BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

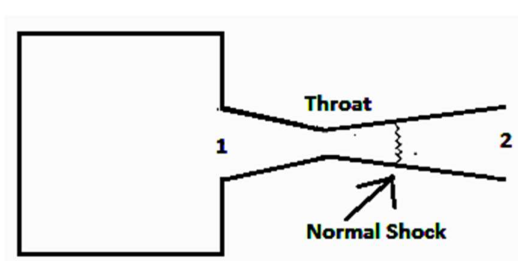
CLASS: BTECH. | **SEMESTER : VI**
BRANCH: MECHANICAL ENGINEERING | **SESSION : SP/2025**

SUBJECT: ME369 GAS DYNAMICS

TIME: 3 Hours | **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
4. Before attempting the question paper, be sure that you have got the correct question paper.
5. Use Gas Table wherever it is required.

			CO	BL
Q.1(a)	Prove that the mass flow rate of compressible fluid flowing through a venture-meter is given as the relation. The Suffix 1 represent inlet to venture-meter and 2 at the throat respectively. $$\dot{m}=\rho_2 A_2\sqrt{\frac{\frac{2\gamma}{\gamma-1}\frac{P_1}{\rho_1}\left[1-\frac{P_2}{P_1}\right]^{\frac{\gamma-1}{\gamma}}}{\left[1-\left(\frac{A_2}{A_1}\right)^2\left(\frac{P_2}{P_1}\right)^{\frac{2}{\gamma}}\right]}}$$	[5]	1	M
Q.1(b)	Determine the Mach number, when an airplane is flying at 1100 km/hour through still air having a pressure of 7 N/cm^2(abs) and temperature 268 Kelvin. The wind velocity may be taken as zero. Take ratio between specific heats (gama) = 1.4 and R = 287.14 J/kg-K. Also determine the pressure, temperature and density of air at stagnation point on the nose of the airplane.	[5]	3	H
Q.2(a)	Prove that the following Rankine –Hugoniot relation across a normal shock: $$\frac{P2}{P1}=\frac{\left(\frac{\gamma+1}{\gamma-1}\right)\frac{\rho_2}{\rho_1}-1}{\left(\frac{\gamma+1}{\gamma-1}\right)-\frac{\rho_2}{\rho_1}}$$	[5]	2	M
Q.2(b)	Air enters a Convergent- Divergent nozzle from a reservoir as shown in figure. The pressure and temperature of air in the reservoir are 29 bar(abs) and 50 degree Centigrade respectively. In the diverging portion a normal shock occurs as shown in the figure. The pressure just before the normal shock shows 5 bar(abs). Determine the pressure just behind the shock. Also determine air mass flow rate per unit area at the throat. Take ratio between specific heats (gama) = 1.4 and R = 287.14 J/kg-K, and Cp= 1004.5 J/kg-K.	[5]	4	H



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Q.3(a)	A gas(gama = 1.3, R = 287 J/kg-K) at P1 = 1 bar(abs), T1 = 400 K enters a 30 cm diameter duct at Mach number of 2.0. A normal shock occurs at Mach number 1.5 and the exit Mach number is 1.0. If the mean value of coefficient of friction f = 0.003, determine the: i) Length of the duct upstream and downstream of the shock, ii) Mass flow rate of the gas. Show the process in the enthalpy-entropy diagram.	[5]	3	H
Q.3(b)	Argon gas enters a constant cross section area duct at Mach number M1 = 0.2, P1 = 320 kPa(Abs), T1 = 400 K at a rate of 1.2 kg/sec. Disregarding frictional losses, determine the highest rate of heat transfer (Q dot) to the argon gas without reducing the mass flow rate. Take gama = 1.67, Cp = 0.5203 kJ/kg-K, R = 0.2081 kJ/kg-K.	[5]	2	H
Q.4(a)	Explain with suitable sketch the principle of operation of Turbojet and Turbofan engines.	[5]	1	L
Q.4(b)	Explain with a neat sketch the principle of operation of Ramjet engine. Also state the advantage, disadvantage and application of it.	[5]	1	L
Q.5(a)	Classify various Rocket engines. Also make a comparison between air breathing and Rocket engines.	[5]	1	L
Q.5(b)	With a suitable sketch explain the working of a liquid propellant Rocket. Also state the advantage and disadvantages of such system.	[5]	1	L

::::::30/04/2025::::::M