M.Tech (Machine Design) Programme Course Structure
(With effect from **2018-19** Admitted Batch onwards)

I-SEMESTER

S.No.	Course Code	Course	L	T	P	C
1	VI8MAT06	Computational Methods in Engineering	3	-	-	3
2	VI8MDT01	Advanced Mechanics of Solids	3	-	-	3
3	VI8MDT02	Advanced Mechanisms	3	-	-	3
4	VI8MDT03	Mechanical Vibrations	3	-	-	3
5	**Elective – I**	VI8MDT04 Design of Automobile Systems VI8MDT05Product Design VI8MDT06 Geometric Modeling VI8MDT07 Non Destructive Evaluation	3	-	-	3
6	**Elective – II**	VI8MDT08 Fracture Mechanics VI8MDT09 Gear Engineering VI8MDT10 Design for Manufacturing & Assembly VI8MDT11 Continuum Mechanics	3	-	-	3
7	VI8MDL01	Machine Dynamics Lab	-	-	4	2
8	VI8MDT41	Seminar – I	-	-	4	2
	Total		**18**		**12**	**22**

Total Contact Hours= 30

II-SEMESTER

S.No.	Course Code	Course	L	T	P	C
1	VI8MDT12	Optimization and Reliability	3	-	-	3
2	VI8MDT13	Theory of Plasticity	3	-	-	3
3	VI8MDT14	Finite Element Method	3	-	-	3
4	VI8MDT15	Design with advanced Materials	3	-	-	3
5	**Elective – III**	VI8MDT16 Tribology VI8MDT17 Signal Analysis and Condition Monitoring VI8MDT18 Computational Fluid Dynamics VI8MDT19 Design Synthesis	3	-	-	3
6	**Elective-IV**	VI8MDT20 Pressure Vessel Design VI8MDT21 Mechanics of Composite Materials VI8MDT22 Mechatronics VI8MDT23 Experimental Stress Analysis	3	-	-	3
7	VI8MDL02	Design Practice Lab	-	-	4	2
8	VI8MDT42	Seminar – II	-	-	4	2
	Total		**18**	**-**	**8**	**22**

Total Contact Hours=26

III-SEMESTER

S.No.	Course Code	Course	L	T	P	C
1	VI8MDL05	MOOCS	-	-	4	MNC
2	VI8MDL06	Comprehensive Viva-Voce	-	-	-	2
3	VI8MDL07	Project Work	-	-	-	-
	Total		-	-	-	2

IV-SEMESTER

S.No.	Course Code	Course	L	T	P	C
1	VI8MDL07	Project Work	-	-	-	24
	Total		-	-	-	24

Total Credits (for all sems) = 70

VI8MAT06	COMPUTATIONAL METHODS IN ENGINEERING	L	P	C
		4	0	3

Course outcomes:

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

- Have a Idea of accuracy & precision rounding off & truncation errors and their propagation.
- Apply numerical techniques for solving linear algebraic equations, non-linear equations and differentiation and integration with due idea of above said concept.
- Understand the interpolation methods, transformation techniques and regression Methods

Unit – I

Introduction to numerical methods applied to engineering problems: Solutions of system of linear equations: Jacobi, Gauss Seidel methods– roots of non linear equations using Newton Raphson method - regression analysis- multiple linear regression.

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.

Unit – III

Transformation Techniques: Fourier integral theorm and transform, Inverse fourier transform, discrete fourier transform (DFT), Fast fourier transform (FFT) and inverse transform.

Unit – IV

Numerical solutions of partial differential equations: Laplace and poisson equations – Representations as a difference equation – 5-point formula – Derivative boundary conditions – Irregular and non – rectangular grids – Matrix patterns, sparseness – ADI method.

Unit – V

Partial differential equations: Bender Schmidt – Crank-Nickelson method –Stability and convergence criteria. Solving wave equation by finite differences-stability of numerical method - wave equation in two space dimensions.

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.

4. S S Sastry- "Introduction to Numerical methods"

References:

1.Ward Cheney and David Kincaid "Numerical mathematics and computing" Brooks/Cole publishing company1999, Fourth edition.

