PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

I. **PEO 1:** Successful Moulding of Graduate into Aeronautical Engineering Professional: Graduates of the programme will acquire adequate knowledge both in practical and theoretical domains in the field of Aeronautical Engineering through rigorous post graduate education.

II. **PEO 2:** Successful Career Development: Graduates of the programme will have successful technical and managerial career in Aeronautical Engineering industries and the allied management.

III. **PEO 3:** Contribution to Aeronautical Engineering Field: Graduates of the programme will have innovative ideas and potential to contribute for the development and current needs of the Aviation industries.

IV. **PEO 4:** Sustainable interest for Lifelong learning: Graduates of the programme will have sustained interest to learn and adapt new technology developments to meet the changing industrial scenarios.

PROGRAMME OUTCOMES (POs)

On successful completion of the programme,
1. Post Graduate will acquire the ability to design and conduct experiments, as well as to analyze and interpret data in the field of Aeronautical Engineering.
2. Post Graduate will have the ability to design a system or a component to meet the design requirements with constraints exclusively meant for Aeronautical Engineering.
3. Post Graduate will become familiar with modern engineering tools and analyze problems within the domains of Aeronautical Engineering
4. Post Graduate will acquire an understanding of professional and ethical responsibility with reference to their career in the field of Aeronautical Engineering and other allied professional fields.
5. Post Graduate will be able to communicate effectively both in verbal and nonverbal forms.
6. Post Graduate will be trained towards developing and understanding the importance of design and development of Airplanes from system integration point of view.
7. Post Graduate will be capable of understanding the value of lifelong learning.
8. Post Graduate will exhibit the awareness of contemporary issues focusing on the necessity to develop new materials, design and testing methods for the solution of problems related to aircraft industry.

9. Post Graduate will have a firm scientific, technological and communication base that helps him to find a placement in the aircraft industry and Research & Development organizations related to Aeronautical Engineering and other professional fields.

10. Post Graduate will be capable of doing doctoral studies and research in inter and multidisciplinary areas.

Mapping of PEOs with POs

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### M.E. Aeronautical Engineering (FT/PT)

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M.E. AERONAUTICAL ENGINEERING (PART TIME)

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EMPLOYABILITY ENHANCEMENT COURSES (EEC)

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OBJECTIVE:
- To impart knowledge to students on basic governing equations of elasticity, solving of 2D problems in Cartesian and polar coordinates and also to introduce various theories and methods to solve torsion related problems.

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 – Biharmonications – 2-D problems– Cantilever and simply supported beams.

UNIT IV  2- D PROBLEMS IN POLAR COORDINATES  12

UNIT V  TORSION  8
Stress function approach and warping function approach – Torsion of Circular, Elliptical and Triangular sections - Membrane analogy.

TOTAL: 45 PERIODS

OUTCOMES:
- Upon completion of the course, students will understand the basic concepts of obtaining exact solution for structural mechanics problems.

REFERENCES
UNIT II PROPELLER THEORY
Momentum theory, Blade element theory, combined blade element and momentum theory, propeller power losses, propeller performance parameters, prediction of static thrust- and in flight, negative thrust, prop fans, ducted propellers, propeller noise, propeller selection, propeller charts.

UNIT III INLETS, NOZZLES AND COMBUSTION CHAMBERS

UNIT IV AXIAL FLOW COMPRESSORS, FANS AND TURBINES

UNIT V ROCKET AND ELECTRIC PROPULSION

OUTCOMES:
- Upon completion of the course, students will learn the principles of operation and design of aircraft and spacecraft power plants.

REFERENCES

AL7152 AEROSPACE STRUCTURES
OBJECTIVE:
- To make students learn important technical aspects on theory of bending, shear flow in open and closed sections, stability problems in structures with various modes of loading and also impart knowledge on how to analyze aircraft structural components under various forms of loading.

UNIT I BENDING OF BEAMS
Elementary theory of bending – Introduction to semi-monocoque structures - Stresses in beams of symmetrical and unsymmetrical sections -Box beams – General formula for bending stresses- principal axes method – Neutral axis method.
UNIT II  SHEAR FLOW IN OPEN SECTIONS  
Shear stresses in beams – Shear flow in stiffened panels - Shear flow in thin walled open tubes – Shear centre – Shear flow in open sections with stiffeners.

UNIT III  SHEAR FLOW IN CLOSED SECTIONS  
Shear flow in closed sections with stiffeners-- Angle of twist - Shear flow in two flange and three flange box beams – Shear centre - Shear flow in thin walled closed tubes - Bredt-Batho theory - Torsional shear flow in multi cell tubes - Flexural shear flow in multi cell stiffened structures.

UNIT IV  STABILITY PROBLEMS  
Stability problems of thin walled structures– Buckling of sheets under compression, shear, bending and combined loads - Crippling stresses by Needham’s and Gerard’s methods–Sheet stiffener panels-Effective width, Inter rivet and sheet wrinkling failures-Tension field web beams(Wagner’s).

UNIT V  ANALYSIS OF AIRCRAFT STRUCTURAL COMPONENTS  
Loads on Wings – Schrenk’s curve - Shear force, bending moment and torque distribution along the span of the Wing. Loads on fuselage - Shear and bending moment distribution along the length of the fuselage. Analysis of rings and frames.

OUTCOMES:  
Upon completion of the course, students will get knowledge on different types of beams and columns subjected to various types of loading and support conditions with particular emphasis on aircraft structural components.

REFERENCES  

AL7153  FLIGHT VEHICLE AERODYNAMICS  

OBJECTIVES:  
- To introduce the students the fundamental concepts and topic related to aerodynamics of flight vehicles like fundamental forms of flow, aerodynamic coefficient, incompressible and compressible flow theories, viscous flow measurements and various configuration of aircraft and wings.

