Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VIII EXAMINATION – WINTER 2015

Subject Code:181906 **Date :12/12/2015**

Subject Name: GAS DYNAMICS

Time: 2:30pm to 5:00pm **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)** Define gas dynamics. State the various laws as applied in the study of gas dynamics. **07**

(b) Supersonic jet of a gas has a Mach number of 1.2. If its temperature is 593K, determine the velocity of sound at static and stagnation conditions. Take $\gamma = 1.3$ and $R = 0.469\ kJ/kgK$. **07**

Q.2 **(a)** Draw the Fanno curve on h-s diagram and discuss the effect of friction in case of subsonic and supersonic flow. What is the limiting value of Mach number? **07**

(b) A circular duct passes 8.25 kg/s of air at an exit Mach number of 0.5. The entry pressure and temperature are 3.45 bar and 38^0C respectively, and the coefficient of friction is 0.005. If the Mach number at entry is 0.15, determine **07**

i. the diameter of the duct.

ii. pressure and temperature at the exit.

M	p/p^*	T/T^*	p_0/p_0^*	$4\bar{f}L/D$
$M_1 = 0.15$	7.319	1.1945	3.928	28.354
$M_2 = 0.50$	2.138	1.1430	1.340	1.069

OR

(b) Air enters a pipe of diameter 10 cm at M = 2.5. Find the **07**

i. the length of the pipe, if air leaves the pipe at M = 1.5.

ii. the length of the pipe, if air leaves the pipe at M = 1.0.

Assume f = 0.003

M	p/p^*	T/T^*	p_0/p_0^*	$4\bar{f}L/D$
1	1	1	1	0
1.5	0.606478	0.827586	1.176167	0.136050
2.5	0.292119	0.533333	2.636719	0.431977

Q.3 **(a)** Derive the following relation from one-dimensional steady flow energy equation. **07**

$$\frac{T^*}{T} = \frac{2}{\gamma+1} + \frac{\gamma-1}{\gamma+1}M^2$$

(b) Derive the following relationship for an isentropic flow. **07**

$$\frac{A}{A^*} = \frac{1}{M}\left(\frac{2}{\gamma+1} + \frac{\gamma-1}{\gamma+1}M^2\right)^{\frac{\gamma+1}{2(\gamma-1)}}$$

OR

Q.3 **(a)** For an isentropic flow, prove that **07**

$$\frac{dA}{A} = (M^2-1)\frac{dV}{V}$$

(b) Explain the behavior of a convergent nozzle under isentropic flow conditions with variation in back pressure. **07**

Q.4 **(a)** Bring out the effect of heat addition and heat extraction on the flow velocity in a constant area duct Rayleigh flow, when the flow is **07**

i. Initially subsonic and

ii. Initially supersonic.

(b) Air at Mach number 1.5, pressure 300 kN/m^2, static temperature 288K, stagnation temperature 418K, is brought to sonic velocity in a frictionless constant area duct through which heat transfer occurs. Determine the final pressure, final temperature and heat added during the process. **07**

M	T/T^*	p/p^*	T_0/T_0^*	p_0/p_0^*
1.5	0.753	0.578	0.909	1.121

OR

Q.4 **(a)** In case of a Rayleigh flow, show that the velocity of gas at maximum entropy point in sonic. **07**

(b) Derive the following expressions in Rayleigh line flow. **07**

i. $\frac{p_1}{p_2} = \frac{1+\gamma M_2^2}{1+\gamma M_1^2}$

ii. $\frac{T_1}{T_2} = \left(\frac{M_1}{M_2}\right)^2 \left(\frac{1+\gamma M_2^2}{1+\gamma M_1^2}\right)^2$

Q.5 **(a)** Derive the following relationship for normal shock: $V_1 . V_2 = a^{*2}$ **07**

(b) Show that the Mach number downstream of the normal shock wave is **07**

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

OR

Q.5 **(a)** Make a sketch of pressure pulse pattern when a point source of disturbance moves at subsonic, sonic and supersonic speed. Show the zone of action in each case. **07**

(b) Write a short note on wind tunnels. **07**

****