3. Understand the manufacturing methods of composite materials
4. Analyze the composite laminates using analytical method as well as FEA based software
5. Estimate natural frequency for SDOF undamped and damped free vibratory systems
6. Determine vibratory responses of SDOF and MDOF systems

Syllabus Contents:

1. Determination of full range stress-strain curve for mild steel specimen as per ASTM-E8M
2. Contact stress analysis of gear pair/ cam and follower using FEM Software
3. Measurement of fatigue life of the test specimen.
4. Fabrication of composite laminate using hand lay-up method supported by compression molding/vacuum bagging method
5. Develop computer program on the basis of Classical Lamination Theory (CLT) for the analysis of composite laminate (CLT).
6. Analysis of composite laminate using any suitable finite element-based software.
7. Determine natural frequency and damping coefficient of damped vibration of single degree freedom system.
8. Computer program to find Eigen values using numerical method
9. Determination of Natural Frequencies of cantilever beam using FFT Analyzer.

Semester II

Finite Element Method (MEPA12201)

Teaching Scheme
Credits : 3
Lectures : 3Hrs/week

Examination Scheme
CIE: 20
ISE: 30
SCE: 20
ESE: 30
PR/OR/ TW: NA

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 :

2. Bathe K. J., ―Finite Element Procedures‖, Prentice-Hall of India (P) Ltd., New Delhi. 42106. ISBN-0-13-301458.
3. S. Moaveni, ―Finite element analysis, theory and application with Ansys. ISBN-0-13-785098-0
4. Fundamental of Finite Element Analysis, David V. Hutton, Tata McGraw-Hill. ISBN-0-07-239536-2
5. 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
6. Gupta S.K.(1995) Numerical Methods for Engineers, New Age International.

Computer Aided Design (MEPA12202)

Teaching Scheme
Credits : 3
Lectures : 3Hrs/week

Examination Scheme
CIE: 20
ISE: 30
SCE: 20
ESE: 30
PR/OR/ TW: NA

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 (MEPA12203)

Teaching Scheme
Credits : 3
Lectures : 3Hrs/week

Examination Scheme
CIE: 20
ISE: 30
SCE: 20
ESE: 30
PR/OR/ TW: NA

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.

Program Elective I
Robotics (MEPA12204A)

Teaching Scheme
Credits : 3
Lectures : 3Hrs/week

Examination Scheme
CIE: 20
ISE: 30
SCE: 20
ESE: 30
PR/OR/ TW: NA

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.

Program Elective I
Fracture Mechanics (MEPA12204B)

Teaching Scheme
Credits : 3
Lectures : 3Hrs/week

Examination Scheme
CIE: 20
ISE: 30
SCE: 20
ESE: 30
PR/OR/ TW: NA

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.

Program Elective I
Process Equipment Design (MEPA12204C)

Teaching Scheme
Credits : 3
Lectures : 3Hrs/week

Examination Scheme
CIE: 20
ISE: 30
SCE: 20
ESE: 30
PR/OR/ TW: NA

Prerequisite: Engg. Mathematics, Machine Design, 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:
By the end of the course, students will
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 1 : Process Design Parameters

Basic concepts in process design, block diagrams for flow of processes, material flow balance. Introduction to design codes like IS-2825, ASME-SECT, EIGHT-DIV-II TEMA.API-650, BS-1500 & 1515.
Process Control : Fundamentals of process measurements and control modern control devices and other controls of major unit operation and processes..

Unit 2 : 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

Unit 3 : Design of Tall Vessels and Large Storage Tanks

Determination of equivalent stress under combined loadings including seismic and wind loads application of it to vertical equipment like distillation column.

Unit 4 : Process Equipment Design

Storage vessels, reaction vessels, agitation and mixers, heat exchangers, filters and driers, centrifuges. selection and specification procedures used in design. Selection of pumps, compressors, electrical equipment and auxiliary services, safety, etc.

Unit 5 : Process Piping Design

Flow diagrams and pipe work symbols, design of layout of water, steam and compressed air pipes work, pipe fitting, linings and flanged connections. Types of valves used on pipe line., expansion joints and pipe supports.

