Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 50083

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2023.

Fifth Semester

Aeronautical Engineering

AE 8503 – AERODYNAMICS – II

(Regulations 2017)

Time : Three hours Maximum : 100 marks

Use of Gas Tables are permitted.

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define Mach angle.
2. Classify flow regimes based on Mach number.
3. Define shock wave.
4. Write a short note on shock polar.
5. Define Fanno flow.
6. Draw a neat sketch explaining the Prandtl-Meyer expansion.
7. Explain briefly about Crocco's theorem.
8. Write a short note on affine transformation.
9. Define drag-divergence Mach number.
10. Define critical Mach number

PART B — (5 × 13 = 65 marks)

11. (a) Derive area-velocity relation. Explain its significance in detail.

Or

(b) With suitable figures and plots, explain in detail about variety of flow fields that can be generated in the convergent-divergent nozzle by controlling its backpressure.

12. (a) Derive Prandtl relation and explain its importance.

Or

(b) (i) An oblique shock in air causes an entropy increase of 11.5 J/kgK. If the shock angle is 25°, determine the Mach number ahead of the shock and the flow deflection angle. (8)

(ii) Explain the significance of $\theta-\beta-M$ relation. (5)

13. (a) An oblique from a wedge in a Mach 2 air stream is reflected from a flat surface. If the flow turning caused by the shock is 11°, determine (i) the wave angle of the reflected shock. (ii) the Mach number downstream of the reflected shock and (iii) the strength of the reflection.

Or

(b) (i) State the general features of characteristics. (5)

(ii) With neat figures, explain in detail how method of characteristics is used in designing the contours of supersonic nozzles. (8)

14. (a) Derive the general potential equation for a three-dimensional compressible flow.

Or

(b) For a flow past slender or planar bodies, use the small perturbation theory to obtain the linearized potential flow equation. Explain the significance of this equation for different flow regimes.

15. (a) Explain the following in detail,

(i) Transonic area rule. (7)

(ii) Shock-induced separation. (6)

Or

(b) Explain in detail about the salient features of hypersonic flow with suitable figures.

PART C — (1 × 15 = 15 marks)

16. (a) A convergent_-divergent nozzle of throat area 10 cm^2 and exit area 24 cm^2 is operated by an air storage tank at 300 kPa and 300K. Calculate the range of backpressure for which (i) the entire divergent portion will be supersonic, and (ii) the exit Mach number is less than 1. (iii) Are the mass flow and exit pressure independent of the backpressure?

Or

(b) At a particular section in a duct through which air is flowing adiabatically, the pressure, temperature and velocity are 2 atm, 10°C and 200 m/s, respectively. If the pressure and velocity at a downstream location are 1.5 atm and 250 m/s, calculate the Mach number and the stagnation pressure, density and temperature at the first location. Also, calculate the maximum velocity, sonic velocity and the stagnation pressure and density at station 2. What is the percentage pressure loss between stations 1 and 2. Assume flow to be incompressible.