

GBCS 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 1000cm². 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 Prandtl's equation

$$a^*{}^2 \frac{\gamma-1}{\gamma+1} C_t^2 = C_{n_1} C_{n_2} \quad (12 \text{ Marks})$$

- b. A gas ($\gamma = 1.3$) at $P_1 = 345 \text{ bar}$, $T_1 = 350 \text{ K}$ 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)