2.Riley K.F,. M.P.Hobson and Bence S.J,"Mathematical methods for physics and engineering", Cambridge University press,1999.

3. Kreysis, Advanced Mathematics

VI8MDT01	ADVANCED MECHANICS OF SOLIDS	L	P	C
		4	0	3

Course Outcomes:

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

- Determined the point of location of applied load to avoid twisting in thin sections used in aerospace applications.
- Understand the concept of distinguish between neutral and centroidal axes in curved beams.
- Understanding the analogy models developed for analyzing the non circular bars subjected to torsion, and also analyzing the stresses developed between rolling bodies and stress in three dimensional bodies.

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.

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.

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.

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.

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.

Textbooks:

1. Advanced Mechanics of materials by Boresi & Sidebottom-Wiely International, 6th edition.
2. Advanced Mechanics of Solids, L.S Srinath- Tata Mc-Graw Hill, 3rd edition

References:

1. Advanced strength of materials by Den Hortog J.P. , DOVER PUBLICATIONS.INC
2. Theory of plates & shells – Timoshenko, 2nd edition
3. Strength of materials & Theory of structures(Vol I&II)by B.C Punmia, laxmi publications, 9th edition
4. Strength of materials by Sadhu singh, kanna publications , 11th edition, 2014

VI8MDT02	ADVANCED MECHANISMS	L	P	C
		4	0	3

Course outcomes:

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

- Understand the kinematic analysis of rolling bodies based on graphical, geometrical and analytical methods.
- Design of mechanisms by using graphically and analytically by involving function generator, rigid body guidance and path generation(Coupler curve) methods

Unit - I

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

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 of of a four bar mechanism.

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.

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.

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.

Text Books:

1. Jeremy Hirschhorn, Kinematics and Dynamics of plane mechanisms,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

VI8MDT03	MECHANICAL VIBRATIONS	L	P	C
		4	0	3

Course Outcomes:
After Successful completion of the course, the student will be able to

- To study the vibrations in machine elements and how to control them.
- Ability to analyze the mathematical model of linear vibratory system to determine its Response
- Obtain linear mathematical models of real life engineering systems
- Determine vibratory responses of single and multi degree of freedom systems to harmonic, periodic and non-periodic excitation

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.

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.

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.

Unit IV

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

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.

Text books:

1. Elements of Vibration Analysis by Meirovitch. 2nd edition Tata Mc Graw Hill

2. Mechanical Vibrations by G.K. Groover. 2009 8th edition

References:

1. Vibrations by W.T. Thomson,1961

2. Mechanical Vibrations – Schaum series., Mc Graw Hill 1996

3. Vibration problems in Engineering by S.P. Timoshenko. 5th editon, 1990

4. Mechanical Viabrations – V.Ram Murthy. Alpha Science International, 2000

VI8MDT04	DESIGN OF AUTOMOBILE SYSTEMS (ELECTIVE-I)	L	P	C
		4	0	3

Course Outcomes:

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

- To understand the conceptual , structural design and analysis of automobile
- To understand the suspension system and human factors design of automobile
- To study the design for safety and performance of automobile

UNIT I

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

UNTI 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.

UNIT III

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

UNIT IV

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

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).

TEXT BOOKS

1 Donald E.Males, Fundamentals of automobile body structure design(R-394), 2011 SAE international

2. W.F.Milliker, D.L.Milliker,Maurice Olly, Chassis design: principles an analysis (R-206) 2002 SAE international

3. J.H Smith, Modern Vehicle System Design, 2001

VI8MDT05	PRODUCT DESIGN (ELECTIVE-I)	L	P	C
		4	0	3

Course Outcomes:
After Successful completion of the course, the student will be able to

- Should know types of customer needs, need gathering methods
- Establish the product function and constraints and modeling process
- Should know environmental objectives global issues, Regional and Local issues and DFE Methods
- Should develop physical models and know design of experiment principles
- Should design the product for robustness.

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.

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

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.

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.

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 project execution.