UNIT I  INTRODUCTION TO AERODYNAMICS  
Hot air balloon and aircrafts, Various types of airplanes, Wings and airfoils, lift and Drag, Centre of pressure and aerodynamic centre, Coefficient of pressure, moment coefficient, Continuity and Momentum equations, Point source and sink, doublet, Free and Forced Vortex, Uniform parallel flow, combination of basic flows, Pressure and Velocity distributions on bodies with and without circulation in ideal and real fluid flows, Magnus effect

UNIT II  INCOMPRESSIBLE FLOW THEORY  
Conformal Transformation, Kutta condition, Karman – Trefftz profiles, Thin aerofoil Theory and its applications. Vortex line, Horse shoe vortex, Biot - Savart law, lifting line theory
UNIT III  COMPRESSIBLE FLOW THEORY  9
Compressibility, Isentropic flow through nozzles, shocks and expansion waves, Rayleigh and
Fanno Flow, Potential equation for compressible flow, small perturbation theory, Prandtl- Glauert
Rule, Linearised supersonic flow, Method of characteristics

UNIT IV  AIRFOILS, WINGS AND AIRPLANE CONFIGURATION IN HIGH SPEED
FLOWS  6
Critical Mach number, Drag divergence Mach number, Shock stall, super critical airfoils, Transonic
area rule, Swept wings (ASW and FSW), supersonic airfoils, wave drag, delta wings, Design
considerations for supersonic airplanes

UNIT V  VISCOS FLOW AND FLOW MEASUREMENTS  9
Basics of viscous flow theory – Boundary Layer – Displacement, momentum and Energy
Thickness – Laminar and Turbulent boundary layers – Boundary layer over flat plate – Blasius
Solution - Types of wind tunnels – Flow visualization techniques– Measurement of force and
moments in wind tunnels.

TOTAL: 45 PERIODS

OUTCOMES:
- Upon completion of the course, students will understand the behaviour of airflow over
bodies with particular emphasis on airfoil sections in the incompressible flow regime.

REFERENCES
2010.
4. E.L. Houghton and N.B. Caruthers, Aerodynamics for Engineering Students, Butterworth-
1989.
1999.

AL7154  ROCKETRY AND SPACE MECHANICS  L T P C
3 0 0 3

OBJECTIVES:
- To familiarize the students on fundamental aspects of rocket propulsion, multi stating of rocket
vehicle and spacecraft dynamics.

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- factors determining life time of satellites – satellite
perturbations – methods to calculate 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.

UNIT IV ROCKET AERODYNAMICS

UNIT V STAGING AND CONTROL OF ROCKET VEHICLES
Need for multi staging of rocket vehicles – multistage vehicle optimization – stage separation dynamics and separation techniques- aerodynamic and jet control methods of rocket vehicles - SITVC.

OUTCOMES:
- Upon completion of the course, students will have an idea about solar system, basic concepts of orbital mechanics with particular emphasis on interplanetary trajectories.

REFERENCES

MA7161 ADVANCED MATHEMATICAL METHODS
OBJECTIVES:
- To familiarize the students in differential equations for solving boundary value problems associated with engineering applications.
- To expose the students to calculus of variation, conformal mappings and tensor analysis.

UNIT I LAPLACE TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS
Laplace transform: Definitions, properties - Transform of error function, Bessel’s function, Dirac Delta function, Unit Step functions – Convolution theorem – Inverse Laplace Transform: Complex inversion formula – Solutions to partial differential equations: Heat equation, Wave equation.

UNIT II FOURIER TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS

UNIT III CALCULUS OF VARIATIONS
Concept of variation and its properties – Euler’s equation – Functional dependant on first and higher order derivatives – Functionals dependant on functions of several independent variables – Variational problems with moving boundaries – problems with constraints - Direct methods: Ritz and Kantorovich methods.
UNIT IV CONFORMAL MAPPING AND APPLICATIONS

Introduction to conformal mappings and bilinear transformations - Schwarz - Christoffel transformation – Transformation of boundaries in parametric form- Physical applications:
Fluid flow heat flow problems.

UNIT V TENSOR ANALYSIS


OUTCOME:
• This subject helps to develop the mathematical methods of applied mathematics and mathematical physics with an emphasis on calculus of variation and integral transforms.

TEXT BOOKS:

REFERENCES:

AL7161 AERODYNAMICS PROPULSION LABORATORY

OBJECTIVE:
• To expose students with a practical knowledge on various aerodynamic principles related to inviscid incompressible fluids, aerodynamic measurement techniques and testing of sub systems and components of aircraft at low speed.

LIST OF EXPERIMENTS:
1. Calibration of subsonic wind tunnel
2. Pressure distribution over a cambered aerofoil section
3. Force and moment measurements using wind tunnel balance
4. Pressure distribution over a wing of symmetric aerofoil section
5. Pressure distribution over a wing of cambered aerofoil section
6. Supersonic flow visualization studies
7. Total pressure measurements along the jet axis of a circular supersonic jet
8. Cold flow studies of a wake region behind flame holders
9. Wall pressure measurements of a noncircular combustor
10. Wall pressure measurements of a subsonic diffuser
11. Cascade testing of compressor blades.
Only 10 experiments need to be conducted.

OUTCOMES:
- Upon completion of the course, students will be in a position to use wind tunnel for pressure and force measurements on various models.

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

AL7201 ADVANCED PROPULSION SYSTEMS

OBJECTIVES:
- To familiarize the students on advanced air breathing propulsion systems like air augmented rockets, scramjets and also to introduce the students various technical details and operating principles of nuclear and electric propulsion.

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 – Subcritical, Critical and Supercritical charging.

UNIT II RAMJETS AND AIR AUGMENTED ROCKETS 8
Preliminary performance calculations – Diffuser design with and without spike, Supersonic inlets – combustion and nozzle design – integral Ram rocket.

UNIT III SCRAMJET PROPULSION SYSTEM 12

UNIT IV NUCLEAR PROPULSION 9

UNIT V ELECTRIC AND ION PROPULSION 8

TOTAL: 45 PERIODS
OUTCOMES:
- Upon completion of the course, students will learn in detail about gas turbines, ramjet, fundamentals of rocket propulsion and chemical rockets.

