ACHARYA INSTITUTE OF TECHNOLOGY
Bangalore - 560090

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10AE61

Sixth Semester B.E. Degree Examination, Dec.2016/Jan.2017
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 and shock tables is permitted.***

PART – A

1 a. Derive an expression for area ratio as a function of mach number with usual notation. **(08 Marks)**

b. Air flowing in a duct has velocity of 300m/s, pressure 1 bar and temperature 290K. Taking $\gamma = 1.4$ and $R = 287$ J/kg – k. Determine :
   i) Stagnation pressure and temperature
   ii) Velocity of sound in the dynamic and stagnation conditions
   iii) Stagnation pressure assuming constant density. **(06 Marks)**

c. Air [$C_p = 1.05$ kJ/kg K, $\gamma = 1.38$) at $P_1 = 3\times10^5$ N/m^2 and $T_1 = 500$K flows with a velocity of 200 m/s in a 30cm diameter duct. Calculate
   i) Mass flow rate
   ii) Stagnation temperature
   iii) Mach number
   iv) Stagnation pressure values.
   Assuming the flow are compressible and incompressible. **(06 Marks)**

2 a. Derive Prandtl Meyer relation and show that $a^* = a_x^* = a_y^*$. **(10 Marks)**

b. The velocity of a normal shock wave moving into stagnant air (p = 1 bar. t = 17°C) is 500m/s. if the area of cross section of duct is constant, determine :
   i) Pressure
   ii) Temperature
   iii) Velocity of air
   iv) Stagnation temperature
   v) Mach number impacted upstream of the wave front. **(10 Marks)**

3 a. Derive an expression for variation of mach number with duct length for a flow in constant area duct with friction. **(08 Marks)**

b. Air at $P_0 = 10$bar, $T_0 = 400$K is supplied to a 50mm diameter pipe the friction factor for the pipe surface is 0.002.
   If the mach number changes from 3 at the entry to 1 at the exit, determine.
   i) The length of the pipe and
   ii) The mass flow rate. **(12 Marks)**

4 a. Explain Rayleigh curve with the help of a suitable sketch. **(08 Marks)**

b. A combustion chamber in a gas turbine plant receives air at 350K, 0.55 bar and 75 m/s. The air fuel ratio is 29 and the calorific value of the fuel is 41.87MJ/kg taking $\gamma = 1.4$ and $R = 0.287$ kJ/kg K for the gas.

Determine :

i) Initial and final mach number

ii) Final pressure, temperature and velocity of the gas

iii) Percent stagnation pressure loss in the combustion chamber

iv) Maximum stagnation temperature attainable. **(12 Marks)**

PART – B

5 a. Derive the general potential equation for three dimensional flow with usual notation. **(10 Marks)**

b. Derive an expression for pressure co-efficient in three and two dimensional flows. **(10 Marks)**

6 a. Explain Von-Karman rule for transonic flow with relevant expression. **(08 Marks)**

b. Explain three dimensional flow over bodies (or) Glauert rule. **(06 Marks)**

c. Briefly explain the application of Glauert rule to wings of finite span. **(06 Marks)**

7 a. Explain the methods of characteristic of airfoils in compressible flow. **(08 Marks)**

b. A flat plate is kept at 15° angle of attack to a supersonic stream at mach 2.4 as shown in Fig. Q7 (b) below. Solve the flow field around the plate and determine the inclination of slip stream to the free stream direction using shock – expansion theory. **(12 Marks)**

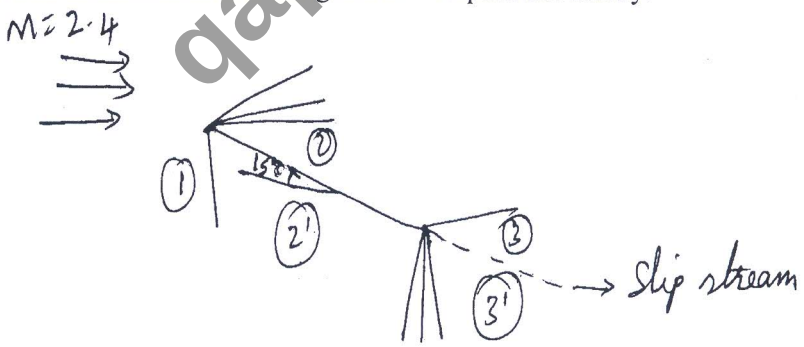

Fig. Q7(b)

8 a. With the help of a neat sketch explain open circuit supersonic tunnel. **(10 Marks)**

b. Explain :

i) Interferometer Technique

ii) Orifice meter. **(10 Marks)**

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