TEXT BOOKS:

1. Product Design and Development / Kari T. Ulrich and Steven D. Eppinger / McGraw Hill International Edns. 1999.5th edition

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, ISBN 0-202-41369-5.
3. Production and Operations Management/Chase/TMH, 8th edition, 1997

		L	P	C
VI8MDT06	**GEOMETRIC MODELING (ELECTIVE-I)**	**4**	**0**	**3**

Course Outcome:
After Successful completion of the course, the student will be able to

- Understand the background of mathematical equations used for development of modeling software modules to develop the various structural related applications

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.

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.

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

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.

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.

TEXT BOOKS:

1. Elements of Computer Graphics by Roger & Adams Tata McGraw Hill. 2nd edition
2. Geometric Modeling by Micheal E. Mortenson, McGraw Hill Publishers, 3rd edition

REFERENCES:

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

		L	P	C
VI8MDT07	**NON-DESTRUCTIVE EVALUATION (ELECTIVE-I)**	**4**	**0**	**3**

Course Outcomes:

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

- Know the working principle of Radiography and do the model analysis using different theorems.
- Use the various Non-destructive testing methods.

UNIT – I

General Methods: Flaw Detection Using Dye Penetrants. Magnetic Particle Inspection introduction to electrical impedance, Principles of Eddy Current testing, Flaw detection using eddy currents.

UNIT – II

X-Ray Radiography: The Radiographic process, X-Ray and Gamma-ray sources, Geometric Principles, Factors Governing Exposure, Radio graphic screens, Scattered radiation, Arithmetic of exposure, Radiographic image quality and detail visibility, Industrial X-Ray films,
Fundamentals of processing techniques, Process control, The processing Room, Special Processing techniques, Paper Radiography, Sensitometric characteristics of x-ray films, Film graininess signal to noise ratio in radiographs, The photographic latent image, Radiation Protection,

UNIT – III

Generation of ultrasonic waves, Horizontal and shear waves, Near field and far field acoustic wave description, Ultrasonic probes- straight beam, direct contact type, Angle beam, Transmission/reflection type, and delay line transducers, acoustic coupling and media, Transmission and pulse echo methods, A-scan, B-scan, C-scan, F-scan and P-scan modes, Flaw sizing in ultrasonic inspection: AVG, Amplitude, Transmission, TOFD, Satellite pulse, Multi-modal transducer, Zonal method using focused beam. Flow location methods, Signal processing in Ultrasonic NDT; Mimics, spurious echos and noise. Ultrasonic flaw evaluation.

UNIT – IV

Holography: Principles and practices of Optical holography, acoustical, microwave, x-ray and electron beam holography techniques.

UNIT – V

Applications: NDT in flaw analysis of Pressure vessels, piping, NDT in Castings, Welded constructions, etc., Case studies.

TEXT BOOKS:

1. Ultrasonic testing by Krautkramer and Krautkramer, 4th edition Springer.
2. Ultrasonic inspection to Training for NDT : E. A. Gingel, Prometheus Press,2006.
3. Metals and alloys, ASTM Standards, Vol 3.01

VI8MDT08	FRACTURE MECHANICS (ELECTIVE-II)	L	P	C
		4	0	3

Course outcomes:
After Successful completion of the course, the student will be able to

- Understand the different modes of failures like fracture, fatigue and creep of ductile and brittle materials

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.

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.

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.

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. Micromechanisms 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 life prediction.

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.

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 2nd ed1993.
3. J.F. Knott, Fundamentals of Fracture Mechanics, Butterworths (1973)
4. J.F. Knott, P Withey, Worked examples in Fracture Mechanics, Institute of Materials.
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 University Press,(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)

VI8MDT09	GEAR ENGINEERING (PSG Design data Book is allowed) (ELECTIVE-II)	L	P	C
		4	0	3

Course outcomes:
After Successful completion of the course, the student will be able to

- Ability to analyze behaviour of mechanical elements under different loads
- Understand the design of different transmission elements of automobile Ability to analyze mechanical elements critically

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.

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.

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.

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

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

TEXT BOOKS:
1. Maleev and Hartman, Machine Design, C.B.S. Publishers, India.6th edition 2015
2. Henry E.Merrit,Gear engineering ,Wheeler publishing,Allahabad,1992.
3. Practical Gear design by Darle W. Dudley,first edition McGraw-Hill book company

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 company Ltd., New Delhi,1994.

