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

Sixth Semester B.E. Degree Examination, June/July 2014

Applied Gas Dynamics

Time: 3 hrs. Max. Marks:100

Note: ***1. Answer any FIVE full questions, selecting atleast TWO questions from each part.***
2. Gas tables and charts are permitted.

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

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. **(08 Marks)**

b. A ramjet flies at 11km attitude with a flight Mach number of 0.9. In the inlet differences the air is brought to the stagnation condition so that it is stationary just before the combustion chamber. Combustion taken place at constant pressure and a temperature increase of 1500°C results. The combustion products are then ejected through the nozzle.

i) Calculate the stagnation pressure and temperature.

ii) What will be the nozzle exit velocity? At inlet P_∞ = 0.3 atm, T_∞ = 213K, At exit P_{exit} = 0.3atm. **(08 Marks)**

c. Explain dynamic head measurement in compressible flow. **(04 Marks)**

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

b. Air approaches a symmetrical wedge (δ = 15°) at a Mach number of 2.0. Determine for the strong and weak waves i) Wave angle; ii) Pressure ratio; iii) Density ratio; iv) Temperature ratio and v) Downstream Mach number. **(12 Marks)**

3 a. Derive the basic fanno flow equation and find the solution of the basic equation with usual notations. **(08 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 is 0.005. If the Mach number at entry is 0.15. Determine: i) The diameter of the duct; ii) Length of the duct; iii) Pressure and temperature at the exit; iv) stagnation pressure loss and v) Verify the exit Mach number through exit velocity and temperature. **(12 Marks)**

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

$$Q_{max} = Q^* = \frac{(1-M^2)^2}{2(1+\gamma)M^2} Cp\tau .$$ **(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 2.5bar and 1000°C respectively. Determine: i) Mach number, pressure and temperature of the gas at entry; ii) the heat supplied per kg of gas and iii) the maximum heat that can be supplied. **(12 Marks)**

PART – B

5 a. Derive an expressional for general potential equation for three dimensional flows. **(10 Marks)**
b. Derive an equation for linearized potential flow equation using small perturbation theory. **(10 Marks)**

6 a. Explain Prandtl-Glauert rule for a two-dimensional subsonic flow. **(10 Marks)**
b. A given profile has at $M\infty = 0.29$ the following lift coefficients:
$C_L = 0.2$ at $\alpha = 3°$
$C_L = -0.1$ at $\alpha = -2°$.
Where α is the angle of attack, plot the relation showing d_{c_L}/d_α Vs M_∞ for the profiles for values of M_∞ upto 10. **(10 Marks)**

7 a. Explain shock wave-boundary layer interaction with relevant sketches. **(10 Marks)**
b. Explain the experimental characteristics of airfoils in compressible flow. **(10 Marks)**

8 a. Explain closed circuit supersonic tunnel with relevant sketch. **(10 Marks)**
b. Write short notes on:
i) Schlieren technique.
ii) Wind tunnel instrumentation and measurement. **(10 Marks)**

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