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**10AE61**

# Sixth Semester B.E. Degree Examination, Dec.2015/Jan.2016
## Applied Gas Dynamics

Time: 3 hrs. Max. Marks:100

**Note:** ***1. Answer any FIVE full questions, selecting atleast TWO questions from each part.***
***2. Use of Shock/Gas 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 a velocity of 300 m/s, pressure 1 bar and temperature 290 K. Taking $\gamma = 1.4$ and R = 287 J/kg.K determine
i) stagnation pressure and temperature
ii) velocity of sound in the dynamics and stagnation condition.
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 30 cm diameter duct. Calculate (i) Mass flow rate (ii) stagnation temperature (iii) mach number (iv) stagnation pressure values assuming the flow as compressible and incompressible. **(06 Marks)**

2 a. Derive Prandtl-Meyer relation and S.T. $a^* = a_x^* = a_y^*$ **(10 Marks)**

b. The velocity of a normal shock wave moving into stagnant air (P = 1 bar, t = 17°C) is 500 m/s. If the area of cross section of the duct is constant, determine
(i) Pressure (ii) temperature (iii) velocity of air (iv) stagnation temperature (v) Mach number imparted 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 50 mm 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, 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 350 K, 0.55 bar and 75 m/s. The air-fuel ratio is 29 and the calorific value of the fuel is 41.87 MJ/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) Gothert rule. **(06 Marks)**
c. Briefly explain the application of Gothert rule to wings of finite span. **(06 Marks)**

7 a. Explain the methods of characteristics 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). Solve the flow field around the plate and determine the inclination of slipstream to the free stream direction using shock-expansion theory. **(12 Marks)**

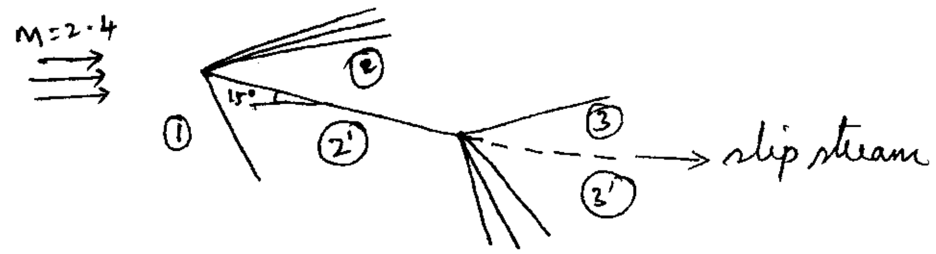

Fig.Q7(b)

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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