UNIT IV BOUNDARY LAYER

PART – A

1. Define boundary layer.
2. Define momentum thickness.
3. What do you mean by drag lift?
4. What are the different methods of preventing the separation of boundary layers?
5. Differentiate between Laminar boundary and turbulent boundary layer.
6. Define displacement thickness.
7. Define boundary layer thickness.
8. Define energy thickness.
9. Write down the Von Karman momentum integral equation.
10. Write down the boundary conditions for the velocity profiles.
11. Differentiate local co-efficient of drag and average co-efficient of drag.
12. What are the conditions for separation of boundary layer?
13. Draw a diagram for drag force on a plate due to boundary layer.
14. Write down the applications of Von Karman momentum integral equation.
15. What do you mean by Laminar Sub – layer?
16. State Boundary layer theory.
17. Write down the values of boundary layer thickness and drag co – efficient for Blasius's solution.
18. Write down the values of boundary layer thickness and drag co – efficient for velocity profile $u/U = 2\,(y/\delta) - (y/\delta)^2$
19. Write down the values of boundary layer thickness and drag co – efficient for velocity profile $u/U = 2\,(y/\delta) - 2(y/\delta)^3 + (y/\delta)^4$
20. Write down the values of boundary layer thickness and drag co – efficient for velocity profile $u/U = \sin(\pi y/2\delta)$.
21. Write down the values of boundary layer thickness and drag co – efficient for velocity profile $u/U = 3/2\,(y/\delta) - 1/2(y/\delta)^3$.

PART - B

1. Briefly explain the boundary layer definitions.
2. Find the displacement thickness, the momentum thickness and energy thickness for the velocity distribution in the boundary layer given by $u/U = y/\delta$, where u is the velocity at a distance y from the plate and u = U at y = δ, where δ = boundary layer thickness. Also calculate the value of δ^*/θ.
3. Find the displacement thickness, the momentum thickness and energy thickness for the velocity distribution in the boundary layer given by $u/U = 2\,(y/\delta) - (y/\delta)^2$.
4. For the velocity profile $u/U = 2\,(y/\delta) - (y/\delta)^2$, find tghe thickness of boundary layer at the end of the plate and the drag force on one side of a plate 1 m long and 0.8 m wide

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when placed in water flowing with a velocity of 150 mm/sec. Calculate the value of co - efficient of drag also. Take μ for water = 0.01 poise.

5. For the velocity profile for laminar boundary layer $u/U = 2 (y/\delta) - (y/\delta)^3 + (y/\delta)^4$ obtain an expression for boundary layer thickness, shear stress, drag force on one side of the plate and co – efficient of drag in term of Reynold number.
6. For the velocity profile for laminar boundary flow $u/U = \sin (\pi y/2\delta)$. Obtain an expression for boundary layer thickness, shear stress, drag force on one side of the plate and co – efficient of drag in terms of Reynold number.
7. For the velocity profile for laminar boundary layer $u/U = 3/2 (y/\delta) - 1/2 (y/\delta)^3$ find the thickness of the boundary layer and the shear stress 1.5 m from the leading edge of a plate. The plate is 2 m long and 1.4 m wide and is placed in water which is moving with a velocity of 200 mm per second. Find the total drag force on the plate if μ for water = 0.01 poise.
8. For the velocity profile for turbulent boundary layer $u/U = (y/\delta)^{1/7}$, obtain an expression for boundary layer thickness, shear stress, drag force on one side of the plate and co – efficient of drag in terms of Reynolds Number. Given the stress (ζ_o) for turbulent boundary layer as
$$\zeta_o = 0.0225 \rho U^2 (\mu/\rho U g)^{1/4}.$$
9. Determine the thickness of the boundary layer at the trailing edge of smooth plate of length 4 m and of the width 1.5 m, when the plate is moving with a velocity of 4 m/s in stationary air. Take kinematic viscosity of air as 1.5×10^{-5} m^2/s.
10. For the following velocity profiles, determine whether the flow has or on the verge of separation or will attach with the surface:
    (i) $u/U = 3/2 (y/\delta) - 1/2 (y/\delta)^3$
    (ii) $u/U = 2 (y/\delta)^2 - (y/\delta)^3$
    (iii) $u/U = - 2 (y/\delta) + (y/\delta)^2$