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

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S.E. (Civil) (Second Semester) EXAMINATION, 2010

FLUID MECHANICS—I

(2008 COURSE)

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

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

Attempt Q. **1** *or* Q. **2**, Q. **3** *or* Q. **4**, Q. **5** *or* Q. **6** from Section I. Q. **7** *or* Q. **8**, Q. **9** *or* Q. **10**, Q. **11** *or* Q. **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.

(*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

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

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(*b*) A glass tube of 0.2 mm diameter is immersed in mercury. The surface tension of mercury in contact with air is 0.5 N/m. The angle of contact for mercury is 130°. Calculate the capillary effect. [6]

(*c*) What parameter is used to determine whether the flow is :

(*i*) Subcritical or critical

(*ii*) Laminar or turbulent

(*iii*) Subsonic or supersonic. [6]

Or

2. (*a*) Calculate the gauge pressure and the absolute pressure within :

(*i*) a droplet of water 0.3 cm in diameter

(*ii*) a jet of water 0.3 cm in diameter.

Assume the surface tension of water as 0.07 N/m and atmospheric pressure as 101.3 N/m^2. [4]

(*b*) The force F on the propeller of an aircraft is known to depend upon speed of the aircraft V, air density ρ, air viscosity μ, propeller diameter D, speed of rotation of propeller N. Derive an expression for force F. [8]

(c) An oil of specific gravity 0.9 and viscosity 0.9 poise is to be transported at the rate of 1000 l/s through a 1.2 m diameter pipe. Tests were conducted on a 10 cm diameter pipe using water at 20°C. Viscosity of water at 20°C is 0.01 poise. Find the rate of flow in the model. [6]

3. (a) Derive an expression for total pressure and the depth of centre of pressure from free surface of liquid, at inclined plane surface submerged in the liquid. [8]

(b) What is metacentre ? Define metacentric height.

A wooden block of specific gravity 0.8 floats in water. If the size of the block is 1 m × 0.6 m × 0.5 m. Find its metacentric height. [8]

Or

4. (a) Explain the procedure of computing the resultant hydrostatic force on a curved surface. [8]

(b) A closed cylindrical tank 2 m diameter, 4 m high contains water upto 3 m when it is rest. The cylinder is rotated with its longitudinal axis vertical. Find :

(i) the angular speed when water just touches the top

(ii) the depth of water at the centre of the tank when it is rotated at 120 r.p.m. [8]

5. (*a*) Derive the continuity equation for one-dimensional flow. State the assumptions made. [8]

(*b*) The velocity components in two-dimensional irrotational flow of an incompressible fluid are :

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

$$v = xy^2 - 2y - \frac{x^3}{3}.$$

Obtain the expression for velocity potential and stream function. [8]

Or

6. (*a*) Explain any *one* method of drawing flownet. Show that the streamlines and equipotential lines intersect each other orthogonally. What are the used of the flownet ? [8]

(*b*) (*i*) Determine the missing component of velocity distribution such that they satisfy continuity equation :

$$v = 2yz^2 + 3z^2,\ w = -4xz - 2yz - \frac{2}{3}z^3,\ u = ?$$

(*ii*) Define stream function ψ. [8]

SECTION II

7. (*a*) State Bernoulli's equation. Derive an expression for measuring discharge of fluid through a pipe with venturimeter. [8]

(*b*) A vertical sharp edged orifice 100 mm in diameter, is discharging water at the rate of 100 l/s under a constant head of 10 m. The co-ordinate of a point on the jet is 4.5 m horizontal and 0.5 m vertical, from the vena contracta. Find :

(*i*) Coefficient of velocity

(*ii*) Coefficient of discharge

(*iii*) Coefficient of contraction. [8]

Or

8. (*a*) Derive Euler's equation of motion and then derive Bernoulli's equation along the stream tube. [8]

(*b*) A pipeline carrying oil (sp. gr. 0.8) changes its diameter from 200 mm to 400 mm, which is 5 m at a higher level. If the pressures at these two points are 100 kN/m^2 and 50 kN/m^2 respectively and the discharge is 250 l/s, determine direction of flow and loss of head. [8]

9. (*a*) For a steady laminar flow through a circular pipe, prove that the velocity distribution is parabolic and average velocity is half of the maximum velocity. [10]

(*b*) The velocity distribution in the boundary layer is :

$$\frac{u}{v} = 2\left(\frac{y}{\delta}\right) - \left(\frac{y}{\delta}\right)^2,$$

δ—thickness of boundary layer.

Calculate :

(*i*) Displacement thickness

(*ii*) Momentum thickness. [8]

Or

10. (*a*) Show that for laminar flow between two parallel plates at rest, the mean velocity is two-third of maximum velocity. [10]

(*b*) Explain the development of boundary layer over a flat plate held parallel to the direction of flow. Also, state various factors affecting growth of boundary layer. [8]

11. (*a*) Write short notes on :

(*i*) Prandtl's mixing length theory

(*ii*) Hydrodynamically smooth and rough pipes. [8]

(*b*) What are the different losses in pipe flow and write expression for computing them ? [8]

Or

12. (*a*) Using Prandtl's mixing length theory, show that velocity variation for turbulent flow is logarithmic. [8]

(*b*) Derive an expression for the loss of head due to sudden enlargement in pipe flow. [8]