Total No. of Questions—**12**] [Total No. of Printed Pages—**7**

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S.E. (Civil) EXAMINATION, 2008

FLUID MECHANICS–I

(2003 COURSE)

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

N.B. :— (*i*) Answer *three* questions from section I and *three* questions 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.

(*v*) Use of electronic non-programmable calculator is allowed.

(*vi*) Assume suitable data if necessary.

SECTION I

1. (*a*) When poured in a measuring flask of 1 liter capacity, the volume of liquid weighing 7.50 N was found to be 800 ml. Determine its :

(*i*) mass density

(*ii*) weight density

(*iii*) specific gravity. [6]

(*b*) State and explain Newton's law of viscosity. Also derive the equation for the same. [6]

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(*c*) Derive expressions for :

(*i*) Froude number

(*ii*) Reynolds number. [6]

Or

2. (*a*) A metal disc of 500 mm diameter slides down an inclined plane covered with a thin oil film of thickness 0.5 mm. The plane is inclined at 30° with horizontal. Viscosity of oil is 2.5 poise. If the speed of the disc is 0.5 m/s, determine its weight. [6]

(*b*) Discuss why water shows capillary rise and mercury shows capillary depression. [2]

(*c*) Explain geometric and kinematic similarity. [4]

(*d*) Using Buckingham's Pi theorem show that the velocity through a circular orifice is given by :

$$V = \sqrt{2\,gH}\,.\,\phi\left[\frac{D}{H}, \frac{\mu}{\rho\,VH}\right],$$

where H is the head causing flow, D is the diameter of the orifice, μ is the coefficient of viscosity, ρ is the mass density and *g* is the acceleration due to gravity. [6]

3. (*a*) State Pascal's law and briefly explain its *two* practical applications. [4]

(*b*) A rectangular plane surface 2 m wide and 4 m deep lies in water in such a way that its plane makes an angle of 30° with the free surface of water. Determine the total pressure and the position of centre of pressure when the upper edge is 2 m below the free surface. [8]

(*c*) Write a short note on stable, unstable and neutral equilibrium conditions of a floating body with neat sketch. [4]

Or

4. (*a*) With the help of diagrammatic presentation explain : [4]

(*i*) atmospheric pressure

(*ii*) gauge pressure

(*iii*) vacuum pressure

(*iv*) absolute pressure.

(*b*) A wooden block in the form of a rectangular prism floats with its shortest axis vertical. The block is 400 mm long, 200 mm wide and 150 mm deep with a depth of immersion of 90 mm. Determine the position of the metacentre and comment on the stability of the block. [8]

(*c*) What do you understand by hydrostatic paradox. [4]

5. (*a*) Derive continuity equation for one-dimensional flow along a streamline. [8]

(*b*) What is flownet ? Draw a typical flownet and explain its applications. [4]

(*c*) State Bernoulli's theorem and assumptions made in. [4]

Or

6. (*a*) Starting from Euler's equation along a stream-line, integrate it to get Bernoulli's equation. Also list its limitations. [8]

(*b*) The velocity components in a two-dimensional flow are as follows :

$$u = 2xy, \; v = b^2 + x^2 - y^2.$$

(*i*) is the flow possible ?

(*ii*) is the flow rotational or irrotational ?

(*iii*) Determine stream function.

(*iv*) Determine velocity potential function. [8]

SECTION II

7. (*a*) Explain concept of Cipolletti weir and derive expression of discharge for it. [8]

(*b*) Find discharge of water flowing through a pipe 40 cm diameter placed in an inclined position where a Venturimeter is inserted, having a throat diameter 20 cm. The difference of pressure between main and throat is measured by a liquid of specific

gravity 0.6 in an inverted U tube which gives a reading of 40 cm. The loss of head between the main and throat is 0.4 times the kinetic head of pipe. [8]

Or

8. (*a*) What is suppressed weir ? Write an equation for the discharge through rectangular weir with '*n*' end contractions considering velocity approach. [6]

(*b*) A 30 cm × 15 cm Venturimeter is provided in a vertical pipeline carrying oil of specific gravity 0.8, the flow being upwards. The difference in the elevation of throat section and entrance section of Venturimeter is 40 cm. The differential U tube mercury manometer shows a gauge deflection of 25 cm. Calculate :

(*i*) Discharge of oil and

(*ii*) The pressure difference between the entrance section and throat section.

Take C_d = 0.98 and specific gravity of mercury as 13.6. [10]

9. (*a*) There is a horizontal crack 40 mm wide and 2.5 mm deep in a wall of thickness 100 mm. Water leaks through the crack. Find the rate of leakage of water through the crack if the difference of pressure between the two ends of the crack is 0.02943 N/cm^2. Take the viscosity of water equals to 0.01 poise. [8]

(*b*) Derive an expression for displacement thickness. [4]

(*c*) State whether for the following velocity profiles the flow has separated or not : [4]

(*i*) $u/U = 3/2(y/\delta) - 1/2(y/\delta)^2$

(*ii*) $u/U = -2(y/\delta) + 3(y/\delta)^2$.

Or

10. (*a*) Find the displacement thickness, the momentum thickness and energy thickness for the velocity distribution in the boundary layer given by : [8]

$$u/U = 2(y/\delta) - (y/\delta)^2.$$

(*b*) A fluid of viscosity 0.8 N-s/m^2 and specific gravity 1.2 is flowing through a circular pipe of diameter 100 mm. The maximum shear stress at the pipe wall is given as 200.2 N/m^2.

Find :

(*i*) the pressure gradient

(*ii*) the average velocity

(*iii*) Reynolds number of the flow. [8]

11. (*a*) Derive Darcy-Weisbach equation for turbulent flow. [8]

(*b*) An old water supply distribution pipe of 350 mm diameter of a city is to be replaced by two parallel pipes of smaller equal diameter having equal lengths and identical friction factor values. Find out the new diameter. [10]

Or

12. (*a*) Explain siphon—its concept, working with neat sketch. [4]

(*b*) A pipeline carrying water has an average height of protrusion from the surface of the boundary of the pipe as 0.20 mm. What type of boundary is it ? The shear stress developed is 5.9 N/m^2. The kinematic viscosity of water is 0.01 stokes. [6]

(*c*) Water is flowing through a rough pipe of diameter 500 mm and length 4000 m at the rate of 0.5 m^3/sec. Find the power required to maintain this flow. Take the average height of roughness as k = 0.4 mm. [8]