LENDI INSTITUTE OF ENGINEERING AND TECHNOLOGY
An Autonomous Institution
Approved by AICTE & Permanently Affiliated to JNTUK, Kakinada
Accredited by NAAC with "A" Grade and NBA (CSE, EEE & ME)
Jonnada (Village), Denkada (Mandal), Vizianagaram Dist. – 535 005
Phone No. 08922-241111, 241112
E-Mail: lendi_2008@yahoo.com **Website: www.lendi.org**

DEPARTMENT OF MECHANICAL ENGINEERING

M.Tech (Machine Design) Course Structure –R19

(w.e.f the academic year 2019-20)

I Year -I Semester

S.No	Course Code	Subject Name	L	P	Credits
1	ME-MD1101	Computational Methods in Engineering	3	0	3
2	ME-MD1102	Advanced Mechanics of Solids	3	0	3
3	ME-MD1103	Advanced Mechanisms	3	0	3
4	ME-MD1104	Mechanical Vibrations	3	0	3
5	ME-MD1105	**Elective – I**	3	0	3
	ME-MD1105.1	1. Design of Automobile Systems			
	ME-MD1105.2	2. Product Design			
	ME-MD1105.3	3. Geometric Modeling			
	ME-MD1105.4	4. Non-Destructive Evaluation			
6	ME-MD1106	**Elective – II**	3	0	3
	ME-MD1106.1	1. Fracture Mechanics			
	ME-MD1106.2	2. Gear Engineering			
	ME-MD1106.3	3. Design for Manufacturing &Assembly			
	ME-MD1106.4	4. Continuum Mechanics			
7	MEMD1107	Machine Dynamics Lab	0	4	2
8	AC-ERPW1101	**Audit Course 1:** English for Research Paper Writing	2	0	0
		Total	20	4	20

I Year –II Semester

S.No	Course Code	Subject Name	L	P	Credits
1	ME-MD1201	Optimization and Reliability	3	0	3
2	ME-MD1202	Experimental Stress Analysis	3	0	3
3	ME-MD1203	Advanced Finite Element Methods	3	0	3
4	ME-MD1204	Material selection in mechanical design	3	0	3
5	ME-MD1205	**Elective – III**	3	0	3
	ME-MD1205.1	1. Tribology			
	ME-MD1205.2	2. Condition Monitoring and Signal Analysis			
	ME-MD1205.3	3. Noise and vibration control			
	ME-MD1205.4	4. Vehicle dynamics			
	ME-MD1205.5	5. Design Synthesis			
6	ME-MD1206	**Elective-IV**	3	0	3
	ME-MD1206.1	1. Pressure Vessel Design			
	ME-MD1206.2	2. Mechanics of Composite Materials			
	ME-MD1206.3	3. Advanced CAD			
	ME-MD1206.4	4. Theory of Plasticity			
7	MEMD1207	Design Practice Lab	0	4	2
8	AC-RMIP1201	**Audit Course 2:** Research Methodology and IPR	2	0	0
		Total	**20**	**4**	**20**

II Year – I Semester

S.No	Course Code	Subject Name	L	P	Credits
1	ME-MD2101	Seminar-I	0	0	02
2	ME-MD2102	Project Stage-I	0	20	10
		Total	**0**	**16**	**12**

II Year – II Semester

S.No	Course Code	Subject Name	L	P	Credits
1	ME-MD2201	Project Stage-II	0	32	16
		Total	**0**	**32**	**16**

I Year -I Semester

Subject Code	Subject Name	L	P	Credits
ME-MD1101	Computational Methods in Engineering	3	0	3

Course Objectives:

- To familiarize the numerical methods applied to engineering problems.
- To equip the students to solve Boundry value problems,Transformation Techniques etc.

Course Outcomes:

At the end of the course students will be able to

1. Evaluate the matrix notations, determinants and inversion, relaxation methods etc. (L3)
2. Evaluate the Solution through a set of equations for derivative boundary conditions, Rayleigh – Ritz method etc (L3)
3. Solve the continuous fourier series, frequency and time domains, laplace transform, fourier integral and transform, discrete fourier transform (DFT), Fast fourier transform(FFT). (L3)
4. Solve the Numerical solutions of partial differential equations (L3)
5. Solve the wave equation by finite differences-stability of numerical method, method of characteristics, wave equation in two space dimensions-computer programs (L3)

Unit – I

Introduction to numerical methods applied to engineering problems: Examples, solving sets of equations – Matrix notation – Determinants and inversion – Iterative methods – Relaxation methods. System of non-linear equations. Least square approximation fitting of non-linear curves by least squares –regression analysis- multiple linear regression, non linear regression - computer programs.

Learning Outcomes:

At the end of the this unit student will be able to

- Solve the set of equations by matrix notation, relaxation method (L3)
- Solve the Least square approximation fitting of non-linear curves by least squares (L3)

Unit – II

Boundry value problems and charecteristic value problems: Shooting method – Solution through a set of equations – Derivative boundary conditions – Rayleigh – Ritz method – Characteristic value problems.

Learning Outcomes:

At the end of the this unit student will be able to

- Solve the derivative boundary conditions for Rayleigh – Ritz. (L3)

Unit – III

Transformation Techniques: Continuous fourier series, frequency and time domains, laplace transform, fourier integral and transform, discrete fourier transform (DFT), Fast fourier transform(FFT).

Learning Outcomes:

At the end of the this unit student will be able to

- Solve the problems using transformation techniques. (L3)

Unit – IV

Numerical solutions of partial differential equations: Laplace's equations – Representations as a difference equation – Iterative methods for Laplace's equations – poisson equation – Examples – Derivative boundary conditions – Irregular and non – rectangular grids – Matrix patterns, sparseness – ADI method – Finite elementmethod.

Learning Outcomes:

At the end of the this unit student will be able to

- Solve the numerical solutions of partial differentail equations. (L3)

Unit – V

Partial differential equations: Explicit method – Crank-Nickelson method – Derivative boundary condition – Stability and convergence criteria. Solving wave equation by finite differences-stability of numerical method –method of characteristics-wave equation in two space dimensions-computer programs.

Learning Outcomes:

At the end of the this unit student will be able to

- Solve the wave equation by finite differences-stability of numerical method, method of characteristics. (L3)

Text Books

1. Steven C.Chapra, Raymond P.Canale "Numerical Methods for Engineers" Tata Mc-Graw Hill
2. Curtis F.Gerald, Partick.O.Wheatly,"Applied numerical analysis"Addison-Wesley,1989
3. Douglas J.Faires,Riched Burden"Numerical methods", Brooks/Cole publishing company,1998.Second edition.

References

1. Ward Cheney and David Kincaid "Numerical mathematics and computing" Brooks/Cole publishing company1999, Fourthedition.
2. Riley K.F,. M.P.Hobson and Bence S.J, "Mathematical methods for physics and engineering", Cambridge Universitypress,1999.
3. Erwin Kreyszig, Advanced Engineering Mathematics, Wiley; 10th Edition edition.

I Year -I Semester

Subject Code	Subject Name	L	P	Credits
ME-MD1102	Advanced Mechanics of Solids	3	0	3

Course Objectives:

- Introduce the concepts of different stresses, strains and their relationships.
- Discuss the principal stresses and components of stress on different planes and maximum shear force and bending moment of different beams under different loading conditions.
- Demonstrate bending stress and shear stress distribution of various cross sections of beams and to predict the maximum slope and deflection of beams.
- Impart strain energy due to axial, bending, and torsional loading.
- Focus on the stresses and deformations of the springs.

Course Outcomes:

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

1. Apply the concepts of stress and strain to machine numbers. (L3)
2. Determine modes of failure of materials. (L2)
3. Solve the bending stresses of non symmetrical bending of beams. (L3)
4. Estimate the torsion in machine members.(L4)
5. Analyse contact stresses in the different members.(L3)

Unit I

Theories of stress and strain, Definition of stress at a point, stress notation, principal stresses, other properties, differential equations of motion of a deformable body, deformation of a deformable body, strain theory, principal strains, strain of a volume element, small displacement theory.

Stress –strain temperature relations: Elastic and non elastic response of a solid, first law of thermodynamics, Hooke's Law, Anisotropic elasticity, Hooke's Law, Isotropic elasticity, initiation of Yield, Yield criteria.

Application: beams and structures

Learning outcomes:

At the end of the unit, student will be able to

- Determine stresses and deformations due to axial loads in simple members. (L3)
- Analyse stresses compound bars due to temperature raise. (L4)
- Analyse principal stresses in biaxial state of loading. (L4)

Unit II

Failure criteria: Modes of failure, Failure criteria, Excessive deflections, Yield initiation, fracture, Progressive fracture, (High Cycle fatigue for number of cycles $N > 10^6$, buckling.

Application of energy methods: Elastic deflections and statically indeterminate members and structures: Principle of stationary potential energy, Castiglione's theorem on deflections, Castiglione's theorem on deflections for linear load deflection relations, deflections of statically determinate structures.

Application: analysis of failure of simple mechanical machine elements like rivets, bolts etc.

Learning outcomes:

At the end of the unit, student will be able to

- Analyze the various modes of failures in members. (L2)

Unit III

Unsymmetrical bending: Bending stresses in Beams subjected to Nonsymmetrical bending; Deflection of straight beams due to nonsymmetrical bending.

Curved beam theory: Winkler Bach formula for circumferential stress – Limitations – Correction factors –Radial stress in curved beams – closed ring subjected to concentrated and uniform loads-stresses in chain links.

Application: analysis of structures and Automobile Chassis.

Learning outcomes:

At the end of the unit, student will be able to

- Determine the bending stresses in Beams subjected to Nonsymmetrical bending. (L2)

- Determine the radial stress in curved beams. (L2)

Unit IV

Torsion: Linear elastic solution; Prandtl elastic membrane (Soap-Film) Analogy; Narrow rectangular cross Section ;Hollow thin wall torsion members ,Multiply connected Cross Section.
Application: twisting moment for wheel and hub of a automobile**.**

Learning outcomes:

At the end of the unit, student will be able to

- Determine the torsion in members. (L2)

Unit-V

Contact stresses: Introduction; problem of determining contact stresses; Assumptions on which a solution for contact stresses is based; Expressions for principal stresses; Method of computing contact stresses; Deflection of bodies in point contact; Stresses for two bodies in contact over narrow rectangular area (Line contact), Loads normal to area; Stresses for two bodies in line contact, Normal and Tangent to contact area.

Learning outcomes:

At the end of the unit, student will be able to

- Determine the problems in contact surfaces and computing it. (L2&L3)

Textbooks

1. Advanced Mechanics of materials by Boresi & Sidebottom-Wiely International.
2. Advanced Mechanics of Solids, L.S Srinath

References

1. Advanced strength of materials by Den HortogJ.P.
2. Theory of plates – Timoshenko.
3. Strength of materials & Theory of structures (Vol I & II) by B.C Punmia
4. Strength of materials by Sadhu singh

I Year -I Semester

Subject Code	Subject Name	L	P	Credits
ME-MD1103	Advanced Mechanisms	3	0	3

Objectives:

- Introduce the concepts of Elements of Mechanisms, Mobility Criterion for Planar mechanisms.
- Discuss the application of the Inflection circle to kinematic analysis.
- Demonstrate relative motion of the output and input links and determination of the output angular acceleration and its Rate of change.
- Discus about Direct and Inverse kinematic analysis of Serial manipulators.

Course Outcomes:

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

1. Apply the concepts of mobility of mechanisms. (L3)
2. Evaluate application of the Inflection circle to kinematic analysis. (L4)
3. Apply the synthesis-Graphical Methods – I&II. (L3)
4. Estimate the angular velocity of driven linkmembers. (L4)
5. Analyse the application of robotic manipulator in industries.(L3)

Unit - I

Introduction: Elements of Mechanisms; Mobility Criterion for Planar mechanisms and manipulators; Mobility Criterion for spatial mechanisms and manipulators. Spherical mechanisms-spherical trigonometry.

Learning outcomes:

At the end of the unit, student will be able to

- Determine the elements of Mechanisms. (L2)

Unit – II

Advanced Kinematics of plane motion- I: The Inflection circle ; Euler – Savary Equation; Analytical and graphical determination of d_i ; Bobillier's Construction; Collineastion axis; Hartmann's Construction ;Inflection circle for the relative motion of two moving planes; Application of the Inflection circle to kinematic analysis.

Advanced Kinematics of plane motion - II: Polode curvature; Hall's Equation; Polode curvature in the four bar mechanism; coupler motion; relative motion of the output and input links; Determination of the output angular acceleration and its Rate of change; Freudenstein's collineation –axis theorem; Carter –Hall circle; The circling – point curve for the Coupler a four barmechanism.

