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10AE61

Sixth Semester B.E. Degree Examination, June/July 2016
Applied Gas Dynamics

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer FIVE full questions, selecting at least TWO questions from each part.***
2. ***Gas Table is allowed in examination. (Gas table compressible Flow Calculation – Sixth Edition S.M. Yahya)***

PART – A

1 a. Derive Impulse function for compressible flow problems is

$$\frac{F}{F^*} = \frac{1+\gamma M^2}{M\sqrt{2(1+\gamma)\left(1+\frac{\gamma-1}{2}M^2\right)}}$$ **(10 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 the throat is 1000cm^2. Determine the following quantities for the tunnel for one dimensional isentropic flow :
i) Pressures, temperatures and velocities of the test section
ii) Area of cross-section of the test section
iii) Mass flow rate
iv) Power required to drive the compressor. **(10 Marks)**

2 a. Show that, the gas velocities before and after the normal shock by using Prandtl-Meyer relationship is expressed by $c_x \cdot c_y = a^{*2}$ $M_x^* \cdot M_y^* = 1$ **(10 Marks)**

b. The velocity of a normal shock wave moving into stagnant air (p = 1.0 bar, t = 17°C) is 500m/sec. if the area of cross-section of the duct is constant deremine
i) pressure ii) temperature iii) velocity of air iv) stagnation temperature and v) the mach number imparted system of the wave front. **(10 Marks)**

3 a. With the help of h-s diagram, show that the gas velocity at the maximum entropy point (F) on the Fanno line is sonic (M =1). **(10 Marks)**

b. Air at P_0 = 10 bar, T_0 = 400 K is supplied to a 50 mm diameter pipe. The friction factor for the pipe surface is 0.002. If the mach number changes from 3.0 at the entry to 1.0 at the exit, determine (i) the length of the pipe and (ii) the mass flow rate. **(10 Marks)**

4 a. Show that in Rayleigh Flow, Maximum possible Heat Transfers is equal to

$$Q_{max} = \frac{(1-M^2)^2}{2(1+\gamma)M^2} C_p T_1$$ **(12 Marks)**

b. If the conditions at sonic point are p^* = 1 bar, T^* = 500K. Calculate pressure, temperature and velocity at the maximum enthalpy point. What is the change of entropy between these points? **(08 Marks)**

PART – B

5 a. What do you mean by, the General potential equation for Three – Dimensional flow, also show that $\left(\frac{a}{a_\infty}\right)^2 = 1 - \frac{\gamma-1}{2} M_\infty^2 \left(\frac{V_x^2 + V_y^2 + V_z^2}{V_\infty^2} - 1\right)$ (12 Marks)

b. Derive the basic potential equation for compressible flow in terms of linearized perturbation velocity potential equation. (08 Marks)

6 a. Explain Prandtl-Glauest transformation rule for subsonic flow in terms of boundary conditions. (08 Marks)

b. How will you define, application of wings to finite span in terms of Gothert Rule? (06 Marks)

c. If the value of the pressure coefficient at the maximum velocity location an a profile is – 2.13, determine the critical mach number. (06 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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