AE- 501

AERODYNAMICS-II

UNIT-I FUNDAMENTAL ASPECTS OF COMPRESSIBLE FLOW
Compressibility, Continuity, Momentum and energy equation, Calorically perfect gas, Mach number, speed of sound –Velocity relation, Mach cone, Mach angle, One dimensional Isentropic flow through variable area duct, Static and Stagnation properties, Critical conditions, Characteristic Mach number, Area-Mach number relation, Maximum discharge velocity.

UNIT-II SHOCK AND EXPANSION WAVES
Normal shock relations, Prandtl's relation, Hugoniot equation, Rayleigh Supersonic Pitot tube equation, Moving normal shock waves, Oblique shocks, Θ-β-M relation, Shock Polar, Reflection of oblique shocks, left running and right running waves, Interaction of oblique shock waves, slip line, Rayleigh flow, Fanno flow, Expansion waves, Prandtl-Meyer expansion, Maximum turning angle, Simple and non-simple regions, operating characteristics of Nozzles.

UNIT-III TWO DIMENSIONAL COMPRESSIBLE FLOW
Potential equation for 2-dimensional compressible flow, Linearization of potential equation, perturbation potential, Linearized Pressure Coefficient, Linearized subsonic flow, Prandtl-Glauert rule, Linearized supersonic flow, Method of characteristics.

UNIT-IV HIGH SPEED FLOW OVER AIRFOILS, WINGS AND AIRPLANE
Supercritical Airfoil Sections, Transonic area rule, Swept wing, Airfoils for supersonic flows, Lift, drag, Pitching moment and Centre of pressure for supersonic profiles, Shock expansion theory, wave drag, supersonic wings, Design considerations for supersonic aircrafts.

UNIT-V SPECIAL TOPICS
Shock-Boundary layer interaction, Wind tunnels for transonic, Supersonic and hypersonic flows, shock tube, Gun tunnels, Supersonic flow visualization, Introduction to Hypersonic Flows.

TEXT BOOKS
1. Anderson, J. D, Modern Compressible Flow, McGraw-Hill & Co., 2002.
2. Rathakrishnan, E, Gas Dynamics, Prentice Hall of India, 2004.

REFERENCES
1. Shapiro, A. H., Dynamics and Thermodynamics of Compressible Fluid Flow, Ronald Press, 1982.
2. Zucrow, M. J. and Anderson, J. D., Elements of Gas Dynamics, McGraw- Hill &Co.
3. Oosthuizen, P.H., & Carscallen, W.E., Compressible Fluid Flow, McGraw- Hill &Co.

LIST OF EXPERIMENTS
1. The lift and drag over an NACA-0012 Aerofoil
2. Study of shock tube
3. Study of supersonic aircraft vehicle.
4. Shock wave generation over the spacecraft.
5. Study of subsonic compressible flow.

AE-502
AIRCRAFT PROPULSION –II

UNIT I AIRCRAFT GAS TURBINES
Impulse and Reaction Types of gas turbines – Velocity triangles and power output –Elementary theory Vortex theory – Choice of blade profile, pitch and chord – Estimation of stage performance– Limiting factors in gas turbine design- Overall turbine performance – Methods of blade cooling –Matching of turbine and compressor – Numerical problems.

UNIT II RAMJET PROPULSION
Operating principle – Sub critical, critical and supercritical operation – Combustion in ramjet Engine – Ramjet performance – Sample ramjet design calculations – Introduction to scramjetPreliminary concepts in supersonic combustion – Integral ram- rocket- Numerical problems.

UNIT III FUNDAMENTALS OF ROCKET PROPULSION
Operating principle – Specific impulse of a rocket - Rocket nozzle classification – Rocket performance considerations – Numerical Problems.

UNIT IV CHEMICAL ROCKETS
Solid propellant rockets – Selection criteria of solid propellants – Important hardware components of solid rockets – Propellant grain design considerations – Liquid propellant rockets– Selection of liquid propellants – Thrust control in liquid rockets – Cooling in liquid rockets –Limitations of hybrid rockets.

UNIT V ADVANCED PROPULSION TECHNIQUES
Electric rocket propulsion – Ion propulsion techniques – Nuclear rocket – Types – Solar sail- Preliminary Concepts in nozzle less propulsion.

