Q.1 Attempt any four of the following. (5x4=20)

(a) Why does the viscosity of a gas increases with the increase in temperature while that of liquid decreases with increase in temperature.

(b) The following case represents the two velocity components; determine the third component of velocity such that they satisfy the continuity equation.
   \[ u = x^2 + y^2 + z^2, \quad v = xy^2 - yz^2 + xy \]

(c) The stream function for a two dimensional flow is given by \( \phi = 2xy \), calculate the velocity at the point \( P(2, 3) \). Find the velocity potential function \( \phi \).

(d) With neat sketches, explain the conditions of equilibrium for floating and submerged bodies.

(e) Distinguish between:
   (i) Steady flow and \( Un \) — steady flow
   (ii) Uniform and Non — uniform flow

(f) What do you mean by repeating variables? How are the repeating variables selected for dimensional analysis?
Q.2 Attempt any two of the following. (10x2=20)

(a) Derive Euler’s equation of motion along a stream line for an ideal fluid stating clearly the assumptions. Explain how this is integrated to get Bernouilli’s equation along a stream line.

(b) 250 litres/s of water is flowing in a pipe having a diameter of 300 mm. If the pipe is bent by 135° (that is change from initial to final direction is 135°), find the magnitude and direction of the resultant force on the bend. The pressure of water flowing is 39.24 N/cm².

(c) A horizontal venturimeter with inlet diameter 20 cm and throat diameter 10 cm is used to measure the flow of oil of specific gravity 0.8. The discharge of oil through venturimeter is 60 litres/s. Find the reading of the oil-mercury differential manometer. Take $C_d=0.98$

Q.3 Attempt any two of the following. (10x2=20)

(a) The pressure difference $\Delta p$ in a pipe of diameter $D$ and length $l$ due to viscous flow depends on the velocity $V$, viscosity $\mu$ and density $\rho$. Using Buckingham’s $\pi$-theorem, obtain an expression for $\Delta p$.

(b) Prove that the scale ratio for discharge for a distorted model is given as

$$\frac{Q_p}{Q_m} = (L_r)_H \times (L_r)_V^{3/2}$$

Where;

$Q_p = \text{Discharge through prototype}$

$Q_m = \text{Discharge through model}$

$(L_r)_H = \text{Horizontal scale ratio}$

$(L_r)_V = \text{Vertical scale ratio}$

(c) A laminar flow is taking place in a pipe of diameter 200 mm. The maximum velocity is 1.5 m/s. Find the mean velocity and the radius at which this occurs. Also calculate the velocity at 4 cm from the wall of the pipe.
Q.4 Attempt any two of the following. \( (10 \times 2 = 20) \)

(a) What do you mean by Prandtl mixing length theory? Find an expression for shear stress due to Prandtl.

(b) Show that velocity distribution for turbulent flow through rough pipe is given by
\[
\frac{u}{u_*} = 5.75 \log_{10} \left( \frac{y}{k} \right) + 8.5
\]

(c) Define the terms:
(i) Boundary Layer  (ii) Boundary Layer Thickness
(iii) Energy Thickness  (iv) Momentum Thickness

Q.5 Attempt any two of the following. \( (10 \times 2 = 20) \)

(a) Find the displacement thickness, the momentum thickness and energy thickness for the velocity distribution in the boundary layer given by
\[
\frac{u}{U} = 2 \left( \frac{y}{\delta} \right) - \left( \frac{y}{\delta} \right)^2
\]

(b) (i) How are drag and lift forces caused on a body immersed in a moving fluid?
(ii) What is the drag force on a sphere in the stoke range?

(c) A man weighing 90 kgf descends to the ground from an aeroplane with the help of a parachute against a resistance of air. The velocity with which the parachute, which is hemispherical in shape, comes down is 20 m/s. Find the diameter of the parachute. Assume \( C_D = 0.5 \) and density of air 1.25 Kg/m\(^3\).

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