Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VIII • EXAMINATION – SUMMER 2013

Subject Code: 181906 **Date: 09/05/2013**

Subject Name: Gas Dynamics (DE-II)

Time: 10:30 am TO 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.**

Q.1 **(a)** Explain the propagation of disturbances in compressible fluid with a neat sketch. **07**

(b) Prove that the mass flow parameter for an air as a perfect gas is given by following expressions: $\frac{\dot{m}_{max}\sqrt{T_o}}{AP_o} = 0.0404$ during a steady one dimensional isentropic flow in variable area passage. **07**

Q.2 **(a)** Derive the following from one dimensional steady flow energy equation **07**

$$\frac{a^2}{\gamma-1}+\frac{1}{2}C^2=\frac{1}{2}C^2{}_{\max}=h_o$$

(b) The pressure, temperature and Mach number at the entry of a flow passage are 2.5 bar, 28°C and 1.5 respectively. If the exit Mach number is 3, determine for adiabatic flow of a perfect gas (γ = 1.3, R = 0.469 kJ/kg-K): (i) Stagnation temperature (ii) temperature and velocity of gas at exit, and (iii) the flow rate per square meter of the inlet cross-section. **07**

OR

(b) Air (γ= 1.4, R = 287 J/kg-K) enters a straight axisymmetric duct at 320 K, 3.8 bar and 180 m/s and leaves it at 280 K, 2.2 bar and 335.8 m/s. The area of cross-section at entry is 400 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.3 **(a)** Explain the variation in area, pressure and velocity with variation in Mach number for nozzle and diffuser. **07**

(b) A conical diffuser has entry and exit diameters 15 cm and 30 cm respectively. The pressure, temperature and velocity of air at entry are 0.69 bar, 340 K and 180 m/s respectively. Determine: **07**

(a) the exit pressure (b) the exit velocity (c) the force exerted on the diffuser walls.

Assume isentropic flow, γ =1.4, Cp =1.00 kJ/kg-K.

Use the following properties for Isentropic flow:

M	M*	T/To	P/Po	A/A*	F/F*	Ap/A*Po
0.10	0.1094	0.998	0.993	5.822	4.624	5.781
0.107	0.1098	0.991	0.992	5.370	4.300	5.724
0.50	0.534	0.952	0.843	1.340	1.203	1.129

OR

Q.3 **(a)** Starting from the energy equation for flow through a normal shock, obtain the Prandtl Mayer relation **07**

$$M_x^* M_y^* = 1$$

(b) Derive the equation of static pressure ratio across the normal shock, **07**

$$\frac{P_y}{P_x} = \frac{2\gamma}{\gamma-1} M_x^2 - \frac{\gamma-1}{\gamma+1}$$

Q.4 **(a)** Derive an equation describing a Fanno curve, show three Fanno curves on the temperature entropy co-ordinates at three mass flow densities. **07**

(b) The air with mach number 0.3, stagnation pressure 6 bar and stagnation temperature 350 K enters into a thermally insulated duct of constant diameter 10 cm. If the duct operates under choking condition, determine the length of duct, flow parameters at duct exit and mass flow rate. Take the mean friction co-efficient for the duct as 0.004. **07**

Use the following properties for Fanno Flow Process:

M	P/P*	c/c* =ρ*/ ρ	T/T*	Po/Po*	F/F*	$\frac{4\bar{f}L_{max}}{D}$
0.3	3.619	0.3257	1.178	2.035	1.698	5.299
0.4	2.696	0.4310	1.163	1.590	1.375	2.308
1.00	1.000	1.000	1.000	1.000	1.000	1.000
1.20	0.804	1.158	0.932	1.030	1.011	0.0336

OR

Q.4 **(a)** Prove that the Mach number at the maximum enthalpy and maximum entropy points on the Rayleigh line are $\frac{1}{\sqrt{\gamma}}$ and 1.0 respectively. **07**

(b) Derive the equation of maximum non-dimensional heat transfer rate in Rayleigh flow process. Also obtain the value of supersonic mach number for the same maximum heat transfer rate. **07**

Q.5 **(a)** Discuss the practical applications of wind tunnels. **07**

(b) Discuss the following terms with help of sketch: **07**
(a) Mach cone (b) Mach angle (c) zone of action (d) zone of silence

OR

Q.5 **(a)** Show that the upper and lower branches of a Fanno curve represent subsonic and supersonic flows respectively. How would the state of a gas change from the supersonic to subsonic branch. **07**

(b) Write a short on reference velocities. **07**

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