Learning outcomes:

At the end of the unit, student will be able to

- Determine the Inflection circle to kinematic analysis. (L2)
- Analyze the curvature in the four bar mechanism (L3)

Unit – III

Introduction to Synthesis-Graphical Methods - I: The Four bar linkage ;Guiding a body through Two distinct positions; Guiding a body through Three distinct positions; The Rotocenter triangle ; Guiding a body through Four distinct positions; Burmester's curve.

Introduction to Synthesis-Graphical Methods - II: Function generation- General discussion; Function generation: Relative –rotocenter method, Overlay's method, Function generation-Velocity – pole method; Path generation: Hrones's and Nelson's motion Atlas, Roberts's theorem.

Learning outcomes:

At the end of the unit, student will be able to

- Analyze the synthesis methods to guiding a body (L3)

Unit – IV

Introduction to Synthesis - Analytical Methods: Function Generation: Freudenstien's equation, Precision point approximation, Precision – derivative approximation; Path Generation: Synthesis of Four-bar Mechanisms for specified instantaneous condition; Method of components; Synthesis of Four-bar Mechanisms for prescribed extreme values of the angular velocity of driven link;

Method of components.

Learning outcomes:

At the end of the unit, student will be able to

- Synthesis of Four-bar Mechanisms for specified instantaneous condition (L3)

Unit – V

Manipulator kinematics : D-H transformation matrix ; Direct and Inverse kinematic analysis of Serial manipulators: Articulated, spherical & industrial robot manipulators- PUMA, SCARA,STANFORD ARM, MICROBOT.

Learning outcomes:

At the end of the unit, student will be able to

- Analyze the industrial robot manipulators (L3)

Text Books

1. Jeremy Hirschhorn, Kinematics and Dynamics of planemechanisms,McGraw-Hill,1962.
2. L.Sciavicco and B.Siciliano, Modelling and control of Robot manipulators, Second edition , Springer -Verlag,London,2000.
3. Amitabh Ghosh and Ashok Kumar Mallik, Theory of Mechanisms and Machines. E.W.P.Publishers.

Reference Books

1. Allen S.Hall Jr., Kinematics and Linkage Design,PHI,1964.
2. J.E Shigley and J.J . Uicker Jr., Theory of Machines and Mechanisms , McGraw-Hill,1995.
3. Joseph Duffy, Analysis of mechanisms and Robot manipulators, Edward Arnold,1980

I Year -I Semester

Subject Code	Subject Name	L	P	Credits
ME-MD1104	Mechanical Vibrations	3	0	3

Course Objective:

- Demonstrate basic concepts and definitions of mechanical vibrations. To write equation of motion for discrete spring-mass systems with different configuration using classical and energy methods.
- To train the students about basic concepts of forced vibrations, vibration transmissibility and isolation and seismic instruments. Further to understand about various vibration control methods.
- To familiarize the students about two degree freedom system and various types of vibration absorbers.
- To analyze the two degree and multi degree of freedom systems.
- To Calculate Natural Frequencies with Rayliegh and Dunkerleys Methods.
- Explain Vibration measuring devices and their applications.

Course outcomes:

After successful completion of the course, the student will be able to

1. find natural frequency of un-damped single degree freedom systems(L1)
2. Analyze the impulse response (L4)
3. analyze the two degree freedom systems with and without damping(L4)
4. Calculate natural frequencies of multi degree freedom system.(L3)
5. Solve the Natural Frequencies Rayleigh and Dunkerleys method (L3)
6. Measure vibration parameters & use mechanical exciters and electrodynamic shaker. (L4)

Unit I

Single degree of Freedom systems: Undamped and damped free vibrations: forced vibrations ; coulomb damping; Response to harmonic excitation; rotating unbalance and support excitation, Vibration isolation and transmissibility, Vibrometers, velocity meters & accelerometers.

Applications: bridges, buildings, mechanical engineering and aerospace structures

Learning Outcomes:

After completion of this unit student will able to

1. find natural frequency of un-damped single degree freedom systems.(L1)
2. find the behavior of single degree freedom systems with damping.(L1)

Unit II

Response to Non Periodic Excitations: unit Impulse, unit step and unit Ramp functions; response to arbitrary excitations, The Convolution Integral; shock spectrum; System response by the Laplace Transformation method.

Applications: Motor pump *s*ystem. There are two equations of motion for a 2DOF system

Learning Outcomes:

After completion of this unit the students will be able to

1. Analyze the impulse response (L4)

Unit III

Multi degree freedom systems: Principal modes – undamped and damped free and forced vibrations ; undamped vibration absorbers, Matrix formulation, stiffness and flexibility influence coefficients; Eigen value problem; normal modes and their properties; Free and forced vibration by Modal analysis; Method of matrix inversion; Torsional vibrations of multi – rotor systems and geared systems; Discrete-Time systems.

Applications: motor pump ***system***. There are ***two*** equations of motion for a 2DOF ***system***

Learning Outcomes:

After completion of this unit the students will be able to

1. analyze the tensional vibrations (L4)
2. analyze the two degree freedom systems with and without damping (L4)
3. solve problems on vibration absorber.(L3)

Unit IV

Numerical Methods: Rayliegh's, stodola's, Matrix iteration, Rayleigh-Ritz Method and Holzer'smethods

Learning Outcomes:

After completion of this unit the students will be able to

1. Solve the vibrations by numerical methods (L3)

Unit V

Application of concepts: Free vibration of strings – longitudinal oscillations of bars-transverse vibrations of beams- Torsional vibrations of shafts. Critical speeds without and with damping, secondary critical speed.

Applications: microphone's sensitivity,applied in an industrial or maintenance.

Learning Outcomes:

After completion of this unit the students will be able to

1. identify various transducers(L1)
2. use different vibration pickups (L3)
3. explain mechanical exciters and electrodynamic shaker (L2)

Text books

1. Elements of Vibration Analysis byMeirovitch.
2. Mechanical Vibrations by G.K.Groover.

References

1. Vibrations by W.T.Thomson
2. Mechanical Vibrations – Schaumseries.
3. Vibration problems in Engineering by S.P.Timoshenko.
4. Mechanical Viabrations – V.RamMurthy.

I Year -I Semester

Subject Code	Subject Name	L	P	Credits
ME-MD1105.1	Design of Automobile Systems (Elective I)	3	0	3

Course Objective:

- Demonstrate Conceptual design of automobiles.
- To know detail design of structural elements.
- To familiarize the suspension system of automobiles.
- To understand the safety aspects of automobiles.

Course outcomes:

After successful completion of the course, the student will be able to

1. Understand the body shape and structure of automobile.(L1)
2. Analyze the structural elements of automobile. (L4)
3. Analyze the Suspension system integration with vehicle for ride comfort (L4)
4. Analyze the design of control systems based on ergonomics, anthropometry, human factors engineering considerations.(L4)
5. Analyze the safety aspects of automobiles (L3)

Unit I

Conceptual design of automobiles: body shape definition based on aerodynamic structure safety, sub - systems integration considerations, road load analysis, transmission of road load structure.

Learning Outcomes:

After completion of this unit the students will be able to

1. Analyze the conceptual design of automobiles (L4)

Unit II

Detail design of structural elements, load analysis for different vehicles, safety consideration, design for bending, torsion conditions, criteria for toppling, based on cornering loads.

Learning Outcomes:

After completion of this unit the students will be able to

1. Analyze the loads on vehicles and safety considerations (L4)

Unit III

Suspension system integration with vehicle for ride comfort, methods of mounting suspension and power train systems.

Learning Outcomes:

After completion of this unit the students will be able to

1. Analyze the loads on vehicles and safety considerations (L4)

Unit IV

Driver cabin/seat design, design of control systems based on ergonomics, anthropometry, human factors engineering considerations.

Learning Outcomes:

After completion of this unit the students will be able to

1. Analyze the design of control systems based on ergonomics, anthropometry, human factors engineering considerations.(L4)

Unit V

Safety aspects of automobiles, devices, energy absorbing systems, crash worthiness, legislation relating to safety, Vehicle performance requirements, sub systems packaging and verification of vehicle performance through testing (lab, field testing).

Learning Outcomes:

After completion of this unit the students will be able to

1. Vehicle performance through testing.(L4)
2. Analyze the safety aspects of automobile.(L4)

Text Books

1. Donald E.Males, Fundamentals of automobile body structure design(R-394), SAE2011
2. W.F.Milliker, D.L.Milliker, Maurice Olly,Chassis design: principle analysis (R- 206) SAE2002
3. J.H Smith, Modern Vehicle System Design

I Year -I Semester

Subject Code	Subject Name	L	P	Credits
ME-MD1105.2	Product Design (Elective I)	3	0	3

Course Objective:

- Demonstrate strategic importance of product development.
- To know concept generation.
- To know fundamental and incidental interactions, related system level and design issues.
- To Investigation of customer needs.

Course outcomes:

After successful completion of the course, the student will be able to

1. Understand the integration of customer, designer, material supplier and process planner, Competitor and costumer.(L1)
2. Determine the development of concepts to design a product. (L2)
3. Analyze the fundamental and incidental interactions, related system level and design issues. (L4)
4. Analyze the quality of industrial design (L3)
5. Estimate the manufacturing cost for reducing the component costs and assembly costs. (L4)

Unit- I

Introduction -Need for IPPD – strategic importance of product development – integration of customer, designer, material supplier and process planner, Competitor and costumer – behavior analysis. Understanding customer – promoting customer understanding – involve customer in development and managing requirements – Organization – process management and improvement – Plan and establish product specification.

Learning Outcomes:

After completion of this unit the students will be able to

1. Understand the integration of customer, designer, material supplier and process planner, Competitor and costumer.(L1)

Unit - II

Concept Generation and Selection: Task – Structured approaches – Clarification – Search – Externally and internally – explore systematically – reflect on the solutions and process – concept selection – methodology – benefits.

Product Architecture: Implications – Product change – variety – component standardization – product performance – manufacturability.

Learning Outcomes:

After completion of this unit the students will be able to

1. Determine the development of concepts and standardization to design a product. (L2)

Unit - III

Product Development Management: Establishing the architecture – creation – clustering – geometric layout development – fundamental and incidental interactions – related system level design issues – secondary systems – architecture of the chunks – creating detailed interface specifications.

Industrial Design: Integrate process design – Managing costs – Robust design – Integrating CAE, CAD, CAM tools – simulating product performance and manufacturing processing electronically – Need for industrial design – impact – design process.

Learning Outcomes:

After completion of this unit the students will be able to

1. Simulating product performance and manufacturing processing electronically.(L4)
2. Analyze the fundamental and incidental interactions, related system level and design issues. (L4)

Unit - IV

Investigation of customer needs – conceptualization – refinement – management of the industrial design process – technology driven products – user – driven products – assessing the quality of

industrial design.

Learning Outcomes:

After completion of this unit the students will be able to

1. Analyze the quality of industrial design (L3)

Unit - V

DESIGN FOR MANUFACTURING AND PRODUCTY DEVELOPMENT: Definition – Estimation of manufacturing cost – reducing the component costs and assembly costs – Minimize system complexity. Prototype basics – Principles of prototyping – planning for prototypes – Economics analysis – Understanding and representing tasks – baseline project planning – accelerating the projectexecution.

Learning Outcomes:

After completion of this unit the students will be able to

1. Estimate the manufacturing cost for reducing the component costs and assembly costs. (L4)

Text Books

1. Product Design and Development / Kari T. Ulrich and Steven D. Eppinger / McGraw Hill International Edns.1999.
2. Concurrent Engg/integrated Product development / Kemnneth Crow / DRM Associates, 26/3, Via Olivera, Palos Verdes, CA 90274(310)377-569, Workshop Book.

References

1 Effective Product Design and Development / Stephen Rosenthal / Business One Orwin, Homewood, 1992, ISBN,1-55623-603-4.

2 Tool Design–Integrated Methods for Successful Product Engineering / Staurt Pugh / Addsion Wesley Publishing, Neyourk, NY, 1991, ISBN0-202-41369-5.

3 Production and Operations Management/Chase/TMH

I Year -I Semester

Subject Code	Subject Name	L	P	Credits
ME-MD1105.3	Geometric Modeling (Elective I)	3	0	3

Course Objective:

- Demonstrate Explicit and implicit equations.
- To know concept generation of cubic splines and Bezier curves.
- To know surfaces of the curves.