REFERENCES

AL7202 AIRPLANE PERFORMANCE, STABILITY AND CONTROL  L  T  P  C
OBJECTIVE:
- To impart knowledge to students on aircraft performance in level, climbing, gliding and accelerated flight modes and also various aspects of stability and control in longitudinal, lateral and directional modes.

UNIT I PRINCIPLES OF FLIGHT
12

UNIT II AIRCRAFT PERFORMANCE IN LEVEL, CLIMBING AND GLIDING FLIGHTS
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 ACCELERATED FLIGHT
10
Take off and landing performance, Turning performance, horizontal and vertical turn, Pull up and pull down, maximum turn rate, V-n diagram with FAR regulations.

UNIT IV LONGITUDINAL STABILITY AND CONTROL
15
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
12
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

OUTCOMES:
- Upon completion of the course, students will understand the static, dynamic longitudinal, directional and lateral stability and control of airplane, effect of maneuvers.

REFERENCES
AL7203  FINITE ELEMENT ANALYSIS  L  T  P  C
4  0  0  4

OBJECTIVES:
• To make students learn using Finite element techniques to solve problems related to
discrete, continuum and isoparametric elements. And also to introduce solution schemes
for static, dynamic and stability problems.

UNIT I  INTRODUCTION  12
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  14
Structural analysis of bar and beam elements for static and dynamic loadings. Bar of varying
section – Temperature effects. Program Development and use of software package for application
of bar and beam elements for static, dynamic and stability analysis. Solution for 2-D problems
(static analysis and heat transfer) using software packages.

UNIT III  CONTINUUM ELEMENTS  14
Plane stress, Plane strain and Axisymmetric problems – CST Element – LST Element. Consistent
and lumped load vectors. Use of local co-ordinates. Numerical integration. Application to heat
transfer problems.

UNIT IV  ISOPARAMETRIC ELEMENTS  12
Definition and use of different forms of 2-D and 3-D elements. - Formulation of element stiffness
matrix and load vector. Solution for 2-D problems (static analysis and heat transfer) using software
packages.

UNIT V  SOLUTION SCHEMES  8
Different methods of solution of simultaneous equations governing static, dynamics and stability
problems. General purpose Software packages.

OUTCOMES:
• Upon completion of the course, students will learn the concept of numerical analysis of
structural components

REFERENCES
2. Tirupathi R. Chandrupatla and Ashok D. Belegundu, Introduction to Finite Elements in
Engineering, Prentice Hall, 2002
4. Robert D. Cook, David S. Malkus, Michael E. Plesha and Robert J. Witt “Concepts and
AL7251 COMPOSITE MATERIALS AND STRUCTURES

OBJECTIVE: 3 0 0 3

- To impart knowledge to the students on the macro mechanics of composite materials, analysis and manufacturing methods of composite materials and introduce failure theories of composites.

UNIT I INTRODUCTION

UNIT II MACROMECHANICS
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
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

UNIT V OTHER METHODS OF ANALYSIS AND FAILURE THEORY
Netting analysis- Failure criteria-Flexural rigidity of Sandwich beams and plates – composite repair- AE technique.

TOTAL: 45 PERIODS

OUTCOMES:
- Upon completion of the course, students will understand the fabrication, analysis and design of composite materials & structures

REFERENCES
OBJECTIVES:
- To introduce to the students various numerical solution methods pertaining to grid generation, time dependant and panel methods and also techniques pertaining to transonic small perturbation force.

UNIT I  NUMERICAL SOLUTIONS OF SOME FLUID DYNAMICAL PROBLEMS  12

UNIT II  GRID GENERATION  12

UNIT III  TRANSONIC RELAXATION TECHNIQUES  12
Small perturbations flows, Transonic small perturbation (TSP) equations, Central and backward difference schemes, conservation equations and shock point 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. 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  12

UNIT V  PANEL METHODS  12
Elements of two and three dimensional panels, panel singularities. Application of panel methods to incompressible, compressible, subsonic and supersonic flows. 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.

OUTCOMES:
Upon completion of the course, students will learn the flow of dynamic fluids by computational methods.

REFERENCES
AL7261  AEROSPACE STRUCTURES LABORATORY  L T P C  0 0 4 2

OBJECTIVES:
- To impart practical knowledge to the students on calibration of photoelastic materials, determination of elastic constant for composite lamina, unsymmetrical bending of beams, determination of shear centre locations for closed and open sections and experimental studies.

LIST OF EXPERIMENTS
1. Constant strength Beams
2. Buckling of columns
3. Unsymmetrical Bending of Beams
4. Shear Centre Location for Open Section
5. Shear Centre Location for Closed Section
6. Flexibility Matrix for Cantilever Beam
7. Combined Loading
8. Calibration of Photo Elastic Materials
10. Vibration of Beams with Different Support Conditions
11. Fabrication of composite laminates
12. Characterization of composite laminates
13. Wagner beam

NOTE: Any TEN experiments will be conducted out of 13.

TOTAL: 60 PERIODS

OUTCOMES:
- Upon completion of the course, students will learn the concept of numerical analysis of structural components

LABORATORY EQUIPMENTS REQUIREMENTS
1. Constant strength beam setup
2. Column setup
3. Unsymmetrical Bending setup
4. Experimental setup for location of shear centre (open & close section)
5. Cantilever beam setup
6. Experimental setup for bending and torsional loads
7. Diffuser transmission type polariscope with accessories
8. Experimental setup for vibration of beams
10. Wagner beam setup

AL7001  ADVANCED COMPUTATIONAL FLUID DYNAMICS AND HEAT TRANSFER  L T P C  3 0 0 3

OBJECTIVES:
- Students will learn computational methods pertaining to compressible, incompressible flow using finite volume method, students will also learn modern computing methods and the computation of chemically reacting flows and combustion.

