Seat No.: _____ Enrolment No.

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER– VIII EXAMINATION – SUMMER 2020

Subject Code: 2171914 **Date:26/10/2020**

Subject Name: GAS DYNAMICS

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.**
4. **Use of Gas Table is permitted.**

			MARKS
Q.1	**(a)**	Define following : 1) Maximum fluid velocity 2) Critical velocity of sound 3) Hypersonic flow	**03**
	(b)	"Bulk moduluas of elasticity of ideal gas is directly proportional to the pressure of the ideal gas in reversible adiabatic process" prove the above	**04**
	(c)	Define M*. Derive following relation: $M^2 = \frac{\left\{\frac{2}{\gamma+1}\right\}M^{*2}}{1-\left\{\frac{\gamma-1}{\gamma+1}\right\}M^{*2}}$ Calculate maximum value of M* for diatomic gas.	**07**
Q.2	**(a)**	Compare adiabatic expansion and isentropic expansion processes on T→S diagram.	**03**
	(b)	Air flowing in a duct has a velocity of 300m/s, pressure 1 bar and temperature 290K. Determine stagnation temperature and velocity of sound corresponds to stagnation condition.	**04**
	(c)	From the continuity equation, derive the equation for non-dimensional mass flow rate in terms of pressure ratio of static and stagnation pressure. Non-dimensional mass flow rate = $\frac{\dot{m}\sqrt{T_0}}{A^* P_0}\sqrt{\frac{R}{\gamma}}$	**07**
		OR	
	(c)	From the continuity equation derive the relation : $\frac{A}{A^*}\frac{p}{p_0} = \frac{\frac{1}{M}\left(\frac{2}{\gamma+1}\right)^{(\gamma+1/2(\gamma-1))}}{\sqrt{\left(1+\frac{\gamma-1}{2}M^2\right)}}$	**07**
Q.3	**(a)**	What is shock strength?.Write the equation which represents shock strength in terms of upstream Mach number.	**03**
	(b)	Upstream gas properties are Mach number 2.5, Pressure 2 bar and temperature 275K.	**04**

What is Mach number, pressure and velocity of gas in downstream side of shock.

(c) Starting from energy equation prove that, **07**
$M_x^* * M^*_y = 1$.
Where upstream and downstream reference Mach numbers for normal shock are represented by M_x^* and M^*_y respectively.

OR

Q.3 **(a)** What is shock? Represent normal shock on h→s diagram along with Rayleigh and Fanno curve. **03**

(b) A gas at a Mach number of 1.8, pressure 0.8 bar and temperature 373 K encounter shock. Determine density after shock and compare it with isentropic density. **04**

(c) From the energy equation, derive the following relation for the normal shock **07**

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

Where upstream and downstream reference Mach numbers for normal shock are represented by M_x^* and M^*_y respectively.

Q.4 **(a)** What is Fanno flow? Give examples of Fanno flow in thermal systems. **03**

(b) Prove that at maximum entropy point on Fanno curve is where Mach number is unity and all processes approach this point. **04**

(c) A circular duct passes 8.25 kg/s of air at an exit Mach number of 0.5. The entry condition of air is 3.45 bar and 38^0C. Co-efficient of friction of duct is 0.005. If entry Mach number is 0.15 determine: **07**

1) Length of duct
2) Diameter of duct
3) Exit pressure and temperature of air.

OR

Q.4 **(a)** Differentiate : Fanno flow and Isothermal flow. **03**

(b) Write governing describing Fanno curve. Draw three different Fanno curve on T→S diagram for three different mass densities. **04**

(c) Air enters a long circular at 3 bar, 312 K and Mach number 0.5. If the flow is isothermal throughout the duct Calculate: **07**

1) Length of the duct require to get Mach number 0.7 at exit.
2) Pressure and temperature at exit where M = 0.7.
3) Limiting Mach number.

Take : Duct diameter 0.125m and friction factor 0.0045.

Q.5 **(a)** What is critical state? Calculate the ratio of stagnation pressure to the critical pressure for monoatomic gas. **03**

(b) State the four assumptions of Rayleigh flow as well as write two applications where Rayleigh flow analysis is applicable. **04**

(c) The Mach number at the exit of combustion chamber is 0.9. The ratio of stagnation temperature at exit and entry is 3.74. if the exit condition is 2.5 bar at 1273K, determine : **07**

1) Pressure, temperature and Mach number at entry.
2) Heat supplied per kg of the gas.

Take : $\gamma = 1.3$ and $C_p = 1.218$ kJ/kg-K

OR

Q.5 **(a)** Write the equation of A/A^* and draw the graph of $(A/A^*) \rightarrow M$. **03**

(b) Write momentum equation for Rayleigh flow. Plot Rayleigh curve on p→v diagram and find : $\left(\frac{dp}{dv}\right)_R$ for Rayleigh line. **04**

(c) The conditions of a gas in a combuster at entry are : 0.343 bar, 310 K and 60 m/s. If the stagnation enthalpy is increased by 1172.5 kJ/kg between entry to exit, Calculate **07**

1) Pressure at exit.
2)Temperature at exit and
3) Mach number at exit.

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