USN | | | | | | | | | | **15AE61**

Sixth Semester B.E. Degree Examination, June/July 2023
Aerodynamics - II

Time: 3 hrs.   Max. Marks: 80

Note : 1. *Answer any FIVE full questions, choosing ONE full question from each module.*
2. *Gas Tables by S.M. Yahya is permitted.*

Module-1

1 a. Derive Momentum equation and write the application of momentum equation. **(08 Marks)**

b. Consider the flow property at a point in a flow where the temperature is 320 K and velocity is 1000 m/s. Find the Mach number at that point. **(02 Marks)**

c. Derive the Relation for velocity of sound for a Calorifically perfect gas. **(06 Marks)**

OR

2 a. Write the steady flow energy equation for a flow process. **(03 Marks)**

b. What is the criteria for obtaining supersonic flow in a nozzle? Draw the performance for various back pressure and explain nozzle operation. **(07 Marks)**

c. A subsonic diffuser operating under isentropic conditions has an inlet area of 0.15m2. Conditions at inlet are $V_1 = 240$ m/s , $T_1 = 300$K , $P_1 = 0.7$ bar. Velocity leaving the diffuser is 120 m/s. Calculate i) Mass flow rate ii) Stagnation pressure and Temperature at exit iii) Static pressure at exit iv) Exit area. **(06 Marks)**

Module-2

3 a. Derive the mach number equation across a normal shock wave in terms of upstream mach number. **(08 Marks)**

b. Describe in detail about moving normal shock waves with a neat sketch and appropriate equations. **(08 Marks)**

OR

4 a. The velocity of a normal shock wave moving into stagnant air (P = 1.0 bar, t = 17°C) is 500 m/s. IF the area of cross-section of duct is constant determine: i) Pressure ii) Temperature iii) Velocity of air iv) Stagnation temperature and v) The Mach number imported upstream of the wave-front.

Note : At $M_x = 1.465$, $M_y = 0.715$
$P_y/P_x = 2.335$, $T_y/T_x = 1.297$. **(08 Marks)**

b. Derive Rankine-Hugnoit equation for normal shock waves and compare the same for isentropic flow. **(08 Marks)**

Module-3

5 a. Derive the Prandtl-Meyer relation for oblique shock wave in perfect gas. **(10 Marks)**

b. Briefly explain the flow past wedges with neat sketch. **(06 Marks)**

OR

6 a. Briefly explain the reflection and intersection of shocks and expansion waves. **(08 Marks)**

b. An oblique shock in air causes an entropy increase of 11.5 J/kg-K. If the shock angle is 25°, determine the Mach number ahead of the shock and the flow deflection angle if $M_2 = 2.7$. **(08 Marks)**

Module-4

7 a. Derive Small Perturbation theory using linearized velocity potential equation. Also write the conclusion. **(10 Marks)**

b. Derive the expression for pressure co – efficient for linearized flow. **(06 Marks)**

OR

8 a. Derive Prandtl – Glavert rule compressibility correction from Small Perturbation theory for supersonic flow. **(08 Marks)**

b. Write about uses of Karman rule and obtain an expression for lift and drag co-efficient using Von – Karman rule. **(08 Marks)**

Module-5

9 a. Explain in detail about flow visualization methods. **(08 Marks)**

b. Describe the operations of various types of Hypersonic wind tunnel with relevant sketches. **(08 Marks)**

OR

10 a. Write a short note on: Shock tubes and shock tunnels with a neat diagram. **(08 Marks)**

b. Explain the operation of transonic wind tunnel with a neat diagram. **(08 Marks)**

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