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10AE61

Sixth Semester B.E. Degree Examination, June/July 2017
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 appropriate gas table permitted.***

PART – A

1 a. Define stagnation enthalpy and stagnation pressure. **(04 Marks)**

b. Derive Bernoulli's equation for isentropic flow by assuming perfect gas. **(08 Marks)**

c. A ramjet flies at 11 km altitude with a flight Mach number of 0.9. In the inlet diffuser, the air is brought to the stagnation condition, so that it's stationary just before the combustor. Combustion takes place at constant pressure and a temperature increase of 1500°K results. The combustion products are then ejected through the nozzle. Calculate (i) The stagnation pressure and temperature (ii) Nozzle exit velocity. Assume $P_\alpha = P_{exit} = 0.3$ atm, $T_\alpha = 213$°K **(08 Marks)**

2 a. Derive static pressure ratio across the normal shock wave in term of upstream Mach number. Also define strength of a shock wave. **(10 Marks)**

b. The velocity of a normal shock wave moving into stagnant air (P = 1.0 bar, t = 17°C) is 500 m/s. If the area of cross section of the duct is constant. Determine (i) Pressure (ii) Temperature (iii) Velocity of air (iv) Stagnation temperature (v) The mach number imparted upstream of the wave front. **(10 Marks)**

3 a. Derive an expression for static temperature ratio and stagnation pressure ratio of Fanno flow. **(10 Marks)**

b. Air enters a long circular duct (d = 12.5 cm, $\bar{f} = 0.0045$) at a Mach number of 0.5, pressure 3.0 bar and temperature 312°K. If the flow is isothermal throughout the duct. Determine (i) the length of the duct required to change the Mach number to 0.7, (ii) Pressure and temperature of air at M = 0.7 (ii) The length of duct required to attain limiting Mach number (iv) State of air at the limiting Mach number. **(10 Marks)**

4 a. What is Rayleigh flow? Obtain an equation representing Rayleigh curve. Also draw Rayleigh curves on h-s plane. **(10 Marks)**

b. The conditions of a gas in a combustor at the entry are $P_1 = 0.343$ bar, $T_1 = 310$°K, $C_1 = 60$ m/s. Determine the Mach number, pressure, temperature and velocity at the exit if the increase in stagnation enthalpy of the gas between entry and exit is 1172.5 KJ/kg. **(10 Marks)**

PART – B

5 a. Derive the basic potential equation for compressible flow. **(12 Marks)**

b. Derive the expression for pressure coefficient. **(08 Marks)**

6 a. Explain Prandtl-Glauert rule for supersonic flow. **(10 Marks)**

b. A given profile has at $M_\alpha = 0.29$, the following lift co-efficient:

$C_L = 0.2$ at $\alpha = 3^0$

$C_L = -0.1$ at $\alpha = -2^0$

where α is angle of attack, plot the relation showing $\frac{dC_L}{d\alpha}$ Vs M_α for the profile for values of M_α upto 1.0. **(10 Marks)**

7 a. Explain the shock expansion theory considering a 2D supersonic flow over an aerofoil. Also show the wave pattern for the flow over a flat plate at an angle of attack. **(10 Marks)**

b. Explain thin aerofoil theory and obtain an expression for the pressure co-efficient. **(10 Marks)**

8 a. Explain velocity measurement for (i) incompressible (ii) compressible (iii) supersonic flow. **(10 Marks)**

b. Write short notes on:

(i) Shock tube.

(ii) Shadow technique. **(10 Marks)**

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