AFFILIATED INSTITUTIONS

ANNA UNIVERSITY, CHENNAI

REGULATIONS - 2009

CURRICULUM II TO IV SEMESTERS (FULL TIME)

M.E. AERONAUTICAL ENGINEERING

SEMESTER II

SL.No.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	AE9321	Flight Mechanics	3	0	0	3
2	AE9322	Finite Element Methods*	3	0	2	4
3	AE9323	Computational Fluid Dynamics in Aerospace Engineering	3	0	2	4
4	E2	Elective II	3	0	0	3
5	E3	Elective III	3	0	0	3
6	E4	Elective IV	3	0	0	3
PRACTICAL						
7	AE9324	Aerodynamics Laboratory	0	0	4	2
		TOTAL	**18**	**0**	**8**	**22**

SEMESTER III

SL.No.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	E5	Elective V	3	0	0	3
2	E6	Elective VI	3	0	0	3
PRACTICAL						
3	AE9331	Project Work (Phase I)	0	0	12	6
		TOTAL	**6**	**0**	**12**	**12**

SEMESTER IV

SL.No.	COURSE CODE	COURSE TITLE	L	T	P	C
PRACTICAL						
1	AE9341	Project Work (Phase II)	0	0	24	12
		TOTAL	**0**	**0**	**24**	**12**

*** Term paper** **TOTAL = 24+ 22 + 12 + 12 = 70**

LIST OF ELECTIVES

COURSE CODE	COURSE TITLE	L	T	P	C
AE9002	Numerical Heat Transfer	2	0	2	3
AE9003	Boundary Layer Theory	3	0	0	3
AE9004	Aircraft Design	2	0	2	3
AE9005	Industrial Aerodynamics	3	0	0	3
AE9006	Helicopter Aerodynamics	3	0	0	3
AE9008	Structural Dynamics	3	0	0	3
AE9009	Aero Elasticity	3	0	0	3
AE9010	High Temperature Problems in Structures	3	0	0	3
AE9011	Fatigue and Fracture Mechanics	3	0	0	3
AE9012	Theory of Elasticity	3	0	0	3
AE9013	Hypersonic Aerodynamics	3	0	0	3
AE9014	High Temperature Gas Dynamics	3	0	0	3
AE9015	Advanced Propulsion Systems	3	0	0	3
AE9016	Experimental Methods in Fluid Mechanics	3	0	0	3
AE9017	Wind Engineering	3	0	0	3
AE9018	Wind Tunnel Techniques	3	0	0	3
AE9019	Rocketry and Space Mechanics	3	0	0	3
AE9020	Composite Materials and Structures	3	0	0	3
AE9007	Theory of Plates and Shells	3	0	0	3
AE9001	Experimental Stress Analysis	3	0	0	3

AE9321 **FLIGHT MECHANICS** **L T P C**
3 0 0 3

OBJECTIVE

To understand the behaviour of airflow over bodies with particular emphasis on airfoil sections in the incompressible flow regime.

UNIT I PRINCIPLES OF FLIGHT 7

Physical properties and structure of the atmosphere, International Standard Atmosphere, Temperature, pressure and altitude relationship, Measurement of speed – True, Indicated and Equivalent air speed, Streamlined and bluff bodies, Various Types of drag in airplanes, Drag polar, Methods of drag reduction of airplanes.

UNIT II AIRCRAFT PERFORMANCE IN LEVEL, CLIMBING AND GLIDING FLIGHT 11

Straight and level flight, Thrust required and available, Power required and available, Effect of altitude on thrust and power, Conditions for minimum drag and minimum power required, Gliding and Climbing flight, Range and Endurance

UNIT III ACCELERATING FLIGHT 8

Take off and landing performance, Turning performance, horizontal and vertical turn, Pull up and pull down, maximum turn rate, V-n diagram

UNIT IV LONGITUDINAL STABILITY AND CONTROL 10

Degrees of freedom of a system, static and dynamic stability, static longitudinal stability, Contribution of individual components, neutral point, static margin, Hinge moment, Elevator control effectiveness, Power effects, elevator angle to trim, elevator angle per g, maneuver point, stick force gradient, aerodynamic balancing, Aircraft equations of motion, stability derivatives, stability quartic, Phugoid motion

UNIT V LATERAL, DIRECTIONAL STABILITY AND CONTROL 9

Yaw and side slip, Dihedral effect, contribution of various components, lateral control, aileron control power, strip theory, aileron reversal, weather cock stability, directional control, rudder requirements, dorsal fin, One engine inoperative condition, Dutch roll, spiral and directional divergence, autorotation and spin

TOTAL : 45 PERIODS

TEXT BOOKS

1. Houghton, E.L., and Caruthers, N.B., Aerodynamics for engineering students, Edward Arnold Publishers, 1988.
2. Perkins C.D., & Hage, R.E. Airplane performance, stability and control, Wiley Toppan, 1974.

REFERENCES

1. Kuethe, A.M., and Chow, C.Y., Foundations of Aerodynamics, John Wiley & Sons, 1982.
2. Clancey,L.J. Aerodynamics, Pitman, 1986.
3. Babister, A.W. Aircraft stability and response, Pergamon Press, 1980.
4. Nelson, R.C. Flight Stability & Automatic Control, McGraw-Hill, 1989.
5. McCormic, B.W., Aerodynamics, Aeronautics & Flight Mechanics John Wiley, 1995.

AE9322 FINITE ELEMENT METHODS L T P C
3 0 2 4

OBJECTIVE

To introduce the concept of numerical analysis of structural components

UNIT I INTRODUCTION 10

Review of various approximate methods – Rayleigh-Ritz, Galerkin and Finite Difference Methods - Stiffness and flexibility matrices for simple cases - Basic concepts of finite element method - Formulation of governing equations and convergence criteria.

UNIT II DISCRETE ELEMENTS 10

Use of bar and beam elements for static, dynamic and structural analysis – Bar of varying section – Temperature effects

Practical 10

Program Development and use of software package for application of bar and beam elements for static, dynamic and stability analysis.

UNIT III CONTINUUM ELEMENTS 12

Different forms of 2-D elements and their applications for plane stress, plane strain and axisymmetric problems – CST Element – LST Element - Consistent and lumped load vectors. Use of local co-ordinates. Numerical integration. – 2-D formulations for scalar variable problems - Application to heat transfer problems.

Practical 10

Solution for 2-D problems (static analysis and heat transfer) using software packages.

UNIT IV ISOPARAMETRIC ELEMENTS 8

Definition and use of different forms of 2-D and 3-D elements. - Formulation of element stiffness matrix and load vector.