UNIT I  COMPUTATION OF INCOMPRESSIBLE VISCOUS FLOWS:
General - Artificial compressibility methods - Pressure correction methods - Semi-implicit method for pressure linked equations (SIMPLE) - Pressure implicit with splitting of operators - Marker and Cell (MAC) method - Vortex methods.
UNIT II  COMPUTATION OF COMPRESSIBLE INVISCID FLOWS:  
Potential equation - Euler equations - Central schemes with combined space time discretization - 
Central schemes with independent space time discretization - First order upwind schemes - 
Second order upwind schemes with low resolution - second order upwind schemes with high 
resolution - Essentially nonoscillatory scheme - Flux corrected transport schemes.

UNIT III  COMPUTATION OF COMPRESSIBLE VISCOUS FLOWS:  
Navier-Stokes system of equations - Preconditioning process for compressible and incompressible 
- Flowfield dependent variation methods - Artificial viscosity flux limiters - Fully implicit high order 
accurate schemes - Point implicit methods

UNIT IV  MODERN COMPUTING METHODS  
Domain decomposition methods - Multigrid methods - Parallel processing - Development of 
parallel algorithms - Parallel processing with domain decomposition and multigrid methods - Load 
balancing - Solution of Poisson equation with domain decomposition parallel processing - Solution 
of Navier-Stokes system of equations with multithreading.

UNIT V  COMPUTATION OF CHEMICALLY REACTIVE FLOWS AND COMBUSTION  
Governing equations in reactive flows - Chemical equilibrium computations - Solution methods of 
stiff chemical equilibrium equations - Applications to chemical kinetics calculations - Hypersonic 
reactive flows - Vibrational and electronic energy in non-equilibrium. 

TOTAL: 45 PERIODS

OUTCOMES:  
- Upon completion of the course students will learn the use of and application of finite 
  volume methods for both incompressible and compressible flows for solution of flow 
  problems and combustion problems.

REFERENCES
1. T.J.Chung, Computational Fluid Dynamics, Cambridge University Press, First South Asian 
   Edition 2003

AL7002  ADVANCED FLIGHT STRUCTURES  
OBJECTIVES:  
To make students learn the methodology to carry out structural design and analysis of 
advanced aerospace structures used in modern aircraft, missiles and spacecraft.

UNIT I  REVIEW  
Aerospace Structural Design Principles (Energy Methods, Beam Bending)

Unit II  PLATE THEORY  
Thin Plate Theory, Stress Resultants and Kinematics - Thin Plate Governing Equations and 
Boundary Conditions

UNIT III  ADVANCED CONCEPTS IN BUCKLING OF LIGHTWEIGHT STRUCTURES  
Thin Plate Solutions and Plate Buckling - Local and Global-Local Buckling of Thin Walled 
Structures
UNIT IV COMPOSITE MATERIALS 12

UNIT V INTRODUCTORY STRUCTURAL DYNAMICS AND AERO ELASTICITY 12
Introduction to Structural Vibration, Beam Free Vibration - Forced Response of a Beam Structure - Airfoil and Wing Divergence, Wing Divergence, Swept Wings - Control Effectiveness and Reversal - Airfoil Flutter, Wing Flutter, Swept Wings

TOTAL: 45 PERIODS

OUTCOMES:
- Upon completion of the course students will be able to carry out structural analysis of complex aerospace structures.

TEXT BOOK:

REFERENCE BOOKS:

AL7003 AERO ELASTICITY L T P C 3 0 0 3

OBJECTIVES:
- To make the students understand aero elastic phenomena, flutter and to make them to solve steady state aero elastic problems.

UNIT I AEROELASTIC PHENOMENA 6

UNIT II DIVERGENCE OF A LIFTING SURFACE 10

UNIT III STEADY STATE AEROLASTIC PROBLEMS 9

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 –

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

OUTCOMES:
Upon completion of the course, Students can understand the theoretical concepts of material behaviour with particular emphasis on their elasticity property.

REFERENCES

AL7004  AEROSPACE MATERIALS  L T P C
3 0 0 3

OBJECTIVES
- To impart knowledge to the students on mechanical behaviour, corrosion & heat treatment of aerospace materials and also to expose them to applications of ceramic & composites and high temperature characterization.

UNIT I  ELEMENTS OF AEROSPACE MATERIALS  9

UNIT II  MECHANICAL BEHAVIOUR OF MATERIALS  9
Linear and nonlinear elastic properties – Yielding, strain hardening, fracture, Bauchinger’s effect – Notch effect testing and flaw detection of materials and components – Comparative study of metals, ceramics plastics and composites.

UNIT III  CORROSION & HEAT TREATMENT OF METAL SAND ALLOYS  10

UNIT IV  CERAMICS AND COMPOSITES  9
UNIT V HIGH TEMPERATURE MATERIALS CHARACTERIZATION

Classification, production and characteristics—Methods and testing—Determination of mechanical and thermal properties of materials at elevated temperatures—Application of these materials in Thermal protection systems of Aerospace vehicles—super alloys—High temperature material characterization.

TOTAL: 45 PERIODS

OUTCOMES:
- Upon completion of this course, students will understand the advanced concepts of aerospace materials to the engineers and to provide the necessary mathematical knowledge that are needed in understanding their significance and operation. The students will have an exposure on various topics such elements of aerospace materials, mechanical behavior of materials, ceramics and composites and will be able to deploy these skills effectively in the understanding of aerospace materials.

REFERENCES
4. Raghavan, V., Materials Science and Engineering, Prentice Hall of India, New Delhi, 1993

AL7005 AIRCRAFT DESIGN

OBJECTIVES:
- To impart knowledge to the students on various types of power plant types and also to expose them principles of aerodynamics and structural design aspects.

UNIT I REVIEW OF DEVELOPMENTS IN AVIATION
Categories and types of aircrafts—various configurations—Layouts and their relative merits—strength, stiffness, fail safe and fatigue requirements—Maneuvering load factors—Gust and maneuverability envelopes—Balancing and maneuvering loads on tail planes.

