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		

I. COURSE OVERVIEW:

Low speed aerodynamics course focuses on the study of the flow of air about a body, and the body can be an airplane, but many of the concepts explored are relevant to a wide variety of applications from sailboats, automobiles and birds. This course will enable learners to gain a fundamental under- standing of concepts and models used to aerodynamically analyze and some classical theories which are useful for design of aircraft components. As this course is an introduction to aerodynamics, it is prerequisite course for high speed aerodynamics as well as can be an advanced subject for students with aerodynamics as specialization.

II. OBJECTIVES:

The course should enable the students to:

I	The fundamental knowledge on basics of aerodynamics and aerodynamic characteristics of wings, airfoils.
II	The mathematical model for lift and drag coefficient of finite wing and wing ofinfinite aspect ratio.
III	The flow over non-lifting bodies from method of singularities and investigate theinterference effect
IV	The effect of viscosity and boundary layer growth over various shaped geometryand its control.

III. COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Develop** the mathematical model of non-lifting, lifting flow over circular cylinder for identifying relation between lift and circulation	Apply
CO 2	**Solve** the lift characteristics of wing of infinite aspect ratio fromclassical thin airfoil for selecting suitable airfoil	Apply
CO 3	**Examine** the flow over finite wing using the concept of Prandtl's liftingline theory for determining the effect of span wise flow on the lift distribution.	Analyze
CO 4	**Identify** the effect of wing twist, wing taper and wing sweep for perceiving the aerodynamic characteristics of finite wing.	Apply
CO 5	**Demonstrate** the effect of propeller slipstream flow on the wing and tail unit for identifying its effect on their aerodynamic characteristics.	Understand
CO 6	**Interpret** the regimes and separation of boundary layer over external fluid flow systems for identifying the effect of viscosity on the drag force	Understand

IV. SYLLABUS:

UNIT-I	INTRODUCTORY TOPICS FOR AERODYNAMICS	Classes: 09

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, C_L-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: 12

Vortex motions, vortex line, vortex tube, vortex sheet; Circulation; Kelvin and Helmhotz theorem; Biot-

Savart'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: 07

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. E. L. Houghton and P. W. Carpenter, "Aerodynamics for Engineering Students", Edward Arnold Publishers Ltd., London, 5th Edition, 1982,
2. J. D. Anderson, "Fundamentals of Aerodynamics", McGraw Hill Book Co., New York, 5th Edition, 1985.
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. L. H. Milne, S. Thomson, "Theoretical Aerodynamics", Dover, 2nd Edition, 1985.
3. K. Karamcheti, " Principles of Ideal-Fluid Aerodynamics", Krieger Pub 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

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