Total No. of Questions—**12**] [Total No. of Printed Pages—**8+2**

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S.E. (Mechanical & Mechanical S/W) (I Sem.) EXAMINATION, 2010

FLUID MECHANICS

(2008 PATTERN)

Time : Three Hours **Maximum Marks : 100**

N.B. **:—** (*i*) Answer *three* questions from each Section.

(*ii*) Answers to the two Sections should be written in separate answer books.

(*iii*) Neat diagrams must be drawn wherever necessary.

(*iv*) Figures to the right indicate full marks.

(*v*) Use of logarithmic tables, slide rule, Mollier charts, electronic pocket calculator and steam tables is allowed.

(*vi*) Assume suitable data, if necessary.

SECTION I

Unit I

1. (*a*) Explain the following terms :

(*i*) Vapour pressure

(*ii*) Compressibility. [6]

(*b*) A cube of 0.2 m sides and mass of 30 kg slides down a plane inclined at 30° to the horizontal and covered by a thin film of viscosity 2.3×10^{-3} Ns/m^2. If the thickness of the film is 0.02 mm, determine the speed of the block. [6]

(c) Differentiate between pathline, streakline and streamline. [6]

Or

2. (a) For the flow of an incompressible fluid the velocity component in the x-direction is $u = ax^2 + by$ and the velocity component in the z-direction is zero. Find the velocity component v in the y-direction such that $v = 0$ at $y = 0$. [6]

(b) Explain how the flows are classified. [6]

(c) A glass tube of internal diameter 2 mm is partially dipped in glycerine with its lower end 30 mm deep below surface. Air is blown in the tube so as to form an air bubble at its bottom end of the tube. If specific weight and surface tension of glycerine are 12.356 kN/m^2 and 0.0637 N/m, find the pressure of air blown. [6]

Unit II

3. (a) Derive expression for total pressure and centre of pressure on inclined plane surface completely submerged in static mass of liquid. [8]

   (b) A wooden block 60 cm long, 30 cm wide and 20 cm deep has its shorter axis vertical with the depth of immersion 15 cm. Calculate the position of the metacentre and comment on the stability of the block. [8]

Or

4. (a) Explain with neat sketches, the condition of equilibrium for floating and submerged bodies. [8]

   (b) A square plate of diagonal 2 m is immersed in water with its diagonal vertical and upper corner 0.5 m below the free surface of water. Find the hydrostatic force on the plate and the depth of centre of pressure from the free surface of water. [8]

Unit III

5. (*a*) Derive Euler's equation of motion along a streamline and hence derive Bernoulli's equation from that. [8]

(*b*) Show that an error of 1% in the measurement of head produces an error of 1.5% in the discharge over a rectangular notch and produces an error of 2.5% in the discharge over a triangular notch. [8]

Or

6. (*a*) Water flows through an inclined venturimeter. The inlet and throat diameters are 10 cm and 5 cm respectively and their height difference $(z_2 - t_1)$ is 20 cm. A mercury manometer located across the inlet and throat indicates 12 cm mercury column at a given flow rate.

Estimate the flow rate, coefficient of discharge and pressure difference between inlet and the throat $(P_1 - P_2)$:

(*i*) neglecting friction

(*ii*) when friction loss is 10%

of the head indicated by the manometer. [8]

(*b*) Explain the terms :

(*i*) End contractions and

(*ii*) Velocity of approach.

