Seat No.: ________　　　　　　　　　　　　*Enrolment No.___________*

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. - SEMESTER – I • EXAMINATION – WINTER • 2013

Subject code: 712103N　　　　　　　　**Date: 03-01-2014**

Subject Name: Fluid Mechanics & Gas Dynamics

Time: 10.30 am – 01.00 pm　　　　　　　　**Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Use of Gas Table is permitted.**
5. **Usual notations are used.**

Q.1	**(a)**	Derive the following equation and draw the shape of nozzle and diffuser for subsonic, sonic and supersonic flow. $\frac{dA}{A} = \frac{\partial p}{\rho c^2}\left(1 - \frac{c^2}{a^2}\right)$	**07**
	(b)	Air (γ=1.4, R=287.43 J/kg K) enters a straight axisymetric duct at 300 K, 3.45 bar and 150 m/s and leaves it at 277 K, 2.058 bar and 260 m/s. The area of cross section at entry is 500 cm^2. Assuming adiabatic flow determine (i) stagnation temperature (ii) maximum velocity (iii) mass flow rate (iv) area of cross section at exit.	**07**
Q.2	**(a)**	Define geometric, kinematic and dynamic similarities. Explain how the condition of dynamic similarity of a hydraulic model is satisfied in actual practice.	**07**
	(b)	Derive equivalent Bernoulli's equation for isentropic compressible flow. $\frac{\gamma}{\gamma-1}\frac{P_0}{\rho_0}\left(\frac{P}{P_0}\right)^{\frac{\gamma-1}{\gamma}} + \frac{1}{2}c^2 = \frac{\gamma}{\gamma-1}\frac{P_0}{\rho_0}$	**07**
		OR	
	(b)	The pressure drop ΔP in pipe of diameter D and length L depends on the density ρ and viscosity μ of the fluid flowing, mean velocity V of flow and the average height of protuberance 't'. Show that the pressure drop can be expressed in the form : $\Delta P = \rho V^2 f\left(\frac{L}{D}, \frac{\mu}{VD\rho}, \frac{t}{D}\right)$	**07**
Q.3	**(a)**	Derive an equation describing a Fanno curve. Show three Fanno curves on the T-s coordinates at three mass flow densities.	**07**
	(b)	The friction factor for a 25 mm diameter 11.5 m long pipe is 0.004. The conditions of air at entry are p_1=2.0 bar, T_1=301 K, M_1=0.25. Determine the mass flow rate, and pressure, temperature and Mach number at exit.	**07**
		OR	
Q.3	**(a)**	Determine ψ for a steady flow of 20 m/s down and to the right at 45 degree to the y-axis.	**07**
	(b)	Explain doublets and vortices with necessary diagrams.	**07**
Q.4	**(a)**	Draw a Rayleigh line on T-s plane. Show the following on this line: (a) stagnation temperature lines for both subsonic and supersonic flows (b) maximum stagnation temperature point (c) constant static and stagnation pressure lines.	**07**

	(b)	The stagnation temperature of air in a combustion chamber is increased to 3.5 times its initial value. If the air at entry is at 5 bar, 105^0C and a Mach number of 0.25. Determine (a) the Mach number, pressure and temperature at the exit, (b) stagnation pressure loss and (c) the heat supplied per kg of air.	**07**
		OR	
Q.4	**(a)**	Derive the momentum equation for compressible fluid flow under steady state conditions	**07**
	(b)	Derive Kutta-Joukowski equation for lift of a cylinder.	**07**
Q.5	**(a)**	Using the equation of change in entropy across shock wave, prove that it is impossible to have shock wave in subsonic flow.	**07**
	(b)	A Mach -2 aircraft engine employs a subsonic inlet diffuser of area ratio 3. A normal shock is formed just upstream of the diffuser inlet. The free stream conditions upstream of the diffuser are: p= 0.10 bar, T= 300 K. Determine (a) Mach number, pressure and temperature at the diffuser exit. (b) Diffuser efficiency including the shock. Assume isentropic flow in the diffuser downstream of the shock.	**07**
		OR	
Q.5	**(a)**	What is an aerofoil? Define Drag and Lift co-efficient in reference of aerofoil. Also explain the variation in the value of the coefficient of lift and the coefficient of drag of an aerofoil with angle of incidence.	**07**
	(b)	Explain the following: (i) Mach angle (ii) Mach cone (iii) Mach wave (iv) Zone of action (v) Zone of silence (v) stagnation Temperature (vi) critical velocity.	**07**

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