Course outcomes:

After successful completion of the course, the student will be able to

1. Understand the parametric equations of different curves.(L1)
2. Analyze the Graphic construction and interpretation.(L4)
3. Analyze the B-spline curves. (L4)
4. Analyze the different types of geometric surfaces.(L4)
5. Analyze the solids of the geometry. (L4)

Unit – I

Cubic spline –I: Definition, Explicit and implicit equations, parametric equations, Algebraic and geometric form of cubic spline, Hermite cubic spline, tangent vectors, parametric space of a curve, blending functions.

Learning Outcomes:

After completion of this unit the students will be able to

1. Analyze the Explicit and implicit equations.(L4)

Unit - II

Cubic Splines-II: Four point form, reparametrization, truncating and subdividing of curves. Graphic construction and interpretation, composite pc curves.

Bezier Curves: Bernstein basis, equations of Bezier curves, properties, derivatives.

Learning Outcomes:

After completion of this unit the students will be able to

1. Analyze the Graphic construction and interpretation of Bezier Curves.(L4)
2. Analyze the Graphic construction and interpretation.(L4)

Unit - III

B-Spline Curves: B-Spline basis, equations, knot vectors, properties, and derivatives.

Learning Outcomes:

After completion of this unit the students will be able to

1. Analyze the B-spline curves.(L4)

Unit –IV

Surfaces: Bicubic surfaces, Coon's surfaces, Bezier surfaces, B-Spline surfaces, surfaces of revolutions, Sweep surfaces, ruled surfaces, tabulated cylinder, bilinear surfaces, Gaussian curvature.

Learning Outcomes:

After completion of this unit the students will be able to

1. Analyze the Bicubic, bezier B-Spline surfaces.(L4)

Unit – V

Solids: Tricubic solid, Algebraic and geometric form.

Solid modeling concepts: Wire frames, Boundary representation, Half space modeling, spatial cell, cell decomposition, classification problem.

Learning Outcomes:

After completion of this unit the students will be able to

1. Analyze the solids of the geometry.(L4)

Text Books

1. Elements of Computer Graphics by Roger & Adams Tata McGrawHill.
2. Geometric Modeling by Micheal E. Mortenson, McGraw HillPublishers

References:

1. Computer Aided Design and Manufacturing, K.Lalit Narayan, K.Mallikarjuna Rao, MMM Sarcar, PHIPublishers

I Year -I Semester

Subject Code	Subject Name	L	P	Credits
ME-MD1105.4	Non Destructive Evaluation (Elective I)	3	0	3

Course Objectives

- Concepts of various NDE techniques using radiography, ultrasonics, liquid penetrates, magnetic particles, eddy currents, infrared and thermal testing are dealt with
- Learn basic principles of these methods and select a testing process.
- Understand the advantages and disadvantages of these techniques
- Knowledge on which method to apply under appropriate circumstances
- Classify various nondestructive testing instruments.
- Knowledge of all the different types of Non-destructive testing

Course Outcomes

1. Comprehensive, theory based understanding of the techniques and methods of non destructive testing. (L2)
2. Apply methods and knowledge of non destructive testing to evaluate products of railways, automobiles, aircrafts, chemical industries etc. (L3)
3. Ability to communicate their conclusions clearly to specialist and non-specialist audiences. (L2)
4. Calibrate the instrument and inspect for in-service damage in the components. (L4)
5. Differentiate various defect types and select the appropriate NDT methods for better evaluation. (L3)

Unit - I

Introduction to Non-Destructive Testing: Radiographic test**,** Sources of X and Gamma Rays and their interaction with Matter, Radiographic equipment, Radiographic Techniques, Safety Aspects of Industrial Radiography

Learning outcomes:

At the end of this unit, the student will be able to

- Explain non destructive testing techniques.(L2)
- Summarize the basic concepts of Radiographic test. (L2)
- Outline the concepts of sources of X and Gamma Rays. (L2)
- Explain the radiographic techniques. (L2)

Applications:

Inspection of products: inspection of welds on pressurized piping, pressure vessels, high-capacity storage containers, pipelines and some structural welds.

1. Airport security: Both hold luggage and carry-on hand luggage are normally examined by X-ray machines using X-ray radiography.
2. Non-intrusive cargo scanning: Gamma radiography and high-energy X-ray radiography are currently used to scan intermodal freight cargo containers in US and other countries.

Unit - II

Ultrasonics Test: Principle of Wave Propagation, Reflection, Refraction, Diffraction, Mode Conversion and Attenuation, Sound Field, Piezo-electric Effect, Ultrasonic Transducers and their Characteristics, Ultrasonic Equipment and Variables Affecting Ultrasonic Test, Ultrasonic Testing, Interpretations and Guidelines for Acceptance, Rejection - Effectiveness and Limitations of Ultrasonic Testing.

Learning outcomes:

At the end of this unit, the student will be able to

- Explain the principle of ultrasonic test. (L2)
- Analyze the performance of wave propagation, reflection, refraction, diffraction and sound field in ultrasonic test. (L4)
- Discuss the characteristics of ultrasonic transducers. (L4)
- Outline the limitations of ultrasonic testing. (L2)

Applications:

1. Forging Test

2. Tube Testing

Unit - IIII

Liquid Penetrant Test: Liquid Penetrant Test, Basic Concepts, Liquid Penetrant System, Test Procedure, Effectiveness and Limitations of Liquid Penetrant Testing

Eddy Current Test: Principle of Eddy Current, Eddy Current Test System, Applications of Eddy Current Testing Effectiveness of Eddy Current Testing

Learning outcomes:

At the end of this unit, the student will be able to

- Illustrate the procedure of Liquid Penetrant, eddy current tests.(L2)
- Outline the limitations of Penetrant, eddy current tests. (L2)
- Explain the effectiveness of Penetrant, eddy current tests. (L2)

Applications:

1. Liquid penetrant inspection can be used successfully on nonporous and fairly smooth materials such as metals, glass, plastics and fired ceramics.
2. The two major applications of eddy current testing are surface inspection and tubing inspections.

Unit - IV

Magnetic Particle Test: Magnetic Materials, Magnetization of Materials , Demagnetization of Materials,Principle of Magnetic Particle Test, Magnetic Particle Test Equipment, Magnetic Particle Test Procedure, Standardization and Calibration, Interpretation and Evaluation, Effective Applications and Limitations of the Magnetic Particle Test.

Learning outcomes:

At the end of this unit, the student will be able to

- Illustrate the procedure of magnetic particle tests.(L2)
- Outline the limitations of magnetic particle tests. (L2)
- Explain the effectiveness of magnetic particle tests. (L2)
- Apply the applications of Magnetic particle test. (L3)

Applications:

1. Surface defects
2. Welded joints
3. Components of pressure systems: boilers, pressure vessels, locomotives and tanks.

Unit - V

INFRARED AND THERMAL TESTING: Introduction and fundamentals to infrared and thermal testing–Heat transfer –Active and passive techniques –Lock in and pulse thermography–Contact and non contact thermal inspection methods–Heat sensitive paints –Heat sensitive papers –-thermally quenched phosphors liquid crystals –techniques for applying liquid crystals –other temperature sensitive coatings –Inspection methods –Infrared radiation and infrared detectors–thermo mechanical behavior of materials–IR imaging in aerospace applications, electronic components, Honey comb and sandwich structures–Case studies.

Learning outcomes:

At the end of this unit, the student will be able to

- Discuss the fundamentals of thermal testing. (L6)
- Explain the techniques of liquid crystals, active and passive. (L2)
- Illustrate thermal inspection methods. (L2)
- Outline the limitations of thermal testing. (L2)
- Explain the applications of honey comb and sandwich structures. (L2)

Applications:

1. Electrical and Mechanical System Inspection.
2. Electronic Component Inspection.
3. Corrosion Damage.
4. Flaw Detection.

Text Books

1. J Prasad, GCK Nair , Non destructive test and evaluation of Materials, Tata mcgraw-Hill Education Publishers, 2008.
2. Josef Krautkrämer, Herbert Krautkrämer, Ultrasonic testing of materials, 3/e, Springer-Verlag, 1983.
3. X. P. V. Maldague, Non destructive evaluation of materials by infrared thermography, 1/e, Springer-Verlag, 1993.

References

1. Gary L. Workman, Patrick O. Moore, Doron Kishoni, Non-destructive, Hand Book, Ultrasonic Testing, 3/e, Amer Society for Nondestructive, 2007.
2. ASTM Standards, Vol 3.01, Metals and alloys

I Year -I Semester

Subject Code	Subject Name	L	P	Credits
ME-MD1106.1	Fracture Mechanics (Elective II)	3	0	3

Course Objectives

- To know the fracture behavior of different materials
- To Understand the concept of fracture energy
- To Acquire the knowledge of critical stress intensity factor
- To Learn the failure prediction parameters
- To Impart the knowledge of Micro mechanisms of fatigue damage
- To Compare of creep performance under different conditions

Course Outcomes

1. Understand the failure mode of brittle and ductile materials (L1)
2. Plot of the resistance to fracture versus crack extension(L4)
3. Analyse the efecdt of thickness thickness on fracture toughness(L4)
4. Understand the crack tip opening displacement (CTOD) test that measures the resistance of a material to the propagation of a crack(L1)
5. Analyse the factors enhancing the fatigue resistance(L4)
6. Compare of creep performance under different conditions(L4)

Unit-I

Introduction: Prediction of mechanical failure. Macroscopic failure modes; brittle and ductile behaviour. Fracture in brittle and ductile materials – characteristics of fracture surfaces; inter-granular and intra-granular failure, cleavage and micro-ductility, growth of fatigue cracks, The ductile/brittle fracture transition temperature for notched and unnotched components. Fracture at elevated temperature.

Learning outcomes

After completion of this unit, students will be able to

- Understand the failure mode of brittle and ductile materials (L1)
- Analyse the fracture behavior for notched and notched components (L4)
- Impart the knowledge of fracture characteristics (L2)

Unit -II

Griffiths analysis: Concept of energy release rate, G, and fracture energy, R. Modification for ductile materials, loading conditions. Concept of R curves.

Linear Elastic Fracture Mechanics, (LEFM). Three loading modes and the state of stress ahead of the crack tip, stress concentration factor, stress intensity factor and the material parameter the critical stress intensity factor, crack tip plasticity, effect of thickness on fracture toughness.

Learning outcomes

After completion of this unit, students will be able to

- Describe the relationship between applied nominal stress and crack length at fracture(L3)
- Understand the concept of fracture energy(L2)
- Plot of the resistance to fracture versus crack extension(L4)

Unit -III

Elastic-Plastic Fracture Mechanics; (EPFM). The definition of alternative failure prediction parameters, Crack Tip Opening Displacement, and the J integral. Measurement of parameters and examples of use.

Learning outcomes

After completion of this unit, students will be able to

- Learn the failure prediction parameters(L1)
- Understand the crack tip opening displacement (CTOD) test that measures the resistance of a material to the propagation of a crack(L1)

Unit -IV

Fatigue: definition of terms used to describe fatigue cycles, High Cycle Fatigue, Low Cycle Fatigue, mean stress R ratio, strain and load control. S-N curves. Goodmans rule and Miners rule. Micro mechanisms of fatigue damage, fatigue limits and initiation and propagation control,

leading to a consideration of factors enhancing fatigue resistance. Total life and damage tolerant approaches to lifeprediction.

Learning outcomes

After completion of this unit, students will be able to

- Understand the fatigue cycles and can plot SN curves(L1)
- Impart the knowledge of Micro mechanisms of fatigue damage(L3)
- Analyse the factors enhancing the fatigue resistance(L4)

Unit -V

Creep deformation: the evolution of creep damage, primary, secondary and tertiary creep. Micro-mechanisms of creep in materials and the role of diffusion. Ashby creep deformation maps. Stress dependence of creep – power law dependence. Comparison of creep performance under different conditions – extrapolation and the use of Larson-Miller parameters. Creep-fatigue interactions. Examples.

