GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3161912
Semester –VI
Subject Name: Gas Dynamics

Type of course: Elective

Prerequisite: -

Rationale: The course is design to provide fundamental knowledge of different type of heat exchangers used for various thermal applications and to learn the sizing of heat exchangers, thermal analysis for various heat exchange applications.

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)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	**Fundamentals of compressible flow:** Ideal gas relationship, The adiabatic energy equation, Mach number and its significance, Mach waves, Mach cone and Mach angle, static and stagnation states, relationship between stagnation temperature, pressure, density and enthalpy in terms of Mach number, stagnation velocity of sound, reference speeds, various regions of flow, Effect of Mach number on compressibility, Area velocity relationship	8
2	**One Dimensional Isentropic flow:** General features of isentropic flow, performance curve, Comparison of adiabatic and isentropic process, One dimensional isentropic flow in ducts of varying cross-section-nozzles and diffusers, operation of nozzles under varying pressure ratio, mass flow rate in nozzles, critical properties and choking, area ratio as function of Mach number, Impulse function, non-dimensional mass flow rate in terms of pressure ratio, area ratio and Mach number, Working charts and gas tables, Application of Isentropic flow. **Wind tunnels:** Requirements, classification and applications of different types of wind tunnels.	10
3	**Normal shock Waves:** Development of shock wave, Thickness of shock wave, governing equations, Strength of shock waves, Prandtl-Mayer relation, Rankine-Hugoniot relation, Mach number in the downstream of normal shock, variation of flow parameters across the normal shock, normal shock in Fanno and Rayleigh flows, impossibility of a rarefaction shock, supersonic diffusers, supersonic pitot tube	9
4	**Flow in constant area duct with friction (Fanno flow):** Fanno curve and Fanno flow equations, solution of Fanno flow equations, variation of flow properties, variation of Mach no. with duct length, isothermal flow in constant area duct with friction, tables and charts for Fanno flow, Experimental friction coefficients	8
5	**Flow in constant area duct with heat transfer (Rayleigh flow):** Simple heating relation of a perfect gas, Rayleigh curve and Rayleigh flow equations, variations of flow properties, maximum heat transfer, tables and charts for Rayleigh flow	7

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
7	**10**	**17**	**18**	**11**	**7**

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. Fundamental of Compressible flow, S. M. Yahya, New age international Publication, Delhi
2. Fundamentals of compressible fluid dynamics-P. Balachandran, PHI Learning, New Delhi
3. The dynamics and thermodynamics of Compressible fluid low Volume-I, Ascher H. Shapiro, the Ronald Press Company, New York.
4. Gas Dynamics, E. Rathakrishnan, PHI Learning Pvt. Ltd.
5. Gas Dynamics and Jet Propulsion-P. Murugaperumal, Scitech Publication, Chennai.
6. Modern Compressible Flow: With Historical Perspective, John D. Anderson, McGraw-Hill Higher Education.

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	To understand the fundamentals of compressible flow.	20
CO-2	To formulate and develop the flow parameters for isentropic flow.	30
CO-3	To analyze the effect of normal shock in compressible flow.	20
CO-4	To study the effect of friction on compressible flow in constant area duct.	20
CO-5	To study the flow through constant area duct with heat transfer	10

List of Experiments:

1) To study the energy equation for flow and non-flow process, significance of Mach number, Mach cone, Mach angle and various regions of flow.
2) To study the static and stagnation properties of compressible fluid in terms of Mach number and its effect on compressibility.
3) To study the expansion in nozzle, compression in diffuser, variation of area ratio with Mach number and impulse function for the isentropic flow.
4) To study the effect of pressure ratio and isentropic flow through convergent, convergent-divergent nozzle and diffuser.
5) To study the different types of wind tunnels.
6) To study the development of shock wave, Rarefraction of wave and develop the Prandtl-Mayer equation for normal shock wave.
7) To study the effect of Mach number on static and stagnation properties across the normal shock.
8) To develop the governing equation for Fanno flow and its solution.
9) To study the variation of flow properties for Fanno flow.

10) To study the frictionless flow process with heat transfer in constant area duct and develop Rayleigh flow relations.

Major Equipment: Wind tunnel

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