GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3150107
Semester –V
Subject Name: Aerodynamics

Type of course: Professional core course

Prerequisite: Fundamentals of Aeronautical Engineering, Fluid Mechanics, Thermodynamics

Rationale: Aerodynamics is one of the core areas in the field of aviation. The concepts of aerodynamics are vitally important to the aeronautical engineer. This course imparts fundamental knowledge regarding fluid and its properties, various types of airfoils and its characteristics.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
4	0	2	5	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs	Weigh tage%
1	**Fundamentals of Aerodynamics:** Airfoil, Types of Airfoils, Airfoil Nomenclature and its characteristics, NACA series, Applications of Airfoils.	**4**	**5**
2	**Characteristics of Low Speed Airfoil:** Effect of incidence on pressure distribution, Lift Curve, Airfoil stalling, Flow Separation, Pitching moment, Span-wise flow variation, downwash, Wind Tunnel and Its type.	**8**	**10**
3	**Incompressible flow over a Two Dimensional Wing:** Vortex Sheet, The Kutta Condition, Kelvin's Circulation Theorem and starting vortex, Classical Thin Airfoil Theory – 1. Symmetrical Airfoil 2. Cambered Airfoil, Vortex Panel Numerical Method for Lifting flow over Arbitrary bodies, Viscous flow over Airfoil – Estimation of airfoil drag for laminar flow & Turbulent flow, Transition and flow separation, Modern Low Speed airfoils, Flow over airfoil – The real case.	**13**	**25**
4	**Incompressible flow over a Finite Wings:** Introduction to Finite Wing, 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.	**9**	**10**
5	**Compressible Flow:** Introduction, Compressibility, Governing equations for inviscid compressible flow, Total conditions, Flow with Normal shock waves: Introduction, Development of a Shockwave, Rarefaction wave, Speed of sound with derivation, Prandtl-Meyer relation, Mach number Downstream of the normal shockwave, Static Pressure ratio across the shock,	**13**	**25**

	Temperature ratio across the shock , Numerical based on Normal Shockwave density ratio across the shock (Rankine–Hugoniot equation), Stagnation pressure ratio across the shock, change in entropy across the shock, Impossibility of shock in subsonic flow, strength of the shock wave, Determination of mach number of supersonic flows, tables and charts for normal shock wave, Moving normal shockwaves.		
6	**Flow with Oblique Shock waves:** Introduction, Nature of flows through oblique shock wave, Fundamentals relations of Oblique shock, Prandtl's relation, Rankine–Hugoniot equation, Numerical based on Oblique Shockwave, Variation of flow parameters, Oblique shock relations from the normal shock equations, Mach waves, Gas tables and charts for Oblique shock, Shock Polar Diagram, Expansion of Supersonic flow.	**13**	**25**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
25%	**25%**	**25%**	**15%**	**10%**	**-**

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, McGraw Hill
2. Fundamentals of Compressible Flow by S M Yahya, New Age International Publishers
3. Aerodynamics by L J Clancy, Sterling Book House
4. Aerodynamics for Engineering Students by E L Houghton and P W Carpenter, Edward Arnold Ltd.
5. Aerodynamics for Engineers by John J Bertin, Pearson Education Inc.

Course Outcomes:

Upon completion of this course students should be able to:

Sr. No.	CO statement	Marks % weightage
CO1	Explain basic terms and effect of aerodynamic properties on the Wings for Incompressible flow	15%
CO2	Understand Incompressible flow over a Finite Wings and Two dimensional wing	35%
CO3	Analyze basic terms and effect of flow on the Wings for compressible flow	10%
CO4	Comprehend the aerodynamics properties across the shockwave	40%

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List of Experiments:

1. Introduction to Wind tunnel and its type.
2. To Study different types of airfoil with applications and its characteristics.
3. To determine characteristics of low speed airfoil
4. Numerical based on incompressible flow over a airfoil using software
5. To determine airfoil drag for different flow.
6. To determine effect of aspect ratio on finite wing.
7. Flow with normal shock wave
8. Flow with oblique shock wave
9. To find out aerodynamic properties over an airfoil using CFD software.
10. To study Delta wing.

List of Open Source Software/learning website:
https://nptel.ac.in/