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CBCS SCHEME

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15AE552

Fifth Semester B.E. Degree Examination, Feb./Mar. 2022
Gas Dynamics

Time: 3 hrs. Max. Marks: 80

Note: 1. ***Answer any FIVE full questions, choosing ONE full question from each module.***
2. ***Gas Tables are permitted.***

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-1

1 a. Derive an expression for Bernoulli's equation for steady flow isentropic compressible flow. **(10 Marks)**

b. Determine the exit velocity of nozzle using adiabatic energy equation. **(06 Marks)**

OR

2 a. Obtain a relation for energy equation for a flow process. **(08 Marks)**

b. With help of control volume approach express the continuity equation for steady flow. **(08 Marks)**

Module-2

3 a. Air (C_p = 1.05kJ/Kg K, γ = 1.38) at $P_1 = 3 \times 10^5 N/m^2$ and T_1 = 500K flows with a velocity of 200m/s in a 30cm diameter duct. Calculate mass flow rate, stagnation temperature, Mach number and stagnation pressure values, assuming the flow as compressible and incompressible. **(08 Marks)**

b. Show that the scope of the Rayleigh line is $\left(\frac{dp}{dv}\right)_h = \frac{\rho^2 a^2}{\gamma}$ and prove that $M^* = \frac{1}{\sqrt{\gamma}}$. **(08 Marks)**

OR

4 a. Obtain a relation for fanno flow bar maximum duct length

$$\left(\frac{4\bar{f}L_{max}}{D}\right)_M = \frac{1-M^2}{\gamma M^2} + \frac{\gamma+1}{2\gamma} \ln \frac{(\gamma+1)M^2}{2+(\gamma-1)M^2}.$$ **(06 Marks)**

b. The Mach number at the exit of a combustion chamber is 0.9. The ratio of stagnation temperatures at exit and entry is 3.74. If the pressure and temperature of the gas at exit are 2.5bar and 100°C respectively. Determine Mach no, pressure and temperature of the gas at entry, the heat supplied per Kg of the gas and the maximum heat that can be applied. **(10 Marks)**

Module-3

5 a. Derive an expression for Hugoniot equation for normal shock wave. **(08 Marks)**

b. Air flow at Mach 4.0 and pressure $10^5 N/m^2$ is turned abruptly by a wall into the flow with a turning angle of 20° as shown in Fig Q5(b). If the shock is reflected by another wall determine the flow properties M and P downstream of the shock.

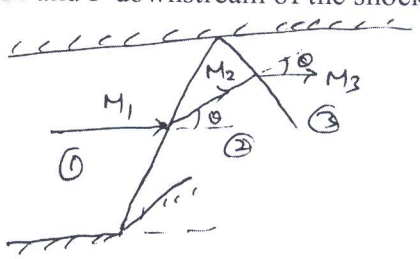

Fig Q5(b) **(08 Marks)**

OR

6 a. Discuss about the deflagration and detonation. **(06 Marks)**

b. A normal shock moves in a constants area tube shown in Fig Q6(b) in region 1. V_1 = 100m/s, T_1 = 30°C, and P_1 = 0.7atm. The shock speed C_s with respect to a fixed coordinate system is 600m/s. Find the fluid properties in region 2.

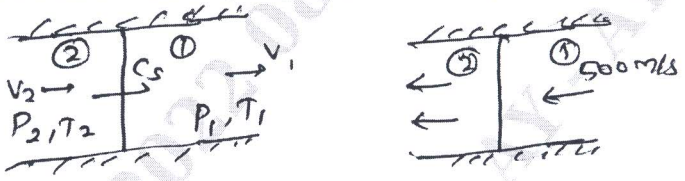

Fig Q6(b) **(10 Marks)**

Module-4

7 a. Show the effect of back pressure on C-D nozzle operation. **(08 Marks)**

b. A convergent nozzle has an exit area of cross section of 1000cm^2. Air expands isentropically through the nozzle from constant inlet condition (P_0 = 5bar, T_0 = 500K) to i) M = 1 ii) M = 0.8. Determine for the above two cases the exit velocity and the mass flow chart. **(08 Marks)**

OR

8 a. Give the criteria for acceleration and deceleration in variable area ducts. **(08 Marks)**

b. Obtain a relation for area ratio as function of Mach number for isentropic flow conditions? **(08 Marks)**

Module-5

9 a. Elucidate the non-dimension numbers used for gas dynamics problem. **(08 Marks)**

b. Describe the flame stabilization used for combustion. **(08 Marks)**

OR

10 a. Difference between premixed flame and diffusion flame? **(06 Marks)**

b. Determine the minimum energy required for ignition for combustible mixture. **(10 Marks)**

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