Learning outcomes

After completion of this unit, students will be able to

- Understand the mechanisms of creep in materials and the role of diffusion(L1)
- Compare of creep performance under different conditions(L3)
- Analyse the creep fatigue interactions(L4)

Text Books

1. T.L. Anderson, Fracture Mechanics Fundamentals and Applications, 2nd Ed. CRC press, (1995)
2. B. Lawn, Fracture of Brittle Solids, Cambridge Solid State Science Series 2nded1993.
3. J.F. Knott, Fundamentals of Fracture Mechanics, Butterworths(1973)
4. J.F. Knott, P Withey, Worked examples in Fracture Mechanics, Institute ofMaterials.
5. H.L.Ewald and R.J.H. Wanhill Fracture Mechanics, Edward Arnold,(1984).
6. S. Suresh, Fatigue of Materials, Cambridge University Press,(1998)
7. L.B. Freund and S. Suresh, Thin Film Materials Cambridge UniversityPress,(2003).
8. G. E. Dieter, Mechanical Metallurgy, McGraw Hill,(1988)
9. D.C. Stouffer and L.T. Dame, Inelastic Deformation of Metals, Wiley(1996)
10. F.R.N. Nabarro, H.L. deVilliers, The Physics of Creep, Taylor and Francis,(1995)

I Year -I Semester

Subject Code	Subject Name	L	P	Credits
ME-MD1106.2	Gear Engineering (Elective II)	3	0	3

Course Objectives

- Explain the Principles of gear tooth action and gear profiles.
- Reinforce the philosophy that real engineering design problems are open-ended and challenging
- Impart design skills to the students to apply these skills for the problems in real life industrial applications
- Inculcate an attitude of team work, critical thinking, communication, planning and scheduling through design projects
- Create awareness amongst students about safety, ethical, legal, and other societal constraints in execution of their design projects.

Course Outcomes.

1. Understand and apply principles of gear design to spur gears and industrial spur gear boxes(L1)
2. Proficient in Design of Helical and Bevel Gear(L3)
3. Analyze Rolling contact bearing and its selection from manufacturer's Catalogue (L4)
4. Design worm gear box for various industrial applications(L3).
5. Inculcate an ability to design belt drives and selection of belt, rope and chain drives(L2)
6. Achieve an expertise in design of Sliding contact bearing in industrial applications.(L6)

Note: PSG Design data Book is allowed

Unit I

Introduction: Principles of gear tooth action, Generation of Cycloid and Involute gears, Involutometry, gear manufacturing processes and inspection, gear tooth failure modes, stresses, selection of right kind of gears.

Learning outcomes

After completion of this unit, students will be able to

- Examine the involute and cycloidal gear profiles(L4)
- Understand the gear tooth failure modes (L1)

Unit – II

Spur Gears, Helical gears, Bevel gears and worm gears, Tooth loads, Principles of Geometry, Design considerations and methodology, Complete design of spur gear teeth considering Lewis beam strength, Buckingham's dynamic load and wear load, Design of gear shaft and bearings.

Learning outcomes

After completion of this unit, students will be able to

- Identify the different types of gears(L1)
- Evaluate the lewis beam strength(L5)
- Design the gear shaft and bearings(L3)

Unit –III

Gear trains: Simple, compound and epicyclic gear trains, Ray diagrams, Design of a gear box of an automobile, Design of gear trains from the propeller shafts of airplanes for auxiliary systems.

Learning outcomes

After completion of this unit, students will be able to

- Understand the importance of gear trains(L1)
- Design the gear box of automobiles(L3)

Unit – IV

Gear failures Analysis of gear tooth failures, Nomenclature of gear tooth wear and failure, tooth breakage, pitting, scoring, wear, overloading, gear-casing problems, lubrication failures

Learning outcomes

After completion of this unit, students will be able to

- Analyse the gear tooth failures(L4)
- Understand the over loading and gear casing problems(L1)

Unit – V

Optimal Gear design: Optimization of gear design parameters, Weight minimization, Constraints in gear train design-space, interference, strength, dynamic considerations, rigidity etc. Compact design of gear trains, multi objective optimization of gear trains. Application of Traditional and non-traditional optimization techniques

Learning outcomes

After completion of this unit, students will be able to

- Analyse the gear design parameters(L4)
- Understand the optimization techniques(L2)

Text Books

1. Maleev and Hartman, Machine Design, C.B.S. Publishers,India.
2. Henry E.Merrit,Gear engineering ,Wheelerpublishing,Allahabad,1992.
3. Practical Gear design by Darle W. Dudley, McGraw-Hill bookcompany

References

1. Earle Buckingham, Analytical mechanics of gears, Dover publications, New York,1949.
2. G.M.Maitha, Hand book of gear design, Tata Mc.Graw Hill publishing companyLtd., NewDelhi,1994.

I Year -I Semester

Subject Code	Subject Name	L	P	Credits
ME-MD1106.3	Design for Manufacturing and Assembly (Elective II)	3	0	3

Course Objectives:

- Explain the product development cycle and manufacturing issues to be considered in design.
- Familiarize manufacturing consideration in cast, machining, cleaning and weld components.
- Describe the manufacture of machine components.
- Impart knowledge of manufacturing assembly of machine components.

Course Outcomes:

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

1. Design mechanical components with economical consideration.(L6)
2. Select dimensional tolerances and surface roughness values.(L3)
3. Identify tolerances for various casting processes.(L3)
4. Apply the design rules for design of dies.(L3)
5. Understand contemporary issues and their impact on design for manufacturing and assembly.(L2&L6)

Unit – I

Introduction to DFM, DFMA: How Does DFMA Work? Reasons for Not Implementing DFMA, What Are the Advantages of Applying DFMA During Product Design?, Typical DFMA Case Studies, Overall Impact of DFMA on Industry.

Design for Manual Assembly: General Design Guidelines for Manual Assembly, Development of the Systematic DFA Methodology, Assembly Efficiency, Effect of Part Symmetry, Thickness, Weight on Handling Time, Effects of Combinations of Factors, Application of the DFA Methodology.

Learning outcomes:

At the end of the unit, student will be able to

- Implement various steps in design process.(L)
- Apply economical considerations at design stage.(L3)
- Develop creativity attitude in designing.(L3)
- Use Ashby charts for material selection(L1)

Unit - II

Machining processes: Overview of various machining processes-general design rules for machining-dimensional tolerance and surface roughness-Design for machining – ease – redesigning of components for machining ease with suitable examples. General design recommendations for machined parts.

Learning outcomes:

At the end of the unit, student will be able to

- Recall various machining processes.(L1)
- Select dimensional tolerances and surface roughness values.(L3)
- Identify the necessity of redesigning of the components.(L3)

Unit - III

Metal casting: Appraisal of various casting processes, selection of casting process,-general design considerations for casting-casting tolerance-use of solidification, simulation in casting design-product design rules for sandcasting.

Extrusion & Sheet metal work: Design guide lines extruded sections-design principles for punching, blanking, bending, deep drawing-Keeler Goodman forging line diagram – component design for blanking.

Learning outcomes:

At the end of the unit, student will be able to

- List various casting processes.(L1)
- Identify tolerances for various casting processes.(L3)
- Understand Simulate sand casting design.(L2)
- Apply the design guidelines the extruded sections.(L3)
- Apply the design principles for various sheet metal operations.(L3)

Unit - IV

Metal joining: Appraisal of various welding processes, factors in design of weldments – general design guidelines-pre and post treatment of welds-effects of thermal stresses in weld joints- design of brazed joints. Forging: Design factors for forging – closed die forging design – parting lines of dies – drop forging die design – general design recommendations.

Learning outcomes*:*

At the end of the unit, student will be able to

1. Understand the general guide lines.(L2)
2. Apply the design rules for design of dies.(L3)

Unit – V

Design for Assembly Automation: Fundamentals of automated assembly systems, System configurations, parts delivery system at workstations, various escapement and placement devices used in automated assembly systems, Quantitative analysis of Assembly systems, Multi station assembly systems, single station assembly lines.

Learning outcomes:

At the end of the unit, student will be able to

1. Apply design with assembly product.(L3)
2. Deduct the time to take assemble if a product contains fewer parts.(L5)

Text Books

1. Design for manufacture, John cobert, Adisson Wesley. 1995
2. Design for Manufacture byBoothroyd,
3. Design for manufacture, James Bralla

Reference

ASM Hand book Vol.20

I Year -I Semester

Subject Code	Subject Name	L	P	Credits
ME-MD1106.4	Continuum Mechanics (Elective II)	3	0	3

Course Objectives:

- Familiarize basic concepts of Tensor calculus.
- Explain eulerian and lagrangian description of continuous and discrete systems.
- Explain Mass conservation in Lagrangen and Eulerian frames.
- Apply the Conservation in angular momentum in lagrengian form.

Course Outcomes:

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

1. Understand the concepts behind Tensor calculus in Continuum Mechanics.(L1)
2. Explain the characteristics continuum models and real materials (L2)
3. Explain the formulation of Conservation of momentum in Lagrangen and Eulerian frames(L2)
4. Explain the Conservation in angular momentum in lagrengian form. (L2)
5. Identify how the Material frame indifference, Elastic Materials, Viscous fluids. (L1)

Unit – I

Tensor calculus: Tensor calculus, Multi linear forms, Definition of Tensor over including vector spaces, Alternating tensors, determinants, orientation, tensor products kinematics of deformations and motion, strain analysis, rotation of tensors, calculations of tensors, internal calculations of tensors and integral identities.

Learning outcomes*:*

At the end of the unit, student will be able to

1. Understand the Tensor calculus.(L2)
2. Apply the tensor products kinematics of deformations.(L3)

Unit – II

Eulerian and Lagrangian description of a continuous, discrete systems, continua, physical quantities and their derivatives. Rigid body motion, Relation between continuum models and real materials.

Learning outcomes:

At the end of the unit, student will be able to

- List various discrete systems.(L1)
- Identify Relation between continuum models and real materials.(L3)

Unit – III

Conservation laws in a continuum: Mass conservation in Lagrangen and Eulerian frames, Conservation of momentum in Lagrangen and Eulerianframes.

Learning outcomes:

At the end of the unit, student will be able to

- Identify Relation between Mass conservation in Lagrangen and Eulerian frames.(L3)
- Identify the necessity of Conservation of momentum in Lagrangen and Eulerianframes.(L3)

Unit – IV

Conservation in angular momentum in lagrengian form. Conservation of energy in Lagrangen and Eulerian frames.Strain and decomposition. Finite deformation, infinitesimal displacements

Learning outcomes:

At the end of the unit, student will be able to

- Implement various steps in Conservation in angular momentum.(L2)
- Apply Conservation of energy in in Lagrangen and Eulerian frames.(L3)

Unit - V

Material frame indifference, Elastic Materials, Viscous fluids, linear visco-elasticity, case studies for metals and polymers.

Learning outcomes:

At the end of the unit, student will be able to

- Analyse steps in , case studies for metals and polymers. .(L4)
- Develop Material frame indifference, Elastic Materials, Viscous fluids.(L3)

Text Book

1. Continuous mechanics, George Backus, Samizdat Press, 1997

References

1. Mechanics of Continua, A.C. Eringan,1962
2. Continuous Physics, Vol. 1, A.C. Eringan, 1967, Academic press
   3.Introduction to Continuous Mechanics, B.L.N.Kennett
3. Quick introduction to Tensor analysis, R.Sharipov, 2004, SamizdatPress.
4. Non-linear continuum mech-win, SEACAS theory manuals part II,T.A.Laursen,S.W.Attaway and R.I.Zadoks

I Year -I Semester

Subject Code	Subject Name	L	P	Credits
ME-MD1107	Machine Dynamics Laboratory	0	4	2

EXPERIMENTS:

1. Determination of damped natural frequency of vibration of the vibrating system with different viscousoils
2. Determination of steady state amplitude of a forced vibratorysystem
3. Static balancing using steel balls & Determination of the magnitude and orientation of the balancing mass in dynamic balancing
4. Field balancing of the thin rotors using vibration pickups.
5. Determination of the magnitude of gyroscopic couple, angular velocity of precession, and representation of vectors.
6. Determination of natural frequency of given structure using FFT analyzer
7. Diagnosis of a machine using FFTanalyzer.
8. .Direct kinematic analysis of arobot
9. Inverse kinematic analysis of arobot
10. 10 An experiment on friction, wear, pin-on-disc
11. An experiment on stress intensity factors / fatigue, fracture
12. Modal analysis of beams and plates

I Year -I Semester

Code	Subject Name	L	T	P	C
AC-ERPW1101	English for Research Paper Writing	2	0	0	0

Course Objectives:

- Understand that how to improve your writing skills and level of readability
- Learn about what to write in each section
- Understand the skills needed when writing a Title Ensure the good quality of paper at very first-time submission

Course Outcomes:

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

1. Develop a writing skills by analyzing model texts (written by 'expert' writers) and texts written by students (with particular focus on issues involving coherence and cohesion);
2. Expand academic vocabulary;
3. Consolidate more advanced aspects of English grammar relevant to writing research papers;
4. Understand the language functions found in research papers;
5. Compare various practices and conventions used in writing research papers across a range of disciplines

Unit I

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

Unit II

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction

Unit III

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

Unit IV

key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature,

Unit V

skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

Text books

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book .
4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

I Year -II Semester

Code	Subject Name	L	T	P	C
ME-MD1201	Optimization and Reliability	3	0	0	3

Course Objectives:

- Familiarize basic concepts of classical optimization techniques.
- Explain numerical methods for optimization.
- Apply the conventional and evolutionary algorithms for problem solving.
- Explain the Concepts of Engineering Statistics.