VI8MDT10	DESIGN FOR MANUFACTURING AND ASSEMBLY (ELECTIVE-II)	L	P	C
		4	0	3

Course outcomes:
After completing this course, the student should be able to

- Understand how a design can be made suitable for various manufacturing processes.
- To study the various factors influencing the manufacturability of components
- To study the use of tolerances in manufacturing
- Application of this study to machining, casting and joining processes

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.

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.

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 sand casting.

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.

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.

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.

TEXT BOOKS:

1. Design for manufacture, John cobert, Adisson Wesley. 1995
2. Design for Manufacture and assembly by Boothroyd,3rd edition CRC press
3. Design for manufacture, James Bralla, 2nd edition Mc Graw Hill

REFERENCE:

ASM Hand book Vol.20, Taylor & Francis 1997

VI8MDT11	CONTINUUM MECHANICS (ELECTIVE-II)	L	P	C
		4	0	3

Course outcomes:
After completing this course, the student should be able to

- Apply the tensor calculus for continuum mechanics
- Understand the conseration laws in momentum
- Study the Eulerian and Lagrangian principles in discrete systems

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.

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.

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

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

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

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, Cambridge, 1st edition 2001
4. Quick introduction to Tensor analysis, R.Sharipov, 2004, Samizdat Press.
5. Non-linear continuum mech-win, SEACAS theory manuals part II, T.A.Laursen, S.W.Attaway and R.I.Zadoks

VI8MDL01	**MACHINE DYNAMICS LABORATORY**	**L**	**P**	**C**
		0	**3**	**2**

EXPERIMENTS:

1. Determination of damped natural frequency of vibration of the vibrating system with different viscous oils
2. Determination of steady state amplitude of a forced vibratory system
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 FFT analyzer.
8. .Direct kinematic analysis of a robot
9. Inverse kinematic analysis of a robot
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

VI8MDT12	OPTIMIZATION AND RELIABILITY	L	P	C
		4	0	3

Course outcomes:
After Successful completion of the course, the student will be able to

- Learn various optimization techniques
- Develop a optimization model for a given problem
- Solve the model using suitable optimization technique.
- Analyze the sensitivity of a solution to different variables.
- Use and develop optimization simulation software for variety of industrial problems

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.

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.

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 .

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.

UNIT V

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

TEXT BOOKS:

1. Optimization for Engineering Design – Kalyanmoy Deb, PHI Publishers, 2^{nd} edition
2. Engineering Optimization – S.S.Rao, New Age Publishers, 3^{rd} edition
3. Reliability Engineering by L.S.Srinath, 3^{rd} edition.2005, East West publications
4. Multi objective genetic algorithm by Kalyanmoy Deb, 2^{nd} edition PHI Publishers, 2012

REFERENCES:

1. Genetic algorithms in Search, Optimization, and Machine learning – D.E.Goldberg, Addison-Wesley Publishers
2. Optimal design – Jasbir Arora, Mc Graw Hill (International) Publishers, 4^{th} edition 2017
3. An Introduction to Reliability and Maintainability Engineering by CE Ebeling, Waveland Printers Inc.,8^{th} edition 2007
4. Reliability Theory and Practice by I Bazovsky, Dover Publications, 2013

VI8MDT13	THEORY OF PLASTICITY (ELECTIVE-IV)	L	P	C
		4	0	3

Course outcomes:
After Successful completion of the course, the student will be able to

- Experimentally investigate yield criteria's for ductile metal.
- Discuss the theory of metal working.
- Describe different stages of plastic yielding.
- Explain the concept of boundary surface theory.

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 yield criteria.

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

UNIT – II

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

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.

UNIT – III

Incremental stress strain relationships: Prandtl-Reuss material model. J2 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.

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

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.

TEXT BOOK:

1. Plasticity for structural engineering W.F.Chen s and D.J.Han, J. Ross Publishing, 2007

REFERENCES:

1. Mechanics of Materials –II, Victor E. Saouma.
2. Theory of plasticity, Sadhu Singh Khanna publications

VI8MDT14	FINITE ELEMENT METHOD	L	P	C
		4	0	3

Course outcomes:

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

- Understand the concepts behind variational methods and weighted residual methods in FEM
- Identify the application and characteristics of FEA elements such as bars, beams, plane and isoparametric elements, and Dimensional elements.
- Develop element characteristic equation procedure and generation of global stiffness equation will be applied. Able to apply Suitable boundary conditions to a global structural equation, and reduce it to a solvable form.
- Able to identify how the finite element method expands beyond the structural domain, for problems
- Involving dynamics, heat transfer, and fluid flow.

