CBCS SCHEME

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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 γ = 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 Hugonoit curve and obtain expression for Hugonoit 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 interms of Mach number. **(10 Marks)**

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.

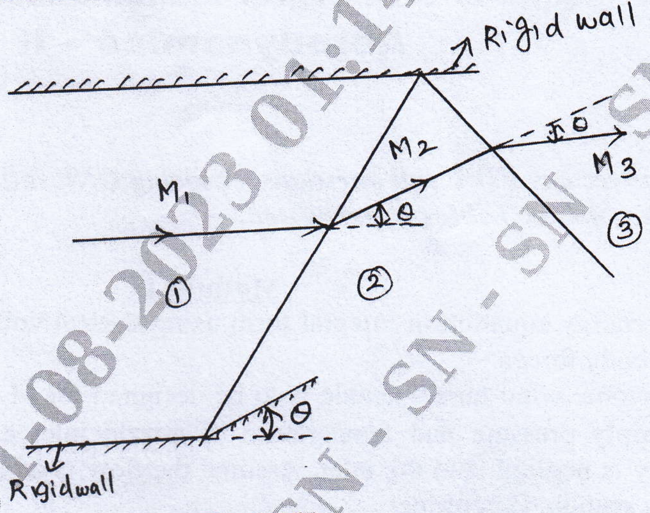

Fig.Q6(b) **(10 Marks)**

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)**

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