Course Outcomes:

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

- Develop the ability to obtain the optimal solution for engineering problems(L3)
- Select the optimization methods to design a thermal/flow system(L2)
- Analyze the Principles of genetic programming(L4)
- Solving for multi-objective problems.(L3)
- Design for reliability.(L6)

Unit - I

Classical Optimization Techniques: Single variable optimization with and without constraints, multi – variable optimization without constraints, multi – variable optimization with constraints – method of Lagrange multipliers, Kuhn-Tucker conditions, merits and demerits of classical optimization techniques.

Learning outcomes:

At the end of the unit, student will be able to

- Implement various steps in variable optimization.(L2)
- Apply method of Lagrange multipliers and Kuhn-Tucker conditions .(L3)

Unit - II

Numerical Methods for Optimization: Nelder Mead's Simplex search method, Gradient of a function, Steepest descent method, Newton's method, Pattern search methods, conjugate method, types of penalty methods for handling constraints, advantages of numerical methods.

Learning outcomes:

At the end of the unit, student will be able to

- Describe various steps in Nelder Mead's Simplex search method.(L2)
- Interpret Steepest descent method and Newton's method.(L3)

Unit - III

Genetic Algorithm (GA) : Differences and similarities between conventional and evolutionary algorithms, working principle, reproduction, crossover, mutation, termination criteria, different reproduction and crossover operators, GA for constrained optimization, draw backs of GA,

Genetic Programming (GP): Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, random population generation, solving differential equations using GP.

Multi-Objective GA: Pareto's analysis, Non-dominated front, multi – objective GA, Non-dominated sorted GA, convergence criterion, applications of multi-objective problems .

Learning outcomes:

At the end of the unit, student will be able to

- Differentiate genetic algorithm and genetic programming.(L4)
- Solve by Pareto's analysis.(L3)

Unit – IV

Applications of Optimization in Design and Manufacturing Systems: Some typical applications like optimization of path synthesis of a four-bar mechanism, minimization of weight of a cantilever beam, optimization of springs and gears, general optimization model of a machining process, optimization of arc welding parameters, and general procedure in optimizing machining operations sequence.

Learning outcomes:

At the end of the unit, student will be able to

- Execute the path synthesis of a four-bar mechanism.(L3)
- Solve for optimization of arc welding parameters and machining process.(L3)

Unit V

Reliability: Concepts of Engineering Statistics, risk and reliability, probabilistic approach to design, reliability theory, design for reliability, numerical problems, hazard analysis.

Learning outcomes:

At the end of the unit, student will be able to

- Execute the Concepts of Engineering Statistics and reliability (L3)
- Design for reliability and hazard analysis.(L6)

Text Books

1. Optimization for Engineering Design – Kalyanmoy Deb, PHIPublishers
2. Engineering Optimization – S.S.Rao, New AgePublishers
3. Reliability Engineering byL.S.Srinath
4. Multi objective genetic algorithm by Kalyanmoy Deb, PHIPublishers.

References

1. Genetic algorithms in Search, Optimization, and Machine learning – D.E.Goldberg, Addison-WesleyPublishers
2. Multi objective Genetic algorithms - Kalyanmoy Deb, PHI Publishers
3. Optimal design – Jasbir Arora, Mc Graw Hill (International)Publishers
4. An Introduction to Reliability and Maintainability Engineering by CE Ebeling, Waveland Printers Inc.,2009
5. Reliability Theory and Practice by I Bazovsky, Dover Publications,2013

I Year -II Semester

Code	Subject Name	L	T	P	C
ME-MD1202	Experimental Stress Analysis	3	0	0	3

Course Objectives:

- Familiarize with three-dimensional stress strain relations.
- Explain photo elastic materials.
- Discuss the static recording and data logging.
- Explain the brittle coating and crack patterns.

Course Outcomes:

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

- Develop the ability to obtain the plane stress and plane strain conditions (L3)
- Select the strain Measurement and Recordings (L2)
- Analyze the Principles of Photo elasticity (L4)
- Solving for geometrical approach to Moire-Fringe analysis.(L3)
- Design for Fringe-order determinations in coatings.(L6)

Unit – I

Introduction: Stress, strain, Plane stress and plane strain conditions, Compatibility conditions. Problems using plane stress and plane strain conditions, stress functions, mohrs circle for stress strain, Three-dimensional stress strain relations.

Learning outcomes:

At the end of the unit, student will be able to

- Develop the ability to obtain the plane stress and plane strain conditions (L6)
- Develop mohrs circle for stress strain.(L6)

Unit – II

Strain Measurement and Recordings: Various types of strain gauges, Electrical Resistance strain gauges, semiconductor strain gauges, strain gauge circuits. Introduction, static recording and data logging, dynamic recording at very low frequencies, dynamic recording at intermediate frequencies, dynamic recording at high frequencies, dynamic recording at very high frequencies, telemetry systems.

Learning outcomes:

At the end of the unit, student will be able to

- Select the strain Measurement and Recordings (L2)
- Design for dynamic recording at high frequencies.(L6)

Unit – III

Photo elasticity: Photo elasticity – Polariscope – Plane and circularly polarized light, Bright and dark field setups, Photo elastic materials – Isochromatic fringes – Isoclinics

Three dimensional Photo elasticity : Introduction, locking in model deformation, materials for three-dimensional photo elasticity, machining cementing and slicing three-dimensional models, slicing the model and interpretation of the resulting fringe patterns, effective stresses, the shear-difference method in three dimensions, applications of the Frozen-stress method, the scattered-light method.

Learning outcomes:

At the end of the unit, student will be able to

- Analyze the Principles of Photo elasticity (L4)
- Design for Isochromatic fringes.(L6)

Unit – IV

Brittle coatings: Introduction, coating stresses, failure theories, brittle coating crack patterns, crack detection, ceramic based brittle coatings, resin based brittle coatings, test procedures for brittle coatings analysis, calibration procedures, analysis of brittle coating data.

Moire Methods: Introduction, mechanism of formation of Moire fringes, the geometrical approach to Moire-Fringe analysis, the displacement field approach to Moire-Fringe analysis, out of plane displacement measurements, out of plane slope measurements, sharpening and multiplication of Moire-Fringes, experimental procedure and techniques.

Learning outcomes:

At the end of the unit, student will be able to

- Solving for geometrical approach to Moire-Fringe analysis.(L3)
- Discuss for brittle coating crack patterns.(L3)

Unit – V

Birefringent Coatings

Introduction, Coating stresses and strains, coating sensitivity, coating materials, application of coatings, effects of coating thickness, Fringe-order determinations in coatings, stress separation methods.

Learning outcomes:

At the end of the unit, student will be able to

- Design for Fringe-order determinations in coatings.(L6)
- Describe for stress separation methods.(L3)

Text Books

1. Theory of Elasticity by Timoshenke and GoodierJr
2. Experimental stress analysis by Dally and Riley,McGraw-Hill

References

1. A treatise on Mathematical theory of Elasticity by LOVE.A.H
2. Photo Elasticity byFrocht
3. Experimental stress analysis, Video course by K.Ramesh /NPTEL

I Year -II Semester

Code	Subject Name	L	T	P	C
ME-MD1203	Advanced Finite Element Method	3	0	0	3

Course Objectives:

- Familiarize basic concepts of formulation techniques procedure.
- Explain theory and characteristics of finite elements structural applications using truss.
- Explain the use of finite elements for to analyse beams.
- Apply the finite element solutions to solve 2D problems like triangular and axi – symmetrical solids.
- Explain the finite element solutions to solve heat transfer problems.
- Explain the use of finite solutions to solve the problems involving dynamics.

Course Outcomes:

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

1. Understand the concepts behind variational methods and weighted residual methods in FEM. (L1)
2. Explain the characteristics of FEA elements for trusses and beams. (L2)
3. Explain the formulation of two – dimensional elements (Triangular and Quadrilateral Elements). (L2)
4. Explain the parametric representation. (L2)
5. Identify how the finite element method expands beyond the structural domain, for problems involving dynamics. (L1)

Unit - I

Formulation Techniques: Methodology, Engineering problem and governing differential equations, finite elements,Variational methods-potential energy method, Raleigh Ritz method, strong and weak forms, Galerkin and weighted residual methods, calculus of variations, Essential and natural boundaryconditions.

Application: analysis of structures

Learning Outcomes:

At the end of the unit, the student will be able to

- understand the numerical methods involved in Finite Element theory.(L2)
- understand the concept of nodes and elements,general steps of finite element methods.(L2)
- understand the role and significance of shape functions in finite element formulations, infer global, local, and natural coordinates. (L2)
- formulate and solve axially loaded bar problems. (L6)

Unit – II

One-dimensional elements: Bar, trusses, beams and frames, displacements, stresses and temperature effects.

Application: analysisof structures

Learning Outcomes:

At the end of the unit, the student will be able to

- understand the numerical methods involved in Finite Element theory.(L2)
- understand the concept of nodes and elements,general steps of finite element methods.(L2)
- Understand the role and significance of shape functions in finite element formulations, infer global, local, and natural coordinates. (L2)
- Formulate and solve axially loaded bar problems. (L6)

Unit – III

Two dimensional problems: CST, LST, four noded and eight nodded rectangular elements, Lagrange basis for triangles and rectangles, serendipity interpolation functions. Axisymmetric Problems: Axisymmetric formulations, Element matrices, boundary conditions. Heat Transfer problems: Conduction and convection, examples: - two-dimensional fin.

Application: hollow cylindrical elements, Analysis of plates

Learning Outcomes:

At the end of the unit, the student will be able to

- Explain the formulation of two – dimensional elements (Triangular and Quadrilateral Elements). (L2)
- Apply the formulation techniques to solve two – dimensional problems using triangle and quadrilateral elements. (L3)
- formulate and solve axisymmetric problems.(L6)

Unit – IV

Isoparametric formulation: Concepts, sub parametric, super parametric elements, numerical integration, Requirements for convergence, h-refinement and p-refinement, complete and incomplete interpolation functions, pascal's triangle, Patch test.

Learning Outcomes:

At the end of the unit, the student will be able to

- Explain the parametric representation. (L2)

Unit – VI

Finite elements in Structural Analysis: Static and dynamic analysis, eigen value problems, and their solution methods, case studies using commercial finite element packages.

Application: Analysis of potential noise and vibration problems.

Learning Outcomes:

At the end of the unit, the student will be able to

- Understand problems involving dynamics using Finite Element Methods.(L1)
- Evaluate the Eigen values and Eigen Vectors for stepped bar.(L5)
- Understand the process of meshing and application of boundary conditions.(L1)

Text Book

1. Finite element methods by Chandrubatla & Belagondu.
2. S.S.Rao, The Finite Element Methods in Engineering, Elsevier Butterworth -Heinemann 2nd Edition, 2011.

References

1. J.N. Reddy, Finite element method in Heat transfer and fluid dynamics, CRCpress, 1994
2. Zienckiwicz O.C. & R. L. Taylor, Finite Element Method,McGraw-Hill,1983.
3. K. J. Bathe, Finite element procedures, Prentice-Hall,1996

I Year -II Semester

Code	Subject Name	L	T	P	C
ME-MD1204	Material Selection in Mechanical Design	3	0	0	3

Course Objectives:

- Competence with a set of tools and methods for product design and development.
- Confidence in your own abilities to create a new product.
- Awareness of the role of multiple functions in creating a new product (e.g. marketing, finance, industrial design, engineering, production).
- Ability to coordinate multiple, interdisciplinary tasks in order to achieve a common objective.
- Reinforcement of specific knowledge from other courses through practice and reflection in an action-oriented setting.
- Enhanced team working skills.

Course Outcomes:

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

1. Explain the concepts and principles of advanced materials and manufacturing processes(L2)
2. Explain different material property charts to understand and select best possible materials for typical applications. (L2)
3. Explain various steels and different Super Alloys with their strengthening mechanism, composition properties and applications and technique to producing metallic glass. (L2)
4. Explain about different composite materials and its processing methods. (L2)
5. Explain different smart materials and with their application. (L2)

Unit – I

Fundamentals of material science: Elasticity in metals, mechanism of plastic deformation, slip twinning, role of dislocations, yield stress, shear strength of perfect and real crystals, strengthening mechanism, work hardening, solid solution, grain boundary strengthening, Poly phase mixture, precipitation, particle, fiber and dispersion strengthening, effect of temperature, strain and strain rate on plastic behavior, super plasticity. Yield criteria: Von mises and Tresca criteria.