TEXT BOOKS
1. Anderson J.D. 'Introduction to flight' McGraw Hill Education (India) Pvt. Ltd.
2. Ganesan V. 'Gas Turbines' McGraw Hill Education (India) Pvt. Ltd.
3. Sutton, G.P., "*Rocket Propulsion Elements*", John Wiley & Sons Inc., New York, 5thEdn.

REFERENCES
1. Cohen, H., Rogers, G.F.C. and Saravanamuttoo, H.I.H., "*Gas Turbine Theory*", Longman Co., ELBS Ed., 1919.
2. Gorden, C.V., "*Aero thermodynamics of Gas Turbine and Rocket Propulsion*", AIAA Education Series, New York, 1919.

LIST OF EXPERIMENTS:-
1. Water Rocket
2. Water jet study
3. Calorific value estimation
4. Ignition Delay Measurement
5. Identification of burning rate

AE 503
AIRCRAFT STRUCTURES –I

UNIT I STATICALLY DETERMINATE STRUCTURES
Analysis of plane truss – Method of joints – 3 D Truss - Plane frames

UNIT II STATICALLY INDETERMINATE STRUCTURES
Composite beam - Clapeyron's Three Moment Equation - Moment Distribution Method.

UNIT III ENERGY METHODS
Strain Energy due to axial, bending and Torsional loads – Castiglione's 1st Theorem - Maxwell's Reciprocal theorem, Principle of virtual work (Unit load method) - application to beams, trusses, frames, etc.

UNIT IV COLUMNS
Columns with various end conditions – Euler's Column curve – Rankine's formula – Column with initial curvature - Eccentric loading – South well plot – Beam column.

UNIT V FAILURE THEORY
Maximum Stress theory – Maximum Strain Theory – Maximum Shear Stress Theory – Distortion Theory – Maximum Strain energy theory – Application to aircraft Structural problems.

TEXT BOOK
1. Ramamrutham S. & Narayan R. 'Theory of Structure' Dhanpat Rai Publishing company.

REFERENCE
1. Timoshenko, S., "*Strength of Materials",* Vol. I and II, Princeton D. Von Nostrand Co, 1990
2. Donaldson, B.K., "*Analysis of Aircraft Structures – An Introduction*", McGraw-Hill, 1993.

LIST OF EXPERIMENTS
1. study the construction of fuselage and identify the primary load carrying members
2. Study the construction of wings.
3. Measurement of deflection of Truss members.
4. Study of Composite structure.
5. Study the construction of landing gears.
6. Measurement of deflection of simply supported beam

AE504
CIVIL AVIATION REQUIREMENTS

UNIT-I   C.A.R.   SERIES 'A AND B'
C.A.R. SERIES A –Procedure for Civil Air Worthiness Requirements and Responsibility Operators Vis-À-Vis Air Worthiness Directorate
 Responsibilities of operators / owners-Procedure of CAR issue, amendments etc., Objectives and targets of airworthiness directorate; Airworthiness regulations & safety oversight of engineering activities of operators.
C.A.R. SERIES'B' –Issue Approval of Cockpit Check List, MEL, CDL

UNIT-II   C.A.R.   SERIES 'C' AND 'D'
C.A.R. SERIES'C' –Defect Recording, Monitoring, Investigation and Reporting
Defect recording, reporting, investigation, rectification and analysis; Flight report; Reporting and rectification of defects observed on aircraft; Analytical study of in-flight readings & recordings; Maintenance control by reliability Method.
C.A.R. SERIES'D' – AND AIRCRAFT MAINTENANCE PROGRAMMES
Reliability Programmes (Engines); Aircraft maintenance programme & their approval; on condition maintenance of reciprocating engines; TBO–Revision programme; Maintenance of fuel and oil uplift and consumption records –Light aircraft engines.

UNIT-III C.A.R. SERIES E AND'F'
C.A.R. SERIES E–Approval of Organisation
Approval of organizations in categories A, B, C, D, E, F, & G - Requirements of infrastructure at stations other than parent base.
C.A.R. SERIES'F'–Airworthiness and Continued Air Worthiness
Procedure relating to registration of aircraft; Procedure for issue/revalidation of Type Certificate of aircraft & its engines/propeller; Issue/revalidation of Certificate of Airworthiness;

UNIT-IV C.A.R. SERIES 'L'&'M'
Issue of AME License, its classification and experience requirements, Mandatory Modifications /Inspections.