UNIT II POWER PLANT TYPES AND CHARACTERISTICS
Characteristics of different types of power plants—Propeller characteristics and selection—Relative merits of location of power plant.

UNIT III PRELIMINARY DESIGN
Selection of geometric and aerodynamic parameters—Weight estimation and balance diagram—Drag estimation of complete aircraft—Level flight, climb, takeoff and landing calculations—range and endurance—static and dynamic stability estimates—control requirements.

UNIT IV SPECIAL PROBLEMS
Layout peculiarities of subsonic and supersonic aircraft—optimization of wing loading to achieve desired performance—loads on undercarriages and design requirements.

UNIT V STRUCTURAL DESIGN
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.

TOTAL: 45 PERIODS
OUTCOMES:
- Upon completion of the course, students will get the basic concept of aircraft design.

REFERENCES

AL7006 DESIGN OF TURBO MACHINES L T P C
3 0 0 3

OBJECTIVES:
- To introduce the students the basic design aspects of gas turbine engine components like compressor, turbine, combustion chamber, inlet and nozzle and also to introduce them to engine parametric analysis.

UNIT I INTRODUCTION TO TURBO MACHINES
Introduction to turbo machines - Types - Dimensional Analysis - Dimensions and Equations - The Buckingham \( \pi \) theorem - Model testing - Energy transfer - Components - Euler turbine equations.

UNIT II HYDRAULIC PUMPS & TURBINES
Centrifugal pumps-Slip factor-Pump losses - effect of blade shape-Volute Collector - Vane and Vane less diffuser - Cavitation-Suction specific speed-Axial flow pump-Pumping system design-life cycle analysis - Changing pump Speed Operation-Multi pump operation.
Pelton wheel - velocity triangles - Losses and Efficiencies - Reaction turbines - Losses-characteristics - Axial flow turbine - Cavitation.

UNIT III CENTRIFUGAL COMPRESSORS AND FANS
Centrifugal Compressor - Effect of Blade Shape on Performance - Velocity diagrams - Slip factor - Work done - diffuser - Compressibility effects - Mach number in the Diffuser - Centrifugal Compressor Characteristics - Stall - Surging - Chocking

UNIT IV AXIAL FLOW COMPRESSORS AND FANS
Velocity diagrams - Degree of reaction - Stage Loading - Lift and Drag Characteristics - Cascade nomenclature and terminology - 3- D Consideration - Multi Stage Performance - Axial Compressor Characteristics

UNIT V AXIAL FLOW AND RADIAL FLOW TURBINES
Introduction- velocity triangles and work output - Degree of reaction Blade loading coefficient - Stator and rotor losses - Free vortex design - Constant angle design.
Radial flow turbine - Velocity and Thermodynamic analysis - Spouting Efficiency - Turbine Efficiency - Application Specific Speed

TOTAL: 45 PERIODS

OUTCOMES:
- Upon completion of the course students will be able to carry out the preliminary design of gas turbine engine components like inlets & diffusers, combustion chambers, compressors and turbines.
REFERENCES:

AL7007  EXPERIMENTAL AERODYNAMICS  L T P C
3 0 0 3

OBJECTIVES:

- To make the students learn basic wind tunnel measurements and flow visualization methods, flow measurement variables and data acquisition method pertaining to experiments in aerodynamics.

UNIT I  BASIC MEASUREMENTS IN FLUID MECHANICS  8

UNIT II  WIND TUNNEL MEASUREMENTS  8

UNIT III  FLOW VISUALIZATION AND ANALOGUE METHODS  10
Visualization techniques – Smoke tunnel – Hele-Shaw apparatus - Interferometer – Fringe-Displacement method – Shadowgraph - Schlieren system – Background Oriented Schlieren (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

OUTCOMES:

- Upon completion of the course, students will learn about the measurement of flow properties in wind tunnels and their associated instrumentation.

REFERENCES
OBJECTIVE:
- To make the students learn basic principles of operation, electrical resistance strain gauges, photoelasticity and interferometric techniques and non destructive methods.

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- Application of strain gauges to wind tunnel balance.

UNIT III  PRINCIPLES OF PHOTOELASTICITY  9

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– thermography– MICRO FOCUS CT scan.

OUTCOMES:
- Upon completion of the course, students will be able to appreciate use of strain gauges and its principles, principle of photo elasticity and its use, NDT techniques

REFERENCES
AL7009  HELICOPTER AERODYNAMICS  

OBJECTIVES:

- To impart knowledge to the students and fundamental aspects of helicopter aerodynamics, performance of helicopters, stability and control aspects and also to expose them basic and aerodynamic design aspects.

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

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

UNIT V  AERODYNAMIC DESIGN  
Blade section design, Blade tip shapes, Drag estimation – Rear fuselage upsweep, vibration problem of Helicopter blades.

TOTAL: 45 PERIODS

OUTCOMES:

- Upon completion of the course, students will learn about the basic ideas of evolution, performance and associated stability problems of helicopter.

REFERENCES

AL7010  HIGH TEMPERATURE GAS DYNAMICS  

OBJECTIVES:

- To make the students learn the kinetic theory of hypersonic flows and statistical thermodynamic aspects of flows at very high temperatures and also to make them familiarize the calculations transport properties of gases high temperature.

UNIT I  INTRODUCTION  
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  
Introduction to statistical thermodynamics – Relevance to hypersonic flow - Microscopic description of gases – Boltzman distribution – Cartesian function

UNIT III  KINETIC THEORY AND HYPersonic FLOWS  
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  
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  

TOTAL: 45 PERIODS

OUTCOMES:
• Upon completion of the course, students will learn statistical thermodynamics and the transport properties of high temperature gases.

REFERENCES
3. William H. Heiser and David T. Pratt, Hypersonic Air breathing propulsion, AIAA Education Series.
5. T.K.Bose, High Temperature Gas Dynamics,

AL7011  MISSILE AERODYNAMICS  L T P C  3 0 0 3

OBJECTIVES:
• To impart knowledge to students on basic missile configurations and preliminary drag estimation. The objective is also to introduce slender body aerodynamics, aerodynamic aspects during launching phase and stability and control aspects of missile.