Practical

Solution for 2-D problems (static analysis and heat transfer) using software packages.**10**

UNIT V SOLUTION SCHEMES 5

Different methods of solution of simultaneous equations governing static, dynamics and stability problems. General purpose Software packages.

L : 45, P:30 TOTAL NUMBER OF PERIODS: 75

TEXT BOOKS

1. Segerlind,L.J. “Applied Finite Element Analysis”, Second Edition, John Wiley and Sons Inc., New York, 1984.
2. Tirupathi R. Chandrupatla and Ashok D. Belegundu, Introduction to Finite Elements in Engineering, Prentice Hall, 2002
3. S.S.Rao, “Finite Element Method in Engineering”, Butterworth, Heinemann Publishing, 3rd Edition, 1998

REFERENCES

1. Robert D. Cook, David S. Malkus, Michael E. Plesha and Robert J. Witt “Concepts and Applications of Finite Element Analysis”, 4th Edition, John Wiley & Sons, 2002.
2. K.J. Bathe and E.L. Wilson, “Numerical Methods in Finite Elements Analysis”, Prentice Hall of India Ltd., 1983.
3. C.S. Krishnamurthy, “Finite Elements Analysis”, Tata McGraw-Hill, 1987.

AE9323 COMPUTATIONAL FLUID DYNAMICS IN AEROSPACE ENGINEERING **L T P C 3 0 2 4**

OBJECTIVE

To study the flow of dynamic fluids by computational methods

UNIT I NUMERICAL SOLUTIONS OF SOME FLUID DYNAMICAL PROBLEMS 9

Basic fluid dynamics equations, Equations in general orthogonal coordinate system, Body fitted coordinate systems, Stability analysis of linear system. Finding solution of a simple gas dynamic problem, Local similar solutions of boundary layer equations, Numerical integration and shooting technique.

Practical 6

Numerical solution for CD nozzle isentropic flows and local similar solutions of boundary layer equations.

UNIT II GRID GENERATION 9

Need for grid generation – Various grid generation techniques – Algebraic, conformal and numerical grid generation – importance of grid control functions – boundary point control – orthogonality of grid lines at boundaries.

Practical 8

Elliptic grid generation using Laplace's equations for geometries like airfoil and CD nozzle.

UNIT III TRANSONIC RELAXATION TECHNIQUES 9

Small perturbation flows, Transonic small perturbation (TSP) equations, Central and backward difference schemes, conservation equations and shockpoint operator, Line relaxation techniques, Acceleration of convergence rate, Jameson's rotated difference scheme -stretching of coordinates, shock fitting techniques Flow in body fitted coordinate system.

Practical 8

Numerical solution of 1-D conduction- convection energy equation using time dependent methods using both implicit and explicit schemes – application of time split method for the above equation and comparison of the results.

UNIT IV TIME DEPENDENT METHODS 9

Stability of solution, Explicit methods, Time split methods, Approximate factorization scheme, Unsteady transonic flow around airfoils. Some time dependent solutions of gas dynamic problems.

Practical 4

Numerical solution of unsteady 2-D heat conduction problems using SLOR methods

UNIT V PANEL METHODS 9

Elements of two and three dimensional panels, panel singularities. Application of panel methods to incompressible, compressible, subsonic and supersonic flows.

Practical 4

Numerical solution of flow over a cylinder using 2-D panel methods using both vertex and source panel methods for lifting and non lifting cases respectively.

L : 45, P : 30 TOTAL : 75 PERIODS

TEXT BOOKS

1. T.J. Chung, Computational Fluid Dynamics, Cambridge University Press, 2002
2. C.Y.Chow, "Introduction to Computational Fluid Dynamics", John Wiley, 1979.
3. A.A. Hirsch, 'Introduction to Computational Fluid Dynamics", McGraw-Hill, 1989.

REFERENCES

1. T.K.Bose, "Computation Fluid Dynamics" Wiley Eastern Ltd., 1988.
2. H.J. Wirz and J.J. Smeldern "Numerical Methods in Fluid Dynamics", McGraw-Hill Co., 1978.
3. John D. Anderson, JR" Computational Fluid Dynamics", McGraw-Hill Book Co., Inc., New York, 1995.

AE9324	**AERODYNAMICS LABORATORY**	**L T P C**
		0 0 4 2

OBJECTIVE

To familiarize the students in basic aerodynamics and use of wind tunnels.

LIST OF EXPERIMENTS

1. Calibration of subsonic wind tunnel
2. Pressure distribution over a smooth and rough cylinders
3. Pressure distribution over a symmetric aerofoil section
4. Pressure distribution over a cambered aerofoil section
5. Force measurement using wind tunnel balance for various models
6. Pressure distribution over a wing of symmetric aerofoil section
7. Pressure distribution over a wing of cambered aerofoil section
8. Flow visualization studies in incompressible flows
9. Calibration of supersonic wind tunnel
10. Supersonic flow visualization studies

TOTAL: 60 PERIODS

LABORATORY EQUIPMENTS REQUIREMENTS

1. Subsonic wind tunnel
2. Rough and smooth cylinder
3. Symmetrical Cambered aerofoil
4. Wind tunnel balance
5. Schlieren system
6. Pressure Transducers

AE 9002 NUMERICAL HEAT TRANSFER L T P C
2 0 2 3

OBJECTIVE

To introduce the concepts of heat transfer to enable the students to design components subjected to thermal loading.

UNIT I BASICS OF HEAT TRANSFER 6
Basic review of heat transfer –Conduction Convection -Radiation– Aerospace problems- Application of numerical methods

UNIT II CONDUCTIVE HEAT TRANSFER 6
Conduction – Convection systems – Numerical treatment of 1-D and 2-D heat conduction – Problems in Cartesian and polar coordinate systems – *conduction with heat generation* - Heat transfer problems in infinite and semi infinite solids – 1-D Transient analysis

UNIT III CONVECTIVE HEAT TRANSFER 6
Convection- Numerical treatment of steady 1-D and 2-d heat convection-diffusion steady-unsteady problems- Computation of thermal boundary layer flows-Transient free convection from a heat vertical plate

UNIT IV RADIATIVE HEAT TRANSFER 6
Radiation- Numerical treatment of radiation problems- transient mixed convection and radiation from a vertical fin.

UNIT V SPECIAL PROBLEMS IN AEROSPACE ENGINEERING 6
Heat transfer problem in gas turbine combustion chamber-ablative heat transfer-Aerodynamic heating-Moving boundary problems - Numerical treatment.

