CBCS SCHEME

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17AE552

Fifth Semester B.E. Degree Examination, Dec.2019/Jan.2020
Gas Dynamics

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. Derive an expression for the thrust function with usual notations. **(10 Marks)**

b. An aircraft flies at 800 km/hr at an altitude of 10,000 metres (T = 223.15K, P = 0.264 bar). The air is reversibly compressed in an inlet diffuser. If the Mach number at the exit of the diffuser is 0.36 determine: i) Entry Mach number ii) Velocity, Pressure and temperature of air at the diffuser exit. **(10 Marks)**

OR

2 a. Derive energy equations for the flow process of an Ideal gas. **(12 Marks)**

b. Air (C_p = 1.05 kJ/kg K, γ = 1.38) at $P_1 = 3 \times 10^5$ N/m^2 and T_1 = 500K flows with a velocity of 200 m/s in a 30cm diameter duct. Calculate:

i) Mass flow rate
ii) Stagnation temperature
iii) Mach number
iv) Stagnation pressure values assuming the flow as compressible and Incompressible. **(08 Marks)**

Module-2

3 a. Derive an expression for entropy change and hence total pressure ratio at any two points in a fanno flow. **(08 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 2.5 bar and 1000°C respectively. Determine: i) Mach number, Pressure and temperature of the gas at entry ii) The heat supplied per kg of the gas iii) The maximum heat that can be supplied. **(12 Marks)**

OR

4 a. Explain Rayleigh flow with the help of suitable plots and energy equation. Also, prove that the flow is sonic when the entropy is constant. **(10 Marks)**

b. A circular duct passes 8.25kg/s of air at an exit Mach number of 0.5. The entry pressure and temperature are 3.45 bar and 38°C respectively and the coefficient of friction 0.005. If the Mach number at entry is 0.15, determine:

i) The diameter of the duct
ii) Length of the duct
iii) Pressure and temperature at the exit
iv) Stagnation pressure loss,
v) Verify the exit Mach number through exit velocity and temperature. **(10 Marks)**

Module-3

5 a. Derive Prandtl-Meyer relation for normal shock i.e. $c_x \cdot c_y = a^{x^2}$ **(10 Marks)**

b. Explain expansion waves and Prandtl-Meyer function with a neat sketch. **(10 Marks)**

OR

6 a. Let us consider a plane shock wave that is moving into a stationary fluid such as shown in Fig.Q.6(a). Determine the conditions that exist after passage of the shock front. **(10 Marks)**

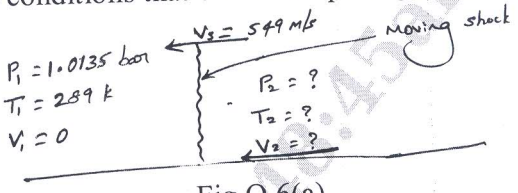

Fig.Q.6(a)

Figure: Moving normal shock with ground as references.

b. Air is flowing through a duct under known conditions and a valve is suddenly closed which results in a shock wave propagating back through the duct as shown in Fig.Q.6(b). Determine the air flow conditions that exist after the passage of shock and also the speed of the shock. **(10 Marks)**

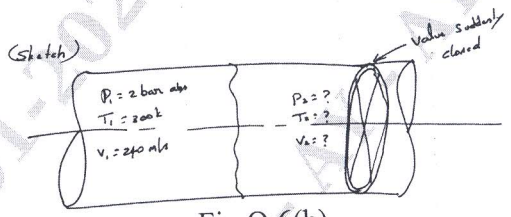

Fig.Q.6(b)

Module-4

7 a. Obtain an equation for area ratio in terms of Mach number. Explain how a variable area duct acts as diffuser (or) nozzle when the flow regimes are different. **(10 Marks)**

b. A nozzle in a wind tunnel gives a test section Mach number of 2.0 Air enters the nozzle from a large reservoir at 0.69 bar and 310K. The cross-sectional area of the throat is 1000cm^2. Determine the following quantities for the tunnel for one-dimensional isentropic flow:

i) Pressures, temperatures and velocities at the throat and test sections.
ii) Area of cross-section of the test section
iii) Mass flow rate
iv) Power required to drive the compressor. **(10 Marks)**

OR

8 a. Explain the effect of pressure ratio on de-level nozzle performance with neat diagram and plot. **(10 Marks)**

b. Air is discharged from a reservoir at $P_0 = 6.91$ bar and $t_0 = 325°C$ through a nozzle to an exit pressure of 0.98 bar. If the flow rate is 3600 kg/hr determine for isentropic flow.

i) Throat area, pressure and velocity
ii) Exit area, Mach number
iii) Maximum velocity. **(10 Marks)**

Module-5

9 a. Define and derive an expression for Reynold's number (R_e), Froude's number, Euler's number, Weber's number and Mach number. **(10 Marks)**

b. Define and derive an expression for Geometric similarity, kinematic similarity and dynamic similarity. **(10 Marks)**

OR

10 a. With a neat sketch explain physical processes in a premixed flame. **(06 Marks)**

b. Write a short note on non-premixed flames (Diffusion flames). **(04 Marks)**

c. Derive an expression for flame speed and thickness. **(10 Marks)**

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