UNIT - I

Formulation Techniques: Methodology, Engineering problems 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 boundary conditions.

UNIT – II

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

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.

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.

UNIT – V

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

TEXT BOOK:

1. Finite element methods by Chandrubatla & Belagondu.4th edition, 2011

REFERENCES:

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

VI8MDT15	DESIGN WITH ADVANCED MATERIALS	L	P	C
		4	0	3

Course outcomes:

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

- understanding of types, manufacturing processes, and applications of composite materials.
- basic understanding of linear elasticity with emphasis on the difference between isotropic and anisotropic material behavior.
- Ability to analyze problems on macro and micro mechanical behavior of lamina
- Ability to analyze problems on macro mechanical behavior of laminate
- An ability to compute the properties of a composite laminate with any stacking sequence.
- An ability to use the ideas developed in the analysis of composites towards using composites in aerospace design.

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.

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.

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.

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 composite materials.

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.

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

REFERENCES:

1. Selection and use of Engineering Materials 3rd edition /Charles J.A/Butterworth Heiremann.
2. Material science and metallurgy by VD Kodgire 2017

VI8MDT16	TRIBOLOGY (ELECTIVE- III)	L	P	C
		4	0	3

Course outcomes:
After Successful completion of the course, the student will be able to

- Understand the different types of lubrications and relevant theories used in supporting elements.
- Understand the failure mechanisms in different types of supporting elements.

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 their selection.

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.

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.

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 film thickness.

UNIT – V

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.

TEXT BOOKS:

1.Rowe WW& O' Dionoghue,"Hydrostatic and Hybrid bearing design " Butterworths & Co.Publishers Ltd,1983.
2.Collacott R.A," Mechanical Fault diagnosis and condition monitoring", Chapman and Hall, London 1977.

3. Bernard J.Hamrock, “ Fundamentals of fluid film lubricant”, Mc Graw-Hill Co.,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

VI8MDT17	SIGNAL ANALYSIS AND CONDITION MONITORING (ELECTIVE- III)	L	P	C
		4	0	3

Course outcomes:
After Successful completion of the course, the student will be able to

- Understand the analysis of different signals
- Understand the condition monitoring of various industrial equipment

UNIT-I
Introduction, Basic concepts. Fourier analysis. Bandwidth. Signal types. Convolution.
Signal analysis: Filter response time. Detectors. Recorders. Analog analyzer types.

UNIT-II
PRACTICAL ANALYSIS OF STATIONARY SIGNALS: Stepped filter analysis. Swept filter analysis. High speed analysis. Real-time analysis.

UNIT-III
PRACTICAL ANALYSIS OF CONTINUOUS NON-STATIONARY SIGNALS: Choice of window type. Choice of window length. Choice of incremental step. Practical details. Scaling of the results.

UNIT-IV
PRACTICAL ANALYSIS OF TRANSIENTS: Analysis as a periodic signal. Analysis by repeated playback (constant bandwidth). Analysis by repeated playback (variable bandwidth).

UNIT-V
CONDITION MONITORING IN REAL SYSTEMS: Diagnostic tools. Condition monitoring of two stage compressor. Cement mill foundation. I.D. fan. Sugar centrifugal. Cooling tower fan. Air separator. Preheater fan. Field balancing of rotors. ISO standards on vibrations, active, passive hybrid methods of condition monitoring

TEST BOOK:

1. Mechanical Fault diagnosis and condition monitoring by R. A .Collacott, Chapman and Hall, 1977

REFERENCES:

1. Frequency Analysis by R.B.Randall.3rd edition 2011
2. Mechanical Vibrations Practice with Basic Theory by V. Ramamurti, Narosa Publishing House.
3. Theory of Machines and Mechanisms by Amitabh Ghosh & AK Malik2nd edition, EWP

VI8MDT18	COMPUTATIONAL FLUID DYNAMICS (ELECTIVE- III)	L	P	C
		4	0	3

Course outcomes:
After Successful completion of the course, the student will be able to

- apply various numerical tools like finite volume, finite difference etc for solving the different fluid flow heat transfer problems.