PRACTICALS
Developing a numerical code for 1D, 2D heat transfer problems. **30**

L : 30, P : 30 - TOTAL : 60 PERIODS

TEXT BOOKS

1. P. S. Ghoshdasidar , "Computer simulation of low and Heat transfer" McGraw-Hill Book Co., Inc., New Delhi, 1998.
2. Yunus A. Cengel, Heat Transfer – A Practical Approach Tata McGraw Hill Edition, 2003
3. S.C. Sachdeva, "Fundamentals of Engineering Heat & Mass Transfer", Wiley Eastern Ltd., New Delhi, 1981.

REFERENCES

1. John H. Lienhard, "A Heat Transfer Text Book", Prentice Hall Inc., 1981.
2. J.P. Holman, "Heat Transfer", McGraw-Hill Book Co., Inc., New York, 6th Edition, 1991.
3. John D. Anderson, JR" Computational Fluid Dynamics", McGraw-Hill Book Co., Inc., New York, 1995.
4. T.J. Chung, Computational Fluid Dynamics, Cambridge University Press, 2002
5. C.Y.Chow, "Introduction to Computational Fluid Dynamics", John Wiley, 1979.

AE 9003 **BOUNDARY LAYER THEORY** **L T P C**
3 0 0 3

UNIT I VISCOUS FLOW EQUATIONS 9
Navier-Stokes Equations, Creeping motion, Couette flow, Poiseuille flow through ducts, Ekman drift.

UNIT II LAMINAR BOUNDARY LAYER 9
Development of boundary layer – Estimation of boundary layer thickness, Displacement thickness - Momentum and energy thicknesses for two dimensional flow – Two dimensional boundary layer equations – Similarity solutions - Blasius solution.

UNIT III TURBULENT BOUNDARY LAYER 9
Physical and mathematical description of turbulence, two-dimensional turbulent boundary layer equations, Velocity profiles – Inner, outer and overlap layers, Transition from laminar to turbulent boundary layers, turbulent boundary layer on a flat plate, mixing length hypothesis.

UNIT IV APPROXIMATE SOLUTION TO BOUNDARY LAYER EQUATIONS 9
Approximate integral methods, digital computer solutions – Von Karman – Polhausen method.

UNIT V THERMAL BOUNDARY LAYER 9
Introduction to thermal boundary layer – Heat transfer in boundary layer - Convective heat transfer, importance of non dimensional numbers – Prandtl number, Nusselt number, Lewis number etc.

TOTAL : 45 PERIODS

TEXT BOOKS

1. H. Schlichting, "Boundary Layer Theory", McGraw-Hill, New York, 1979.
2. Frank White – Viscous Fluid flow – McGraw Hill, 1998

REFERENCES

1. A. J. Reynolds, "Turbulent flows in Engineering", John Wiley & Sons, 1980.
2. Ronald L., Panton, "Incompressible fluid flow", John Wiley & Sons, 1984.
3. Tuncer Cebeci and Peter Bradshaw, "Momentum transfer in boundary layers", Hemisphere Publishing Corporation, 1977.

AE 9004 **AIRCRAFT DESIGN** **L T P C**
2 0 2 3

OBJECTIVE

- To introduce and develop the basic concept of aircraft design.
- Each student is assigned the design of an Airplane (or Helicopter or any other flight vehicle), for given preliminary specifications. The following are the assignments to be carried out:

UNIT I REVIEW OF DEVELOPMENTS IN AVIATION 6

Categories and types of aircrafts – various configurations – Layouts and their relative merits – strength, stiffness, fail safe and fatigue requirements – Manoeuvering load factors – Gust and manoeuverability envelopes – Balancing and maneuvering loads on tail planes.

UNIT II POWER PLANT TYPES AND CHARACTERISTICS 6

Characteristics of different types of power plants – Propeller characteristics and selection – Relative merits of location of power plant.

UNIT III PRELIMINARY DESIGN 6

Selection of geometric and aerodynamic parameters – Weight estimation and balance diagram – Drag estimation of complete aircraft – Level flight, climb, take – off and landing calculations – range and endurance – static and dynamic stability estimates – control requirements.

UNIT IV SPECIAL PROBLEMS 6

Layout peculiarities of subsonic and supersonic aircraft – optimisation – of wing loading to achieve desired performance – loads on undercarriages and design requirements.

UNIT V STRUCTURAL DESIGN 6

Estimation of loads on complete aircraft and components – Structural design of fuselage, wings and undercarriages, controls, connections and joints. Materials for modern aircraft – Methods of analysis, testing and fabrication.

PRACICALS

Conceptual design of an aircraft for given specifications. **30**

L : 30, P : 30 – TOTAL : 60 PERIODS

TEXT BOOKS

1. D.P. Raymer, "Aircraft conceptual design", AIAA Series, 1988.
2. G. Corning, "Supersonic & Subsonic Airplane Design", II Edition, Edwards Brothers Inc., Michigan, 1953.
3. E.F. Bruhn, "Analysis and Design of Flight Vehicle Structures", Tristate Offset Co., U.S.A., 1980.

REFERENCES

1. E. Torenbeek, "Synthesis of Subsonic Airplane Design", Delft University Press, London, 1976.
2. H.N.Kota, Integrated design approach to Design fly by wire" Lecture notes Interline Pub. Bangalore, 1992.
3. A.A. Lebedenski, "Notes on airplane design", Part-I, I.I.Sc., Bangalore, 1971.

AE 9005 INDUSTRIAL AERODYNAMICS L T P C
3 0 0 3

OBJECTIVE:
To familiarize the learner with non-aeronautical uses of aerodynamics such as road vehicle, building aerodynamics and problems of flow induced vibrations.

UNIT I ATMOSPHERE 9
Types of winds, Causes of variation of winds, Atmospheric boundary layer, Effect of terrain on gradient height, Structure of turbulent flows.

UNIT II WIND ENERGY COLLECTORS 9
Horizontal axis and vertical axis machines, Power coefficient, Betz coefficient by momentum theory.

UNIT III VEHICLE AERODYNAMICS 9
Power requirements and drag coefficients of automobiles, Effects of cut back angle, Aerodynamics of trains and Hovercraft.

UNIT IV BUILDING AERODYNAMICS 9
Pressure distribution on low rise buildings, wind forces on buildings. Environmental winds in city blocks, Special problems of tall buildings, Building codes, Building ventilation and architectural aerodynamics.

UNIT V FLOW INDUCED VIBRATIONS 9
Effects of Reynolds number on wake formation of bluff shapes, Vortex induced vibrations, Galloping and stall flutter.