Unit 6 : Erection of Process Equipment

Planning, manufacture, inspection and erection of process equipment like pressure vessels, chimneys, ducting, heat exchangers, pulverising equipment, etc. protective coatings, lining of vessels.

Term-Work

Following assignments / experiments comprise the laboratory practice :-

1. Design and optimization of tall vessels and large tanks.
2. Design of Heat exchangers used in industries.
3. Design of crystallisers.
4. Design and development of equipment useful to process industries such as sugar, cement, chemical industries.
5. Preparing flow diagrams of processes, piping layout, etc.
6. Report based on visit to industries such as sugar, cement, chemical industries.

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. Max and Timasulaus Kalus, Plant Design and Economics, McGraw-Hill Science, ISBN: 9780072392661

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. H. Bedna, "Pressure Vessel Design Hand Book", ISBN: 9780442254162
5. Stanley M.Walas, "Chemical Process Equipment Selection and Design", Butterworth-Heinemann Series in Chemical Engineering. ISBN: 9781591241966

Program Elective II
Multi-body Dynamics (MEPA12205A)

Teaching Scheme
Credits : 3
Lectures : 3Hrs/week

Examination Scheme
CIE: 20
ISE: 30
SCE: 20
ESE: 30
PR/OR/ TW: NA

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

Program Elective II
Condition Based Monitoring (MEPA12205B)

Teaching Scheme
Credits : 3
Lectures : 3Hrs/week

Examination Scheme
CIE: 20
ISE: 30
SCE: 20
ESE: 30
PR/OR/ TW: NA

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

Program Elective II
Optimization Techniques in Design (MEPA12205C)

Teaching Scheme
Credits : 3
Lectures : 3Hrs/week

Examination Scheme
CIE: 20
ISE: 30
SCE: 20
ESE: 30
PR/OR/ TW: NA

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.

Open Elective II
Project Planning and Management (IOEP12206A)

Teaching Scheme
Credits :2
Lectures :2 hrs / week

Examination Scheme
CIE: NA
ISE: NA
SCE: NA
ESE: NA
PR/OR/ TW:50

Prerequisite: Basic understanding of Project Management at UG level

Course Objectives:
The course will help students
- To impart knowledge of project life cycle.
- To introduce students to Project Identification Process, Project Initiation, Pre-Feasibility Study and Project feasibility Studies,
- To construct CPM, PERT network for a project.
- To introduce students to Steps in Risk Management, Risk Identification, Risk Analysis and Reducing Risks
- To introduce students to process of project Performance Measurement, Evaluation and closeout.

Course Outcomes:
By the end of the course, students will be able to
1. **Understand** principles of Project Management and phases of project life
2. **Understand** the Project Identification Process, Project Initiation, Pre-Feasibility Study and Project feasibility Studies
3. **Construct** CPM, PERT network for a project.
4. **Understand** the process of project Performance Measurement, Evaluation and closeout.

Unit I: Basics of Project Management

Introduction, Need, Project Management Knowledge Areas and Processes, Concept of Organizational Structure and types, The Project Life Cycle (preferably with case study), Essentials Project Management Principles.

Unit II: Project Identification and Selection

Introduction, Project Identification Process, Project Initiation, Pre-Feasibility Study, Feasibility Studies, Project Break-even point. Case study is preferred.

Unit III: Project Planning

Introduction, Need for Project Planning, Work Breakdown Structure (WBS), LOB, CPM and PERT, Network Cost System, Resource Allocation, Scheduling, Project Cost Estimate and Budgets,concept of Project Risk Management

Unit IV: Project Performance Measurement, Evaluation and closeout

Introduction, Performance Measurement, Productivity, Project Performance Evaluation, Benefits and Challenges of Performance Measurement and Evaluation, Controlling the Projects. Project Close-out, Steps for Closing the Project, Project Termination, and Project Follow-up. Case study is preferred.

Students are encouraged to register for On-line course in the relevant above course approved by authority.

