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

Seat No.	

[4657]-10

S.E. (Civil) (Second Semester) EXAMINATION, 2014

Fluid Mechanics-I

(2008 PATTERN)

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

N.B. **:—** (*i*) Answer Q. No. **1** *or* Q. No. **2**, Q. No. **3** *or* Q. No. 4, Q. No. **5** *or* Q. No. **6** from Section I. Q. No. **7** *or* Q. No. **8**, Q. No. **9** *or* Q. No. **10**, Q. No. **11** *or* Q. No. **12** from Section II.

(*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.

SECTION I

1. (*a*) Define absolute viscosity and give classification of fluids based on Newton's law of viscosity and represent it graphically. [6]

P.T.O.

(*b*) Write short notes on : [4]

(*i*) Capillarity

(*ii*) Surface tension.

(*c*) The pressure drop 'dp' in a pipeline of diameter 'D' and length 'L' depends upon density 'ρ' and viscosity 'μ' of flowing fluid, mean velocity 'V' and average height of roughness projection '*k*'. Obtain an expression for 'dp' in the form : [8]

$$dp = \rho V^2 \phi\left[\frac{L}{D}, \frac{\mu}{\rho VD}, \frac{k}{D}\right].$$

Or

2. (*a*) If the equation of a velocity profile over a plate is $u = 2y^{2/3}$ in which the velocity in m/s at a distance of '*y*' meters above the plate, determine the shear stress at $y = 0$, and $y = 0.075$ m. [6]

Given $\mu = 0.835$ Ns/m^2.

(*b*) Calculate the capillary rise in a glass tube of 2 mm diameter when immersed in (*i*) water (*ii*) mercury. Both the liquids at 20ºC and the values of the surface tension for water and mercury at 20ºC in contact with air are respectively 0.0075 N/m and 0.052 N/m. [6]

(*c*) Explain any *one* of the methods of dimensional analysis. [6]

3. (*a*) A triangular gate which has a base of 1.5 m and an altitude of 2 m lies in a vertical plane. The vertex of the gate is 1 m below the surface of tank which contains oil of S.G. 0.8, find the force exerted by the oil on the gate and the position of the centre of pressure. [8]

(*b*) What are the conditions of equilibrium for floating and submerged bodies ? Explain them with neat sketches. [8]

Or

4. (*a*) A wooden cylinder of diameter '*d*' and length '2*d*' floats in water with its axis vertical. Is the equilibrium stable ? Locate the metacentre with reference to water surface. S.G. of wood is 0.6. [8]

(*b*) Explain the terms total pressure and centre of pressure. Also show that the centre of pressure of any lamina immersed under liquid is always below its centroid. [8]

5. (*a*) Define and distinguish between : [8]

(*i*) Steady and unsteady flow;

(*ii*) Uniform and non-uniform flow

(*iii*) Rotational and irrotational flow

(*iv*) Streamline and streakline

(*b*) For a two-dimensional flow : [8]

$$\phi = 3xy \quad \text{and} \quad \psi = \frac{3}{2}\left(y^2 - x^2\right).$$

Determine the velocity components at the points (1, 3) and (3, 3). Also find the discharge passing between the streamlines passing through the points given above.

Or

6. (*a*) What is flow net ? Give the uses and limitations of flow net. [8]

(*b*) The velocity component in a two-dimensional flow field for an incompressible fluid are expressed as :

$$u = \frac{y^3}{3} + 2x - x^2y$$

and $$v = xy^2 - 2y - x^3/3$$

Obtain an expression for velocity potential ϕ and strem function ψ. [8]

SECTION II

7. (*a*) A venturimeter of throat diameter 6 cm is fitted into a 12 cm diameter pipeline. Determine the flow in the pipeline when the reading of differential U-tube manometer is 20 cm. If the

energy loss in downstream part of divergent cone is 10 times the velocity head in pipe, calculate the total head loss.

Take Cd = 0.96. [8]

(*b*) Define Hydraulic Gradient and Total Energy line. Draw H.G.L. and T.E.L. for flow of ideal fluid in a pipeline. [4]

(*c*) State Bernoulli's theorem and limitations of the same. [6]

Or

8. (*a*) A drainage pump has tapered suction pipe. The pipe is running full of water. The pipe diameters at the inlet and at the upper end are 1 m and 0.5 m respectively. The free water surface is 2 m above the centre of the inlet and centre of the upper end is 3 m above the top of free water surface. The pressure at the tip of the pipe is 25 cm of mercury and it is known that the loss of head by friction between top and bottom section is one tenth of the velocity head at the top section. Compute the discharge. Neglect the loss of head at the entrance of the tapered pipe. [8]

(*b*) Explain with a neat sketch working of pitot tube. Derive expression for measurement of velocity in a pipe by pitot tube. [6]

(*c*) Explain coefficient of velocity of orifice is determined experimentally. [4]

9. (*a*) Derive an equation for velocity distribution for viscous flow through a circular pipe. Also sketch the distribution of velocity and shear stress across a section of pipe. [8]

(*b*) A flat plate 450 mm × 150 mm has been placed longitudinally in a stream of crude oil (specific gravity 0.925 and kinematic viscosity of 0.9 stoke) which flows with a velocity of 6 m/s.

Calculate :

(*i*) The friction drag on the plate

(*ii*) Thickness of the boundary layer at the trailing edge and

(*iii*) Shear stress at the training edge. [8]

Or

10. (*a*) Crude oil of viscosity 0.9 poise and relative density 0.9 is flowing through a horizontal circular pipe of diameter 120 mm and length 12 m. Calculate the pressure difference at the two ends of the pipe, if 785 N of oil is collected in a tank in 25 seconds. [8]

(*b*) Prove that the momentum thickness and energy thickness for boundary layer flow is given by : [8]

$$\theta = \int_0^{\delta} \frac{u}{U}\left(1 - \frac{u}{U}\right)dy \quad \text{and} \quad \delta_e = \int_0^{\delta} \frac{u}{U}\left(1 - \frac{u^2}{U^2}\right)dy .$$

11. (*a*) A horizontal pipe 150 mm in diameter is joined by sudden enlargement to a 225 mm diameter pipe. Water is flowing through it at the rate of 0.05 m^3/s.

Find :

(*i*) loss of head due to sudden abrupt expansion

(*ii*) Pressure difference in two pipes. [8]

(*b*) Explain 'Prandtl's mixing length theory' and show that the velocity distribution across a section of circular pipe is logarithmic for turbulent flow. [8]

Or

12. (*a*) Water is discharged from a reservoir into the atmosphere through a pipe 39 m long. There is a sharp entrance to the pipe and the diameter is 50 mm for 15 m from the entrance. The pipe then enlarges suddenly to 75 mm in diameter for the reminder of its length. Taking into account the loss of head at entry and at the enlargement calculate the difference of level between the surface of the reservoir and the pipe exit which will maintain a flow of 0.0028 m^3/s. Take f as 0.0048 for the 50 mm pipe and 0.0058 for the 75 mm pipe. [8]

(*b*) Briefly explain the following : [8]

(*i*) Temporal mean velocity

(*ii*) Shear velocity

(*iii*) Instantaneous velocity

(*iv*) Karman-Prandtl velocity distribution equation.