AERODYNAMICS

IV Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB10	Core	3	1	-	4	30	70	100
Contact Classes: 45	Tutorial Classes: 15	Practical Classes: Nil				Total Classes: 60		

COURSE OBJECTIVES:

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.

COURSE OUTCOMES:

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

CO 1 **Explain** the velocity potential, stream function and their importance for solving the flow over arbitrary shape.

CO 2 **Develop** the mathematical model using method of singularities for non-lifting, lifting flow over circular cylinder

CO 3 **Illustrate** various types of airfoil, their nomenclature and aerodynamic characteristics for its suitable selection**.**

CO 4 **Solve** the lift characteristics of wing of infinite aspect ratio from classical thin airfoil forreal world applications

CO 5 **Construct** the mathematical model using the concept of Prandtl's lifting line theory forwing of finite aspect ratio.

CO 6 **Summarize** the effect of wing twist, wing taper and wing sweep for perceiving the aerodynamic characteristics of finite wing.

CO 7 **Apply** vortex panel and vortex lattice methods forflow over non-lifting bodies

CO 8 **Demonstrate** the effect of propeller slipstream flow on the aerodynamic characteristics of wing and tail unit

CO 9 **Interpret** the regimes and separation of boundary layer growth over external fluid flow systems for identifying its effect on boundary layer properties

Module-I	INTRODUCTORY TOPICS FOR AERODYNAMICS
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**
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.	
Module-III	**FINITE WING THEORY**
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 INTERFERENCE EFFECTS**
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.	
Module-V	**BOUNDARY LAYERTHEORY**
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 , Mc Graw 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.

E-Text Books:

1. https://bookboon.com/en/engineering-fluid-mechanics-ebook
2. https://www.slideshare.net/asifzhcet/fluid-mechanics-and-hydraulic-machines-dr-r-k-bansal
3. https://eprints.staffs.ac.uk/222/1/engineering-fluid-mechanics%5B1%5D.pdf
4. https://www.engr.uky.edu/~acfd/me330-lctrs.pdf