Term Work:
Assignments for all units

Text books:

1. Operations Research by Premkumar Gupta and D.S.Hira, S. Chand Publications (2014)
2. Project Management – K Nagrajan – New age International Ltd.
3. Project Management – Ahuja H.N. – John Wiely, New York.
4. Project Management-Planning and Control---Rory Burkey 4th ed.—Wiley,India.

Open Elective II
Blockchain Technologies (IOEP12206B)

Teaching Scheme
Credits :2
Lectures :2 hrs / week

Examination Scheme
CIE: NA
ISE: NA
SCE: NA
ESE: NA
PR/OR/ TW:50

Prerequisite: Knowledge of programming language and script language

Course Objectives: The course will help students
- To introduce fundamentals of Blockchain
- To explain Bitcoin Blockchain
- To explain Ethereum Architecture & Components
- To discuss Emerging Trends in Blockchain and Use cases

Course Outcomes: By the end of the course, students will be able to
1. **Explain** fundamental knowledge of Blockchain (Understand)
2. **Illustrate** Bitcoin Blockchain (Understand)
3. **Summarize** Ethereum Architecture & Components (Understand)
4. **Explore** emerging trends in Blockchain and Use cases (Understand)

Unit I: Overview of Blockchain

Introduction to Blockchain, History of Blockchain, Network and protocols, Smart Contract and Consensus Algorithms, Blockchain users and adoption, Blockchain challenges

Unit II: Bitcoin Blockchain

Blockchain TOC Bitcoin/Blockchain data structures, Keys as Identity, Digital Signatures, Hashes, Hashes as Addresses, Hash Pointers and Data Structures, Blockchain transactions, Blockchain block structure

Unit III: Ethereum Architecture & Components

Evolution of Ethereum, Ethereum Components, Ethereum Virtual Machine, Types of Transactions, Solidity language, Ethereum Smart Contracts, Tokenization, Dapps.

Unit IV: Emerging Trends in Blockchain and Use cases

Introduction of Hyperledger, Corda, Ripple, R3. Blockchain and cloud computing, Blockchain and Artificial Intelligence, Blockchain use cases in Health Care, Banking, Government Sector, Supply Chain Management, Identity Management, etc.

Term Work:
Case study on various Crypto currencies.
Case study on various Blockchain Platforms.

Text books:
1. Mastering Bitcoin: Unlocking Digital Crypto currencies, by Andreas Antonopoulos
2. Blockchain by Melanie Swa, O'Reilly
3. Mastering Ethereum Building Smart Contracts and DApps, Andreas M. Antonopoulos, Gavin Wood, O'Reilly
4. Hyperledger Fabric - https://www.hyperledger.org/projects/fabric

Reference books:
1. Zero to Blockchain - An IBM Redbooks course, by Bob Dill, David Smits
2. Etherium Yellow Paper : "Ethereum: A Secure Decentralised Generalised Transaction Ledger Petersburg", Dr. Gavin Wood

Open Elective II
Data Science for Engineers (IOEP12206C)

Teaching Scheme
Credits :2
Lectures :2 hrs / week

Examination Scheme
CIE: NA
ISE: NA
SCE: NA
ESE: NA
PR/OR/ TW:50

Prerequisite: 10 hrs of pre-course material will be provided.

Course Objectives:
- Introduce the mathematical foundation.
- Introduce data science algorithms and data analytics.
- Introduce a practical capstone case study.

Course Outcomes:
At the end of the course, students will be able to:
1. Describe a flow process for data science problems.
2. Classify data science problems.
3. Correlate results to the solutions.
4. Construct use cases to validate approach.

Unit I : Linear Algebra Basics

Linear algebra for data science, Algebraic view - vectors, matrices, product of matrix & vector, rank, null space, solution of over-determined set of equations and pseudo-inverse), Geometric view - vectors, distance, projections, eigenvalue decomposition.

Unit II : Statistics and Optimization:

Statistics (descriptive statistics, notion of probability, distributions, mean, variance, covariance, covariance matrix, understanding univariate and multivariate normal distributions, introduction to hypothesis testing, confidence interval for estimates) and Optimization.

