Register Number: ……..

B.E., DEGREE EXAMINATIONS: NOV/DEC 2012

Seventh Semester

AERONAUTICAL ENGINEERING

AER 134: High Speed Aerodynamics

(*Use of Gas Table is permitted)*

Time: Three Hours **Maximum Marks: 100**

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. Bernoulli's theorem deals with the law of conservation of
   a) Mass b) momentum
   c) energy d) none of the above
2. _____ due to the presence of shock waves and dependent on Mach number
   a) Induced drag b) Viscous drag
   c) Roughness drag d) Wave drag
3. The speed of sound is an important factor in high-speed flight because
   a) M_{crit} occurs at M=1 b) the pressure waves generated by the plane move at sonic speed
   c) shock waves form when local air velocities are supersonic d) Both (b) and (c)
4. After passing through a normal shock wave, airflow is
   a) Subsonic b) Not changed in direction.
   c) Heated up and increased in pressure density d) All of the above.
5. Airflow passing through an expansion wave
   a) Speeds up b) increase the energy of the airstream
   c) Decreases the temperature of the air d) Both (a) and (c)
6. Mach angle is simply determined by the local
   a) Oblique shock b) speed of sound
   c) Mach wave d) Mach number
7. Critical Mach number, M_{crit}, is the aircraft's speed when
   a) It goes supersonic b) The airflow first reaches sonic speed.
   c) Shock waves form. d) Both (b) and (c).

8. A uniform supersonic stream with $M_1 = 3$, $p_1 = 1$ atm, and $T_1 = 288$ K encounters a compression corner which deflects the stream by an angle $\theta = 30°$. Calculate the Mach number behind the shock wave.

a) 3.8 b) 9.16

c) 1.41 d) 2.95

9. Laminar flow airfoils have less drag than conventional airfoils because

a) the adverse pressure gradient starts farther back on the airfoil b) the airfoil is thinner

c) more of the airflow is laminar d) Both (a) and (c)

10. Dynamic pressure of an airstream is

a) Directly proportional to the square of the velocity. b) Directly proportional to the air density.

c) Neither (a) nor (b) d) Both (a) and (b).

PART B (10 x 2 = 20 Marks)

11. Compare one dimensional and quasi one dimensional flow
12. Define Compressibility of a gas
13. Define Oblique Shock and Expansion waves
14. What is shock polar?
15. Write down the linearized perturbation- velocity potential equation and linearized pressure coefficient equation.
16. How will you define Similarity rule
17. Define critical Mach number and drag divergence Mach number
18. Briefly discuss about transonic area rule
19. What is a shock tube?
20. What is the principle of operation of an interferometer?

PART C (5 x 14 = 70 Marks)

21. a) Obtain an expression for velocity of sound in terms of ratio of specific heat and local temperature in air medium from the one dimensional continuity, momentum and energy equations.

(OR)

b) (i) Derive the continuity, momentum and energy equation for steady 1-D flow (10)

(ii) Describe the performances of C-D nozzle under various back pressures. (4)

22. a) (i) Derive the Prandtl's relation for flow across a normal shock and explain its significance (10)

ii) Consider a 15° half-angle wedge at zero angle of attack. Calculate the pressure coefficient on the wedge surface in a Mach 3 flow of air. (4)

(OR)

b) (i) Consider a Mach 2.8 supersonic flow over a compression corner with a deflection angle of 15°. If the deflection angle is doubled to 30°, what is the increase in shock strength? Is it also doubled? (4)

(ii) Obtain an expression for θ–β-M relation for oblique shocks and also graphically represent the θ –β-M relation. (10)

23. a) What are the salient features of small perturbation theory of air flows? Obtain an expression for linearized perturbation velocity potential equation

(OR)

b) (i) Define similarity law and obtain an expression of Prantdtl- Glauert rule for subsonic compressible flows. (10)

(ii) Explain: Mach waves and mach angles? (4)

24. a) (i) Explain the role of area rule in the design of high speed aircraft (7)

(ii) Briefly explain the Characteristics of swept wings. (7)

(OR)

b) (i) With a neat illustration, explain the concept of 'shock induced separation". (7)

(ii) Explain the effects of thickness, camber and Aspect Ratio of wings (7)

25. a) (i) Explain the basic principle of shadowgraph method (7)

(ii) Explain about the types of wind tunnels and their design features. (7)

(OR)

b) (i) Describe Shock tube construction and its applications. (7)

(ii) Explain the Schlieren method of flow visualization and its basic principle. (7)

****