AERODYNAMICS-I

IV Semester

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
A5AE11	PCC	3	1	-	4	30	70	100

COURSE OBJECTIVES

1. Understand the theoretical concepts underlying the development of lift, drag, and movement forces on aeronautical vehicle
2. Understand the concept of superposition of elementary flows for linear incompressible flow
3. Analyze the characteristics of airfoil and wing geometries and plan-form shapes to assist in determining aircraft performance
4. Analyze the characteristics of wing geometries and plan-form shapes to assist in determining aircraft performance
5. Be equipped to evaluate new lift-enhancement or drag-reduction devices and appreciate the directions and promise of upcoming developments in aerodynamic technology

UNIT-I BASICS OF AERODYNAMICS

NEW: Review of Fluid flow parameters, Flow regimes, Wing and airfoil geometry, aerodynamic force and moments, estimation of lift, drag and pitching moment from the pressure distribution, aerodynamic centre, centre of pressure, types of drag.
Governing Equations in integral and differential forms

UNIT-II ELEMENTARY FLOWS & COMBINATION OF FLOWS

Scalar and vector fields(revision), Velocity Potential and Stream function for 2-Dincompressible flow, Governing equation for irrotational incompressible flow- Laplace‘s equations, boundary conditions – Wall boundary and Free stream boundary
Uniform flow, source flow, doublet flow and vortex flow, Combination of uniform flow with a Source and Sink, Doublet, non-lifting and lifting flow over a circular cylinder. Kutta- Joukowski theorem and Magnus Effect, D Alembert s paradox.

Assignment/Project submission: Program to plot pressure distribution over a non-rotating cylinder and a spinning cylinder

UNIT-III AIRFOIL CHARACTERISTICS & THIN AIRFOIL THEORY

Introduction to airfoils- nomenclature, Types of Airfoils- NACA Series and their applications, Laminar flow airfoils, Low Reynolds number airfoils, Subsonic compressible flow past airfoils; Critical Mach number, drag divergence Mach number, supercritical airfoils, area rule.

THIN AIRFOIL THEORY: Vortex Filament, The vortex sheet, Kutta condition and Kelvin‘s circulation theorem. Classical thin airfoil theory: symmetric and cambered airfoil.

Assignment/Project submission: Program to calculate lift over NACA 2412 at a given angle of attack using thin airfoil theory

UNIT-IV FINITE WING THEORY

Downwash, induced drag, Biot-Savart’s law and Helmholtz’s theorem. Prandtl’s classical lifting line theory and fundamental equations. Elliptic and general lift distribution over finite unswept wings, effect

of aspect ratio, taper and thickness to chord ratio, **Subsonic** flow past swept and delta wings.

Assignment/Project submission: Program to calculate lift over wing Prandtl's classical lifting line theory

UNIT-V	APPLIED AERODYNAMICS

Lift augmentation and Drag Reduction methods - Flaps, slats, slots, winglets, Leading edge root extensions, Large Eddy Breakup device, Co-flow jet, Cuffs and vortex generators Circulation control, strakes. Drag augmentation methods – spoilers, Air brakes.
Propellers: Airscrew geometry, Froude Momentum Theory, Thrust Co-eff, Torque Co-eff, Power Co-eff, Efficiency, Activity factor, Blade element theory
Assignment/Project submission: Prepare models for wings different flap positions, and leading edge devices

Text Books:

1. Anderson J .D.(2011), Fundamental of Aerodynamics, 5th edition, McGraw-Hill International Edition, New York
2. E. L. Houghton, P.W. Carpenter (2010), Aerodynamics for Engineering Students, 5th edition, Elsevier, New York.

Reference Books:

1. L. J. Clancy, Aerodynamics, 1/e, Shroff Publications, 2006
2. J. J. Bertin and R. Cummings, Aerodynamics for Engineers, 6/e, Pearson, 2013.

COURSE OUTCOMES

Upon successful completion of this course, the student will have

1. The student shall be able to determine the Dimensional parameters Analyze Pressure distribution on airfoil, Estimation of lift, drag and pitching moment coefficient.
2. The student shall be able to propose the combination of elementary flows to solve the real time problem theoretically.
3. The student shall be able to solve wing section properties by using thin airfoil theory.
4. The student shall be able to determine the flow around wing, circulation distribution, downwash distribution, wake and relationship between them.
5. Apply the concept of aerodynamic theories to produce high lift and reduce drag..