USN

10AE61

Sixth Semester B.E. Degree Examination, Dec.2019/Jan.2020
Applied Gas Dynamics

Time: 3 hrs. Max. Marks:100

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

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. Derive on expression for steady flow energy equation. **(04 Marks)**

b. Derive the following relation for a Quasi – Id isentropic flow through variable area duct

i) $\frac{dA}{A} = \frac{-dV}{V}[1-M^2]$

ii) $\frac{m\sqrt{T_0}}{AP_0}$ interms of mach number. **(10 Marks)**

c. Air at a stagnation state of 3.5 MPa and 500°C is expanded isentropically through a Delaval nozzle to a pressure of 0.7 MPa at the nozzle exit. If the mass flow rate through the nozzle is 1.3 kg/s, determine:

i) Exit Mach number
ii) The exit area
iii) The throat area. **(06 Marks)**

2 a. Derive an expression for Mach number downstream of the normal shock wave. **(08 Marks)**

b. Write short notes on intersection of shocks of same and opposite family. **(06 Marks)**

c. A Jet Y air at a Mach number of 2.5 in deflected inwards at the corner of a curved wall. The wave angle at the corner is 60°. Determine the deflection angle of the wall, pressure and temperature ratio and final mach number. **(06 Marks)**

3 a. Explain the Fanno line flow and derive an expression for adiabatic, constant area flow of perfect gas with friction, the variation of mach number with duct length. **(12 Marks)**

b. A straight pipe of 0.05 M diameter is attached to a large reservoir at pressure $13.8 \times 10^5 N/m^2$ and temperature 310K. The exit of the pipe is open to atmosphere. Assuming adiabatic flow with an average friction coefficient 0.005, calculate the pipe length necessary to obtain a mass flow rate of 2.25 Kg/s. **(08 Marks)**

4 a. For flow through constant area duct involving heat transfer drive relations for (i) stagnation pressure (ii) Stagnation temperature (iii) Impulse function. **(12 Marks)**

b. Define and sketch the Rayleigh curve for a flow through duct in T-S and PV plane and prove that, At maximum enthalpy point, $\mu = \frac{1}{\sqrt{y}}$. **(08 Marks)**

PART – B

5 a. Derive the linearized potential equation for compressible flow over an airfoil using small perturbation theory. **(10 Marks)**

b. Derive an expression for linearized pressure co-efficient. **(05 Marks)**

c. Write a short note on boundary conditions to be considered in perturbation analysis. **(05 Marks)**

6 a. Derive the relation for aerodynamic coefficients based on Prandtl-Glavert subsonic similarity rule. **(10 Marks)**

b. Obtain an expression relating the aerodynamic characteristics for the actual and transformed bodies using Gothert's rule. **(10 Marks)**

7 a. Explain in brief about the shock wave boundary layer interaction phenomenon with a neat sketch. **(10 Marks)**

b. Explain the nature of pressure distribution over supersonic airfoils in compressible flow with expression for different angle of attack. **(10 Marks)**

8 a. Name the different types of optical flow visualization methods in high speed wind tunnel. Explain any two with a neat sketch. **(12 Marks)**

b. Explain in detail about the temperature and velocity measurement in supersonic tunnels. **(08 Marks)**

* * * * *