CBCS SCHEME

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18AE/AS52

Fifth Semester B.E. Degree Examination, June/July 2024
Aerodynamics - II

Time: 3 hrs. Max. Marks: 100

Note: *Answer any FIVE full questions, choosing ONE full question from each module.*

Module-1

1 a. Derive an expression for Area ratio as a function of Mach number with usual notation. **(10 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/kg. K.
i) Stagnation temperature.
ii) Temperature and velocity of gas at exit.
iii) The flow rate per square meter of the inlet cross section. **(10 Marks)**

OR

2 a. Derive impulse function for compressible flow problem is **(10 Marks)**

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

b. A Nozzle in a wind tunnel gives a test section mach number of 2. Air enters the nozzle from a large reservoir at 0.69 bar and 310K. 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. **(10 Marks)**

Module-2

3 a. Show that the gas velocities before and after the normal shock by using Prandtl – Meyer relationship is expressed by $C_x \cdot C_y = a^{*2}$ (or) $M_x^* \cdot M_y^* = 1$. **(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, $T_x = 278$ K.
Calculate the Mach number, Pressure, temperature and velocity of the gas downstream of the shock, check the calculated values with those given in the gas tables. **(10 Marks)**

OR

4 a. Derive the Rankine – Hugoniot relation for a normal shock wave ie. **(12 Marks)**

$$\frac{\rho_y}{\rho_x} = \frac{1+\frac{\gamma+1}{\gamma-1}\frac{P_y}{P_x}}{\frac{\gamma+1}{\gamma-1}+\frac{P_y}{P_x}}.$$

b. A gas ($\gamma = 1.4$, $R = 0.287$ kJ/kg K) 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. **(08 Marks)**

Module-3

5 a. Starting from the general energy equation for flow through an oblique shock obtain the Prandtls equation

$$a^{*2} - \frac{\gamma - 1}{\gamma + 1} C_t^2 = C_{n_1} C_{n_2}.$$

(12 Marks)

b. A gas ($\gamma = 1.3$) at $P_1 = 345$ bar, $T_1 = 350K$ and $M_1 = 1.5$ is to be isentropically expanded to 138 bar. Determine i) The deflection ii) Final mach number iii) The temperature of the gas. (08 Marks)

OR

6 a. Derive an expression for variation of mach number with duct length for a flow in constant area duct with friction. (10 Marks)

b. Explain Rayleigh curve with the help of a suitable sketch. (10 Marks)

Module-4

7 a. Derive the general potential equation for three dimensional flow with usual notation. (12 Marks)

b. Derive an expression for pressure co-efficient in three and two dimensional flows. (08 Marks)

OR

8 a. Explain Von Karman rule for transonic flow with relevant expression. (10 Marks)

b. Explain three dimensional flow over bodies (or) Gothert rule. (10 Marks)

Module-5

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

b. Explain the following :
i) Interferometer Technique ii) Orifice meter. (10 Marks)

OR

10 a. With the help of a neat sketch, explain Closed circuit supersonic tunnel. (12 Marks)

b. Explain in detail about the temperature measurement in supersonic tunnels. (08 Marks)

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