UNIT I  BASICS ASPECTS OF MISSILE AERODYNAMICS  
Classification of missiles-Aerodynamics characteristics and requirements of air to air missiles, air to surface missiles and surface to air missiles-Missile trajectories-fundamental aspects of hypersonic aerodynamics.

UNIT II  MISSILE CONFIGURATIONS AND DRAG ESTIMATION  
Types of Rockets and missiles-various configurations-components-forces on the vehicle during atmospheric flight-nose cone design and drag estimation
UNIT III AERODYNAMICS OF SLENDER AND BLUNT BODIES 9
Aerodynamics of slender and blunt bodies, wing-body interference effects-Asymmetric flow separation and vortex shedding-unsteady flow characteristics of launch vehicles- determination of aero elastic effects.

UNIT IV AERODYNAMIC ASPECTS OF LAUNCHING PHASE 9
Booster separation-cross wind effects-specific considerations in missile launching-missile integration and separation-methods of evaluation and determination- Wind tunnel tests – Comparison with CFD Analysis.

UNIT V STABILITY AND CONTROL OF MISSILES 9

OUTCOMES:
Upon completion of the course, Students will learn the concept of high speed aerodynamics and Configurations of missiles.

REFERENCES:

AL7012 NON DESTRUCTIVE TESTING AND EVALUATION L T P C 3 0 0 3

OBJECTIVE:
To impart knowledge to students on the fundamentals of nondestructive testing methods and techniques, aircraft inspection methodology using NDT methods and the structural health monitoring of aerospace structures. Students will also learn modern NDT techniques like acoustic emission, ultrasonic and thermographic testing methods.

UNIT I INTRODUCTION 9
Definition -Need for NDT→ NDT in PAF→NDT application- Structure Inspection - Detecting manufacturing or service- induced damage- Structural Deterioration- Structural Deterioration - Corrosion→ Fatigue (cyclic loading)→ Fabrication defects→ Operation and Maintenance→Unforeseen loading (overloads)- Inspection Levels- General Visual Inspection→ During pre, tru or post flight- Detailed Visual Inspection (DET) - During periodic inspection- Special Detailed Inspection (SDET) - Uses of NDT Methods.

UNIT II AIRCRAFT INSPECTION 6

UNIT III MODERN NDT TECHNIQUES 12
Sensor Based Inspections- Principle Excitation Source Signal - Image Display Recognition Result Input transducer Measurement Signal – Image transducer Processing- Infrared and thermal testing (IR)→ Impulse excitation technique (IET)→ Guided wave testing (GWT)→ Ellipsometry→ Remote field testing (RFT)-Magnetic flux leakage testing (MFL) - Direct current potential drop
measurement (DCPD) - Alternating current potential drop measurement (ACPD) - Alternating current field measurement (ACFM) - Electromagnetic testing (ET) – Acoustic emission testing (AE or AT) - Wire Rope NDT - Phased Array (PA) Ultrasonic's - Thermo graphic Testing

UNIT IV FUSELAGE INSPECTION

Digital Radiography- High Density Line Scan Solid State detectors-Flat Panel detectors (FPDs)- Pulsed Eddy Current Inspection- Shearography.

UNIT V STRUCTURAL HEALTH MONITORING

SHM- Continuous monitoring- fatigue, corrosion, excessive loads, impact – Advantages-
Production parameters- Environmental conditions – Flight parameters and conditions –
Loads/Strains - Damages- Structural Health Monitoring/Management - Automated assessment and prognostic of the health of aircraft

OUTCOMES:

- Upon completion of the course students will be capable of using or operating some non destructive methods like acoustic emission, ultrasonic and other structural health monitoring methods.

REFERENCES:


TEXT BOOKS:


AL7013 STRUCTURAL DYNAMICS

OBJECTIVE:

- To introduce the students the force deflection properties of structures, natural modes of vibration, principles of dynamics and energy and approximate methods for aerospace structures.

UNIT I FORCE DEFLECTION PROPERTIES OF SYSTEMS

UNIT II  PRINCIPLES OF DYNAMICS  9
Free and forced vibrations of systems with finite degrees of freedom – Response to periodic excitation – Impulse Response Function – Convolution Integral

UNIT III  NATURAL MODES OF VIBRATION  9
Equations of motion for Multi degree of freedom Systems - Solution of Eigen value problems – Normal coordinates and orthogonality Conditions. Modal Analysis

UNIT IV  ENERGY METHODS  9

UNIT V  APPROXIMATE METHODS  9
Approximate methods of evaluating the Eigen frequencies and eigen vectors by reduced, subspace, Lanczos, Power, Matrix condensation and QR methods.

TOTAL: 45 PERIODS

OUTCOMES:
• To study the effect of periodic and aperiodic forces on mechanical systems with matrix approach and also to get the natural characteristics of large sized problems using approximate methods.

TEXT BOOKS:

REFERENCES:

AL7014 THEOREY OF PLATES AND SHELLS  L T P C 3 0 0 3

OBJECTIVES:
• Gives exposure to formulation of governing equations, various types of analyses plate problems and the methods of solution.

UNIT I  CLASSICAL PLATE THEORY  8
Classical Plate Theory – Assumptions – Governing Equation – 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.- Different edge conditions and loads.

UNIT III  FREE VIBRATION ANALYSIS  8
Stability and Free Vibration Analysis of Rectangular Plates with various end conditions.
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.

OUTCOMES:
- Upon completion of the course, students will acquire knowledge on the analysis of plates
  and shells with different geometry under various types of loads.

REFERENCES
  Co., 1990.