Application: Advanced materials like nano materials, smart materials

Learning Outcomes: At the end of this unit, the student will be able

1. To analyze different properties of materials(L4)
2. Explain the Properties and test them (L2)

Unit –II

Motivation of selection, cost basis and service requirements, selection for mechanical properties, strength, toughness, fatigue, impact and creep, use of material property charts for material selection.

Application: Best possible materials selection for typical uses

Learning Outcomes: At the end of this unit, the student will be able

1. To demonstrate the power of the material selection and a number of common property combinations (L1)
2. To select suitable material based on previous experiments. (L1)

Unit – III

Modern metallic Materials: Dual phase steels, micro alloyed steels, high strength low alloy (HSLA) Steel, maraging steel, intermetalics, Ni and Ti aluminides, super alloys.

Application: Hip joints, Bone plates and screws

Learning Outcomes: At the end of this unit, the student will be able

1. To analyze different phases of steels(L4)
2. Explain the Properties of super alloys(L2)

Unit – IV

Non metallic materials: Polymeric materials and their molecular structures, production techniques for fibers, foams, adhesives and coatings, structure, properties and applications of engineering polymers.

Composites: Introduction, reinforcement, types of composite materials, - properties, processing and application of compositematerials.

Application: Fiber reinforced composite ,Thermosetting plastics, thermo Plastics, anti pollutant coatings

Learning Outcomes: At the end of this unit, the student will be able

1. To understand polymeric structures and its applications(L4)
2. Explain different foams , adhesives and its properties and applications (L2)
3. To learn different composites and properties (L1)
4. Explain the Applications of different composites(L2)

Unit – V

Properties, structure and applications of Smart materials, shape memory alloys, metallic glass, quasi crystal and nano crystalline materials, ceramic materials, ceremets, high temperature materials, refractory materials.

Application: Piezoelectric material, Electro active polymer (EAP) , Magnetostrictive material

Learning Outcomes: At the end of this unit, the student will be able

1. To remember the applications and its processing methodologies of smart materials(L4)
2. Explain different crystalline materials (L2)

Text Books

1. Mechanical behavior of materials/Thomas H.Courtney/2nd Edition, McGraw-Hill,2000
2. Mechanical Metallurgy/George E.Dieter/McGraw Hill,1998
3. Material selction in mechanical design by M.F Ashby.Bott
4. E. Paul Degarmo, J.T. Black, and Ronald A Kohser. "Materials and Processing in Manufacturing," John Wiley and Sons Inc., 12th Edition, 5th July 2017, ISBN: 978- 1118987674.
5. K.K.Chawla,"Composite Materials: Science & Engineering," Springer-Verlag, New York, 3rd Edition, 2012, ISBN: 978-0387743646.
6. A.K. Sinha. "Powder Metallurgy," Dhanpat Rai Publications, ISBN: 978-9383182145.

References

1. Selection and use of Engineering Materials 3e/Charles J.A/Butterworth Heiremann. Material science and metallurgy by V.D. Kodgire, Everestpublishing house.
2. Mich Wilson, Kamalikannangara, et. Al., "Nano Technology: Basic Science and Emerging Technology," Chapman and Hall/CRC, 1st Edition, 27th June 2002, ISBN: 978- 1584883395.
3. V. S. R Murthy, A. K. Jena, K. P. Gupta and G.S.Murthy, "Structure and Properties of Engineering Materials," Tata McGraw Hill Education, 2003, ISBN: 9780070482876.
4. M. M. Schwartz, "Composite Materials Hand Book," McGraw Hill Higher Education, ISBN: 9780070557437.
5. Rakesh Rathi, "Nanotechnology," S.Chand and Company, 1st December 2010, ISBN: 978-8121930826.

I Year -II Semester

Code	Subject Name	L	T	P	C
ME-MD1205.1	Tribology (Elective - III)	3	0	0	3

Course Objective:

- To know the contact surface effects of bearings
- To know the seals and analysis of failure

Course Outcomes:

- Understand about contact surfaces & Effects of lubricants**(L1)**
- Understand About Rolling contact bearings **(L1)**
- Understand About Hydrostatic Bearings**(L1)**
- Understand About Hydrodynamic Bearings**(L1)**
- Explain about seals**(L2)**

Unit –I

Introduction: Nature of surfaces and contact-Surface topography-friction and wear mechanisms, wear maps, effect of lubricants- methods of fluid film formation.

Lubrication: Choice of lubricants, types of oil, Grease and solid lubricants- additives- lubrication systems and theirselection.

Learning outcomes:

After completion of this unit, students will be able to

- Know about contact surfaces & Effects of lubricants
- Analyze on Bearings till it failure

Application: Automobile&& Machine components

Unit –II

Selection of rolling element bearings: Nominal life, static and dynamic capacity-Equivalent load, probabilities of survival- cubic mean load- bearing mounting details, pre loading of bearings, conditioning monitoring using shock pulse method.

Applicaion: Automobile&& Machine components

Learning outcomes:

After completion of this unit, students will be able to

- Can prepare Rolling contact bearings

Unit –III

Hydrostatic Bearings: Thrust bearings – pad coefficients- restriction- optimum film thickness- journal bearings – design procedure –Aerostatic bearings; Thrust bearings and Journal bearings – design procedure.

Learning outcomes:

After completion of this unit, students will be able to

- Can prepare Hydrostatic Bearings

Applicaion: Machine components

Unit –IV

Hydrodynamic bearings: Fundamentals of fluid formation – Reynold's equation; Hydrodynamic journal bearings – Sommerfield number- performance parameters – optimum bearing with maximum load capacity – Friction – Heat generated and Heat dissipated. Hydrodynamic thrust bearings; Raimondi and Boyd solution for hydrodynamic thrust bearings- fixed tilting pads, single and multiple pad bearings-optimum condition with largest minimum filmthickness.

Applicaion: Automobile&& Machine components

Learning outcomes:

After completion of this unit, students will be able to

- Can prepare Hydrodynamic Bearings

Unit –IV

Seals: different type-mechanical seals, lip seals, packed glands, soft piston seals, Mechanical piston rod packing, labyrinth seals and throttling bushes, oil flinger rings and drain grooves –

selection of mechanical seals.

Failure of Tribological components: Failure analysis of plain bearings, rolling bearings, gears and seals, wear analysis using soap and Ferrography.

Dry rubbing Bearings: porous metal bearings and oscillatory journal bearings – qualitative approach only.

Applicaion: Automobile&& Machine components, Construction & Material optimization on Mechanical components

Learning outcomes:

After completion of this unit, students will be able to

- Can prepare Hydrodynamic Bearings

Text Books

1. Rowe WW& O' Dionoghue,"Hydrostatic and Hybrid bearing design " Butterworths& Co.PublishersLtd,1983.
2. Collacott R.A," Mechanical Fault diagnosis and condition monitoring", Chapman andHall, London1977.
3. Bernard J.Hamrock, " Fundamentals of fluid film lubricant", Mc Graw-HillCo.,1994.

References

1. Neale MJ, (Editor) " Tribology hand Book"Neumann Butterworths, 1975.
2. Connor and Boyd JJO (Editors) " Standard hand book of lubrication engineers "ASLE,Mc Graw Hill Book &Co.,1968
3. Shigley J, E Charles," Mechanical Engineering Design", McGraw Hill Co.,1989

I Year -II Semester

Code	Subject Name	L	T	P	C
ME-MD1205.2	Condition Monitoring and Signal Analysis (Elective - III)	3	0	0	3

Course objectives

- Teach the basics of the theory and practice of Condition monitoring
- Introduce experimental techniques in Condition monitoring
- Teach the primary signal processing techniques
- To teach techniques of data Collection for the analysis of vibration monitoring
- To introduce advanced methods (tool wear monitoring, lubricant analysis and radiographic techniques) in conditioning monitoring.
- Tool wear monitoring techniques

Course outcomes

At the end of the Course, the student will be able to

1. Explain the basics of the theory and practice of Condition monitoring(L2)
2. Introduce experimental techniques in Condition monitoring(L1)
3. Understand the primary signal processing techniques (L2)
4. Explain techniques of data Collection for the analysis of vibration monitoring(L2)
5. Understand advanced methods (tool wear monitoring, lubricant analysis and radiographic techniques) in Conditioning monitoring.(L2)

Unit I

Introduction to Condition monitoring: Basic Concept, techniques - visual monitoring, temperature monitoring, vibration monitoring, lubricant monitoring, crack monitoring, thickness monitoring, noise and sound monitoring.

Application: monitoring of temperature, crack, thickness in assembly plant

Learning outcomes:

After Completion of this unit, students will be able to

- List the techniques for Condition monitoring (L1)
- Explain various Condition monitoring techniques such as visual monitoring, temperature monitoring, vibration monitoring, lubricant monitoring, crack monitoring, thickness monitoring, noise and sound monitoring (L2)

Unit II

Basic signal processing techniques: Probability distribution and density, Fourier analysis, Hilbert transform cestrum analysis, digital filtering, deterministic/random signal separation, time-frequency analysis

Learning outcomes:

After Completion of this unit, students will be able to

- List the essential elements of an automated system related to different manufacturing industries(L1)

Unit III

Wavelet transform: Introduction to wavelets, Continuous wavelet transform (cwt), discrete wavelet transform (DWT), wavelet packet transform (WPT), types of wavelets – haarwavelets, shannon wavelets, meyer wavelets, daubechies wavelets, COifmann wavelets and applications of wavelets.

Application: pattern recognition, edge recognition

Learning outcomes:

After Completion of this unit, students will be able to

- Explain various wavelet transforms such as Continuous, discrete, wavelet packet transforms (L2)
- Identify various types of wavelets(L3)
- Classify wavelets such as haarwavelets, shannon wavelets, meyer wavelets, daubechies wavelets, Coffman wavelets and applications of wavelets. (L2)

Unit IV

Vibration monitoring, mention bearing and gear faults: Introduction, vibration data Collection, techniques, instruments, transducers, selection, measurement location, time domain analysis, frequency domain analysis, time-frequency domain analysis and Commonly witnessed machinery

faults diagnosed by vibration analysis. Vibration signals from rotating and reciprocating machines – signal classification, signals generated by rotating machines, signals generated by reciprocating machines. Introduction, Construction, types of faults, rolling element, rolling element bearing diagnostics and gear diagnostics.

Application: Testing and analysis to ensure products Comply with specified vibration tolerance limits

Learning outcomes:

After Completion of this unit, students will be able to

- Identify the Commonly witnessed machinery faults diagnosed by vibration analysis. (L3)
- Illustrate vibration signals from rotating and reciprocating machines and classify signals (L2)

Unit V

Other methods in Condition monitoring: Wear monitoring and lubricant analysis - sources of Contamination, techniques, spectrometric oil analysis procedure (soap) and ferrography, radiographic test**,** sources of x and gamma rays and their interaction with matter, radiographic equipment, radiographic techniques, safety aspects of industrial radiography. Machine tools wear monitoring techniques and case studies.

Learning outcomes:

After Completion of this unit, students will be able to

- Demonstrate wear monitoring and lubricant analysis techniques (L2)
- Identify various techniques to identify the sources of Contamination (L3)
- Explain spectrometric oil analysis and ferrography and radiographic tests(L2)
- Identify the sources of x and gamma rays and their interaction with matter (L3)
- Apply various radiography techniques to identify the tool wear monitoring (L4)
- List various sensors used in the tool wear monitoring (L1)
- Explain different tool wear techniques (L2)
- Apply various tool wear monitoring techniques to identify the tool wear in manufacturing industries(L4)

Test Book

1. Condition Monitoring of Mechanical Systems /Kolacat.

References

1. Frequency Analysis/R.B.Randall.
2. Mechanical Vibrations Practice with Basic Theory / V. Ramamurti/ Narosa Publishing House.
3. Theory of Machines and Mechanisms/ Amitabh Ghosh & AK Malik/EWP

I Year -II Semester

Code	Subject Name	L	T	P	C
ME-MD1205.3	Noise and Vibration Control (Elective - III)	3	0	0	3

Course Objectives

- Understand the sources of vibration and noise in automobiles and make design modifications to reduce the vibration and noise and improve the life of the components.
- Design and develop vibrations and noise control systems.

