Course Type	Course Code	Name of Course	L	T	P	Credits
DE	NMED510	Fundamentals of Aerodynamics	3	0	0	3

Course Objectives

Prerequisite: Basic knowledge of fluid mechanics is essential

To illustrate and explain to students the basics principals and governing conservation equations and how these fundamentals can be applied to estimate aerodynamic forces and moments and to understand other related interesting problems.

Learning Outcomes

- On successful completion of the course, the students will
- Learn the fundamental principles of fluid mechanics and thermodynamics required to investigate the aerodynamics of airfoils, wings, and airplanes and other related problems;
- Learn about the geometric features of airfoils, wings, and airplanes and how the names for these features are used in aerodynamics communications;
- Explore the aerodynamic forces and moments that act on airfoils, wings, and airplanes and learn how we describe, estimate and compute numerically and theoretically these loads quantitatively in dimensional form and as coefficients;
- Learn the reason behind induced drag and the formation of trailing edge vortices for a 3D finite wing and its relevance in other related problems occurring in nature;
- Learn about the effects of compressibility, formation of shocks and expansion fans on the aerodynamic performances of streamlined, bluff bodies and the jet exhaust.

Unit No.	Topics to be Covered Lecture	Lecture Hours	Learning Outcomes
1	Basic overview of aerodynamics; Aerodynamic forces and moments; Continuity, Momentum and Energy equations; Inviscid incompressible flow; Applicability of the Bernoulli's equation	5L	Understanding of the basic overview of Aerodynamics, Ideas on aerodynamics moments and forces, Derivation on the continuity and momentum and energy equation, Ideas on the basics of inviscid incompressible flows, flow features, Ideas on the application of Bernoulli's equation
2	Incompressible flow in a low speed wind tunnel, Potential flows with source and doublet, Potential flow over a circular cylinder, Kutta-Joukowski theorem and conformal mapping	4L	Basic ideas on the characteristics of the incompressible flow in a low-speed wind tunnel, Ideas on sources and doublets and their application to the potential flow over a circular cylinder, Ideas on Conformal Transformation and Kutta-Jukowski Theorem and its application to estimate the lift coefficient of a 2D airfoil section

3	Incompressible flow over airfoils and finite wings, Kutta condition, Kelvin's circulation theorem, Biot-Savart law, Helmholtz vortex theorem	7L	Ideas on the incompressible flows over airfoil, The effects of finite wing, Ideas on downwash as a consequence of wing-tip vortex, Estimation of induced drag, Applicability of the Kutta-condition to fix the condition on the trailing edge, Ideas on the Kelvin's circulation theorem, Biot-Savart law and Helmholtz Theorems
4	Thin aerofoil theory; Prandtl's classical lifting line theory; Three dimensional source and doublet	7L	Derivation of the thin airfoil theory and Prandtl's lifting line theory, Uses of these theories to estimate dependence of lift coefficient on the angle of attack, Introduction to the 3D source and doublet and extension of the 2D potential flow to 3D flow cases
5	Inviscid compressible flow, normal and oblique shocks, expansion waves, supersonic wind tunnels	8L	Ideas on the inviscid compressible flow, normal and oblique shocks and Prandtl Meyer expansion fan and their reflection, General idea on the operational principals of supersonic wind-tunnel
6	Elements of hypersonic flow, Newtonian theory; Equations of viscous flow; Laminar and turbulent boundary layers	4L	Ideas on the elements of hypersonic flows and Newtonian theory, Ideas on the equations of viscous flow, Basic concepts on the laminar turbulent transition in a boundary layer
7	Panel methods in aerodynamics, Flow separation and control, Jet flow and mixing layer	7L	Ideas on the panel methods to estimate lift coefficients for arbitrary shaped bodies based on Potential flow theory, Basic ideas on flow separation and control, Jet flow and mixing layer
	Total	42 hrs	

Text Books

1. J. D. Jr. Anderson, Fundamentals of Aerodynamics, McGraw- Hill , 6th Edition, 2016.

Reference books

1. J. J. Bertin, Aerodynamics for Engineers, Pearson Education, 4th Edition, 2002.

2. E. L. Houghton and N. B. Carruthers, Aerodynamics for Engg. Students, Arnold Pub., 3rd Revised Edition, 1988.

3. A. M. Kuethe, and C. Y. Chow, Foundations of Aerodynamics, Wiley, 5th Edition, 1998.

4. L. J. Clancy, Aerodynamics, Himalayan Books, 1st Edition, 2006.