INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

AERODYNAMICS								
IV Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
AAED08	**Core**	3	0	-	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite: Fluid Dynamics								

I. COURSE OVERVIEW:

Aerodynamics deals with the study of the flow of air about a body, and the body can be an airplane, missiles, helicopters, and any other vehicles. This course will delve into several key areas, including the principles airflows and generation of aerodynamic forces. The concept of this course is relevant to a wide variety of applications ranging from sailboats, automobiles, birds, insects, and other aircrafts. 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. It forms an essential corner stone for mechanical, chemical, and aerospace engineers and plays a pivotal role in the study of airflows not only for engineers but also for medical domain.

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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 will be able to:

CO 1 Illustrate the aerodynamic flows with velocity potential for non-lifting and lifting flow based on fundamental laws of aerodynamics using Kutta-Joukowski theorem.
CO 2 Make use of thin airfoil theory to ascertain aerodynamic characteristics, centre of pressure, and generation of lift force for the infinite aspect ratio wing using Kutta trailing edge condition.
CO 3 Develop the vortex model for flow past of finite wing to ascertain drag using Kelvin and Helmhotz theorem, and Biot-Savart's law.
CO 4 Demonstrate the influence of taper, twist, sweep back, and Delta wings for the generation of the aerodynamic forces using Source Panel, Vortex panel and Vortex lattice methods.
CO 5 Illustrate the effect of interference due to wing body, propeller and other non-lifting surfaces for the total aerodynamic characteristic's estimation using Cauchy-Reiman relations and Kutta-Joukowski transformation.
CO 6 Compare the basic concepts of Viscous flow model with Inviscid flow model for the finite wing by using Displacement body model and Wall transpiration model.

IV. COURSE CONTENT:

MODULE-I: INTRODUCTORY TOPICS FOR AERODYNAMICS (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.

MODULE –II: THIN AEROFOIL THEORY (10)
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; High lift airfoils, High lift devices. Use of XFLR5 for simulation of lift on different aerofoils and compare.

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. Use of XFLR5 for simulation of effects of taper, sweep, and delta wing for demonstration.

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: VISCOUS EFFECT IN AERODYNAMIC FLOWS (08)
Inviscid flow model, Displacement effect: normal mass flow matching, normal mass flux in real flow; Improved Inviscid Flow Model: Displacement body model, Wall transpiration model, Wake modeling, Improved flow model advantages, Viscous decambering stall mechanism; Consideration in flow model selection.

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. Mark Drela "Flight Vehicle Aerodynamics" The MIT Press, Cambridge, Massachusetts, London, England, 2014.

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. ELECTRONICS RESOURCES:

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. MATERIALS ONLINE

1. Course template
2. Tutorial question bank
3. Tech talk topics
4. Open end experiments
5. Definitions and terminology
6. Assignments
7. Model question paper – I
8. Model question paper - II
9. Lecture notes
10. E-learning readiness videos (ELRV)
11. Power point presentation