**(3 Hours)** **[Total Marks: 80]**

**NB:**

1. **Question No.1** is compulsory
2. Attempt **any three questions from remaining questions**.
3. **Neat diagram must be drawn** wherever necessary
4. **Assume suitable data** if necessary and **state clearly**.
5. **Appropriate figures** to the right indicate marks.

**1** **Answer any four from the following** **20**

**a.** An ornament weighing 36 gm in air weighs only 34 gm in water. Assuming that some copper is mixed with gold to prepare the ornament. Find the amount of copper in it. Specific gravity of gold is 19.3 and that of copper is 8.9.

**b.** Water is flowing from a hose attached to water main at 400 kPa (gauge). A child places a thumb to cover most of the hose outlet, causing a thin jet of high speed water to emerge. If the hose is held vertical upward, what is maximum height that jet could achieve .Assume flow is steady, incompressible and laminar.

**c.** A ball falling in a lake of depth 200 m creates a decrease 0.1% in its volume at the bottom. The bulk modulus of material of ball is.

**d.** Explain for the boundary layer flow, whether the curve representing $\delta$ (boundary layer thickness) as a function of X over a flat plate is a stream line of flow or not.

**e.** Distinguish with the help of neat sketches, between a hydrodynamically rough surface and hydrodynamically smooth surface.

**2** **a.** For the laminar boundary layer on a flat plate is **12**

$$f(\eta) = 3\eta/2 - \eta^3/2 \text{ where, } \eta = \frac{y}{\delta} \text{ and } f(\eta) = \frac{u}{U}$$

Determine;

a. Boundary Layer Thickness

b. Local coefficient of drag

c. Check whether the flow is attached or not.

**b.** Air at an absolute pressure 60.0 kPa and $27^0$C enters a passage at 486 m/s. The cross-sectional area at the entrance is 0.02 $m^2$. At section 2, further downstream, the pressure is 78.8 kPa (abs). Assuming isentropic flow, calculate the Mach number at section 2. Also identify the type of nozzle. **08**

TURN OVER

**3 a.** Use the appropriate form of Navier-stokes equation to derive an equation of velocity profile in couette flow. State assumptions made at each stage. Plot the dimensionless velocity profile for different value of $\frac{dp}{dx}$. **10**

**b.** In a parallel two dimensional flow in the positive x- direction, the velocity varies linearly from zero at $y = 0$ to 32 m/s at $y = 1\,m$ in perpendicular direction. Determine the expression for stream function $(\psi)$ and plot streamline at interval of $d\psi = 3\,m^2/s$. Is the flow is irrotational. Consider unit width of flow. **10**

**4 a.** A pipe 0.6 m in diameter takes off water from the reservoir 150 m high above the datum. The pipe is 5000 m long and is laid completely at the datum level. For the last 1200 m, water is drawn by service pipe at uniform rate of 0.1 $m^3$/sec per 300 m. Find the head lost in the last 1200 m length of pipe. Take friction factor as 0.04 and velocity is zero at dead end. **12**

**b.** Derive the expression for linear with angular deformation and pure rotation phenomenon in fluid flow. **08**

**5** Using Reynold's Transport Theorem derive the mass flow rate equation and momentum equation to solve the following **06**

Water at a pressure of 72 kN/$m^2$ flows through a horizontal pipe of diameter 360 mm at the rate of 300 lps. The direction of water is changed through $120^0$ by a vertical bend whose exit diameter is 240 mm. The volume of the bend is 0.14 $m^3$. The exit of the bend is 2.4 m above the inlet. Find the magnitude and direction of the resultant force on the bend due to water. Neglect friction and minor losses. **14**

**6** Write short note for the following **20**

**a.** Moody's diagram

**b.** Induced drag on aerofoil

**c.** Stream function and velocity potential function and their importance in ideal fluid flow theory.

**d.** Conditions of equilibrium for floating and submerged bodies.

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