TOTAL : 45 PERIODS

TEXT BOOKS
1. M.Sovran (Ed), “Aerodynamics and drag mechanisms of bluff bodies and road vehicles”, Plenum press, New York, 1978.
2. P. Sachs, “Winds forces in engineering”, Pergamon Press, 1978.

REFERENCES
1. R.D. Blevins, “Flow induced vibrations”, Van Nostrand, 1990.
2. N.G. Calvent, “Wind Power Principles”, Charles Griffin & Co., London, 1979.

AE 9006 HELICOPTER AERODYNAMICS L T P C
3 0 0 3

OBJECTIVE
To present the basic ideas of evolution, performance and associated stability problems of helicopter.

UNIT I INTRODUCTION 7
Types of rotorcraft – autogiro, gyrodyne, helicopter, Main rotor system – articulated, semi rigid, rigid rotors, Collective pitch control, cyclic pitch control, anti torque pedals.

UNIT II HELICOPTER AERODYNAMICS 12

Momentum / actuator disc theory, Blade element theory, combined blade element and momentum theory, vortex theory, rotor in hover, rotor model with cylindrical wake and constant circulation along blade, free wake model, Constant chord and ideal twist rotors, Lateral flapping, Coriolis forces, reaction torque, compressibility effects, Ground effect.

UNIT III PERFORMANCE 9

Hover and vertical flight, forward level flight, Climb in forward flight, optimum speeds, Maximum level speed, rotor limits envelope – performance curves with effects of altitude

UNIT IV STABILITY AND CONTROL 9

Helicopter Trim, Static stability – Incidence disturbance, forward speed disturbance, angular velocity disturbance, yawing disturbance, Dynamic Stability.

UNIT V AERODYNAMIC DESIGN 8

Blade section design, Blade tip shapes, Drag estimation – Rear fuselage upsweep,

TOTAL : 45 PERIODS

TEXT BOOKS

1. J. Seddon, " Basic Helicopter Aerodynamics", AIAA Education series, Blackwell scientific publications, U.K, 1990.
2. A. Gessow and G.C.Meyers, "Aerodynamics of the Helicopter", Macmillan and Co., New York, 1982.

REFERENCES

1. John Fay, "The Helicopter", Himalayan Books, New Delhi, 1995.
2. Lalit Gupta, "Helicopter Engineering", Himalayan Books, New Delhi, 1996.
3. Lecture Notes on "Helicopter Technology", Department of Aerospace Engineering, IIT –Kanpur and Rotary Wing aircraft R&D center, HAL, Bangalore, 1998.

AE 9008 STRUCTURAL DYNAMICS

L	T	P	C
3	0	0	3

UNIT I FORCE-DEFLECTION PROPERTIES OF STRUCTURES 10

Constraints and Generalized coordinates – Virtual work and generalized forces – Force – Deflection influence functions – stiffness and flexibility methods.

UNIT II PRINCIPLES OF DYNAMICS 10

Free and forced vibrations of systems with finite degrees of freedom – Damped oscillations – D"Alembert's principle – Hamilton's principle – Lagrangean equations of motion and applications.

UNIT III NATURAL MODES OF VIBRATION 10

Equations of motion for free vibrations. Solution of Eigen value problems – Normal coordinates and orthogonality conditions of eigen vectors.

UNIT IV ENERGY METHODS 8

Rayleigh's principle – Rayleigh – Ritz method – Coupled natural modes – Effect of rotary inertia and shear on lateral vibrations of beams – Natural vibrations of plates.

UNIT V APPROXIMATE METHODS 7

Approximate methods of evaluating the eigen values and the dynamic response of continuous systems. Application of Matrix methods for dynamic analysis.

TOTAL : 45 PERIODS

TEXT BOOKS

1. W.C. Hurty and M.F. Rubinstein, "Dynamics of Structures", Prentice Hall of India Pvt., Ltd., New Delhi, 1987.
2. F.S.Tse, I.E. Morse and H.T. Hinkle, "Mechanical Vibration", Prentice Hall of India Pvt., Ltd., New Delhi, 1988.

REFERENCES

1. R.K. Vierck, "Vibration Analysis", 2nd Edition, Thomas Y. Crowell & Co., Harper & Row Publishers, New York, U.S.A., 1989.
2. S.P. Timoshenko and D.H. Young, "Vibration Problems in Engineering", John Willey & Sons Inc., 1984.
3. Von. Karman and A.Biot, "Mathematical Methods in Engineering", McGraw-Hill Book Co., New York, 1985.

AE 9009 AERO ELASTICITY

L T P C
3 0 0 3

OBJECTIVE

To understand the theoretical concepts of material behaviour with particular emphasis on their elasticity property.

UNIT I AEROELASTIC PHENOMENA 6

Stability versus response problems – The aero-elastic triangle of forces – Aeroelasticity in Aircraft Design – Prevention of aeroelastic instabilities. Influence and stiffness co-efficients. Coupled oscillations.

UNIT II DIVERGENCE OF A LIFTING SURFACE 10

Simple two dimensional idealisations-Strip theory – Integral equation of the second kind – Exact solutions for simple rectangular wings – 'Semirigid' assumption and approximate solutions – Generalised coordinates – Successive approximations – Numerical approximations using matrix equations.

UNIT III STEADY STATE AEROLASTIC PROBLEMS 9

Loss and reversal of aileron control – Critical aileron reversal speed – Aileron efficiency – Semi rigid theory and successive approximations – Lift distribution – Rigid and elastic wings. Tail efficiency. Effect of elastic deformation on static longitudinal stability.

UNIT IV FLUTTER PHENOMENON 14

Non-dimensional parameters – Stiffness criteria – Dynamic mass balancing – Dimensional similarity. Flutter analysis – Two dimensional thin airfoils in steady incompressible flow – Quasisteady aerodynamic derivatives. Galerkin method for critical flutter speed – Stability of disturbed motion – Solution of the flutter determinant – Methods of determining the critical flutter speeds – Flutter prevention and control.

UNIT V EXAMPLES OF AEROELASTIC PROBLEMS 6

Galloping of transmission lines and Flow induced vibrations of transmission lines, tall slender structures and suspension bridges.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Y.C. Fung, "An Introduction to the Theory of Aeroelasticity", John Wiley & Sons Inc., New York, 2008.
2. E.G. Broadbent, "Elementary Theory of Aeroelasticity", Bun Hill Publications Ltd., 1986.

