

## AERODYNAMICS

<b>IV Semester: AE</b>								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
AAEB10	Core	L	T	P	C	CIA	SEE	Total
		3	1	-	4	30	70	100
<b>Contact Classes: 45</b>		<b>Tutorial Classes: 15</b>		<b>Practical Classes: Nil</b>			<b>Total Classes: 60</b>	
<b>I. COURSE OVERVIEW:</b>								
<p>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 sail- boats, 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.</p>								
<b>II. OBJECTIVES:</b>								
<b>The course should enable the students to:</b>								
<p>I The fundamental knowledge on basics of aerodynamics and aerodynamic characteristics of wings, airfoils.</p> <p>II The mathematical model for lift and drag coefficient of finite wing and wing of infinite aspect ratio.</p> <p>III The flow over non-lifting bodies from method of singularities and investigate the interference effect</p> <p>IV The effect of viscosity and boundary layer growth over various shaped geometry and its control.</p>								
<b>III. COURSE OUTCOMES:</b>								
<b>After successful completion of the course, students should be able to:</b>								
<p>CO 1 <b>Develop</b> the mathematical model of non-lifting, lifting flow over circular cylinder for identifying relation between lift and circulation Apply</p> <p>CO 2 <b>Solve</b> the lift characteristics of wing of infinite aspect ratio from classical thin airfoil for selecting suitable airfoil Apply</p> <p>CO 3 <b>Examine</b> 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</p> <p>CO 4 <b>Identify</b> the effect of wing twist, wing taper and wing sweep for perceiving the aerodynamic characteristics of finite wing. Apply</p> <p>CO 5 <b>Demonstrate</b> the effect of propeller slipstream flow on the wing and tail unit for identifying its effect on their aerodynamic characteristics. Understand</p> <p>CO 6 <b>Interpret</b> the regimes and separation of boundary layer over external fluid flow systems for identifying the effect of viscosity on the drag force Understand</p>								
<b>IV. SYLLABUS:</b>								
<b>MODULE -I</b>	<b>INTRODUCTORY TOPICS FOR AERODYNAMICS</b>						<b>Classes: 09</b>	
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.								
<b>MODULE -II</b>	<b>THIN AEROFOIL THEORY</b>						<b>Classes: 09</b>	
Aerofoil nomenclature, aerodynamic characteristics, centre of pressure and aerodynamic centre; Wing of infinite aspect ratio, $C_L$ - $\alpha$ - 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.								

<b>MODULE -III</b>	<b>FINITE WING THEORY</b>	<b>Classes: 12</b>
<p>Vortex motions, vortex line, vortex tube, vortex sheet; Circulation; Kelvin and Helmholtz 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.</p> <p>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.</p>		
<b>MODULE -IV</b>	<b>FLOW PAST NON-LIFTING BODIES AND INTERFERENCE EFFECTS</b>	<b>Classes: 08</b>
<p>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.</p>		
<b>MODULE -V</b>	<b>BOUNDARY LAYER THEORY</b>	<b>Classes: 07</b>
<p>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.</p>		
<b>Text Books:</b>		
<ol style="list-style-type: none"> <li>1. E. L. Houghton and P. W. Carpenter, "Aerodynamics for Engineering Students", Edward Arnold Publishers Ltd., London, 5<sup>th</sup> Edition, 1982,</li> <li>2. J. D. Anderson, "Fundamentals of Aerodynamics", Mc Graw Hill Book Co., New York, 5<sup>th</sup> Edition, 1985.</li> <li>3. John J. Bertin and Russell M. Cummings, "Aerodynamics for Engineering Students", Pearson, 5<sup>th</sup> Edition, 2009.</li> </ol>		
<b>Reference Books:</b>		
<ol style="list-style-type: none"> <li>1. L. J. Clancy, "Aerodynamics", Pitman, 1<sup>st</sup> Edition, 1986.</li> <li>2. L. H. Milne, S. Thomson, "Theoretical Aerodynamics", Dover, 2<sup>nd</sup> Edition, 1985.</li> <li>3. K. Karamcheti, "Principles of Ideal-Fluid Aerodynamics", Krieger Pub Co; 2<sup>nd</sup> edition, 1980.</li> </ol>		
<b>Web References:</b>		
<ol style="list-style-type: none"> <li>1. <a href="https://www.loc.gov/rr/scitech/tracer-bullets/aerodynamicstb.html">https://www.loc.gov/rr/scitech/tracer-bullets/aerodynamicstb.html</a></li> <li>2. <a href="https://www.myopencourses.com/subject/aerodynamics-2">https://www.myopencourses.com/subject/aerodynamics-2</a></li> <li>3. <a href="https://tocs.ulb.tu-darmstadt.de/211658790.pdf">https://tocs.ulb.tu-darmstadt.de/211658790.pdf</a></li> <li>4. <a href="https://www.princeton.edu/~stengel/MAE331Lecture3.pdf">https://www.princeton.edu/~stengel/MAE331Lecture3.pdf</a></li> </ol>		
<b>E-Text Books:</b>		
<ol style="list-style-type: none"> <li>1. <a href="https://bookboon.com/en/a-first-course-on-aerodynamics-ebook">https://bookboon.com/en/a-first-course-on-aerodynamics-ebook</a></li> <li>2. <a href="https://airspot.ru/book/file/22/houghton_aerodynamics_for_engineering_students.pdf">https://airspot.ru/book/file/22/houghton_aerodynamics_for_engineering_students.pdf</a></li> <li>3. <a href="https://www.adl.gatech.edu/extrovert/Ebooks/ebook_Lowspeed.pdf">https://www.adl.gatech.edu/extrovert/Ebooks/ebook_Lowspeed.pdf</a></li> <li>4. <a href="https://rahauav.com/Library/Aerodynamic/Aerodynamics%20for%20engineering%20students_6th_www.rahauav.com.pdf">https://rahauav.com/Library/Aerodynamic/Aerodynamics%20for%20engineering%20students_6th_www.rahauav.com.pdf</a></li> </ol>		