Seat No.: _____ *Enrolment No.*______

GUJARAT TECHNOLOGICAL UNIVERSITY
BE SEM-VIII Examination May 2012
Subject code: 181906
Subject Name: Gas Dynamics

Date: 08/05/2012 **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 the Gas tables given at end of paper.**

Q.1 **(a)** Describe the behavior of flow in a convergent divergent nozzle when it is operated at (i) Design pressure ratio (ii) Pressure ratio higher than design value (iii) Pressure ratio less than design value. **07**

(b) Prove that the mass flow parameter is given by following expressions. **07**

$$\frac{m\sqrt{To}}{APo} = \sqrt{\frac{2y}{R(y-1)}\left\{\left(\frac{p}{po}\right)^{\frac{2}{y}} - \left(\frac{p}{po}\right)^{\frac{y+1}{y}}\right\}}$$

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

$$\frac{a^2}{\gamma-1} + \frac{1}{2}C^2 = \frac{1}{2}C^2{}_{\max} = H_o = \frac{1}{2}a^{*2}\left(\frac{\gamma+1}{\gamma-1}\right) = \frac{\gamma}{\gamma-1}\frac{p_o}{\rho_o}$$

(b) Air (c_p=1.045 kJ/kg K, γ=1.35) at $p_1=3.5\times10^5$ N/m^2 and T_1=505 K flows with a velocity of 202 m/s in a 30 cm diameter duct. Calculate (a)Mass flow rate (b) Stagnation temperature (c) Mach number (d) Stagnation pressure values assuming the flow as compressible and incompressible. **07**

OR

(b) An aircraft is flying at an altitude of 12000 metres (T= 216.65 K, p=0.193 bar) at a Mach number of 0.82. The cross sectional area of the inlet diffuser before the L.P. compressor stage is 0.5 m^2. Determine (a) the mass of air entering the compressor per second (b) the speed of the aircraft (c) the stagnation pressure and temperature of air at the diffuser entry. **07**

Q.3 **(a)** Explain the expansion and compression both adiabatically and isentropically with help of T-S and P-V diagrams. **07**

(b) The pressure, velocity and temperature of air (γ=1.4, Cp=1.0 KJ/kg K) **07**

at the entry of a nozzle are 2 bar, 145 m/s and 330 K; the exit pressure is 1.5 bar. Determine for isentropic flow (a) the mach number at entry and exit (b) the flow rate and maximum possible flow rate.

OR

Q.3 **(a)** Derive the expression for the pressure ratio, across normal shock in terms of density ratio (Rankine Hugoniot expression). **07**

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

$$\frac{Py}{Px} = \frac{2\gamma}{\gamma-1}Mx^2 - \frac{\gamma-1}{\gamma+1}$$

Q.4 **(a)** Obtain an expression for change in entropy as a function of stagnation pressure ratio for Fanno flow process. Hence show that stagnation pressure always **07**

decreases in the process.

(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**

OR

Q.4 **(a)** Explain the mechanism of energy conversion in Rayleigh flow. **07**

(a) When a subsonic flow is heated
(b) When a supersonic flow is cooled.

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

$$Mx^* My^* = 1$$

Q.5 **(a)** What are the various types of wind tunnels used for low and high speed testing of models? Describe briefly the special problems of the supersonic tunnels. **07**

(b) Define the following terms:(a)Stagnation pressure (b)Stagnation temperature (c)Stagnation velocity of sound (4)Mach number (5)Critical and maximum velocity. **07**

OR

Q.5 **(a)** Prove that upper part of Fanno flow process is subsonic and lower part is supersonic. 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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Isentropic Flow Table (Flow of perfect gas, γ=1.4):

M	T/To	P/Po	A/A*	F/F*
0.4	0.969	0.895	1.59	1.375
0.75	0.898	0.688	1.062	1.031
0.8	0.886	0.656	1.038	1.018

Fanno Flow Table (Flow of perfect gas with friction, γ=1.4):

M	P/P*	c/c*=ρ*/ ρ	T/T*	Po/Po*	F/F*	$\frac{4\bar{f}Lmax}{D}$
0.3	3.619	0.3257	1.178	2.035	1.698	5.299
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