REFERENCES

1. R.L. Bisplinghoff, H.Ashley, and R.L. Halfmann, "Aeroelasticity", II Edition Addison Wesley Publishing Co., Inc., 1996.
2. R.H. Scanlan and R.Rosenbaum, "Introduction to the study of Aircraft Vibration and Flutter", Macmillan Co., New York, 1981.
3. R.D.Blevins, "Flow Induced Vibrations", Krieger Pub Co., 2001

AE 9010 HIGH TEMPERATURE PROBLEMS IN STRUCTURES

L	T	P	C
3	0	0	3

UNIT I TEMPERATURE EQUATIONS & AERODYNAMIC HEATING 9

For condition, radiation and convection – Fourier's equation – Boundary and initial conditions – One-dimensional problem formulations – Methods and Solutions. Heat balance equation for idealised structures – Adiabatic temperature – Variations – Evaluation of transient temperature.

UNIT II THERMAL STRESS ANALYSIS 9

Thermal stresses and strains – Equations of equilibrium – Boundary conditions – Thermoelasticity – Two dimensional problems and solutions – Airy stress function and applications.

UNIT III THERMAL STRESS IN BEAMS, TRUSSES AND THIN CYLINDERS 9

Thermal stresses in axially loaded members, beams with varying cross sections. Effect of temperature in thin cylinders.

UNIT IV THERMAL STRESSES IN PLATES 9

Membrane thermal stresses – Circular plates – Rectangular plates – Bending thermal stresses – Thick plates with temperature varying along thickness – Thermal vibration of plates.

UNIT V SPECIAL TOPICS & MATERIALS 9

Thermal bucking, Fatigue and shock applications – High temperature effects on material properties.

TOTAL : 45 PERIODS

TEXT BOOKS

1. A.B. Bruno and H.W. Jerome, "Theory of Thermal Stresses", John Wiley & Sons Inc., New York, 1980.
2. N.J. Hoff, "High Temperature effects in Aircraft Structures", John Wiley & Sons Inc., London, 1986.

REFERENCE

1. D.J. Johns, "Thermal Stress Analysis", Pergamon Press, Oxford, 1985.

AE 9011	FATIGUE AND FRACTURE MECHANICS	L T P C
		3 0 0 3

UNIT I FATIGUE OF STRUCTURES 10

S.N. curves – Endurance limit – Effect of mean stress – Goodman, Gerber and Soderberg relations and diagrams – Notches and stress concentrations – Neuber's stress concentration factors – plastic stress concentration factors – Notched S-N curves.

UNIT II STATISTICAL ASPECTS OF FATIGUE BEHAVIOUR 8

Low cycle and high cycle fatigue – Coffin-Manson's relation – Transition life – Cyclic Strain hardening and softening – Analysis of load histories – Cycle counting techniques – Cumulative damage – Miner's theory – other theories.

UNIT III PHYSICAL ASPECTS OF FATIGUE 5

Phase in fatigue life – Crack initiation – Crack growth – Final fracture – Dislocations – Fatigue fracture surfaces.

UNIT IV FRACTURE MECHANICS 15

Strength of cracked bodies – potential energy and surface energy – Griffith's theory – Irwin – Orwin extension of Griffith's theory to ductile materials – Stress analysis of cracked bodies – Effect of thickness on fracture toughness – Stress intensity factors for typical geometries.

UNIT V FATIGUE DESIGN AND TESTING 7

Safe life and fail safe design philosophies – Importance of Fracture Mechanics in aerospace structure – Application to composite materials and structures.

TOTAL : 45 PERIODS

TEXT BOOKS

1. D.Brock, "Elementary Engineering Fracture Mechanics", Noordhoff International Publishing Co., London, 1994.
2. J.F.Knott, "Fundamentals of Fracture Mechanics", Butterworth & Co., (Publishers) Ltd., London, 1983.

REFERENCES

1. W.Barrois and L.Ripley, "Fatigue of Aircraft Structures", Pergamon Press, Oxford, 1983.
2. C.G.Sih, "Mechanics of Fracture", Vol.1 Sijthoff and Noordhoff International Publishing Co., Netherland, 1989.

AE 9012	THEORY OF ELASTICITY	L T P C
		3 0 0 3

OBJECTIVE

To understand the theoretical concepts of material behaviour with particular emphasis on their elasticity property.

UNIT I INTRODUCTION 6

Definition, notations and sign conventions for stress and strain – Stress - strain relations, Strain-displacement relations- Elastic constants.

UNIT II BASIC EQUATIONS OF ELASTICITY 10

Equations of equilibrium – Compatibility equations in strains and stresses –Boundary Conditions - Saint-Venant's principle - Stress ellipsoid – Stress invariants – Principal stresses in 2-D and 3-D.

UNIT III 2 - D PROBLEMS IN CARTESIAN COORDINATES 9

Plane stress and plain strain problems - Airy's stress function – Biharmonic equations – 2-D problems – Cantilever and simply supported beams.

UNIT IV 2 - D PROBLEMS IN POLAR COORDINATES 12

Equations of equilibrium – Strain – displacement relations – Stress – strain relations – Airy's stress function – Axisymmetric problems - Bending of Curved Bars - Circular Discs and Cylinders – Rotating Discs and Cylinders - Kirsch, Boussinasque's and Michell's problems.

UNIT V TORSION 8

Coulomb's theory-Navier's theory-Saint Venant's Semi-Inverse method – Torsion of Circular, Elliptical and Triangular sections - Prandtl's theory-Membrane analogy.

TOTAL : 45 PERIODS

TEXT BOOKS

1. S.P. Timoshenko and J.N. Goodier, Theory of Elasticity, McGraw-Hill, 1985.
2. E. Sechler, "Elasticity in Engineering" John Wiley & Sons Inc., New York, 1980.

REFERENCES
1. Ugural, A.C and Fenster, S.K, Advanced Strength and Applied Elasticity, Prentice hall, 2003
2. Wang, C.T. Applied elasticity, McGraw Hill 1993
3. Enrico Volterra and Caines, J.H, Advanced strength of Materials, Prentice Hall, 1991

AE 9013 HYPERSONIC AERODYNAMICS L T P C
3 0 0 3

OBJECTIVE:
To present the basic ideas of hypersonic flow and the associated problem areas.

UNIT I BASICS OF HYPERSONIC AERODYNAMICS 8
Thin shock layers – entropy layers – low density and high density flows – hypersonic flight paths hypersonic flight similarity parameters – shock wave and expansion wave relations of inviscid hypersonic flows.

