AERODYNAMICS

IV Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEC08	Core	3	0	0	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 45		

Prerequisite: Knowledge of Engineering Thermodynamics

I. COURSE OVERVIEW:

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 understanding 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. COURSE OBJECTIVES:

The students will try to learn:

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 of infinite aspect ratio.
III. The flow over non-lifting bodies from method of singularities and investigate the interference effect.
IV. The effect of viscosity and boundary layer growth over various shaped geometry and 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 from classical thin airfoil for selecting suitable airfoil	Apply
CO 3	**Examine** the flow over finite wing using the concept of Prandtl's lifting line 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	**Make use of** the Kutta-Joukowski transformation for mathematically modeling the flow over airfoil.	Apply
CO 6	**Distinguish** the regimes and separation of boundary layer over external fluid flow systems for finding the effect of viscosity on the drag force	Apply

IV. SYLLABUS

MODULE-I: INTRODUCTORY TOPICS FOR AERODYNAMICS (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.

MODULE –II: THIN AEROFOIL THEORY(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; High lift airfoils, High lift devices.

MODULE –III: FINITE WING THEORY (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.

MODULE –IV: FLOW PAST NON-LIFTING BODIES AND CONFORMAL TRANSFORMATION (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.

Potential, Cauchy-Reiman relations, Complex conformal transformation, Kutta-Joukowski transformation

MODULE –V: BOUNDARY LAYERTHEORY (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.

V. 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.

VI. 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.

VII. 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

VIII. 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