UNIT-V C.A.R.   SERIES 'T'&'X'
Flight testing of (Series) aircraft for issue of C of A; Flight testing of aircraft for which C of A had been previously issued. Registration Markings of aircraft; Weight and balance control of an
aircraft; Provision of first aid kits & Physician's kit in an aircraft; Concessions; Aircraft log books; Document to be carried on board on Indian registered aircraft; Procedure for issue of tax permit.
TEXT BOOKS
1. Aeronautical Information Circulars (relating to Airworthiness) from DGCA 2000.

REFERENCES
"Aircraft Manual (India) Volume"–Latest Edition, the English Book Store, 17-1, Connaught Circus, New Delhi

AE-505
FLIGHT DYNAMICS

Unit- I DRAG ON THE AIRPLANE
International Standard Atmosphere - Forces and moments acting on a flight vehicle - Equation of motion of a rigid flight vehicle - Different types of drag - Drag Polars of vehicles from low speed to high speeds - Variation of thrust, power with velocity and altitudes for air breathing engines - Power available and power required curves.

Unit- II AIRCRAFT PERFORMANCE
Performance of airplane in level flight - Maximum speed in level flight - Conditions for minimum drag and power required - Range and endurance - Climbing and gliding flight (Maximum rate of climb and steepest angle of climb, minimum rate of sink and shallowest angle of glide) -Turning performance (Turning rate turn radius). Bank angle and load factor - Limitations of pull up and push over - V-n diagram and load factor.

Unit – III STATIC LONGITUDINAL STABILITY
Degree of freedom of rigid bodies in space - Static and dynamic stability - Purpose of controls in airplanes -Inherently stable and marginal stable airplanes – Static, Longitudinal stability - Stick fixed stability - Basic equilibrium equation - Stability criterion - Effects of fuselage and nacelle - Influence of CG location - Power effects - Stick fixed neutral point - Stick free stability-Hinge moment coefficient - Stick free neutral points-Symmetric maneuvers - Stick force gradients - Stick _ force per 'g' - Aerodynamic balancing. Determination of neutral points from flight test.

Unit – IV LATERAL AND DIRECTIONAL STABILITY
Dihedral effect - Lateral control - Coupling between rolling and yawing moments – Adverse yaw effects - Aileron reversal - Static directional stability - Weather cocking effect – Rudder requirements - One engine inoperative condition - Rudder lock.

Unit –V DYNAMIC STABILITY
Dynamic longitudinal stability: Phugoid and short period oscillation, Equations of motion - Stability derivatives - Characteristic equation of stick fixed case - Modes and stability criterion - Effect of freeing-the stick - Brief description of lateral and directional. Dynamic stability - Spiral, wing torsional divergence, Dutch roll, Autorotation and spin.

Text Books:
1. Anderson J.D. 'Introduction to flight' McGraw Hill Education (India) Pvt. Ltd.
2. Clancy L.J. 'Aerodynamics' Sterling book house India.

References:
1 Perkins, C.D., and Hage, R.E., "Airplane Performance stability and Control", John Wiley & Son, Inc., New York, 1988.
1. Etkin, B., "Dynamics of Flight Stability and Control", Edn. 2, John Wiley, New YBabister, A.W., "Aircraft Dynamic Stability and Response", Pergamon Press, Oxford, 1980

LIST OF EXPERIMENTS

1. Introduction to flight testing (V-n diagram).
2. Evaluation of glider drag polar.
3. Evaluation of cruise and climb performance of a small airplane.
4. Observations of airplane dynamic modes and stall characteristics.
5. Introduction to GPS based navigation.
6. Introduction to auto-pilot.

AE 506
AIRCRAFT STRUCTURES REPAIR LAB

LIST OF EXPERIMENTS

1.   Patch repair welding using TIG.
2.   Patch repair welding using MIG.
3.   Patch repair welding using Plasma Arc.
4.   Exercise on pipe bending.
5.   Exercise on Riveted joints & repair work.
6.   Exercise on composites & repair work.
7.   Repair of Sandwich panels.
8.   Exercise on Sheet metal forming.
9.   Exercise on cable swaging.