

CBCS SCHEME

18AE/AS52

Fifth Semester B.E. Degree Examination, June/July 2023 Aerodynamics – II

Time: 3 hrs.

Max. Marks: 100

- 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 energy equation in Integral form using control volume approach for steady, inviscid and no body forces. (10 Marks)
b. A supersonic wind tunnel nozzle is to be designed for $M = 2.5$ with test section 1 m^2 area. The supply pressure and temperature of nozzle inlet are 7 bar and 27°C respectively. Velocity is negligible at the inlet. Assume the flow is adiabatic and 1 dimensional at throat and test section. Determine:
(i) Throat area and temperature
(ii) Velocity and mass flow rate of test section (10 Marks)

OR

- 2 a. Derive expression for speed of sound and write about Mach number regimes. (10 Marks)
b. Explain how to obtain supersonic flow with De-Laval nozzle with the help of back pressure. (10 Marks)

Module-2

- 3 a. Derive Prandtl relation for normal shock wave and write the expression for shock strength in terms of free stream Mach number. (10 Marks)
b. The state of gas at upstream of normal shock waves is given as Mach no 2.5, $P_1 = 2$ bar and $T_1 = 275$ K. Assume $\gamma = 1.3$ and $R = 0.469$ kJ/kg-K. Calculate the Mach number, pressure, velocity and temperature downstream of the shock. Verify the values with gas tables. (10 Marks)

OR

- 4 a. Obtain the expression for fluid velocity behind shock wave for a moving shock in terms of shock strength. (12 Marks)
b. Draw Hugoniot curve and obtain expression for Hugoniot equation. (08 Marks)

Module-3

- 5 a. Derive the expression for deflection angle in relation with shock angle and Mach number. Discuss about the shock properties for various conditions of deflection angle. (10 Marks)
b. Draw and explain about the following:
(i) Intersection of shocks of opposite families with different strengths
(ii) Intersection of shocks of same family
(iii) Shock reflection from a Rigid wall. (10 Marks)

OR

- 6 a. Draw an expansion wave and obtain Prandtl-Meyer function for expansion waves in terms of Mach number. (10 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8=50, will be treated as malpractice.

- b. Airflow at Mach 4.0 and pressure 1 bar is turned abruptly by a wall into the flow with a turning angle of 20° as in Fig.Q6(b). If the shock is reflected by another wall, determine flow properties M and P downstream of reflected shock.

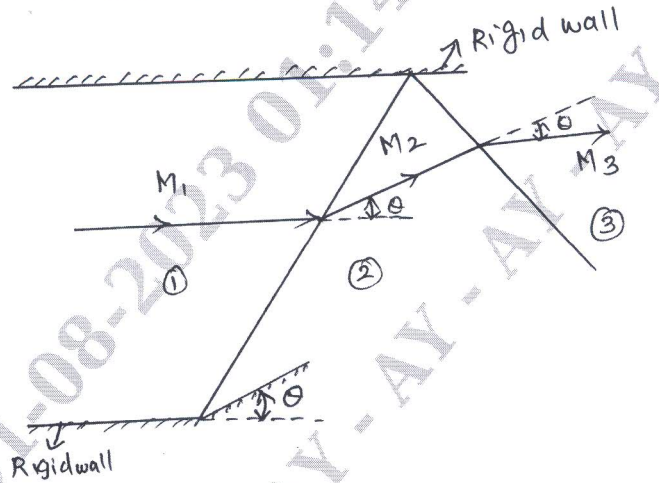


Fig.Q6(b)

(10 Marks)

Module-4

- 7 a. Derive linearized potential equation using small perturbation theory applicable for supersonic flow. (10 Marks)
 b. Obtain the relation for pressure coefficient for three dimensional compressible flow. (05 Marks)
 c. Discuss about solution of non-linear potential equation. (05 Marks)

OR

- 8 a. Derive expression for basic potential equation for compressible flow. (10 Marks)
 b. Derive Von-Karman rule for Transonic flow and use of Karman rule. (10 Marks)

Module-5

- 9 a. Draw and explain about following:
 (i) Blow down type tunnel
 (ii) Induction type tunnel
 (iii) Continuous supersonic tunnel (12 Marks)
 b. Explain about pressure measurement devices used in wind tunnels. (08 Marks)

OR

- 10 Explain about the following with neat sketch:
 a. Shock tube
 b. Smoke flow visualization technique
 c. Mach-Zhender interferometer
 d. Shadowgraph technique (20 Marks)
