USN | | | | | | | | | | | **10AE61**

Sixth Semester B.E. Degree Examination, Dec.2017/Jan.2018

Applied Gas Dynamics

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer FIVE full questions, selecting at least TWO questions from each part.***
2. ***Use of thermodynamics table and gas tables are allowed.***

PART – A

1 a. Explain De-Laval nozzle. Derive an expression for area ratio as a function of Mach number for a De-Laval nozzle. **(10 Marks)**

b. A conical diffuser has entry and exit diameters of 15 cm and 30 cm respectively. The pressure, temperature and velocity of air at entry are 0.69 bar, 340 K and 180 m/s respectively. Determine: (i) exit pressure, (ii) exit velocity, (iii) force exerted on diffuser wall. Assume isentropic flow, r = 1.4, c_p = 1 kJ/kgK. **(10 Marks)**

2 a. Derive Prandtl-Meyer relation for normal shock waves with usual notations. **(10 Marks)**

b. A gas (r = 1.4, R = 0.287 kJ/kgK) at a Mach number of 1.8, P = 0.8 bar and T = 373 K passes through a normal shock. Determine its density after the shock. Compare this value in an isentropic compression through the same pressure ratio. Assume for normal shock tables for r = 1.4, at M_x = 1.8, (P_y/P_x) = 3.613, (T_y/T_x) = 1.532. **(10 Marks)**

3 a. Draw a Fanno line and show that $h = h_0 - \frac{1}{2}\left(\frac{G}{\rho}\right)^2$. **(10 Marks)**

b. A circular duct passes 8.25 kg/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 duct
ii) Length of 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)**

4 a. Define Rayleigh flow process and by a suitable graph, explain the Rayleigh curve and its significance and also show that at maximum entropy point, the flow is sonic analytically. **(10 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) Heat supplied per kg of the fluid
iii) Maximum heat that can be supplied.
Take r = 1.3 and c_p = 1.218 kJ/kgK. **(10 Marks)**

PART – B

5 a. Explain the small perturbation theory and show the linearization of the potential equation. (10 Marks)

b. Derive an expression for linearized pressure coefficient. (10 Marks)

6 a. Explain Prandtl-Glauert rule for a two dimensional subsonic flow. (10 Marks)

b. Discuss the Von-Karman rule for transonic flow. (10 Marks)

7 a. Explain the thin aerofoil theory and obtain an expression for the pressure distribution. (10 Marks)

b. Discuss the typical aerodynamic characteristics of an aerofoil at low speeds. (10 Marks)

8 a. Explain closed circuit supersonic tunnel with relevant sketch. (10 Marks)

b. Explain the following with suitable sketch:

i) Hot wire anemometer

ii) Mach Zender Inter ferometer. (10 Marks)

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