Roll No. | | | | | | | | | | | | | Total No. of Pages : 02

Total No. of Questions : 09

B.Tech.(ANE) (Sem.–7,8)

HIGH SPEED AERODYNAMICS

Subject Code : ANE-411

Time : 3 Hrs. Max. Marks : 60

INSTRUCTIONS TO CANDIDATES :

1. **SECTION-A is COMPULSORY consisting of TEN questions carrying TWO marks each.**
2. **SECTION-B contains FIVE questions carrying FIVE marks each and students have to attempt any FOUR questions.**
3. **SECTION-C contains THREE questions carrying TEN marks each and students have to attempt any TWO questions.**

SECTION–A

1. Explain the followings briefly :

a) Expansion Wave

b) Supersonic aerofoil thickness and camber

c) Supersonic flow deceleration

d) Transonic flow characteristics

e) Stagnation temperature change across a shock

f) Effect of supersonic wing leading edge bluntness

g) Importance of supersonic wing leading edge sweep

h) Shock tunnel

i) Shock-shock interaction

j) Pitot pressure

SECTION–B

2. Prove that static pressure jump across a normal shock wave for air is given by :

$$\frac{P_2}{P_1} = \frac{7M_1^2 - 1}{6}$$

3. Derive the $\theta - \beta - M$ relationship for an oblique shock wave. Plot the relation and explain the salient features of the diagram obtained.

4. Using p- θ diagram and neat sketch, explain shock-shock interaction between two unequal strength shock waves, One left running and the other right running wave.

5. Consider a flat plate with chord length 'C' at an angle of attack α to a supersonic freestream of Mach number M_∞. Let L and D be the lift and drag per unit span, and S be the planform area of the plate per unit span, S = c (1). Using linearized theory, derive the following expressions for the lift and drag coefficients.

$$C_L = \frac{4\alpha}{\sqrt{M^2{}_{\infty-1}}}$$

$$C_D = \frac{4\alpha^2}{\sqrt{M^2{}_{\infty-1}}}$$

6. Draw a neat sketch of a bow shock wave. Label different flow regions and types of shock waves that can be depicted by a typical bow shock wave.

SECTION–C

7. With the help of a neat sketch, explain the working of a Schlieren system. How is it possible to visualize the shocks as well as the boundary layer formed on a flat plate placed in a supersonic flow?

8. State the assumptions and derive Potential equation for compressible flows.

$$\left[1-\frac{1}{a^2}\left(\frac{\partial\phi}{\partial x}\right)^2\right]\frac{\partial^2\phi}{\partial x^2}+\left[1-\frac{1}{a^2}\left(\frac{\partial\phi}{\partial y}\right)^2\right]\frac{\partial^2\phi}{\partial y^2}-\frac{2}{a^2}\left(\frac{\partial\phi}{\partial x}\right)\left(\frac{\partial\Phi}{\partial y}\right)\left(\frac{\partial^2\phi}{\partial x\partial y}\right)=0$$

Where,

$$a = ao^2 - \frac{\gamma-1}{2}\left[\left(\frac{\partial\phi}{\partial x}\right)^2+\left(\frac{\partial\phi}{\partial y}\right)^2\right]$$

9. Write short notes on the following :

   a) Shock wave boundary layer interaction

   b) Prandtl-Glauert Transformation

NOTE : Disclosure of Identity by writing Mobile No. or Making of passing request on any page of Answer Sheet will lead to UMC against the Student.