LOW SPEED AERODYNAMICS

IV Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAE004	Core	3	1	-	4	30	70	100
Contact Classes: 45	Tutorial Classes: 15	Practical Classes: Nil				Total Classes: 60		

OBJECTIVES:

The course should enable the students to:

I. Understand the basics of aerodynamics, aerofoil and wing characteristics.
II. Calculate forces and moments acting on aero foils and wings under ideal flow conditions.
III. Design a propeller and determine aerodynamic interaction effects between different components of aircraft

COURSE LEARNING OUTCOMES (CLOs):

1. Apply knowledge and understand the essential facts, concepts and principles of aerodynamics.
2. Adapt the basic knowledge of mathematics, science and engineering for problem solving.Determine the resultant and apply conditions of static equilibrium to a plane force system.
3. Describe principles of physics and aerodynamics to study the wing-body interference junction.Analyze planer and spatial systems to determine the force in the members of truss and frames.
4. Explain the concept of boundary layer flows to increase the performance of the body.
5. Understand the concept of source, sink, doublet and vortex
6. Demonstrate importance of aerodynamics to develop effective aircraft design and operations.Explore knowledge & ability to solve various particle motion problems.
7. Apply the concept of lifting line theory to study potential flows over different aerofoils.Determine the impact, impulse and impulsive forces occurring in the system and able to solve the problems.
8. Identify the elliptic load distribution for obtaining high lift performance on finite wings.
9. Evaluate the source and vortex panel method for non-lifting and lifting aerofoils.
10. Illustrate the propeller aerodynamics and the effects of propeller on the wing.
11. Understand the concept of Prandtl‘s lifting line theory and eliptical lift distribution.
12. Understand the lift augmentation techniques for high-lift devices and slats.
13. Understand aerodynamic effect of taper and twist applied to wings.
14. Apply temperature effects on boundary layer, transition and turbulent flow regimes.
15. Understand the aerodynamic effect of vortex formation around wings.
16. Evaluate flow past non lifting bodies and method of singularities
17. Understand the effect of sweep in the context of delta wings.
18. Understand the relation between circulation and lift.
19. Understand the various sources of drag including induced drag and skin friction drag.
20. Evaluate displacement thickness, momentum thickness, energy thickness.

UNIT-I	INTRODUCTORY TOPICS FOR AERODYNAMICS	Classes: 10

Potential flow, velocity potential, stream function, Laplace equation, flow singularities-Uniform flow, source, sink, doublet, Vortex, Non lifting and lifting flow over a cylinder Kutta-Joukowski theorem.

UNIT -II	THIN AEROFOIL THEORY	Classes: 09

Aerofoil nomenclature, aerodynamic characteristics, centre of pressure and aerodynamic centre; Wing of infinite aspect ratio, CL-α- diagram for a wing of infinite aspect ratio, generation of lift, starting Vortex, Kutta's trailing edge condition; Thin aerofoil theory; Elements of panel method; High lift airfoils, High lift devices.

UNIT-III	FINITE WING THEORY	Classes: 10

Vortex motions, vortex line, vortex tube, vortex sheet; Circulation; Kelvin and Helmhotz theorem; BiotSavart's law, applications, Rankine's vortex; Flow past finite wings, vortex model of the wing and bound vortices; Induced drag; Prandtl's lifting line theory; Elliptic wing.

Influence of taper and twist applied to wings, effect of sweep back wings; Delta wings, primary and secondary vortex; Elements of lifting surface theory. Source Panel Vortex panel and Vortex lattice methods

UNIT-IV	FLOW PAST NON-LIFTING BODIES AND INTERFERENCE EFFECTS	Classes: 08

Flow past non lifting bodies, method of singularities; Wing-body interference; Effect of propeller on wings and bodies and tail unit; Flow over airplane as a whole.

UNIT-V	BOUNDARY LAYER THEORY	Classes: 08

Introduction to boundary layer, laminar and turbulent boundary layer, transition, boundary layer on flat plate, displacement thickness, momentum thickness, energy thickness, effect of curvature, temperature boundary layer.

Text Books:

1. J.D.Anderson, "Fundamentals of Aerodynamics", McGraw-Hill publications, 5th Edition, 2011.
2. E. L. Houghton and P.W. Carpenter, "Aerodynamics for Engineering Students", Edward Arnold Publishers Ltd., London, 5th Edition, 1982.
3. John J. Bertin and Russell M. Cummings, "Aerodynamics for Engineering Students", Pearson, 5th Edition, 2009.

Reference Books:

1. L. J. Clancy, "Aerodynamics", Pitman, 1st Edition, 1986.
2. Louis M. Milne, "Thomson, Theoretical Aerodynamics", 2nd Edition, Dover Publications, 1985.
3. K. Karamcheti, "Principles of Ideal-fluid Aerodynamics", 2nd Edition, Krieger Publication & Co; 2nd Edition, 1980.

Web References:

1. https://www.loc.gov/rr/scitech/tracer-bullets/aerodynamicstb.html
2. https://www.myopencourses.com/subject/aerodynamics-2
3. https://tocs.ulb.tu-darmstadt.de/211658790.pdf
4. https://www.princeton.edu/~stengel/MAE331Lecture3.pdf

E-Text Books:

1. https://bookboon.com/en/a-first-course-on-aerodynamics-ebook
2. https://airspot.ru/book/file/22/houghton_aerodynamics_for_engineering_students.pdf
3. https://www.adl.gatech.edu/extrovert/Ebooks/ebook_Lowspeed.pdf
4. https://rahauav.com/Library/Aerodynamic/Aerodynamics%20for%20engineering%20students_6th_www.rahauav.com.pdf.