Question Paper Code : 91031

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2014.

Fifth Semester

Aeronautical Engineering

AE 2303/AE 1303/AE 53/10122 AE 503 — AERODYNAMICS — II

(Regulation 2008/2010)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Write the one-dimensional energy and momentum equations for an adiabatic compressible steady flow.

2. What is meant by De-Laval nozzle?

3. Differentiate between normal and oblique shock.

4. Draw the shock polar for different Mach numbers.

5. Bring out two important differences between Rayleigh flow and Fanno flow.

6. Give any two practical examples of interaction and reflection of shock waves.

7. List out the practical application of linearised two-dimensional supersonic theory.

8. How lift and drag varies with the angle of attack for a supersonic profile?

9. Define lower critical Mach number.

10. State transonic area rule.

PART B — (5 × 16 = 80 marks)

11. (a) Derive energy equation for one-dimensional steady compressible flow from first principle. Deduce the isentropic relation between stagnation and sonic conditions for temperature, pressure and density.

Or

(b) (i) Explain why a converging diverging configuration is required for the acceleration of flow from subsonic to supersonic conditions. (8)

(ii) Air flow is discharged to sea level atmosphere through a sonic nozzle. If the airstorage pressure at the reservoir is $40 \times 10_5$ N/m², determine the pressure, temperature density at the exit of the nozzle. Assume that the reservoir air is at ambient temperature. (8)

12. (a) (i) Derive Rankine- Hugoniot equation. What are the applications of Rankine Hugoniot relation? (10)

(ii) Write short notes on:

(1) Weak and detached shocks (2)

(2) Shock polar (2)

(3) Concave corners. (2)

Or

(b) (i) Briefly explain the functions of Pitot static tube and list out the corrections needed for subsonic and supersonic flows. (10)

(ii) A Pitot tube is inserted into an airflow where the static pressure is 1 atm. Calculate the flow Mach number when the Pitot tube measures

(1) 1.276 atm (2)

(2) 2.714 atm (2)

(3) 12.06 atm. (2)

13. (a) (i) Explain the concept of Prandtl-Meyer expansion round a convex corner with a neat sketch. (8)

(ii) If a compression corner of angle 20 degree is allowed to encounter an uniform stream of supersonic flow at Mach 5, calculate the shock wave angle and pressure and Mach number behind the shock wave. (8)

Or

(b) (i) Write short notes on expansion hodograph. (8)

(ii) Briefly explain the features of two dimensional supersonic nozzle contours. (8)

14. (a) (i) Based on small perturbation theory, derive the linearised velocity potential equation for compressible flows. (10)

(ii) Based on the above equation establish the Prandtl-Glauert rule. (6)

Or

(b) (i) Write short notes on :

(1) Mach wave (4)

(2) Mach angles. (4)

(ii) Briefly explain the lift, drag, pitching moment and center of pressure of supersonic profiles. (8)

15. (a) (i) Explain with neat sketch about the shock induced separation. (8)

(ii) Briefly explain the characteristics and features of swept wings. (8)

Or

(b) Briefly explain the effects of thickness, camber and aspect ratio over the performance of wings in high speed flows.