How is the discharge over a rectangular notch affected by these ? [8]

SECTION II

Unit IV

7. (*a*) Assuming the viscous force F exerted by a fluid on sphere of diameter D depends on viscosity 'μ', mass density 'ρ' and velocity of sphere 'v'. Obtain expression for the viscous force. [8]

(*b*) A fluid is flowing through a smooth circular pipe of uniform diameter 'd' with velocity 'u'. Reynolds number for the flow is 1800. Derive the expression for the velocity profile at any cross-section of the pipe. Assume density of the fluid as ρ and dynamic viscosity as μ. Draw the velocity profile for the flow. [8]

Or

8. (*a*) The performance of an oil ring consuming a discharge Q of oil depends on the internal diameter '*d*' of the ring, the rotational speed N of the shaft the density ρ, the viscosity μ, surface tension λ and specific weight of the oil ω, show that : [8]

$$Q = Nd^3 \, \Phi \left\{ \frac{\mu}{\rho N d}, \frac{\lambda}{\rho N^2 d^2}, \frac{\omega}{\rho d N^2} \right\}.$$

(*b*) A laminar flow is taking place in a pipe of diameter of 200 mm. The maximum velocity is 1.5 m/sec. Find the mean velocity and the radius at which this occurs. Also calculate the velocity at 40 mm from the wall of the pipe. [8]

Unit V

9. (*a*) A horizontal pipeline 40 metres long is connected to a water tank at one end and discharges freely into the atmosphere at the other end. For the first 25 metres of its length the pipe is 15 cm diameter and then its diameter is suddenly enlarged to 30 cm. The height

of water level in the tank is 8 mts above centre of pipe. Considering all losses of head which occur determine the rate of flow. Take $f = 0.01$ for both the sections of the pipe. [8]

(b) A siphon of diameter 200 mm connects two reservoirs having a difference in elevation of 15 mt. The total length of siphon is 600 m and summit is 4 m above the water level in the upper reservoir. If separation takes place at 2.8 m water absolute, find the maximum length of siphon from upper reservoir to summit take friction coefficient as 0.004 and atmospheric pressure as 10.3 m of water. [8]

Or

10. (a) Oil is pumped in a horizontal 150 mm dia pipe 200 m long. The specific gravity of oil is 0.89 and kinematic viscosity is 1.3 strokes. The friction factor for the flow is given by $\frac{64}{\text{Re}}$. It has 25 HP to drive the pump of efficiency 65%. Find the flow rate of oil. [8]

(*b*) A main pipe divides into two parallel pipes which again forms one pipe. The length of parallel pipes is 2000 m and diameters are 1.0 m and 0.8 m respectively. Find the flow in each parallel pipe if total flow in the main pipe is 3 m^3/sec. Assume coefficient of friction for each pipe as 0.005. [8]

Unit VI

11. (*a*) A plate 3 m × 3 m is held vertically in water moving at 1.25 m/sec parallel to its length. If the flow in the boundary layer is laminar at the leading edge, find :

(*i*) Distance from the leading edge where the flow become turbulent.

(*ii*) Thickness of the boundary layer at this section.

(*iii*) Frictional drag on both the sides of the plate.

Assume the viscosity of water as 0.001 Pa.sec. [6]

(*b*) Velocity distribution in boundary layer is given by $\left(\frac{r}{V}\right) = \left(\frac{y}{\delta}\right)^{\frac{1}{7}}$.

Calculate displacement thickness, momentum thickness and energy thickness of the boundary layer. [6]

(*c*) What is boundary layer ? Explain Laminar sublayer in turbulent boundary layer. [6]

Or

12. (*a*) What is drag ? Explain different types of drag on an immersed body. [6]

(*b*) A metallic ball of diameter 0.002 m drops in a fluid of specific gravity 0.95 and viscosity 15 poise. Density of ball is 12000 kg/m^3, find :

(*i*) Drag force exerted on ball

(*ii*) Pressure drag and friction drag

(*iii*) Terminal velocity of the ball. [6]

(*c*) A flat plate 1.5 m × 1.5 m moves at a speed of 50 kmph in stationary air of density 1.15 kg/m^3. Coefficient of drag and lift are 0.15 and 0.75 respectively. Determine :

(*i*) The lift force on plate

(*ii*) The drag force on plate

(*iii*) Resultant force on plate

(*iv*) Direction of the resultant force

(*v*) Power required to keep the plate in motion. [6]