BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(MID SEMESTER EXAMINATION SP/2025)

CLASS: B.TECH. **SEMESTER : VI**
BRANCH: MECHANICAL ENGINEERING **SESSION : SP/2025**
SUBJECT: ME369 GAS DYNAMICS
TIME: 02 Hours **FULL MARKS: 25**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 5 marks and total 25 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
***4*. Tables/Data handbook/Graph paper etc., if applicable, will be supplied to the candidates**
5. Use Gas Table wherever required

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Q.1(a)	Define the following: (i) subsonic flow, (ii) sonic flow and (iii) supersonic flow.	[2]	1	L
Q.1(b)	Determine the sonic velocity of the following fluids (i) crude oil of sp.gr. 0.8 and bulk modulus 153036 x 10^4 N/m^2, (ii) Mercury having sp.gr. 13.6 and bulk modulus 2648700 x 10^4 N/m^2.	[3]	1	M
Q.2(a)	Derive an expression for Bernoulli's equation when the flow process is isentropic in nature.	[2]	1	M
Q.2(b)	An aeroplane is flying at a height of 15000 m where the temperature is 223K. Determine the speed of the aeroplane, when it is flying with a Mach number 2.0. Assuming specific heat ratio as 1.4 and R = 287 J/Kg-k, pressure at 15000 m from sea level is 1.2108 x 10^4 Pa(abs).	[3]	1	M
Q.3(a)	Define the term strength of a shock.	[2]	1	L
Q.3(b)	Determine the stagnation pressure, stagnation temperature, stagnation density at the stagnation point on the nose of a plane, which is flying at 800 km/hour through still air having a pressure 8 x10^4 N/m^2 (abs) and temperature 263K. Take specific heat ratio as 1.4 and R = 287 J/Kg-k.	[3]	1	M
Q.4(a)	Briefly explain how a Mach cone is formed in front of a sharp nosed object flying with a supersonic velocity.	[2]	2	L
Q.4(b)	A re-entry vehicle at an altitude of 15000m and has a velocity of 1769 m/s. A bow shock wave envelops the vehicle. Determine the static and stagnation temperature, pressure just behind the shock of the re-entry vehicle centerline, where the shock wave may be treated as normal shock. Take specific heat ratio as 1.4 and R = 287 J/Kg-k and pressure and temperature at an altitude of 15000m as 1.2108 x10^4 Pa (abs) and 216.5 K respectively.	[3]	2	M
Q.5(a)	Draw the following characteristic curves of a subsonic convergent nozzle operating in a compressible flow regime: (i) Pressure ratio P_b/P_0 vs length of the nozzle. Specify the point on the curve where P_b/P_0 = 0.528. (ii) Mass flow rate per unit area through the nozzle vs Pressure ratio P_b/P_0 . Specify the point on the curve where P_b/P_0 = 0.528.	[2]	2	M
Q.5(b)	A supersonic nozzle is provided with a constant diameter circular duct at its exit as shown in Figure. The duct diameter is same as the nozzle exit diameter. The nozzle exit cross section is 3 times that of its throat. The entry conditions of the gas (gamma = 1.4, R=287 J/kg-K) are P_{01} = P_{0x}= 10 bar (Abs), T_{01} =T_{0x}= 600 K. Determine the static pressure(P_y), Mach Number(M_y) and the velocity(V_y) of the gas in the duct for the condition when a normal shock occurs at the exit of the nozzle.	[3]	2	M