Seat No.: ________ Enrolment No.

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VII (NEW) EXAMINATION – WINTER 2017

Subject Code: 2171914 **Date: 02/11/2017**

Subject Name: Gas Dynamics(Department Elective - I)

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 : 1) Isothermal compressibility 2) Stagnation state 3) Critical velocity of sound.	**03**
	(b)	Define: Mach number. Show graphically that zone of silence is greater than zone of action when object is moving with speed more than the velocity of sound.	**04**
	(c)	What is M*? What is the advantage of using it instead of Mach number ? Derive the relation : $M^{*2} = \frac{\frac{1}{2}(\gamma+1)M^2}{1+\frac{1}{2}(\gamma-1)M^2}$.	**07**
Q.2	**(a)**	Define critical state? Calculate the ratio of stagnation density to critical density for monoatomic ideal gas.	**03**
	(b)	From continuity equation derive following equation for isentropic flow: $C = \left[2\frac{\gamma}{\gamma-1} R\, T_0 \left\{1 - \left(\frac{p}{p_0}\right)^{(\gamma-1)/\gamma}\right\}\right]^{1/2}$	**04**
	(c)	Air is discharged from a reservoir at P_0 = 6.91 bar and T_0 = 325^{0}C through a nozzle to an exit pressure of 0.98 bar. If the flow rate is 3600 kg / hr determine for isentropic flow: 1) Throat area and throat pressure 2) Exit area and exit Mach number.	**07**
		OR	
	(c)	A supersonic wind tunnel settling chamber expands air through a nozzle from a pressure of 10 bar to 4 bar in the test section. Calculate the stagnation temperature to be maintained in the settling chamber to obtain a velocity of 500 m/s in the test section for air. What is the value of Mach number at test section. Take : C_p = 1.025 kJ/ kg-K and C_v = 0.735 kJ/ kg-K.	**07**
Q.3	**(a)**	What is shock wave? State the assumptions for studying normal shock wave.	**03**
	(b)	Air enters a convergent-divergent nozzle with a pressure of 2.9MPa. When shock occurs pressure at upstream side is 0.5MPa. Determine Mach number and pressure at the downstream side of the shock.	**04**
	(c)	Derive the equation for ratio of downstream pressure to upstream pressure in terms of upstream Mach number for normal shock.	**07**
		OR	
Q.3	**(a)**	What is the order of size of control volume to accommodate shock	**03**

wave? Write the governing equations to study behavior of shock wave.

	(b)	A compression shock wave occurs in a divergent air flow passage. On the upstream side of the shock, the velocity of air is 400m/s, temperature is 35^0C and pressure 0.2 MPa. Find pressure and temperature at downstream side.	**04**
	(c)	Derive Prandtl-Meyer equation for the normal shock in perfect gas.	**07**
Q.4	**(a)**	State assumptions made in deriving equations for Fanno flow. State two engineering fluid flow conditions which can be analyzed as Fanno flow.	**03**
	(b)	From the adiabatic energy equation prove that irrespective of entry condition of flow limiting condition at exit for Fanno flow is when M =1.	**04**
	(c)	Air flows through an insulated circular pipe at a rate of 495 kg/min. The pressure, temperature and Mach number at entrance to the pipe are 0.3MPa, 27^0C and 0.15 respectively. The co-efficient of friction of pipe is constant and its value is 0.005. If the Mach number at exit is 0.5, Calculate 1) Diameter of pipe 2) Length of pipe 3) Pressure at the exit of pipe.	**07**

OR

Q.4	**(a)**	What is Fanno flow? Write governing equations for Fanno flow.	**03**
	(b)	Draw h→s and h→v curves for Fanno flow process for two different mass flux. Here h ,s and v represent specific enthalpy, specific entropy and specific volume respectively.	**04**
	(c)	The average friction factor of a 25mm diameter 12m long pipe is 0.004. The condition of air at entry is 0.2Mpa, and 300K. Determine, Pressure, Temperature and Mach number at exit. Consider sound velocity is four times higher as compared to air velocity at inlet.	**07**
Q.5	**(a)**	Write equation of $\frac{dA}{A}$. Based on that show that to obtain accelerating flow 1) Flow area should be increased in a supersonic flow and 2) Flow area is decreased in subsonic flow.	**03**
	(b)	Enlist two flow situations where Rayleigh flow analysis is applicable. Represent Rayleigh flow process on h → s diagram. Show locus of stagnation enthalpy and Maximum entropy also.	**04**
	(c)	Represent Rayleigh line on p → v diagram. Based on diagram show that Mach number is $1/\sqrt{\gamma}$ when enthalpy becomes maximum.	**07**

OR

Q.5	**(a)**	Draw Prandtl velocity ellipse and show different flow regimes on that.	**03**
	(b)	How the enthalpy changes in the Rayleigh flow when heat addition continues beyond maximum enthalpy point?	**04**
	(c)	Derive the equations for $\frac{P}{P*}$ and $\frac{P_0}{P_0*}$ for Rayleigh flow. Where P^* is critical pressure and P_0^* is critical stagnation pressure.	**07**

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