UNIT II SURFACE INCLINATION METHODS FOR HYPERSONIC INVISCID FLOWS 9
Local surface inclination methods – modified Newtonian Law – Newtonian theory – tangent wedge or tangent cone and shock expansion methods – Calculation of surface flow properties

UNIT III APPROXIMATE METHODS FOR INVISCID HYPERSONIC FLOWS` 9
Approximate methods hypersonic small disturbance equation and theory – thin shock layer theory – blast wave theory - entropy effects - rotational method of characteristics - hypersonic shock wave shapes and correlations.

UNIT IV VISCOUS HYPERSONIC FLOW THEORY 10
Navier–Stokes equations – boundary layer equations for hypersonic flow – hypersonic boundary layer – hypersonic boundary layer theory and non similar hypersonic boundary layers – hypersonic aerodynamic heating and entropy layers effects on aerodynamic heating.

UNIT V VISCOUS INTERACTIONS IN HYPERSONIC FLOWS 9
Strong and weak viscous interactions – hypersonic shockwaves and boundary layer interactions – Role of similarity parameter for laminar viscous interactions in hypersonic viscous flow.

TOTAL : 45 PERIODS

TEXT BOOKS
1. John D. Anderson, Jr, Hypersonic and High Temperature Gas Dynamics, McGraw-Hill Series, New York, 1996.

REFERENCES
1. John.D.Anderson, Jr., Modern Compressible Flow with Historical perspective Hypersonic Series.

2. William H. Heiser and David T. Pratt, Hypersonic Air Breathing propulsion, AIAA Education Series.
3. John T. Bertin, Hypersonic Aerothermodynamics, 1994 AIAA Inc., Washington D.C.

AE 9014 HIGH TEMPERATURE GAS DYNAMICS L T P C
3 0 0 3

UNIT I INTRODUCTION 8
Nature of high temperature flows – Chemical effects in air – Real perfect gases – Gibb's free energy and entropy by chemical and non equilibrium – Chemically reacting mixtures and boundary layers.

UNIT II STATISTICAL THERMODYNAMICS 8
Introduction to statistical thermodynamics – Relevance to hypersonic flow - Microscopic description of gases – Boltzman distribution – Cartesian function

UNIT III KINETIC THEORY AND HYPERSONIC FLOWS 9
Chemical equilibrium calculation of equilibrium composition of high temperature air – equilibrium properties of high temperature air – collision frequency and mean free path – velocity and speed distribution functions.

UNIT IV INVISCID HIGH TEMPERATURE FLOWS 10
Equilibrium and non – equilibrium flows – governing equations for inviscid high temperature equilibrium flows – equilibrium normal and oblique shock wave flows – frozen and equilibrium flows – equilibrium conical and blunt body flows – governing equations for non equilibrium inviscid flows.

UNIT V TRANSPORT PROPERTIES IN HIGH TEMPERATURE GASES 10
Transport coefficients – mechanisms of diffusion – total thermal conductivity – transport characteristics for high temperature air – radiative transparent gases – radiative transfer equation for transport, absorbing and emitting and absorbing gases.

TOTAL : 45 PERIODS

TEXT BOOKS
1. John D. Anderson, Jr., Hypersonic and High Temperature Gas Dynamics, McGraw-Hill Series, New York, 1996.
2. John D. Anderson, Jr., Modern Compressible Flow with Historical perspective McGraw-Hill Series, New York, 1996.

REFERENCES
1. William H. Heiser and David T. Pratt, Hypersonic Air breathing propulsion, AIAA Education Series.
2. John T. Bertin, Hypersonic Aerothermodynamics publishers - AIAA Inc., Washington, D.C.,1994.
3. T.K.Bose, High Temperature Gas Dynamics,

AE 9015 ADVANCED PROPULSION SYSTEMS L T P C
3 0 0 3

OBJECTIVE

To study in detail about gas turbines, ramjet, fundamentals of rocket propulsion and chemical rockets

UNIT I THERMODYNAMIC CYCLE ANALYSIS OF AIR-BREATHING PROPULSION SYSTEMS 8

Air breathing propulsion systems like Turbojet, turboprop, ducted fan, Ramjet and Air augmented rockets – Thermodynamic cycles – Pulse propulsion – Combustion process in pulse jet engines – inlet charging process – Supercritical charging and subcritical discharging – Subcritical charging and subcritical discharging – Subcritical charging and supercritical discharging.

UNIT II RAMJETS AND AIR AUGMENTED ROCKETS 8

Preliminary performance calculations – Diffuser design and hypersonic inlets – combustor and nozzle design – air augmented rockets – engines with supersonic combustion.

UNIT III SCRAMJET PROPULSION SYSTEM 12

Fundamental considerations of hypersonic air breathing vehicles – Preliminary concepts in engine airframe integration – calculation of propulsion flow path – flowpath integration – Various types of supersonic combustors – fundamental requirements of supersonic combustors – Mixing of fuel jets in supersonic cross flow – performance estimation of supersonic combustors.

UNIT IV NUCLEAR PROPULSION 9

Nuclear rocket engine design and performance – nuclear rocket reactors – nuclear rocket nozzles – nuclear rocket engine control – radioisotope propulsion – basic thruster configurations – thruster technology – heat source development – nozzle development – nozzle performance of radiosotope propulsion systems.

UNIT V ELECTRIC AND ION PROPULSION 8

Basic concepts in electric propulsion – power requirements and rocket efficiency – thermal thrusters – electrostatic thrusters – plasma thruster of the art and future trends – Fundamentals of ion propulsion – performance analysis – electrical thrust devices – ion rocket engine.

TOTAL : 45 PERIODS

TEXT BOOKS

1. G.P. Sutton, "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 1998.
2. William H. Heiser and David T. Pratt, Hypersonic Airbreathing propulsion, AIAA Education Series, 2001.

REFERENCES

1. Fortescue and Stark, Spacecraft Systems Engineering, 1999.
2. Cumpsty, Jet propulsion, Cambridge University Press, 2003.

AE 9016 EXPERIMENTAL METHODS IN FLUID MECHANICS

	L	T	P	C
	3	0	0	3

UNIT I BASIC MEASUREMENTS IN FLUID MECHANICS 8

Objective of experimental studies – Fluid mechanics measurements – Properties of fluids – Measuring instruments – Performance terms associated with measurement systems – Direct measurements - Analogue methods – Flow visualization –Components of measuring systems – Importance of model studies - Experiments on Taylor-Proudman theorem and Ekman layer – Measurements in boundary layers -

UNIT II WIND TUNNEL MEASEUREMENTS 8

Characteristic features, operation and performance of low speed, transonic, supersonic and special tunnels - Power losses in a wind tunnel – Instrumentation and calibration of wind tunnels – Turbulence- Wind tunnel balance – Principle and application and uses – Balance calibration.

