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10AE61

Sixth Semester B.E. Degree Examination, Dec.2018/Jan.2019
Applied Gas Dynamic

Time: 3 hrs. Max. Marks:100

Note: *1. Answer any FIVE full questions, selecting at least TWO full questions from each part.*
2. Use of thermodynamics data book and gas tables are allowed.

PART – A

1 a. Air from the storage chamber at pressure 1 atm and temperature 288K is expanded through a CD nozzle having an exit to throat area ratio of 2.0. Calculate the Mach number, pressure, temperature at both throat and exit for the following cases:
i) If the flow is supersonic at exit
ii) If the flow is subsonic at exit with chocked throat. **(10 Marks)**

b. Explain the following flow conditions in a flow through convergent divergent nozzle with suitable graphs:
i) Chocking condition
ii) Under expanded condition
iii) Over expanded condition. **(10 Marks)**

2 a. Explain the flow field characteristic phenomenon for the following cases of oblique shock wave reflections:
i) Intersection shock of opposite family
ii) Intersection of shock of same family. **(10 Marks)**

b. Plot the variation between Mach number (M), flow deflection angle (θ), and shock wave angle (β) and bring out the inference. **(06 Marks)**

c. Find the flow field properties downstream of the shock, if the flow at Mach number 3 and pressure 1 bar is turned abruptly by a wall is to the flow with turning angle 20°. **(04 Marks)**

3 a. Air flows out of a pipe with a diameter 0.3m at a rate of 1000m^3 per minute at a pressure and temperature of 150kPa and 293K respectively. If the pipe is 50m long, find assuming that f = 0.005, the mach number at the exit, the inlet pressure, and the inlet temperature. **(10 Marks)**

b. Define fanno flow and plot the curve in h-s plane and express the governing equation in the dimensional analysis of fanno flow. **(05 Marks)**

c. Air flows in a 5cm diameter pipe. The air enters at M = 2.5 and leaves at M = 1.5. What length of pipe is required? What length of pipe would give M = 1 at the exit? Assume that f = 0.002 and that the flow is adiabatic. **(05 Marks)**

4 a. Represent the heat addition and heat removal process for a Rayleigh flow is h-s plane and write the inference of the flow phenomenon in subsonic and supersonic flows. **(05 Marks)**

b. Prove that for a Rayleigh flow, the Mach number is units and $1/\sqrt{r}$ at the maximum entropy point and enthalpy point respectively. **(07 Marks)**

c. Air flows through a constant area duct whose walls are kept at a low temperature. The air enters the pipe at a Mach number of 0.52, a pressure of 1 kPa and a temperature of 350°C. The rate of heat transfer from the air to the wall of pipe is estimated to be 400kJ/kg of air. Find the Mach number, temperature and pressure at exit of the pipe. Assume a steady flow with negligible wall friction and air as perfect gas. Assume $C_p = 1.007$ kJ/kg K. **(08 Marks)**

PART – B

5 a. Obtain the expression for linearized velocity potential equation by using small perturbation theory starting from non-linear velocity potential equation. **(10 Marks)**

b. Derive an expression for the linearized pressure coefficient for an inviscid compressible flow. **(06 Marks)**

c. What are the various methods by which a non-linear equation are solved? Write a short note on them. **(04 Marks)**

6 a. Based on Prandtl-Glavert rule obtain the subsonic and supersonic similarity law for 2D flow. **(14 Marks)**

b. A given profile has at $M_\alpha = 0.29$ the following lift coefficient, $C_L = 0.2$, @ $\alpha = 3°$, $C_L = -0.01$ at $\alpha = -2°$, where 'α' is angle of attack. Using Prandtl glavert rule find the value of $dCL/d\alpha$ variation upto Mach number. One from 0.5 with 0.1 increments. **(06 Marks)**

7 a. Explain qualitatively the phenomenon of shock wave boundary layer interaction and associated flow field changes with neat sketch. **(10 Marks)**

b. Obtain the expression for C_r and C_d for a supersonic flow over a diamond wedge shaped airfoil using shock expansion theory assuming zero angle of attack. **(06 Marks)**

c. A 1m wide flate plate set at an angle of 5° to the upstream flow. If the wing is placed in a flow with a Mach number of 3 and a static pressure of 50kPa. Calculate lift and drag coefficient, **(04 Marks)**

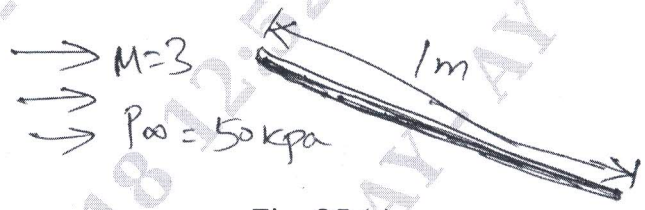

Fig. Q7 (c)

8 a. Explain the detail about the Schlieren and shadow graph techniques with suitable Ray diagrams. **(12 Marks)**

b. What is a blow down tunnel? Explain the various components of an intermittent open circuit blow down tunnel stating advantages and disadvantages. **(08 Marks)**

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