Course Outcomes:

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

1. Explain the noise, vibration, damping and its response.(L2)
2. Analyze the sound intensity from vibrations. (L4)
3. Analyze the noise measurement from various instruments. (L4)
4. Analyze the source of noise and vibrations. (L4)
5. Explain the control methods. (L2)

Unit-I

Fundamentals of Vibration: Introduction, classification of vibration: free and forced vibration, undamped.and damped vibration, linear vibration, response of damped and undamped systems under harmonic force, analysis of single degree freedom system, torsional vibration, determination of natural frequencies.

Learning outcomes:

After Completion of this unit, students will be able to

- Explain the noise, vibration, damping and its response.(L2)

Unit -II

Fundamentals of Noise: Decibel, sound pressure level, sound intensity, sound fields, reflection, absorption and transmission.

Learning outcomes:

After Completion of this unit, students will be able to

- Analyze the sound intensity from vibrations. (L4)

Unit -III

Noise Measurement: Sound meter

Analysis of Noise: Frequency analysis, tracking analysis, sound quality analysis

Learning outcomes:

After Completion of this unit, students will be able to

- Analyze the noise measurement from various instruments. (L4)

Unit -IV

Automotive Noise Sources: Noise Characteristics of engines, engine overall noise levels, assessment of combustion noise, assessment of mechanical noise, engine radiated noise, intake and exhaust noise, engine accessory contributed noise, transmission noise, aerodynamic noise, tyre noise, brake noise.

Learning outcomes:

After Completion of this unit, students will be able to

- Analyze the source of noise and vibrations. (L4)

Unit -V

Vibration Isolation And Control Methods: Vibration isolation, tuned absorbers, untuned viscous dampers, damping treatments, application dynamic forces generated by 1C engines, engine isolation, crank shaft damping, modal analysis of shock absorbers.

Learning outcomes:

After Completion of this unit, students will be able to

- Explain the control methods. (L2)

Text Books

1. Singiresu S.Rao, Mechanical Vibrations, Pearson Education, ISBM -81-297-0179-0 - 2004.
2. Kewal Pujara, Vibrations and Noise for Engineers, Dhanpat Rai & Sons, 1992.

3. Bernard Challen and Rodica Baranescu, Diesel Engine Refrence Book, Second edition - SAE International - ISBN 0-7680-0403-9-1999.
4. Julian Happian-Smith, An Introduction to Modern Vehicle Design, Butterworth-Heinemann, ISBN 0750-5044-3 - 2004
5. John Fenton, Handbook of Automotive body Construction and Design Analysis, Professional Engineering Publishing, ISBN 1-86058-073- 1998.

I Year -II Semester

Code	Subject Name	L	T	P	C
ME-MD1205.4	Vehicle Dynamics (Elective - III)	3	0	0	3

Course Objectives

- Understand the dynamics of vehicle ride
- Calculate and refer the loads and forces associated to the vehicles
- Analyse the behavior of the vehicles under acceleration, ride and braking

Course Outcomes:

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

1. Evaluate the performance characteristics of Vehicle (L4)
2. Analyze the mechanics of air flow around a vehicle. (L4)
3. Design the tire of an automobile by considering breaking, cornering etc. (L3)
4. Analyze the suspension system of an automobile. (L4)
5. Analyze the forces and moments during design of a steering mechanism (L4)

Unit-I

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

Learning outcomes:

After Completion of this unit, students will be able to

- Evaluate the performance characteristics of Vehicle (L4)

Unit -II

Aerodynamics: Mechanics of Air Flow Around a Vehicle, Pressure Distribution on a Vehicle, Aerodynamic Forces, Drag Components, Aerodynamics Aids.

Learning outcomes:

After Completion of this unit, students will be able to

- Analyze the mechanics of air flow around a vehicle. (L4)

Unit -III

Tire Mechanics: Tire Construction, Size and Load Rating, Terminology and Axis System, Tractive Properties, Cornering Properties, Camber Thrust, Aligning Moment, Combined Braking and Cornering, Conicity and Ply Steer, Slip, Skid, Rolling Resistance, Elastic Band Model for longitudinal slip, Simple model for lateral slip, Combined longitudinal/lateral slip (friction ellipse), Taut string model for lateral slip, Magic Tire Formula

Learning outcomes:

After Completion of this unit, students will be able to

- Design the tire of an automobile by considering breaking, cornering etc. (L3)

Unit -IV

Suspensions: Suspension Kinematics, Suspension types, Solid Axles, Independent Suspensions, Anti-Squat and Anti-Pitch Suspension Geometry, Anti-Dive Suspension Geometry, Roll Center Analysis, Suspension Dynamics, Multi-body vibration, Body and Wheel hop modes, Invariant points, Controllable Suspension Elements: Active, Semi-Active. Choice of suspension spring rate, Calculation of effective spring rate, Vehicle suspension in fore and apt directions

Learning outcomes:

After Completion of this unit, students will be able to

- Analyze the suspension system of an automobile. (L4)

Unit -V

The Steering System: The Steering Linkages, Steering System Forces and Moments, Steering System Models, Steering Geometry, Steady Handling (2 DOF steady-state model), Understeer and Oversteer, Effect of Tire Camber and Vehicle Roll (3 DOF steady-state model), Transient Handling and Directional Stability (2 DOF unsteady model), Effect of Vehicle Roll on Transient Handling (3 DOF unsteady model), Steady-State and Transient Handling of Articulated Vehicles. .

Learning outcomes:

After Completion of this unit, students will be able to

- Analyze the forces and moments during design of a steering mechanism (L4)

Text Books

1. Hans Pacejka, Tire and Vehicle Dynamics, Elsevier, 2012.
2. Thomas D Gillespie, "Fundamentals of Vehicle dynamics", SAE USA 1992.
3. Rajesh Rajamani, Vehicle Dynamics & control, Springer.

Reference Books

1. R.V. Dukkipati, Vehicle dynamics, Narsova Publications.
2. Wong J Y, "Theory of Ground Vehicles", John Wiley & Sons, New York, 1978.
3. Milliken W F and Milliken D L, Race car Vehicle Dynamics, SAE.
4. Garrett T K, Newton K and Steeds W, "Motor Vehicle", Butter Worths & Co., Publishers Ltd., New Delhi, 2001.
5. Heinz Heister, "Vehicle and Engine Technology", SAE Second Edition, 1999.
6. Vittore Cossalter, Motorcycle Dynamics, 2nd Edition, Publisher: LULU.com
7. R N Jazar, Vehicle Dynamics: Theory and Application, Springer.

I Year -II Semester

Code	Subject Name	L	T	P	C
ME-MD1205.5	Design Synthesis (Elective - III)	3	0	0	3

Objectives:

- Explain the product development cycle and manufacturing issues to be considered in design.
- Familiarize manufacturing consideration in cast, machining, cleaning and weld components.
- Describe the manufacture of machine components with accuracy.
- Impart knowledge of manufacturing of machine components with optimisation.

Course Outcomes:

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

1. Develop various steps in design process.(L3)
2. Understand the load and weight ratio.(L2)
3. Identify tolerances for various casting processes.(L3)
4. Understand assembly and dismantling.(L2)
5. Understand the concepts design optimization.(L2)

Unit – I

Design process and methodologies of systematic design conceptual design variants and evaluation; Standardization and its exploitation in design.

Learning outcomes:

At the end of the unit, student will be able to

- Develop various steps in design process.(L3)
- Apply economical considerations at design stage.(L3)
- Improve and developing technical standards based on the consensus of different parties.(L6&L3)

Unit – II

Tolerance from process and function; interchangeability and selective assembly; selection of fits for different design situations, surface finish. Load transmission, load equalization light weigh and rigid constructions.

Learning outcomes:

At the end of the unit, student will be able to

- Understand to selections of fits for designs.(L2)
- Understand the load and weight ratio.(L2)

Unit – III

Design of cast forged sheet metal parts and welded constructions machining considerations.

Learning outcomes:

At the end of the unit, student will be able to

- List various casting processes.(L1)
- Identify tolerances for various casting processes.(L3)
- Understand Simulate sand casting design.(L2)

Unit – IV

Design for assembly and dismantling; Modular constructions erection, operation inspection and maintenance considerations; Ergonomics Design of accuracy; Location pins and registers, Machining in assembly, adjustment, Backlash and Clearance adjustment.

Learning outcomes:

At the end of the unit, student will be able to

- Understand assembly and dismantling.(L2)
- Identify modular constructions erection.(L3)
- Understand accuracy and high efficiency designs.(L2)
- Develop the machine components.(L3)

Unit – V

Problems formulation for design optimization Example illustration the various principles available design variants for some of the common basic functional requirements.

Learning outcomes:

At the end of the unit, student will be able to

- Understand the concepts design optimization.(L2)
- Apply the principle to design process.(L3)

Text Book

1. Engineering Design a material and processing approach/ George Dieter/ McGraw Hi8 ll international book company1983

References

1. Engineering Design a systematic approach/ G. Phal W. Beitz/ Springer /3rdEdition
2. Mechanical Design Theory Methodology/ Manjula B. Waldron and Kenneth J. Waldron/ Springer Verlag New York1996.

I Year -II Semester

Code	Subject Name	L	T	P	C
ME-MD1206.1	Pressure Vessel Design (Elective - IV)	3	0	0	3

Course objectives

- Teach the Materials-shapes of Vessels-stresses in cylindrical
- Introduce Theory of thick cylinders
- Teach the Pure bending-different edge conditions
- To teach cylindrical vessel under axially symmetrical loading,

Course outcomes

At the end of the Course, the student will be able to

- Explain the bending and torque for computation of pressure vessels-conical and tetrahedral vessels (L2)
- Design of dome bends, shell connections, flat heads and cone openings. (L6)
- Understand the Pure bending-different edge conditions (L2)
- Explain techniques of discontinuity stresses in pressure vessels (L2)
- Understand the pressure vessel materials and their environment.(L2)

Unit – I

Introduction: Materials-shapes of Vessels-stresses in cylindrical, spherical and arbitrary, shaped shells. Cylindrical Vessels subjected to internal pressure, wind load, bending and torque for computation of pressure vessels-conical and tetrahedral vessels.

Learning outcomes:

At the end of the unit, student will be able to

- Explain the bending and torque for computation of pressure vessels-conical and tetrahedral vessels (L2)

Unit – II

Theory of thick cylinders: Shrink fit stresses in built up cylinders-auto frettage of thick cylinders. Thermal stresses in Pressure Vessels.

Learning outcomes:

At the end of the unit, student will be able to

- Design of dome bends, shell connections, flat heads and cone openings. (L6)

Unit – III

Theory of rectangular plates: Pure bending-different edge conditions.

Theory circular plates: Simple supported and clamped ends subjected to concentrated and uniformly distributed loads-stresses from local loads. Design of dome bends, shell connections, flat heads and cone openings.

Learning outcomes:

At the end of the unit, student will be able to

- Understand the Pure bending-different edge conditions (L2)

Unit – IV

Discontinuity stresses in pressure vessels: Introduction, beam on an elastic foundation, infinitely long beam, semi infinite beam, cylindrical vessel under axially symmetrical loading, extent and significance of load deformations on pressure vessels, discontinuity stresses in vessels, stresses in a bimetallic joints, deformation and stresses inflanges.

Learning outcomes:

At the end of the unit, student will be able to

- Explain techniques of discontinuity stresses in pressure vessels (L2)

Unit – V

Pressure vessel materials and their environment: Introduction, ductile material tensile tests, structure and strength of steel, Leuder's lines, determination of stress patterns from plastic flow observations, behaviour of steel beyond the yield point, effect of cold work or strain hardening on the physical properties of pressure vessel steels, fracture types in tension, toughness of materials, effect of neutron irradiation of steels, fatigue of metals, fatigue crack growth, fatigue life prediction, cumulative fatigue damage, stress theory of failure of vessels subject to steady state and fatigueconditions.

Learning outcomes:

At the end of the unit, student will be able to

- Understand the pressure vessel materials and their environment.(L2)

Text Books

1. Theory and design of modern Pressure Vessels by John F.Harvey, Van nostrand reihold company, New York.
2. Pressure Vessel Design and Analysis by Bickell, M.B.Ruizcs.

References

1. Process Equipment design- Beowll & YoundEtt.
2. Indian standard code for unfired Pressure vesselsIS:2825.
3. Pressure Vessel Design Hand Book, Henry H.Bednar, P.E., C.B.S.Publishers, NewDelhi.
4. Theory of plates and shells- Timoshenko & Noinosky.

