Aerodynamics I – 2 Marks questions

Unit I

1. Write energy equation for a steady incompressible flow.

$$\frac{P}{\rho} + \frac{v^2}{2} + gz = c$$

2. State Bernoulli's equation for compressible fluid flow.

$$\frac{\gamma}{\gamma - 1}\frac{P}{\rho} + \frac{v^2}{2} + gz = c$$

3. State equation of continuity for two dimensional incompressible steady flows in differential form.

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0$$

4. What are the applications of Bernoulli's equations in aerodynamics?
   - ✈ Bernoulli's principle can be used to calculate the lift force on an aerofoil. The distribution of speed past the top and bottom surfaces of a wing is known, the lift forces can be calculated using Bernoulli's equations
   - ✈ Bernoulli's principle is used to calibrate the airspeed of an Aircraft.
   - ✈ The maximum possible drain rate for a tank with a hole or tap at the base can be calculated directly from Bernoulli's equation.

5. Define Momentum Principle.

   Net force acting on a mass of fluid is equal to the rate of change of momentum in that direction. (or) The rate of change of momentum is directly proportional to the applied force and it is acting in the direction of force.

6. Define moment of a momentum principle with reference to a turbo machine.

   The torque acting on a rotating fluid is equal to the rate of change of momentum.

7. State the types of forces.
   - ✈ Body force
   - ✈ Surface force

Unit III

8. Define Circulation.

   Circulation is defined as the line integral of velocity about a closed path.

$$\Gamma = \oint_{C_\alpha} v \cos\theta \, ds$$

9. What is a barotropic fluid?

   A fluid having density either constant or a function of its pressure is said to be a **barotropic fluid**.

10. State Kutta conditions.

    i. For a given airfoil at a given angle of attack, the value of Γ around the airfoil is such that the flow leaves the trailing edge smoothly.
    ii. If the trailing edge angle is finite, then the trailing edge is a stagnation point.
    iii. If the trailing edge is cusped, then the velocities leaving the top and bottom surfaces at the trailing edge are finite and equal in magnitude and direction.

11. Write the equation for Lift generation.

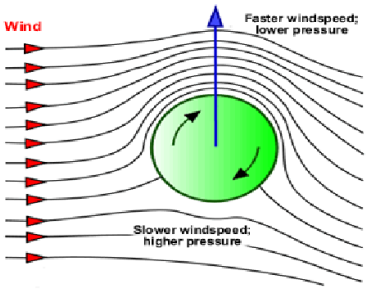
$$L' = \rho_\alpha v_\alpha \Gamma$$

12. Define Vorticity.

    Vorticity is defined as circulation per unit area.

13. Define Magnus Effect.

    The rotating circular cylinder or sphere produces lift force when it is placed in the uniform flow. The lift force is perpendicular to angular velocity or circulation of the body.



14. State Joukowski Hypothesis.

    In order to obtain a smooth flow at trailing edge, the stagnation point is moved by increasing the strength of the circulation. This method of specifying the magnitude of circulation is known as **Joukowski Hypothesis**.

15. State D' Alembertz Paradox.

    For incompressible and inviscid potential flow, the drag force is zero on a body moving with constant velocity relative to the fluid.

16. State the assumptions made in Bernoulli's equation.
    - ✈ The fluid is ideal.
    - ✈ The flow is steady.
    - ✈ The flow is incompressible.
    - ✈ The flow is irrotational.

17. State Kelvin's circulation theorem.

    Kelvin's circulation theorem states, *in an inviscid, barotropic flow with conservative body forces, the circulation around a closed curve moving with the fluid remains constant with time*.

$$\frac{d\Gamma}{dt} = 0$$

Unit IV

18. What is conformal transformation?

    It is a study of methods whereby an orthogonal flow pattern in z-plane (Plane I) is transformed to some other different flow pattern in Z-plane (Plane II) while the element retains its same form and proportion.

19. Explain the nomenclature of NACA 65-218 Aerofoil.
    i. The number "6" indicating the series.
    ii. "5" describing the distance of the minimum pressure area in tens of percent of chord (0.5 C).
    iii. A hyphen.
    iv. "2" describing the design lift coefficient in tenths (0.2).
    v. "18" describing the maximum thickness in hundreds of percent of chord (0.18 C).

20. State Biot-Savart's law.

    For a vortex line of infinite length, the induced velocity at a point is given by

$$v = \frac{\Gamma}{2\pi r}$$

21. Define Starting Vortex.

    The **starting vortex** is a vortex which forms in the air adjacent to the trailing edge of an airfoil as it is accelerated from rest in a fluid.

22. Define Bound Vortex.

    A vortex that is considered to be tightly associated with the body around which a liquid or gas flows, and equivalent with respect to the magnitude of speed circulation to the real vorticity that forms in the boundary layer owing to viscosity.

23. Define Shed Vortex.

    A vortex shed from the trailing edge, spinning opposite to the predicted bound vortex in the airfoil is called as **shed vortex**.

24. Define Horseshoe Vortex.

The **horseshoe vortex** is a simplified representation of the vortex system of a wing. In this, the wing vorticity is demonstrated by a bound vortex of constant circulation, travelling with the wing, and two trailing vortices, therefore having an unclear shape of a horseshoe.

25. Define Centre of Pressure.

The **center of pressure** is the point on a body where the total sum of a pressure field acts, causing a force and no moment about that point.

26. Define Aerodynamic Centre.

The **aerodynamic center** is the point at which the moment coefficient for the airfoil does not vary with lift coefficient. (Or) It is a point on the airfoil about which the moment is independent of angle of attack.

$$\frac{dC_m}{dC_L} = 0$$

27. What is viscous flow?

A type of fluid movement in which all particles of the fluid, flow in a straight line parallel to the axis of a containing pipe or channel with little or no mixing or turbidity is called as **viscous flow**.

28. Define potential flow of a fluid.

The irrotational motion of an incompressible fluid is called **potential flow**.

29. What is a vortex pair?

Two vortices of equal strength, but of opposite sign or with opposite direction of rotation constitute is called as **vortex pair**.

30. Write the Joukowski transformation.

$$Z = z + \frac{b^2}{z}$$

31. Define Induced angle of Attack.

Induced angle of attack is a slight decrease in the effective angle of attack of a wing due to the diversion of the air stream by the wings.