GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3160113
Semester –VI
Subject Name: Advance Aerodynamics

Type of course: Professional core course

Prerequisite: Fundamentals of Aeronautical Engineering, Fluid Mechanics, Thermodynamics, Aerodynamics, Flight Mechanics

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
				Theory Marks		Practical Marks		
L	T	P	C	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	**Introduction of Aero-Thermodynamics:-** Basic Concept of Aerodynamics and Thermodynamics, Subsonic flow, waves and Supersonic flow,	**5**	**10**
2	**Fundamentals of Hypersonic flows** Introduction to Hypersonic flow, Preliminary thoughts: Thin shock layers, entropy layer, Viscous retraction, High temp flows, Low density flows, Recapitulation, Mach No. independence. Shock expansion theory	**10**	**20**
3	**Hypersonic shock & Expansion wave relation** Introduction, Applications of Hypersonic flow Basic hypersonic shock relations, Hypersonic shock relation in terms of hypersonic similarity parameters, Examples related to Hypersonic Flow, Hypersonic expansion wave relation	**15**	**25**
4	**Local Surface Inclination Methods** Newtonian flow model, stagnation region flow field properties, Modified Newtonian flow, Wave riders, Aerodynamic heating, Centrifugal force correction to Newtonian theory, Tangent-wedge/ Tangent – cone methods, Shock expansion method, Numericals	**12**	**15**
5	**Compressible Flow over Airfoils** Introduction, The velocity potential equation, The linearized velocity potential equation, Prandtl-Glauert Compressibility correction, Supersonic flow over a cone, Critical Mach number, Drag divergence mach number – The sound barrier, Area Rule, Supercritical Airfoil, Rayleigh flow, Fanno flow.	**9**	**15**
6	**Linearized Supersonic flow** Introduction to supersonic flow, Derivation of the Linearized supersonic pressure coefficient formula, Application to supersonic airfoils, Supersonic airfoil drag,	**9**	**15**

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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
6. Hypersonic and high temperature gas dynamics – J D Anderson
7. Hypersonic Aerothermodynamics - John J Bertin
8. Supersonic aerodynamics – E R C Miles

Course Outcomes:

Upon completion of this course students should be able to:

Sr. No.	CO statement	Marks % weightage
CO1	Knowledge in basics of hypersonic and supersonic aerodynamics	15%
CO2	Acquiring knowledge in theory of hypersonic flow.	35%
CO3	Comprehend the concept of fluid flow and Understanding of boundary layers of hypersonic flow and viscous interaction	10%
CO4	Comprehend the aerodynamics properties across the shockwave.	40%

List of Experiments:

1. Introduction to Supersonic flow and hypersonic flow.
2. Experimental investigation of pressure distribution over the Symmetric Airfoil and force acting on that in a uniform flow with the use of wind tunnel.
3. Flow over the Symmetric Airfoil using CFD Software & Compare with Practical data
4. Experimental investigation of pressure distribution over the Unsymmetric Airfoil and force acting on that in a uniform flow with the use of wind tunnel.
5. Flow over the Unsymmetrical Airfoil using CFD Software & Compare with Practical data
6. Experimental investigation of pressure distribution over the Cylinder and force acting on that in a uniform flow with the use of wind tunnel.

7. Flow over the Cylinder using CFD Software & Compare with Practical data

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