AL7015  TRANSONIC AERODYNAMICS  L T P C
3 0 0 3

OBJECTIVES:
- Students will be exposed to linearized theory and unsteady flow characteristics of transonic
  flow.
- Students will also learn transonic expansion procedures and design and operation of
  transonic wind tunnels

UNIT I  INTRODUCTION  6

UNIT II  LINEARIZED THEORY  9
Equations of Acoustics. Galilean Transformation - Uniform Translation. Slender Body Theory -
Acoustics. Exact Equations of Planar Flow; Shock Waves and Entropy Jump. Linearized Theory
for Thin Airfoils.

UNIT III  TRANSONIC EXPANSION PROCEDURES  12
Expansion Procedure Applied to the Basic System of Equations. Expansion Procedures for Jet
Slender Bodies; Expansion Procedure, Area Rule. Lift and Drag Integrals. Unsteady Transonic
Flow.

UNIT IV  TRANSONIC AIRFOIL THEORY  9
Problem Formulation. Nose Singularity. Shock Waves at a Curved Surface. Numerical Methods-
TSP equations - Solution Methods - Physical Plane, Steady Flow. Airfoils at Sonic Velocity. The
Stabilization Law.
UNIT V TRANSONIC WIND TUNNELS

Wind tunnels- Wide slots, Narrow slots- slotted walls - Slotted walls with perforated Cover Plates- Transonic testing with wing flow Technique-Movable walls, Slotted walls, Perforated walls.

OUTCOMES:

- Upon completion of the course students will learn operational procedures of transonic wind tunnels and also transonic expansion procedures which will be useful in handling the flows containing both subsonic and supersonic regimes.

REFERENCES:


AL7016 WIND TURBINE ENGINEERING

OBJECTIVES:

- To make students learn the aerodynamic design aspects and controlling methods of wind turbines and also environmental aspects of wind energy production estimating methods.

UNIT I INTRODUCTION TO WINDENERGY

Background, Motivations, and Constraints, Historical perspective, Modern wind turbines, Components and geometry, Power characteristics.

UNIT II WIND CHARACTERISTICS AND RESOURCES

General characteristics of the wind resource, Atmospheric boundary layer characteristics, Wind data analysis and resource estimation, Wind turbine energy production estimates using statistical techniques

UNIT III AERODYNAMICS OF WIND TURBINES

Overview, 1-D Momentum theory, Ideal horizontal axis wind turbine with wake rotation, Airfoils and aerodynamic concepts -Momentum theory and blade element theory General rotor blade shape performance prediction - Wind turbine rotor dynamics

UNIT IV WIND TURBINE DESIGN& CONTROL

Brief design overview – Introduction -Wind turbine control systems -Typical grid-connected turbine operation -Basic concepts of electric power- Power transformers -Electrical machines

UNIT V ENVIRONMENTAL AND SITE ASPECTS


OUTCOMES:

- Upon completion of the course, students will learn about aerodynamics, design and control of wind turbines.

REFERENCES:

AL7071  COMBUSTION IN JET AND ROCKET ENGINES  L T P C  3 0 0 3

OBJECTIVES:

- To impart knowledge to the students and basic principles of combustion, types of flames and also make them familiarize the combustion process in gas turbine, ramjet, scram jet and rocket engines.

UNIT I  THERMODYNAMICS OF COMBUSTION  8
Stoichiometry – absolute enthalpy- enthalpy of formation- enthalpy of combustion- laws of thermochemistry- pressure and temperature effect on enthalpy of formation, adiabatic flame temperature, chemical and equilibrium products of combustion.

UNIT II  PHYSICS AND CHEMISTRY OF COMBUSTION  9

UNIT III  PREMIXED AND DIFFUSED FLAMES  12

UNIT IV  COMBUSTION IN GAS TURBINE , RAMJET AND SCRAMJET  8
Combustion in gas turbine chambers, recirculation, combustion efficiency, flame holders, subsonic combustion in ramjet, supersonic combustion in scramjet. Subsonic and supersonic combustion controlled by decision mixing and heat convection.

UNIT V  COMBUSTION IN CHEMICAL ROCKET  8

TOTAL: 45 PERIODS

OUTCOMES:

- Upon completion of the course, students will learn about the thermodynamics, physics and chemistry of combustion.

REFERENCES

AL7072  FATIGUE AND FRACTURE MECHANICS  L T P C  3 0 0 3

OBJECTIVE:

- To make the students learn about fundamentals of fatigue & fracture mechanics, statistical aspects of fatigue behaviour & fatigue design and testing of aerospace structures.

UNIT I  FATIGUE OF STRUCTURES  10
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

UNIT IV  FRACTURE MECHANICS  15

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

OUTCOMES:
• Upon completion of the course, students will learn about fracture behaviour, fatigue design and testing of structures.

REFERENCES

AL7073  HIGH SPEED JET FLOWS  L T P C
30 0 3

OBJECTIVES:
• To make the students learn about various jet control methods, jet acoustics aspects and free shear layer flow theory pertaining to turbulent jets with high speed.

UNIT I  INTRODUCTION  9

UNIT II  COMPRESSIBLE FLOW THEORY  9
One-dimensional compressible fluid flow – flow through variable area passage – nozzles and diffusers –normal and oblique shock waves and calculation of flow and fluid properties across the shocks and expansion fans. Interaction of shocks with solid and fluid surface.

UNIT III  JET CONTROL  9
Types of jet control - single jet, multi jet, co-flow jet, parallel flow jet. Subsonic jets- Mathematical treatment of jet profiles- Theory of Turbulent jets- Mean velocity and mean temperature-
Turbulence characteristics of free jets - Mixing length- Experimental methods for studying jets and the Techniques used for analysis- Expansion levels of jets- Overexpanded, Correctly expanded, Underexpanded jets - Control of jets. Centre line decay, Mach number Profile, Iso-Mach (or isobaric) contours, Shock cell structure in underexpanded and overexpanded jets, Mach discs.

UNIT IV BOUNDARY LAYER CONCEPT
Boundary Layer – displacement and momentum thickness- laminar and turbulent boundary layers over flat plates – velocity distribution in turbulent flows over smooth and rough boundaries- laminar sublayer. Shock-boundary layer interactions.

