CBCS SCHEME

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15AE552

Fifth Semester B.E. Degree Examination, July/August 2021
Gas Dynamics

Time: 3 hrs. Max. Marks: 80

Note: ***Answer any FIVE full questions.***

1 a. Derive continuity equation in differential form for 3-Dimensional flow. **(08 Marks)**

b. Define flow and non-flow process. Also derive steady flow energy equation for a flow process. **(08 Marks)**

2 a. Derive Euler equation and obtain Bernoulli's equation relation for compressible flow. **(08 Marks)**

b. Derive the expression for thrust and explain it with neat sketch. **(08 Marks)**

3 a. Define Mach Angle. Explain mach cone and obtain relation for mach angle. **(08 Marks)**

b. A combustion chamber in a gas turbine plant receives air at 350K, 0.55bar and 75m/s. The air-fuel ratio is 29 and calorific value of fuel is 41.87 mJ/kg, (γ = 1.4, R = 0.287kJ/Kg.K) Find :

i) Mach number (M_1, M_2)
ii) P_2, T_2, V_2 of gas
iii) Percentage of stagnation pressure loss in combustion chamber
iv) Maximum stagnation temperature. **(08 Marks)**

4 a. Derive maximum heat transfer in a Rayleigh flow. **(04 Marks)**

b. Explain Fanno flow and How the fluid properties change in Fanno flow. In subsonic and supersonic region. **(06 Marks)**

c. Air at P_0 = 10bar, T_0 = 400K is supplied to a 50mm diameter pipe. Friction factor is 0.002, If mach number changes from M_1 = 3.0 to M_2 = 1.0 at exit. Determine: i) Length of pipe ii) Mass flow rate. **(06 Marks)**

5 a. Write Equation of motion for normal stock wave and derive normal shock relation for perfect gas. **(08 Marks)**

b. A re-entry vehicle is at an altitude of 15km has velocity of 1850m/s. A bow shock envelops vehicle. Determine static and stagnation temperature by neglecting dissociation just behind shock wave in re-entry vehicle centre line where shock wave is normal to flow. Take (γ = 1.4, R = 287J/Kg.K). **(08 Marks)**

6 a. Draw an oblique shock and derive relation between θ, β, M. **(08 Marks)**

b. Explain the differences in measuring dynamic pressure in compressible and incompressible flow using Pitot-static tube. **(08 Marks)**

7 a. Explain how to obtain a supersonic flow with nozzle. Also draw the performance under various back pressures. **(08 Marks)**

b. A supersonic wind tunnel nozzle is to be designed for M = 2.0 with throat section 1m^2 in area. Pressure and temperature at nozzle inlet are 7 bar and 40°C and velocity is negligible. Assume that flow is one-dimensional at throat and test section.
Calculate : i) Mass flow rate ii) Area of test section iii) Pressure, Temperature and density at throat and test section. **(08 Marks)**

8 a. Derive Area-mach number relation for De-leval nozzle and explain the possibilities for various (A/A^*) ratios. **(08 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 throat is $1000cm^2$. Assume isentropic and one-dimensional flow. Determine:

i) Pressure, temperature and velocities at throat and test section.
ii) Area of cross section of test section
iii) Mass flow rate
iv) Power required to drive compressor. **(08 Marks)**

9 a. Write and drive the relation for model laws used in model analysis. **(08 Marks)**

b. Derive the relation for thrust developed by the propeller (T), which depends on speed (V), Diameter (D), Angular velocity (W), Dynamic viscosity (μ), Density (ρ) and Speed of sound (C) by Buckingham's π-theorem. **(08 Marks)**

10 a. Define flame propagation and explain about diffusion and premixed flames. **(08 Marks)**

b. Describe flame stabilization and explain various methods of flame stabilization techniques. **(08 Marks)**

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