

# GUJARAT TECHNOLOGICAL UNIVERSITY

## AERONAUTICAL ENGINEERING

### AERODYNAMICS II

**SUBJECT CODE:** 2160101

B.E. 6<sup>th</sup> SEMESTER

**Type of course:** Engineering Science

**Prerequisite:** Basics of Fluid Mechanics, Aerodynamics I, Flight Mechanics, Computational Fluid Dynamics

**Rationale:** Aerodynamics is one of the core areas in the field of aviation. The concepts of aerodynamics are vitally important to the aeronautical engineer.

#### Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P		Theory Marks			Practical Marks			
			ESE (E)	PA (M)		ESE (V)		PA (I)		
				PA	ALA	ESE	OEP			
4	0	2	6	70	20	10	20	10	20	150

#### Content:

Sr. No.	Content	Total Hrs	% Weightage
<b>1</b>	<p><b>Incompressible flow over a Two Dimensional Wing</b></p> <p>Introduction – Airfoil Nomenclature and Characteristics, Low speed flow over an Airfoil – Vortex Sheet, The Kutta Condition, Kelvin’s Circulation Theorem, Classical Thin Airfoil Theory – The Symmetrical Airfoil, The Cambered Airfoil, The Vortex Panel Numerical Method for Lifting flow over bodies, Viscous flow over Airfoil – Estimation of airfoil drag for laminar flow &amp; Turbulent flow, Transition and flow separation, Modern Low Speed airfoils, Flow over airfoil – The real case, Conformal Transformation.</p>	<b>20</b>	<b>35</b>
<b>2</b>	<p><b>Incompressible flow over a Finite Wing</b></p> <p>Introduction to Finite Wing, downwash and induced drag, The Vortex system, Laws of Vortex motion – The vortex filament, Biot-Savart Law and Helmholtz’s theorem, Prandtl’s Classical Lifting Line Theory, A Numerical Nonlinear Lifting Line Method, The Vortex Lattice Numerical Method, The Delta Wing.</p>	<b>16</b>	<b>25</b>
<b>3</b>	<p><b>Subsonic Compressible Flow over Airfoils: Linear Theory</b></p> <p>Introduction, The velocity potential equation, The linearized velocity potential equation, Prandtl-Glauert Compressibility correction, Critical</p>	<b>6</b>	<b>20</b>

	Mach number, Drag divergence mach number – The sound barrier, Area Rule, Supercritical Airfoil.		
<b>4</b>	<b>Linearized Supersonic flow</b> Introduction to supersonic flow, Derivation of the Linearized supersonic pressure coefficient formula, Application to supersonic airfoils, Supersonic airfoil drag.	<b>6</b>	<b>10</b>

**Suggested Specification table with Marks (Theory):**

<b>Distribution of Theory Marks</b>					
R Level	U Level	A Level	N Level	E Level	C Level
<b>35%</b>	<b>25%</b>	<b>20%</b>	<b>15</b>	<b>5</b>	<b>0%</b>

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)**

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

**Reference Books:**

1. Fundamentals of Aerodynamics by John D Anderson Jr.
2. Aerodynamics by L J Clancy
3. Aerodynamics for Engineering Students by E L Houghton & P W Carpenter
4. Aerodynamics for Engineers by Bertin & Smith
5. Theoretical Aerodynamics by Milne Thomson

**Course Outcome:**

After learning the course the students should be able to

1. Understand basic terms used in Aerodynamics.
2. Understand the effect of the flow on the aircraft.
3. Comprehend the concept of fluid flow.

**List of Practical:**

1. Fundamentals of Aerodynamics
2. Incompressible flow over an airfoil
3. Incompressible flow over a finite wing
4. Linear theory
5. Linearized supersonic flow
6. Transformation of a Cylinder into a flat plate
7. Transformation of a Cylinder into a an ellipse
8. Transformation of a Cylinder into a Symmetric airfoil

## 9. Delta Wing

### **Design based Problems (DP)/Open Ended Problem:**

1. Make a model of symmetric airfoil
2. Make a model of unsymmetrical airfoil
3. To study vortex generation

**Major Equipment:** Subsonic and Supersonic Wind tunnel, Scaled model of Wing, Flat Plate, and Cylinder is needed to perform aerodynamics analysis.

**List of Open Source Software/learning website:** <http://nptel.iitm.ac.in/courses.php>

**ACTIVE LEARNING ASSIGNMENTS:** Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.