UNIT III FLOW VISUALIZATION AND ANALOGUE METHODS 10

Visualization techniques – Smoke tunnel – Hele-Shaw apparatus - Interferometer – Fringe-Displacement method – Shadowgraph - Schlieren system – Background Oriented Schliren (BOS) System - Hydraulic analogy – Hydraulic jumps – Electrolytic tank

UNIT IV PRESSURE, VELOCITY AND TEMPERATURE MEASUREMENTS 10

Pitot-Static tube characteristics - Velocity measurements - Hot-wire anemometry – Constant current and Constant temperature Hot-Wire anemometer – Hot-film anemometry – Laser Doppler Velocimetry (LDV) – Particle Image Velocimetry (PIV) – Pressure Sensitive Paints - Pressure measurement techniques - Pressure transducers – Temperature measurements.

UNIT V DATA ACQUISITION SYSTEMS AND UNCERTAINTY ANALYSIS 9

Data acquisition and processing – Signal conditioning - Estimation of measurement errors – Uncertainty calculation - Uses of uncertainty analysis.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Rathakrishnan, E., “Instrumentation, Measurements, and Experiments in Fluids,” CRC Press – Taylor & Francis, 2007.

REFERENCES

1. Robert B Northrop, “Introduction to Instrumentation and Measurements”, Second Edition, CRC Press, Taylor & Francis, 2006.

AE9017 WIND ENGINEERING

	L	T	P	C
	3	0	0	3

UNIT I THE ATMOSPHERE 6

Atmospheric Circulation – Stability of atmospheres – definitions & implications – Effects of friction – Atmospheric motion – Local winds, Building codes, Terrains different types.

UNIT II ATMOSPHERIC BOUNDARY LAYER 9
Governing Equations – Mean velocity profiles, Power law, logarithmic law wind speeds, Atmospheric turbulence profiles – Spectral density function – Length scale of turbulence, Roughness parameters simulation techniques in wind tunnels.

UNIT III BLUFF BODY AERODYNAMICS 10
Governing Equations – Boundary layers and separations – Wake and Vortex formation two dimensional – Strouhal Numbers, Reynolds numbers – Separation and Reattachments Oscillatory Flow patterns Vortex sheding flow switching – Time varying forces to wind velocity in turbulent flow – Structures in three dimensional

UNIT IV WIND LOADING 10
Introduction, Analysis and synthesis loading coefficients, local & global coefficients pressure shear stress coefficients, force and moment coefficients – Assessment methods – Quasi steady method – Peak factor method – Extreme value method

UNIV V AEROELASTIC PHENOMENA 10
Vortex shedding and lock in phenomena in turbulent flows, across wind galloping wake galloping - Torsional divergence, along wind galloping of circular cables, cross wind galloping of circular cables, Wind loads & their effects on tall structures – Launch vehicles

TOTAL : 45 PERIODS

TEXT BOOKS

1. Emil Simiu & Robert H Scanlan, Wind effects on structures - fundamentals and applications to design, John Wiley & Sons Inc New York, 1996.

REFERENCES:

1. Tom Lawson Building Aerodynamics Imperial College Press London, 2001
2. N J Cook, Design Guides to wind loading of buildings structures Part I & II, Butterworths, London, 1985
3. IS: 875 (1987) Part III Wind loads, Indian Standards for Building codes.

AE9018 WIND TUNNEL TECHNIQUES L T P C
3 0 0 3

UNIT I PRINCIPLES OF MODEL TESTING: 6
Buckingham Theorem – Non dimensional numbers – Scale effect – Geometric Kinematics and Dynamic similarities.

UNIT II WIND TUNNELS: 8
Classification – special problems of testing in subsonic, transonic, supersonic and hypersonic speed regions – Layouts – sizing and design parameters.

UNIT III CALIBRATION OF WIND TUNNELS: 10
Test section speed – Horizontal buoyancy – Flow angularities – Turbulence measurements – Associated instrumentation – Calibration of supersonic tunnels.

UNIT IV WIND TUNNEL MEASUREMENTS: 12

Steady and Unsteady Pressure and Velocity measurements – Force measurements – Three component and six component balances – Internal balances – Principles of Hotwire Anemometer.

UNIT V FLOW VISUALIZATION: 9

Smoke and Tuft techniques – Dye injection special techniques – Optical methods of flow visualization.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Rae, W.H. and Pope, A., Low Speed Wind Tunnel Testing, John Wiley Publications, 1984.
2. Pope, A., and Goin, L., High Speed Wind Tunnel Testing, John Wiley, 1985.

REFERENCES

1. P. Bradshaw, Experimental Fluid Mechanics, Pergamon Press, Macmillan Co., New York, 1964.

AE9019 ROCKETRY AND SPACE MECHANICS L T P C
3 0 0 3

OBJECTIVE

To introduce basic concepts of design and trajectory estimation of rockets and missiles.

UNIT I ORBITAL MECHANICS 9

Description of solar system – Kepler's Laws of planetary motion – Newton's Law of Universal gravitation – Two body and Three-body problems – Jacobi's Integral, Librations points - Estimation of orbital and escape velocities

UNIT II SATELLITE DYNAMICS 9

Geosynchronous and geostationary satellites life time – satellite perturbations – Hohmann orbits – calculation of orbit parameters – Determination of satellite rectangular coordinates from orbital elements

UNIT III ROCKET MOTION 10

Principle of operation of rocket motor - thrust equation – one dimensional and two dimensional rocket motions in free space and homogeneous gravitational fields – Description of vertical, inclined and gravity turn trajectories determinations of range and altitude – simple approximations to burnout velocity – staging of rockets.

UNIT IV ROCKET AERODYNAMICS 9

Description of various loads experienced by a rocket passing through atmosphere – drag estimation – wave drag, skin friction drag, form drag and base pressure drag – Boat-tailing in missiles – performance at various altitudes – conical and bell shaped nozzles – adapted nozzles – rocket dispersion – launching problems.

UNIT V STAGING AND CONTROL OF ROCKET VEHICLES 8

Need for multistaging of rocket vehicles – multistage vehicle optimization – stage separation dynamics and separation techniques- aerodynamic and jet control methods of rocket vehicles - SITVC.

TOTAL : 45 PERIODS

TEXT BOOKS

1. G.P. Sutton, "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 5th Edition, 1986.
2. J.W. Cornelisse, "Rocket Propulsion and Space Dynamics", J.W. Freeman & Co., Ltd., London, 1982.