Unit III : Linear regression:

Typology of data science problems and a solution framework, Simple linear regression and verifying assumptions used in linear regression, Multivariate linear regression, model assessment, assessing importance of different variables, subset selection.

Unit IV : Classification techniques

Classification using logistic regression, Classification using kNN and k-means clustering.

Term work: Assignment on each unit will be given by the course teacher.

Text Books :
1. Gilbert Strang, "Introduction to Linear Algebra," 2nd Ed., Wellesley-Cambridge Press.

Reference Books :
1. Douglas Montgomery and George Runger "Applied Statistic and Probability for engineers," 6th Ed., Wiley.

Intellectual Property Rights (CVPB12207)

Teaching Scheme
Credits :2
Lectures :2 hrs / week

Examination Scheme
CIE: NA
ISE: NA
SCE: NA
ESE: NA
PR/OR/ TW:50

Prerequisite: NA

Course Objectives:
The course will help students to
- Explain the importance of ideas, concept and creativity
- Transfer the knowledge about the IPR required for Engineer's
- Describe the how IPR creates National wealth
- Teach National and International IP System

Course Outcomes:
By the end of the course, students will be able to
1. **Explain** property and Intellectual property their nature, importance and objectives.
2. **Discuss** types of IPR: Patents, Designs, Trademarks (Registered and unregistered trademarks), Copyright, Traditional Knowledge, Geographical Indications, Trade Secrets, Idea Patenting
3. **Understand** the process of patenting, development and International scenario: WIPO, TRIPs
4. **Explain** administration of patent system.

Unit I: Introduction to the concepts Property and Intellectual Property

Introduction to the concepts Property and Intellectual Property, Nature and Importance of Intellectual Property Rights, Objectives of understanding Intellectual Property Rights, IPR and IITs

Unit II: Intellectual Property Rights

Understanding the types of Intellectual Property: - Patents, Designs, Trademarks (Registered and unregistered trademarks), Copyright, Traditional Knowledge, Geographical Indications, Trade Secrets, Idea Patenting, (Case Studies)

Unit III: New Developments in IPR

New Developments in IPR, Process of Patenting and Development: technological research, innovation, patenting, development, understanding of IPR issues in cyber world, International Scenario: WIPO, TRIPs, Indian Patent Office

Unit IV: Administration of Patent System

Administration of Patent System – Patenting under Indian Patent Act, Patenting under PCT, Patent Rights and its Scope, Licensing and transfer of technology, Patent information and database. Provisional and Non-Provisional Patent Application and Specification.

Term work: Assignment on each unit.

Text Books :
1. Resisting Intellectual Property by Halbert, Taylor & Francis Ltd ,2007
2. Industrial Design by Mayall, Mc Graw Hill F. Y. M. Tech (Structures) Pattern 2020 58
3. Intellectual Property in New Technological Age by Robert P. Merges, Peter S. Menell, Mark A. Lemley

Reference Books :
1. Intellectual Property Rights under WTO by T. Ramappa, S. Chand Introduction to Design by Asimov, Prentice Hall

Laboratory II
(MEPA12208)

Teaching Scheme
Credits: 2
Practical : 4 Hrs/week

Examination Scheme
CIE: NA
ISE: NA
SCE: NA
ESE: NA
PR/OR/ TW:50

Course Outcomes:
At the end of the course students will be able to:
1. Develop finite element code for solving 1D problems
2. Solve real life problems using FEA software
3. Analyze 2D and 3D analysis of mechanical components
4. Understand DFMA.
5. Analyze complex mechanisms.
6. Synthesize the mechanism for suitable application

Syllabus Contents:
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. Stress and deflection analysis of any machine component consisting of 3-D elements using FEA software.
3. Modal analysis of any machine (Bracket) component using FEA software.
4. Stress and deflection analysis of plate 2D Mechanical Component
5. Stress and deflection analysis of plate 3D Mechanical Component
6. Assignment on Design for Manufacturing and Assembly (Software Base)
7. Velocity analysis of the mechanism of complex mechanism
8. Couple curve analysis using Robert-Chebychev Theorm
9. Assignment on analytical synthesis of mechanism