UNIT – I

Introduction: Finite difference method, finite volume method, finite element method, governing equations and boundary conditions. Derivation of finite difference equations.

Solution methods: Solution methods of elliptical equations – finite difference formulations, interactive solution methods, direct method with Gaussian elimination.

Parabolic equations-explicit schemes and Von Neumann stability analysis, implicit schemes, alternating direction implicit schemes, approximate factorization, fractional step methods, direct method with tridiagonal matrix algorithm.

UNIT – II

Hyperbolic equations: explicit schemes and Von Neumann stability analysis, implicit schemes, multi step methods, nonlinear problems, second order one-dimensional wave equations.

Burgers equations: Explicit and implicit schemes, Runge-Kutta method.

UNIT – III

Formulations of incompressible viscous flows: Formulations of incompressible viscous flows by finite difference methods, pressure correction methods, vortex methods.

Treatment of compressible flows: potential equation, Eluer equations, Navier-stokes system of equations, flow field-dependent variation methods, boundary conditions, example problems.

UNIT – IV

Finite volume method: Finite volume method via finite difference method, formulations for two and three-dimensional problems.

UNIT – V

Standard variational methods: Linear fluid flow problems, steady state problems, Transient problems.

TEXT BOOK:

1. Computational fluid dynamics, T. J.Chung, Cambridge University press, 2nd edition 2002.

REFERENCE:

1. Text book of fluid dynamics, Frank Chorlton, CBS Publishers &distributors, 1985.

VI8MDT19	DESIGN SYNTHESIS (ELECTIVE- III)	L	P	C
		4	0	3

Course outcomes:
After Successful completion of the course, the student will be able to

- Understand the design process and standardization of parts.
- Understand and apply tolerances from process and function and interchangeability of parts
- Understand Design of cast forged sheet metal and welded parts based on machining considerations
- Understand the design for assembly and dismantling of parts
- Understand the design for optimization

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

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.

UNIT – III
Design of cast forged sheet metal parts and welded constructions Machining considerations.

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.

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

TEXT BOOK:
1. Engineering Design a material and processing approach/ George Dieter/ McGraw Hill international book company 5th edition 2012

REFERENCES:
1. Engineering Design a systematic approach/ G. Phal W. Beitz/ Springer /3rd Edition
2. Mechanical Design Theory Methodology/ Manjula B. Waldron and Kenneth J. Waldron/ Springer Verlag New York 1996.

VI8MDT20	PRESSURE VESSEL DESIGN (ELECTIVE-IV)	L	P	C
		4	0	3

Course outcomes:
After Successful completion of the course, the student will be able to

- Understand the different pressures and loading conditions in various types of pressure vessels
- Understand the various design considerations and material selection based on various failure criteria in various pressure vessels

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.

UNIT – II

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

UNIT – III

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

Theory of 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.

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 in flanges.

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 fatigue conditions.

TEXT BOOKS:

1. Theory and design of modern Pressure Vessels by John F.Harvey, Van nostrand Reihold Company, New York., 1980
2. Pressure Vessel Design and Analysis by Bickell, M.B.Ruizcs.,2009

REFERENCES:

1. Process Equipment design- Beowll & Yound Ett, WILEY 2009
2. Pressure Vessel Design Hand Book, Henry H.Bednar, P.E., C.B.S.Publishers, New Delhi. 1987
3. Theory of plates and shells- Timoshenko & Noinosky.Mc Graw Hill, 2nd edition, 2017

<table>
<tr><td rowspan="2">VI8MDT21</td><td rowspan="2">MECHANICS OF COMPOSITE MATERIALS

(ELECTIVE-IV)</td><td>L</td><td>P</td><td>C</td></tr>
<tr><td>4</td><td>0</td><td>3</td></tr>
</table>

Course outcomes:
After Successful completion of the course, the student will be able to

- understanding of types, manufacturing processes, and applications of composite materials.
- basic understanding of linear elasticity with emphasis on the difference between isotropic and anisotropic material behavior.
- Ability to analyze problems on macro and micro mechanical behavior of lamina
- Ability to analyze problems on macro mechanical behavior of laminate
- An ability to predict the loads and moments that cause an individual composite layer and a composite laminate to fail and to compute hygro thermal loads in composites.
- An ability to compute the properties of a composite laminate with any stacking sequence.
- An ability to use the ideas developed in the analysis of composites towards using composites in aerospace design

UNIT-I

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

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 Angle Lamina

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,

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

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.