UNIT V JET ACOUSTICS

OUTCOMES:
- Upon completion of the course, students will learn the basics of nozzle flows, methods of jet control and acoustics of jet.

REFERENCES
UNIT IV INTERPLANETARY TRAJECTORIES

UNIT V BALLISTIC MISSILE TRAJECTORIES

TOTAL: 45 PERIODS

OUTCOMES:
- Upon completion of the course student will be to perform basic trajectory computations pertaining to interplanetary flight, ballistic missile flight and will be able to learn computational methods for satellite injection and satellite perturbations.

TEXT BOOKS:

REFERENCES:

AL7075 THEORY OF BOUNDARY LAYERS

OBJECTIVES
- To impart knowledge to students on growth of boundary layer and its effect on the aerodynamic design of airframe of flight vehicles and also to introduce them the solution methods for boundary layer problems.

UNIT I FUNDAMENTAL EQUATIONS OF VISCOUS FLOW
Fundamental equations of viscous flow, Conservation of mass, Conservation of Momentum-Navier-Stokes equations, Energy equation, Mathematical character of basic equations, Dimensional parameters in viscous flow, Non-dimensionalising the basic equations and boundary conditions, vorticity considerations, creeping flow, boundary layer flow

UNIT II SOLUTIONS OF VISCOUS FLOW EQUATIONS
Solutions of viscous flow equations, Couette flows, Hagen-Poiseuille flow, Flow between rotating concentric cylinders, Combined Couette-Poiseuille Flow between parallel plates, Creeping motion, Stokes solution for an immersed sphere, Development of boundary layer, Displacement thickness, momentum and energy thickness.

UNIT III LAMINAR BOUNDARY LAYER
Laminar boundary layer equations, Flat plate Integral analysis of Karman – Integral analysis of energy equation – Laminar boundary layer equations – boundary layer over a curved body-Flow separation- similarity solutions, Blasius solution for flat-plate flow, Falkner–Skan wedge flows, Boundary layer temperature profiles for constant plate temperature –Reynold’s analogy, Integral equation of Boundary layer – Pohlhausen method – Thermal boundary layer calculations
UNIT IV  TURBULENT BOUNDARY LAYER  10
Turbulence-physical and mathematical description, Two-dimensional turbulent boundary layer equations — Velocity profiles – The law of the wall – The law of the wake – Turbulent flow in pipes and channels – Turbulent boundary layer on a flat plate – Boundary layers with pressure gradient, Eddy Viscosity, mixing length , Turbulence modelling

UNIT V  BOUNDARY LAYER CONTROL  7
Boundary layer control in laminar flow-Methods of Boundary layer control: Motion of the solid wall-Acceleration of the boundary layer-Suction- Injection of different gas-Prevention of transition-Cooling of the wall-Boundary layer suction-Injection of a different gas.

TOTAL: 45 PERIODS

OUTCOMES:
• To make the student understand the importance of viscosity and boundary layer in fluid flow. To introduce the theory behind laminar and turbulent boundary layers.

TEXT BOOKS:

REFERENCES:

AS7151  COMPUTATIONAL HEAT TRANSFER  L T P C
3 0 0 3

OBJECTIVES:
• To make the students learn to solve conductive, transient conductive, convective, radiative heat transfer problems using computational methods.

UNIT I  INTRODUCTION  9
Finite Difference Method-Introduction-Taylor’s series expansion-Discretisation Methods Forward, backward and central differencing scheme for 1st order and second order Derivatives – Types of partial differential equations-Types of errors. Solution to algebraic equation-Direct Method and Indirect Method-Types of boundary condition. FDM - FEM - FVM.

UNIT II  CONDUCTIVE HEAT TRANSFER  9

UNIT III  TRANSIENT HEAT CONDUCTION  9

UNIT IV  CONVECTIVE HEAT TRANSFER  9
UNIT V  RADIATIVE HEAT TRANSFER


OUTCOMES:

- Upon completion of the course, students will learn the concepts of computation applicable to heat transfer for practical applications.

REFERENCES


AS7251 CHEMICAL ROCKET TECHNOLOGY  L T P C

3 0 0 3

OBJECTIVES:

- To make student to acquire in depth knowledge in solid, liquid, hybrid rocket propulsion systems and also testing and performance of rocket propellants.

UNIT I  SOLID ROCKET PROPULSION

Various subsystems of Solid rocket motor and their functions-Propellant grain design-erosive burning- L*instability –internal ballistics of solid rocket motor–types of ignites- igniter design considerations– special problems of solid rocket nozzles.

UNIT II  LIQUID ROCKET PROPULSION


UNIT III HYBRID ROCKET PROPULSION


UNIT IV PROPELLANT TECHNOLOGY

UNIT V   TESTING AND SAFETY
Static testing of rocket—instrumentation required—thrust Vs time—pressure Vs time diagrams—specific impulse calculation—safety procedures for testing of rockets and solid propellants—ignition delay testing.

OUTCOMES:
Upon completion of this course, students acquire knowledge in depth about chemical rocket propulsion

REFERENCES

AS7253   HYPersonic aerodynamics

OBJECTIVES:
To make students learn the peculiar hypersonic speed flow characteristics pertaining to flight vehicles and the approximate solution methods for hypersonic flows. The objective is also to impart knowledge on hypersonic viscous interactions and their effect on aerodynamic heating.

UNIT I   BASICS OF HYPERSONIC AERODYNAMICS
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
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

UNIT IV   VISCOUS HYPERSONIC FLOW THEORY
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 – heat flux estimation.

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

OUTCOMES:
Upon completion of the course, students will learn basics of hypersonic flow, shock wave-boundary layer interaction and hypersonic aerodynamic heating.

TOTAL: 45 PERIODS
REFERENCES
2. John D. Anderson, Jr., Modern Compressible Flow with Historical perspective Hypersonic Series.