REFERENCES

1. Van de Kamp, "Elements of astromechanics", Pitman Publishing Co., Ltd., London, 1980.
2. E.R. Parker, "Materials for Missiles and Spacecraft", McGraw-Hill Book Co., Inc., 1982.

AE9020 COMPOSITE MATERIALS AND STRUCTURES

L	T	P	C
3	0	0	3

OBJECTIVE

To understand the fabrication, analysis and design of composite materials & structures.

UNIT I INTRODUCTION 10

Classification and characteristics of composite materials - Types of fiber and resin materials, functions and their properties – Application of composite to aircraft structures- Micromechanics-Mechanics of materials, Elasticity approaches-Mass and volume fraction of fibers and resins-Effect of voids, Effect of temperature and moisture.

UNIT II MACROMECHANICS 10

Hooke's law for orthotropic and anisotropic materials-Lamina stress-strain relations referred to natural axes and arbitrary axes.

UNIT III ANALYSIS OF LAMINATED COMPOSITES 10

Governing equations for anisotropic and orthotropic plates- Angle-ply and cross ply laminates- Analysis for simpler cases of composite plates and beams - Interlaminar stresses.

UNIT IV MANUFACTURING & FABRICATION PROCESSES 8

Manufacture of glass, boron and carbon fibers-Manufacture of FRP components- Open mould and closed mould processes. Properties and functions of resins.

UNIT V OTHER METHODS OF ANALYSIS AND FAILURE THEORY 7

Netting analysis- Failure criteria-Flexural rigidity of Sandwich beams and plates.

TOTAL : 45 PERIODS

TEXT BOOKS

1. R.M. Jones, "Mechanics of Composite Materials", 2nd Edition, Taylor & Francis, 1999

2. L.R. Calcote, “Analysis of laminated structures”, Van Nostrand Reinhold Co., 1989.
3. Autar K. Kaw, Mechanics of Composite Materials, CRC Press LLC, 1997

REFERENCES

1. G.Lubin, “Hand Book on Fibre glass and advanced plastic composites”, Van Nostrand Co., New York, 1989.
2. B.D. Agarwal and L.J. Broutman, “Analysis and Performance of fiber composites”, John-Wiley and Sons, 1990.

AE 9007 THEORY OF PLATES AND SHELLS L T P C
3 0 0 3

OBJECTIVE:
To study the behaviour of the plates and shells with different geometry under various types of loads.

UNIT I CLASSICAL PLATE THEORY 8
Classical Plate Theory – Assumptions – Differential Equations – Boundary Conditions.

UNIT II PLATES OF VARIOUS SHAPES 10
Navier’s Method of Solution for Simply Supported Rectangular Plates – Levy’s Method of Solution for Rectangular Plates under Different Boundary Conditions – Circular plates.

UNIT III EIGEN VALUE ANALYSIS 8
Stability and Free Vibration Analysis of Rectangular Plates.

UNIT IV APPROXIMATE METHODS 10
Rayleigh – Ritz, Galerkin Methods– Finite Difference Method – Application to Rectangular Plates for Static, Free Vibration and Stability Analysis.

UNIT V SHELLS 9
Basic Concepts of Shell Type of Structures – Membrane and Bending Theories for Circular Cylindrical Shells.

L :45 –TOTAL NUMBER OF PERIODS : 45

TEXT BOOKS

1. Timoshenko, S.P. Winowsky. S., and Kreger, Theory of Plates and Shells, McGraw Hill Book Co., 1990.
2. T.K.Varadan & K. Bhaskar, “Análysis of plates – Theory and problems”, Narosha Publishing Co., 1999.

REFERENCES

1. Flugge, W. Stresses in Shells, Springer – Verlag, 1985.
2. Timoshenko, S.P. and Gere, J.M., Theory of Elastic Stability, McGraw Hill Book Co. 1986.
3. Harry Kraus, ‘Thin Elastic Shells’, John Wiley and Sons, 1987.

AE 9001 EXPERIMENTAL STRESS ANALYSIS L T P C
3 0 0 3

OBJECTIVE

To bring awareness on experimental method of finding the response of the structure to different types of load.

UNIT I INTRODUCTION 8

Principle of measurements-Accuracy, sensitivity and range- Mechanical, Optical, Acoustical and Electrical extensometers.

UNIT II ELECTRICAL RESISTANCE STRAIN GAUGES 12

Principle of operation and requirements-Types and their uses-Materials for strain gauge-Calibration and temperature compensation-Cross sensitivity-Rosette analysis-Wheatstone bridge-Potentiometer circuits for static and dynamic strain measurements-Strain indicators.

UNIT III PRINCIPLES OF PHOTOELASTICITY 9

Two dimensional photo elasticity-Concepts of photoelastic effects-Photoelastic materials-Stress optic law-Plane polariscope–Circular polariscope-Transmission and Reflection type-Effect of stressed model in Plane and Circular polariscope. Interpretation of fringe pattern Isoclinics and Isochromatics.-Fringe sharpening and Fringe multiplication techniques-Compensation and separation techniques-Introduction to three dimensional photoelasticity.

UNIT IV PHOTOELASTICITY AND INTERFEROMETRY TECHNIQUES 9

Fringe sharpening and Fringe multiplication techniques-Compensation and separation techniques-Calibration methods –Photo elastic materials. Introduction to three dimensional photoelasticity. Moire fringes – Laser holography – Grid methods-Stress coat

UNIT V NON DESTRUCTIVE TECHNIQUES 7

Radiography- Ultrasonics- Magnetic particle inspection- Fluorescent penetrant technique-Eddy current testing- Acoustic emission technique.

L : 45, TOTAL : 45

TEXT BOOKS

1. J.W. Dally and M.F. Riley, “Experimental Stress Analysis”, McGraw-Hill Book Co., New York, 1988.
2. Srinath,L.S., Raghava,M.R., Lingaiah,K. Gargesha,G.,Pant B. and Ramachandra,K. – Experimental Stress Analysis, Tata McGraw Hill, New Delhi, 1984
3. P. Fordham, “Non-Destructive Testing Techniques” Business Publications, London, 1988.

REFERENCES

1. M. Hetenyi, “Handbook of Experimental Stress Analysis”, John Wiley & Sons Inc., New York, 1980.
2. G.S. Holister, “Experimental Stress Analysis, Principles and Methods”, Cambridge University Press, 1987.
3. A.J. Durelli and V.J. Parks, “Moire Analysis of Strain”, Prentice Hall Inc., Englewood Cliffs, New Jersey, 1980.