CBCS SCHEME

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15AE61

Sixth Semester B.E. Degree Examination, Dec.2019/Jan.2020
Aerodynamics – II

Time: 3 hrs. Max. Marks: 80

Note: 1. *Answer any FIVE full questions, choosing ONE full question from each module.*
2. *Use of gas tables is permitted.*

Module-1

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

b. The pressure, temperature and Mach number at the entry of a 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/kgK)
(i) Stagnation temperature.
(ii) Temperature and velocity of gas at exit.
(iii) The flow rate per square meter of the inlet cross section. **(08 Marks)**

OR

2 a. Derive impulse function for compressible flow problems is,

$$\frac{F}{F^*} = \frac{1+\gamma m^2}{m\sqrt{2(1+\gamma)\left(1+\frac{\gamma-1}{2}m^2\right)}}$$ **(08 Marks)**

b. A Nozzle in a wind tunnel gives a test section Mach number of 2.0. Air enters the nozzle from a large reservoir at 0.69 bar and 310 K. The cross sectional area of the throat is 1000 cm^2. Determine the following quantities for the tunnel for one dimensional isentropic flow:
(i) Pressure, temperature and velocities at the throat and test section.
(ii) Area of cross section of the test section.
(iii) Mass flow rate.
(iv) Power required to drive the compressor. **(08 Marks)**

Module-2

3 a. Show that, the gas velocities before and after the normal shock by using Prandtl meyer relationship is expressed by $C_X.C_Y = a^{*2}$ (or) $M_x^*.M_Y^* = 1$. **(08 Marks)**

b. The state of a gas ($\gamma = 1.3$, R = 0.469 KJ/kgK) 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 down stream of the shock, check the calculated values with those given in the gas tables. **(08 Marks)**

OR

4 a. Derive the Rankine-Hugoniot relation for a normal shock wave. i.e.

$$\frac{\rho_Y}{\rho_X} = \frac{1+\frac{\gamma+1}{\gamma-1}\frac{P_Y}{P_X}}{\frac{\gamma+1}{\gamma-1}+\frac{P_Y}{P_X}}$$

(10 Marks)

b. A gas (γ = 1.4, R = 0.287 KJ/kgK) at a Mach number of 1.8, P = 0.8 bar and T = 373 K passes through a normal shock. Determine its density after the shock. Compare this value in an isentropic compression through the same pressure ratio. **(06 Marks)**

Module-3

5 a. Starting from the general energy equation for flow through an oblique shock obtain the Prandtl's equation $a^{*2} - \frac{\gamma-1}{\gamma+1}C_t^2 = C_{n_1}C_{n_2}$ **(10 Marks)**

b. A gas (γ = 1.3) at P_1 = 345 bar, T_1 = 350 K and M_1 = 1.5 is to be isentropically expanded to 138 bar. Determine (i) The deflection angle. (ii) Final Mach number (iii) The temperature of the gas. **(06 Marks)**

OR

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

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

Module-4

7 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. **(06 Marks)**

OR

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

b. Explain three dimensional flow over bodies (or) Golhert rule. **(08 Marks)**

Module-5

9 a. With the help of a neat sketch, explain open circuit supersonic tunnel. **(08 Marks)**

b. Explain the following:
- Interferometric technique.
- Orifice meter. **(08 Marks)**

OR

10 a. With the help of a neat sketch, explain a closed circuit continuous supersonic wind tunnel. **(10 Marks)**

b. Explain in detail about the temperature measurements in supersonic tunnels. **(06 Marks)**

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