I Year -II Semester

Code	Subject Name	L	T	P	C
ME-MD1206.2	Mechanics of Composite Materials (Elective - IV)	3	0	0	3

Course Objective:

- Can Prepare composites
- Formulate the Relationship between Stress& Strain for any material
- Analize Macro mechanically on a lamina related to 2 dimensional objects
- Analize Macro mechanically on a lamina related to 3 dimensional objects
- Understand the effects of Laminates

Course outcomes:

After completion of this unit, students will be able to

1. Understand About composites and its classification**(L1)**
2. Explain the Relationship between Stress& Strain(**L2)**
3. Analize Macro mechanically on a lamina related to 2 dimensions**(L4)**
4. Analize Macro mechanically on a lamina related to 3 dimensions**(L4)**
5. Design of Laminates**(L6)**

Unit –I

Introduction to Composites: Introduction, Classification, matrix materials, reinforced matrix of composites

Applicaion: Construction & Material optimization on Mechanical components

Unit –II

Hooke's Law for a Two-Dimensional Angle Lamina, Engineering Constants of an Angle Lamina, Invariant Form of Stiffness and Compliance Matrices for an Angle Lamina Strength Failure Theories of an Angle Lamina : Maximum Stress Failure Theory Strength Ratio, Failure Envelopes,Maximum Strain Failure Theory ,Tsai–Hill Failure Theory, Tsai–Wu Failure Theory, Comparison of Experimental Results with Failure Theories. Hygrothermal Stresses and Strains in a Lamina: Hygrothermal Stress–Strain Relationships for a Unidirectional Lamina, Hygrothermal Stress–Strain Relationships for an AngleLamina

Applicaion: Construction & Material optimization on Mechanical components

Unit –III

Macromechanical Analysis of a Lamina :Introduction ,Definitions: Stress, Strain ,Elastic Moduli, Strain Energy. Hooke's Law for Different Types of Materials, Hooke's Law for a Two-Dimensional Unidirectional Lamina, Plane Stress Assumption, Reduction of Hooke's Law in Three Dimensions to Two Dimensions, Relationship of Compliance and Stiffness Matrix to Engineering Elastic Constants of a Lamina,

Applicaion: Material optimization on planes.

Unit –IV

Micromechanical Analysis of a Lamina: Introduction, Volume and Mass Fractions, Density, and Void Content, Evaluation of the Four Elastic Moduli, Strength of Materials Approach, Semi-Empirical Models ,Elasticity Approach, Elastic Moduli of Lamina with Transversely Isotropic Fibers, Ultimate Strengths of a Unidirectional Lamina, Coefficients of Thermal Expansion, Coefficients of Moisture Expansion

Macromechanical Analysis of Laminates: Introduction, Laminate Code, Stress–Strain Relations for a Laminate, In-Plane and Flexural Modulus of a Laminate, Hygrothermal Effects in a Laminate, Warpage of Laminates, hybrid laminates

Application: Construction & Material optimization on Mechanical components

Unit –V

Design of Laminates : Introduction , thin plate theory, specially orthotropic plate, cross and angle ply laminated plates, problems using thin plate theory, Failure Criterion for a Laminate, Design of a Laminated Composites.

Applicaion: Construction & Material optimization on Mechanical components

Learning outcomes:

After completion of this unit, students will be able to

- Can Prepare composites
- Formulate the Relationship between Stress& Strain for any material
- Analize Macro mechanically on a lamina related to 2 dimensional objects
- Analize Macro mechanically on a lamina related to 3 dimensional objects
- Understand the effects of Laminates
- Can Design Laminates

Text Books

1. Engineering Mechanics of Composite Materials by Isaac and M Daniel, Oxford University Press,1994.
2. B. D. Agarwal and L. J. Broutman, Analysis and performance of fibre Composites,Wiley-Interscience, New York, 1980.
3. Mechanics of Composite Materials, Second Edition (Mechanical Engineering), By AutarK. Kaw ,Publisher: CRC

References

1. R. M. Jones, Mechanics of Composite Materials, Mc Graw Hill Company,NewYork, 1975.
2. L. R. Calcote, Analysis of Laminated Composite Structures, Van Nostrand Rainfold, New York,1969.

I Year -II Semester

Code	Subject Name	L	T	P	C
ME-MD1206.3	Advanced Computer Aided Design (Elective - IV)	3	0	0	3

Course Objectives:

- To understand the basics of design & Strength of Materials
- To understand the basics of Finite Element Methods
- To understand the plane stress& plane strain with Iso- parametric representation & Axi-Symmetric representation
- To understand the types of elements, mesh convergence & Cyclic Symmetry
- To understand the conditions in Finite element Analysis
- To learn different types of analysis techniques

Course Outcomes:

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

1. Explain the basics of design & Strength of Materials (L2)
2. Understand the basics of Finite Element Methods (L1)
3. Evaluate the plane stress& plane strain with Iso- parametric representation & Axi-Symmetric representation. (L4)
4. Evaluate the types of elements, mesh convergence & Cyclic Symmetry. (L4)
5. Explain the conditions in Finite element Analysis. (L2)

Unit I

Fundamentals of Stress Analysis: Stress strain curve, Engineering vs. true stress, Engineering vs. true strain, Bending, Membrane and shear stresses, Principal Stresses for an inclined plane, Failure Theories: Maximum Shear Stress theory, Maximum Principal Strain Theory, Maximum Strain energy Theory, Maximum Distortion Energy theory

Application: bars and plate elements

Learning Outcomes:

At the end of the unit, the student will be able to

- explain the concepts of true stress and true strain.(L2)
- formulate different types of stress theories.(L1)

Unit II

Introduction to Finite Element Method: Linear & Quadratic shape functions, potential energy equation (for 1D Spring Element), FEM vs. FDM, Implicit Analysis vs. Explicit analysis, Static, Dynamic and time history

Application: structural analysis

Learning Outcomes:

At the end of the unit, the student will be able to

- understand the numerical methods involved in Finite Element theory.(L2)
- understand the concept of nodes and elements.(L2)
- understand the general steps of finite element methods.(L2)

Unit III

Model Idealization: Plane Stress, Plane Strain, iso-Parametric representation, Axi-symmetry, Cyclic Symmetry

Application: hollow cylindrical elements, plates, long cylinders and rings

Learning Outcomes:

At the end of the unit, the student will be able to

- explain the formulation of two – dimensional elements (Triangular and Quadrilateral Elements). (L2)
- Formulate and solve axisymmetric problems.(L6)

Unit IV

Finite Element Modeling: Hooks law, Types of elements, modeling with 1D/2D/3D Elements, Element Quality, Mesh convergence, Non-linearity

Application: linear and non linear shaped materials with different plastic deformations

Learning Outcomes:

At the end of the unit, the student will be able to

- explain the formulation of two – dimensional elements (Triangular and Quadrilateral Elements). (L2)
- apply the formulation techniques to solve two – dimensional problems using triangle and quadrilateral elements. (L3)

Unit V

Loads & Boundary Conditions: Constrains, coupling/Constraint Equations

Application: load conditions in beams, trusses and plates

Learning Outcomes:

At the end of the unit, the student will be able to

- understand the process of application of boundary conditions.(L1)

Reference Books

1. Introduction to finite elements in engineering by Tirupathi R. Chandrupatla, Ashok D. Belegundu
2. Finite element procedures by K.J Bathe
3. Mechanical Engineering Design by Shigley
4. Machine design by R.S Khurmi & J.K. Gupta

I Year -II Semester

Code	Subject Name	L	T	P	C
ME-MD1206.4	Theory of Plasticity (Elective - IV)	3	0	0	3

Course Objectives:

- To familiarize the principal stresses and strains.
- To know yield criteria and concept of failure.

Course Outcomes:

At the end of the course students will be able to

1. Evaluate the basic concepts of failure criteria stress. (L3)
2. Evaluate the different Yield criteria. (L3)
3. Explain the general Isotropic materials. (L2)
4. Explain deformation theory of plasticity under various loads.(L2)
5. Solve the Numerical algorithms for solving non linear equations (L3)

Unit – I

Introduction: Modeling Uniaxial behavior in plasticity. Index notation, Cartesian tensors. Yield and failure criteria Stress, stress deviator tensors. Invariants, principal, mean stresses. Elastic strain energy. Mohr's representation of stress in 2 & 3 dimensions. Haigh-Westergaard stress space. Equilibrium equations of a body. Yield criteria: Tresca's, von Mises rules, Drucker-Prager criterion, anisotropic yieldcriteria.

Strain at point: Cauchy's formulae for strains, principal strains, principal shear strains, derivative strain tensor. Strain-displacement relationships. Linear elastic stress strain relations, Generalized Hooke's law, nonlinear elastic stress strain relations.

Learning outcomes:

At the end of this unit, the student will be able to

- Explain uniaixal behaviour in plasticity.(L2)
- Summarize the basic concepts of failure criteria stress. (L2)

Unit – II

Principle of virtual work and its rate forms: Drucker's stability postulate, normality, convexity and uniqueness for an elastic solid. Incremental stress strainrelations.

Criteria for loading and unloading: Elastic and plastic strain increment tensors, Plastic potential and flow rule associated with different Yield criteria, Convexity, normality and uniqueness considerations for elastic–plastic materials. Expansion of a thick walled cylinder.

Learning outcomes:

At the end of this unit, the student will be able to

- Explain Drucker's stability postulate.(L2)
- Explain the criteria for loading and unloading. (L2)

Unit – III

Incremental stress strain relationships: Prandtl-Reuss material model. J_2 deformation theory, Drucker-Prager material, General Isotropic materials.

Deformation theory of plasticity: Loading surface, Hardening rules. Flow rule and Druckers stability postulate. Concept of effective stress and effective strain, mixed hardening material. Problems.

Learning outcomes:

At the end of this unit, the student will be able to

- Explain deformation theory of plasticity under various loads.(L2)
- Explain the general Isotropic materials. (L2)

Unit – IV

Finite element formulation for an elastic plastic matrix: Numerical algorithms for solving non linear equations, Convergence criteria, Numerical implementations of the elastic plastic incremental constitutive relations.

Learning outcomes:

At the end of this unit, the student will be able to

- Explain the finite element formulation for an elastic plastic matrix.(L2)

Unit – V

Bounding surface theory: Uniaxial and multiaxial loading anisotropic material behaviour Theroms of limit analysis : Statically admissible stress field and kinematically admissible velocity field. Upper and lower bound theorms, examples and problems.

Learning outcomes:

At the end of this unit, the student will be able to

- Explain the theroms of limit analysis.(L2)

Text Book

1. Plasticity for structural engineering W.F.Chen s and D.J.Han, Springer verlag-1987.

References

1. Mechanics of Materials –II, Victor E.Saouma.
2. Theory of plasticity, SadhuSingh

I Year -II Semester

Code	Subject Name	L	T	P	C
ME-MD1207	Design Practice Laboratory	0	0	4	2

I. Modeling

1. Surface modeling
2. Solid modeling
3. Drafting
4. Assembling

II. Structural Analysis using any FEA Package for different structures that can be discretised with 1-D,2-D & 3-Delements

1. Static Analysis
2. ModalAnalysis
3. HarmonicAnalysis
4. SpectrumAnalysis
5. BucklingAnalysis
6. Analysis ofComposites
7. Fracture mechanics

III. Thermal Analysis using any FEA Package for different structures that can be discretised with 1-D,2-D & 3-Delements

1. Steady state thermal analysis
2. Transient thermal analysis

IV. Transient analysis using any FEA Package for different structures that can be discretised with 1-D,2-D & 3-Delements

V. Prudent Design – a case study

References

1. User manuals of ANSYS package
2. Version 9.0 I-DEAS Package Version 9.0

I Year -II Semester

Subject Code	Subject Name	L	P	Credits
AC- RMIP1201	**Research Methodology and IPR**	2	0	0

Course Objectives:

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

- Introduce the research problem formulation.
- Learn research related information Follow research ethics
- Introduce the when IPR would take such important place in growth of individuals & nation, it is needless to emphasise the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
- Introduce the IPR protection provides an incentive to inventors for further research work and investment in R & D.

Course Outcomes:

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

1. Understand research problem formulation.
2. Analyze research related information and Follow research ethics
3. Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
4. Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasise the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
5. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits

Unit I

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

Unit II

Effective literature studies approaches, analysis Plagiarism, Research ethics,

Unit III

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

Unit IV

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

Unit V

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

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

References

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2nd Edition , "Research Methodology: A Step by Step Guide for beginners"
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
5. Mayall , "Industrial Design", McGraw Hill, 1992.
6. Niebel , "Product Design", McGraw Hill, 1974.
7. Asimov , "Introduction to Design", Prentice Hall, 1962.

8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.
9. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008