GUJARAT TECHNOLOGICAL UNIVERSITY

AERONAUTICAL ENGINEERING
HIGH SPEED AERODYNAMICS
SUBJECT CODE: 2180105
B.E. 8thSEMESTER

Type of course: Engineering Science

Prerequisite: Basics of Fluid Mechanics, Aerodynamics I, Computational Fluid Dynamics, Aerodynamics II, Boundary Layer Theory

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

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)	
					PA	ALA	ESE	OEP		
4	0	2	6	70	20	10	20	10	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	Introduction of Aero-Thermodynamics:- Basic Concept of Aerodynamics and Thermodynamics, Subsonic flow, waves and Supersonic flow,	**6**	**15**
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.	**8**	**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	**12**	**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**	**20**
5	Experimental Method in Aerodynamics Introduction to wind tunnel & its components, measurements of various quantities in wind tunnel, solid blockage, wake blockage, wind tunnel balances, corrections, flow visualization techniques, supersonic wind tunnels, high speed subsonic tunnels, transonic wind tunnel, shock tube, hypersonic wind tunnel , experimental methodology.	**10**	**20**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
35%	**25%**	**20%**	**15%**	**5%**	**0%**

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. Aerodynamics for engineers – John J Bertin
2. Hypersonic and high temperature gas dynamics – J D Anderson
3. Aerodynamics – L J Clancy
4. Hypersonic aerothermodynamics – John J Bertin
5. Supersonic aerodynamics – E R C Miles

Course Outcome:

After learning the course the students should be able to:

To know about the basic fundamentals of High Speed Aerodynamics, Wind tunnel,
Understand basic terms used in Supersonic flow and Hypersonic flow, Understand the effect of the flow on the aircraft.

List of Experiments:

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

Design based Problems (DP)/Open Ended Problem:

Apart from above experiments a group of students has to undertake one open ended problem/design problem.
Few examples of the same are given below.

1. Develop a Small Scale Windtunnel

Major Equipment:

Subsonic Windtunnel, Supersonic Windtunnel,

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

http://www.iitk.ac.in/aero/2014-09-17-10-03-52

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.