

B.E DEGREE EXAMINATIONS: NOV/DEC 2014

(Regulation 2009)

Fifth Semester

AERONAUTICAL ENGINEERING

AER108: Aerodynamics II

(Use of Gas Tables and Shock wave charts are Permitted)

Time: Three Hours

Maximum Marks: 100

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. Density change is represented as ρ / ρ_0 , where ρ_0 is the air density at
 - a) Critical mach number
 - b) Zero mach number
 - c) Subsonic
 - d) Transonic
2. If the flow speed is more than speed of sound wave then the flow is called
 - a) subsonic flow
 - b) transonic flow
 - c) supersonic flow
 - d) hypersonic flow
3. For inviscid flow:
 - a) Euler equation is the right governing equation
 - b) Bernoulli equation is the right governing equation
 - c) No-slip boundary condition applies at the solid-fluid interface
 - d) Slip boundary condition applies at the solid-fluid interface
4. For steady, uniform flow over a flat plate at high Reynolds number
 - a) The boundary layer thickness is small
 - b) Different characteristic scales apply along streamwise and cross-stream directions
 - c) The two inertial terms are of the same order
 - d) Viscous term(s) are of the same order as inertial term(s)
5. Small disturbances created by a slender body in a supersonic flow will propagate diagonally away as

18. At choked flow condition what will be the values of pressure ratio and temperature ratio, where $\gamma = 1.35$?
19. Distinguish between Critical Mach number and Drag divergence Mach number.
20. Write short note on (i) Prandtl-Glauert rule, and (ii) Transonic area rule.

PART C (5 x 14 = 70 Marks)

21. a) (i) Derive the area velocity mach number relation and explain its significance. (7)
- (ii) Air flow through a large reservoir through a convergent divergent nozzle, the pressure and temperature in the reservoir being 130Kpa and 40° respectively. The throat area of the nozzle is 10^{-4}m^2 and the pressure on the nozzle exit plane is 60Kpa and temperature is 20° C. Assuming the flow through the nozzle to be isentropic, steady and one dimensional. Estimate (1) The mass flow rate through the nozzle (2). The exit area of the nozzle. (7)

(OR)

- b) (i) Derive an expression for speed of sound. (7)
- (ii) Derive a relation for compressibility correction to dynamic pressure. (7)

22. a) (i) Show that for the local mach number is unity at the point of maximum entropy on the Rayleigh line ? (7)
- (ii) Derive the Rankine-Hugoniot relation for a shock. Can this relation be applied for the chemically reacting gas? if yes how? If not why? (7)

(OR)

- b) (i) Derive Prandtl relation for a normal shock in a perfect gas. (7)
- (ii) Air at $P_1=0.3$ bar $T_1=350\text{k}$ and $M_1=1.5$ to be expanded isentropically to 0.13 bar. Determine (i) the flow deflection angle (ii) Mach number (iii) Temperature of air after expansion. (7)

23. a) (i) Explain the concepts of Prandtl meyer expansion around a convex corner and represent it in hodograph plane. (7)

- (ii) A supersonic flow at $M_1=1.58$ and $P_1=1$ atm expand around a sharp corner. If the pressure downstream of the corner is 0.1306 atm. Calculate the deflection of the corner. (7)

(OR)

- b) For an oblique shock wave bring out proper relationships between the flow parameter in front of the shock and behind the shock.

24. a) (i) Based on small perturbation theory derive the linearized velocity potential equation for compressible flows. (8)

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

(OR)

- b) Derive the expression for Prandtl relation. Show the relation between θ , β and M for an oblique shock.

25. a) (i) Write the brief note on (1) Shock induced separation (2) Effect of thickness on the characteristics of wings. (8)

- (ii) Briefly discuss the area rule and supercritical aerofoil. (6)

(OR)

- b) (i) Describe the transonic flow regime with suitable sketches of flow pattern over a two dimensional airfoil. (7)

- (ii) Explain how large drag increase takes place at transonic flow. What are control measures adopted at the design stage. (7)
