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10AE61

Sixth Semester B.E. Degree Examination, July/August 2021
Applied Gas Dynamics

Time: 3 hrs. Max. Marks:100

Note: *1. Answer any FIVE full questions.*
2. Use of gas tables is permitted.

1 a. Derive an expression for the flow through converging diverging passages in terms of area and mach number. Explain under what circumstances the passages works as a nozzle and a diffuser. **(10 Marks)**

b. The pressure, temperature and Mach number at the entry of C flow passage are 2.45 bar, 26.5°C and 1.4 respectively. If the exit mach number is 2.5, determine for adiabatic flow of a perfect gas ($\gamma = 1.3$, $R = 0.469$kJ/kg.k)
i) Stagnation temperature
ii) Temperature and velocity of gas at exit
iii) The flow rate per square meter of the inlet. **(10 Marks)**

2 a. Derive an expression for Prandtl-Meyer relation for a normal shock wave. **(10 Marks)**

b. The state of a gas ($\gamma = 1.3$, $R = 0.469$kJ/kg.k) upstream of a normal shock wave is given by the following data : $M_x = 2.5$, $P_x = 2$ bar $T_x = 275$K. Calculate the mach number, pressure, temperature and velocity of the gas downstream of the shock. **(10 Marks)**

3 a. Draw a Fanno line and derive on expression for enthalpy in terms of stagnation enthalpy mass flow density and enthalpy. **(10 Marks)**

b. Air at $P_0 = 10$ bar, $T_0 = 400$K, and supplied to a 50mm 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 diameter determine.
i) The length of the pipe ii) Mass flow rate. **(10 Marks)**

4 a. With the help of a neat sketch, explain constant entropy and constant enthalpy line in Rayleigh flow. **(10 Marks)**

b. A combustion chamber in a gas turbine plan receives air at 350K, 0.55 bar and 75m/s. The air-fuel ratio is 29 and the calorific value of the fuel is 41.87 kJ/hg. Taking $\gamma = 1.4$, and $R = 0.287$kJ/kg°K for the gas, determine :
i) The initial and final Mach number
ii) Final pressure temperature and velocity of gas
iii) Percentage stagnation pressure loss in the combustion chamber
iv) The maximum stagnation temperature attainable. **(10 Marks)**

5 a. With the help of relevant sketches, describe small perturbation theory and derive on expression for potential equation. **(10 Marks)**

b. Explain the various methods of solution of non-linear potential equations. **(10 Marks)**

6 With the help of expression and sketches describe,
i) Prandtl-Glauert transformation ii) Von-Karman rule for transonic flow. **(20 Marks)**

7 a. With the help of a neat schematic diagram explain the shock wave – boundary layer interaction. **(10 Marks)**

b. Describe the application of thin aerofoil theory to the following :
i) A flat plate ii) Demand shape aerofoil. **(10 Marks)**

8 a. List the classification of wind tunnel and explain open circuit supersonic wind tunnel. **(10 Marks)**

b. With the help of sketches, explain Interferometer technique of flow visualization. **(10 Marks)**

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