

CBCS SCHEME

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18AE/AS52

Fifth Semester B.E. Degree Examination, Jan./Feb. 2021

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. Write the principle of energy equation and derive the relation for energy equation in differential form. (10 Marks)
- b. A supersonic wind tunnel nozzle is to be designed for $M = 2.5$ with a test-section 1m^2 in area. The supply pressure and temperature at the nozzle inlet are $7 \times 10^5\text{N/m}^2$ and 27°C respectively where the velocity is negligible. Assume that the flow is isentropic with $\gamma = 1.4$. Also consider flow is one-dimensional at throat and test-section. Calculate :
- Throat area
 - Temperature at throat
 - Velocity of flow at test section
 - Mass flow rate through the test section. (10 Marks)

OR

- 2 a. How will you obtain supersonic flow in a De-Laval nozzle? Explain the performance for various back pressure using necessary curves. (10 Marks)
- b. Derive an expression for steady flow energy equation. (05 Marks)
- c. Derive area-mach number relation for De-Laval nozzle. (05 Marks)

Module-2

- 3 a. Write the equations of motion for normal shock wave and obtain Prandtl-relation for normal shock wave. (10 Marks)
- b. The Upstream properties of normal shock in air is given as $M_1 = 2.5$, $P_1 = 1\text{atm}$, $\rho_1 = 1.225\text{kg/m}^3$. Determine the values of downstream pressure, temperature, mach number, velocity and stagnation temperature. Verify the values with relation and gas tables. (10 Marks)

OR

- 4 a. Obtain the relation for moving shock speed in terms of speed of sound for moving normal shock. (10 Marks)
- b. Explain about Hugoniot curve and obtain relation for Hugoniot equation. (10 Marks)

Module-3

- 5 a. Draw an oblique shock and obtain its relation for θ - β - M relation and explain its importance. (10 Marks)
- b. With neat sketch explain about reflection and intersection of shocks and expansion waves for same and opposite family. (10 Marks)

OR

- 6 a. With neat sketch of expansion wave, derive the relation for Prandtl-Meyer function as a function of mach number. (10 Marks)
- b. Draw Rayleigh curve and write the governing equation for Rayleigh flow, summarize the flow property changes in subsonic and supersonic region. When heat is added. (10 Marks)

Module-4

- 7 a. Derive small-perturbation theory applicable for compressible flow. (10 Marks)
b. Briefly write about solution of non-linear potential equation. (05 Marks)
c. Derive relation for pressure co-efficient for linearized compressible flow. (05 Marks)

OR

- 8 a. Derive Prandtl-Glauert rule for supersonic flow. (10 Marks)
b. Derive relation for von-Karman rule for transonic flow and write the uses of karman rule. (10 Marks)

Module-5

- 9 a. Write about types of wind tunnel and explain with neat sketch. (10 Marks)
b. Write and explain about various pressure measurement devices used in wind tunnels. (10 Marks)

OR

- 10 a. Draw neatly and explain about working of:
i) Schlieren system (10 Marks)
ii) Shadowgraph technique. (05 Marks)
b. Draw and explain about shock-tubes. (05 Marks)
c. The test-section area of a Mach 2.5 tunnel is half of the nozzle inlet area. If the test section pressure is 100KPa, determine the pressure and Mach number at the nozzle inlet. (05 Marks)
