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10AE61

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

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO questions from each part.***

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. With the help of a neat sketch, explain the following for a Rayleigh flow:
i) Constant entropy lines.
ii) Constant enthalpy lines. **(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 and iii) the maximum heat that can be supplied. Take $\gamma = 1.4$. **(12 Marks)**

PART – B

5 a. Derive an equation for linearization of potential flow or small perturbation theory with usual notation. **(10 Marks)**

b. Derive an expression for pressure coefficient in three dimensional and two dimensional flows and explain the bodies of revolution. **(10 Marks)**

6 a. Explain Prandtl Glavret rule for subsonic and supersonic flow. **(12 Marks)**

b. A given profile has at $M_\infty = 0.29$, the following lift coefficients:

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

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

where α is the angle of attack. Plot the relation showing $\frac{dCL}{d\alpha}$ Vs M_∞ for the profile for values of M_∞ upto 1.0. **(08 Marks)**

7 a. Define experimental characteristics of airfoils in compressible flow. If cumbered aerofoil at an angle of attack, then explain

i) Kinetic flow condition

ii) At $z \rightarrow \pm\infty$, perturbation velocities are zero as finite. **(12 Marks)**

b. With the help of neat sketch, show nature of pressure distribution profile for symmetrical and unsymmetrical aerofoil's **(08 Marks)**

8 a. How many types of supersonic wind tunnel is there, with the help of diagram explain the working of them? **(12 Marks)**

b. The data of a mach – 2 supersonic wind tunnel is given below :

Pressure in the test section	0.69bar
Area of cross – section of the nozzle threat	$1000cm^2$
Ambient pressure	1.02bar
Ambient temperature	311K

The air is taken from the atmosphere and compressed continuously in a multistage compressor to the reservoir pressure. That test secion of tunnel directly exhausts into the atmosphere. Determine :

i) Temperature of air in the test section

ii) Mass flow rate of air

iii) Cross – sectional area of the test section

iv) Power required to drive the compressor

Assume reversible flow throughout. **(08 Marks)**

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