CBCS SCHEME

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15AE552

Fifth Semester B.E. Degree Examination, Aug./Sept. 2020
Gas Dynamics

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. Obtain area Mach number relation for a De Laval nozzle. **(08 Marks)**

b. An aircraft files at 800 km/h at an altitude of 10,000m. 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
Assume that at 10,000m, T = 223.15K, P = 0.264 bar. Let subscripts i and e refer to conditions at entry and exit of the diffuser. From the isentropic flow table, for r = 1.4, $M_i = 0.74$, $P_i/P_0 = 0.695$, $M_C = 0.36$, $P_e/P_0 = 0.914$, $T_e/T_0 = 0.975$. **(08 Marks)**

OR

2 a. Air with specific heat C_p = 1.005 kJ/kg.k, r = 1.38, P_1 = 3 bar, T_1 = 500K flows with a velocity 200m/s with diameter 30cm of duct. Determine : i) mass flow rate ii) mach number iii) stagnation temperature iv) stagnation pressure. Assume flow as compressible. **(08 Marks)**

b. Write a note on flow thorough diffusers. **(08 Marks)**

Module-2

3 a. Explain flow with friction in constant area duct. Formulate an expression for skin friction using momentum equation. **(08 Marks)**

b. Explain convergent – Divergent nozzle with neat diagram. **(08 Marks)**

OR

4 a. A combustion chamber in a gas turbine plant receivers air at 350K, 0.55 bar and 75m/s. The air fuel ratio is 29 and the calorific value of the fuel is 41.87MJ/kg. Taking r = 1.4 and R = 0.287 kJ/kg.K for the gas, determine,
i) Initial and final Mach number.
ii) Final pressure and temperature of the gas
iii) Percent stagnation pressure loss in the combustion chamber
iv) Maximum stagnation temperature attainable. **(08 Marks)**

b. Draw a fannoline and show that, $h = h_0 - \frac{1}{2}\left(\frac{G}{\rho}\right)^2$. **(08 Marks)**

Module-3

5 a. Derive Prandtl – Meyer relation for normal shock waves with usual notations. **(08 Marks)**

b. Air at P_0 = 10bar, T_0 = 400K is supplied to a 50mm diameter pipe. The friction factor for the pipe surface is 0.002. If the Mach number changes from 3 at the entry to 1 at the exit, determine :
i) the length of the pipe ii) mass flow rate. **(08 Marks)**

OR

6 a. Derive an expression for the variation of temperature as a flow property. **(08 Marks)**

b. Show that the maximum heat transfer in a Rayleigh flow is given by

$$Q_{max} = \frac{(1-m^2)^2}{2(1+r)m^2} C_p . T_1 .$$ **(08 Marks)**

Module-4

7 a. The flow Mach number, pressure and temperature ahead of a normal shock are given as 2, 0.5 atm, and 300K respectively. Determine M_2, P_2, T_2 and C_2 behind the wave. **(08 Marks)**

b. The Mach number at the exit of a combustion chamber is 0.9. The ratio of stagnation temperature 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) Heat supplied per kg of the gas. Take r = 1.3 and C_p = 1.218kJ/kg.K. **(08 Marks)**

OR

8 a. Derive an expression for general potential equation for three dimensional flows. **(08 Marks)**

b. With a plot explain the effect of back pressure on nozzle flow. **(08 Marks)**

Module-5

9 a. Formulate an equation for linearized potential flow equation using small perturbation theory. **(08 Marks)**

b. Describe the expression for change in following flow parameters with neat diagram temperature and pressure. **(08 Marks)**

OR

10 a. Explain the flame stabilization with the help of a stability loop. **(08 Marks)**

b. Define similitude and explain the types of similarities. **(08 Marks)**

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