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 Autar K. Kaw Publisher, 2nd edition,

REFERENCES:

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

VI8MDT22	MECHATRONICS (ELECTIVE-IV)	L	P	C
		4	0	3

Course outcomes:
After Successful completion of the course, the student will be able to

- Explain Mechatronics systems, control systems, sensors, transducers, real time interfacing and hardware components for Mechatronics .
- Explain fabrication, design and packaging of MEMS and Microsystems.
- Identify advanced applications in Mechatronics .

UNIT – I

Introduction: Definition of Mechatronics products, design considerations and trade offs. Overview of Mechtronic products. Intelligent machine Vs Automatic machine economic and social justification.

Actuators and drive systems: Mechanical, Electrical, hydraulic drive systems, Characteristics of mechanical, Electrical, Hydraulic and pneumatic actuators and their limitations.

UNIT – II

Motion Control: Control parameters and system objectives, Mechanical Configurations, Popular control system configurations. S-curve, motor/load inertia matching, design with linear slides.

Motion Control algorithms: Significance of feed forward control loops, shortfalls, fundamentals concepts of adaptive and fuzzy – control. Fuzzy logic compensatory control of transformation and deformation non- linearity's.

UNIT – III

Sensor interfacing: Analog and digital sensors for motion measurement, digital transducers, human-Machine and machine- Machine inter facing devices and strategy.

Architecture of intelligent machines: Introduction to Microprocessor and programmable logic controls and identification of systems. System design classification, motion control aspects in design.

UNIT – IV

Machine vision: Feature and pattern recognition methods, concepts of perception and cognition in decision-making, basics of image processing, binary and grey scale images, sharpening and smoothening of images.

UNIT – V

Micromechatronic Sytems: Micro sensors, micro actuators, smart instrumentation, micro-fabrication methods – lithography, etching, micro-joing.

TEXT BOOKS:

1. “Mechatronics and Measurement systems”by .Michel B.Histand and david G. Alciatore.4th edition
2. Introduction to Mechatronics and Measurement systems, Tata Mc Graw Hill.
3rd edition 2007
3. Control sensors and actuators C.W.desilva, Prentice Hall.CRC Press, 2007

VI8MDT23	EXPERIMENTAL STRESS ANALYSIS	L	P	C
		4	0	3

Course Outcomes:

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

- Know the working principle of stress and strain and do the model analysis using different theorems.
- Know the concepts of photo elasticity and its applications.
- Use the various Non-destructive testing methods.

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.

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.

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.

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.

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.

TEXT BOOKS :

1. Theory of Elasticity by Timoshenke and Goodier Jr, 3rd edition, 2010 Mc Graw-Hill

2. Experimental stress analysis by Dally and Riley, , 3rd edition, 1991, Mc Graw-Hill

REFERENCES:

1. A treatise on Mathematical theory of Elasticity by LOVE .A.H 4th edition 1927, Cambridge

2. Photo Elasticity by Frocht, Volume 1 Wiley Publications, 1941

3. Experimental stress analysis, Video course by K.Ramesh / NPTEL

VI8MDL02	DESIGN PRACTICE LABORATORY	L	P	C
		-	3	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 discretized with 1-D,2-D & 3-D elements

1. Static Analysis
2. Modal Analysis
3. Harmonic Analysis
4. Spectrum Analysis
5. Buckling Analysis
6. Analysis of Composites
7. Fracture mechanics

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

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-D elements

V. Prudent Design – a case study

REFERENCES :

User manuals of ANSYS package Version 9.0
I-DEAS Package Version 9.0