Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VII(NEW) EXAMINATION – SUMMER 2019

Subject Code:2171914 Date:10/05/2019

Subject Name:Gas Dynamics

Time:02:30 PM TO 05:00 PM Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

			MARKS
Q.1	**(a)**	Define Mach Number. Classify compressible flow on the basis of Mach Number.	**03**
	(b)	An aircraft is flying at an altitude of 8 km where the ambient temperature is 250 K. Find the Mach number and classify as subsonic or supersonic when the speed of the aircraft is a) 30 m/s b) 300 m/s.	**04**
	(c)	Air flows through a duct at a pressure of 0.196 MPa with a velocity 350 m/s. The temperature of the air is 40°C. Determine the isentropic Stagnation pressure, Stagnation temperature and Stagnation density.	**07**
Q.2	**(a)**	Prove that $\left(\frac{T_0}{T^*}\right) = \frac{(\gamma+1)}{2}$	**03**
	(b)	Draw the shape of subsonic and supersonic nozzle and diffuser and mention the varying properties.	**04**
	(c)	Derive following expression for area ratio in terms of Mach number $$\frac{A}{A^*} = \frac{1}{M}\left[\frac{2}{\gamma+1} + \frac{\gamma-1}{\gamma+1}M^2\right]^{(\gamma+1)/2(\gamma-1)}$$	**07**
		OR	
	(c)	Air expands isentropically from 20 bar and 100°C to 12 bar. Determine the temperature and density at the final state. Also find the ratio if initial to final acoustic velocity.	**07**
Q.3	**(a)**	Write general characteristic of normal shock.	**03**
	(b)	The pressure and Mach number upstream of a normal shock are 0.1 MPa and 2.0 respectively. Determine the Mach number and pressure downstream of the shock.	**04**
	(c)	Derive the following relation for normal shock $V_1V_2 = a^{*2}$.	**07**
		OR	
Q.3	**(a)**	Write three governing equations which satisfy the state before and after a normal shock.	**03**
	(b)	Define strength of a shock wave. Find the strength of a shock wave when normal shock appears at M = 2.	**04**

(c) A normal shock wave moves through a duct of constant cross-section with a velocity of 500 m/s. The air in the duct is stationary and is a pressure and temperature of 0.1 MPa and 200 K respectively. Determine the velocity of air after the passage of the shock. Also find the pressure, temperature, Mach number and stagnation temperature imparted upstream of the wave. **07**

Normal Shock table:

M_1	M_2	P_{02}/P_{01}	P_2/P_1	T_2/T_1
1.46	0.71	.941	2.33	1.29

Isentropic table:

M	T/T_0	P/P_0	ρ/ρ_0
0.56	0.940	0.808	0.858
0.58	0.936	0.796	0.849

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

(b) Draw Fanno line on h-s diagram and discuss the effect of friction in subsonic and supersonic flow. **04**

(c) The average friction of a 25 mm diameter 12 meter long pipe is 0.004. The condition of air at the entry are 2 bar and 300 K. Determine the mass flow rate, pressure, temperature and the mach number at exit, if the mach number at inlet is 0.25. **07**

OR

Q.4 **(a)** Define dimensionless Critical Mach number. Give its uses. **03**

(b) Explain phenomenon of chocking in Isentropic flow. **04**

(c) Air flows through an insulated circular pipe at a rate of 495 kg/minute. The pressure, temperature and Mach number of air at entrance to the pipe are 0.3 MPa, 300 K and 0.15 respectively. The coefficient of friction for the pipe is assumed constant and its value is 0.005. if the Mach number at exit is 0.5, determine: **07**

a) The diameter of the pipe

b) The length of the pipe.

Q.5 **(a)** Define fanning's coefficient of friction and hydraulic diameter. **03**

(b) Air flow in a duct with a velocity of 215 m/s. The temperature of air measured at a point along the duct is 30°C and the air pressure is 5 bar. Determine the stagnation pressure. **04**

(c) Show that the Mach number corresponds to the maximum entropy point of a Fanno curve is unity. **07**

OR

Q.5 **(a)** Air enters in a pipe of 0.05 m diameter at stagnation condition of 10 bar and 400 K at Mach number of 2.8. Find the mass flow rate in pipe the pipe. **03**

(b) 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) Explain the characteristics of Rayleigh flow with suitable graphs. **07**

Fanno Flow Table (for air):

	M =0.14	M= 0.16	M =0.24	M= 0.26	M= 0.50	M= 0.52	M= 0.54
$4f\frac{L_{max}}{D}$	32.511	24.197	9.38	7.68	1.069	0.917	0.786
P/P*	7.80	6.829	4.538	4.185	2.138	2.051	1.971
T/T*	1.195	1.193	1.186	1.183	1.142	1.138	1.133

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