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

[3762]-106

S.E. (Civil) (II Sem.) 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.

(*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.

(*vii*) Solve 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.

SECTION I

1. (*a*) Explain Vapour Pressure and Capillarity. [6]

(*b*) A 400 mm diameter shaft is rotating at 200 rpm in a bearing of length 120 mm. If the thickness of oil film is 1.5 mm and the dynamic viscosity of oil is 0.7 N-S/m^2, determine :

(*i*) Torque required to overcome friction in bearing.

(*ii*) Power used in overcoming viscous resistance. [6]

P.T.O.

(*c*) A ship 300 m long moves in seawater whose density is 1030 kg/m^3. A 1 : 75 model of this ship is to be tested in a wind tunnel. The velocity of air in wind tunnel is 29 m/s and the resistance of the model is 60 N. Determine velocity and resistance of the ship in seawater.

Air density is 1.24 kg/m^3.

Kinematic viscosity of air = 0.018 stokes

Kinematic viscosity of seawater = 0.01 stokes. [6]

Or

2. (*a*) The pressure of a liquid is increased from 400 Pa to 1200 Pa producing a decrease in volume of 0.15 percent. Find the bulk modulus of elasticity of the liquid. [4]

(*b*) Obtain the relationship between the size of a bubble, surface tension and pressure inside it. [4]

(*c*) The efficiency of a fan depends on the dynamic viscosity μ and density ρ of the fluid, angular velocity ω, diameter of the rotor D and the discharge. Using dimensional analysis, express efficiency η in terms of dimensionless parameters. [10]

3. (*a*) A piezometer tube is fitted to a tank containing water at a point 500 mm above the bottom of the tank. The liquid in the manometer is carbon tetrachloride (sp. gr. 1.6). Find the height of the free water surface above the bottom of the tank if the piezometric reading is 600 mm. Find the pressure intensity at the bottom of the tank. [6]

(*b*) A hemispherical projection of diameter 1.2 m exists on one of the vertical sides of the tank. If the tank contains water upto the height of 2.5 m above the centre of the hemisphere. Calculate the horizontal and vertical forces acting on the projection. Assume length of tank 1 m. [7]

(*c*) Define gauge pressure, vacuum pressure and absolute pressure. [3]

Or

4. (*a*) Derive an expression for determination of metacentric height of floating bodies by analytical method and also prove BM = I/V. [10]

(*b*) A 4 m diameter cylindrical tank is filled to the depth of 3 m with water. The height of the tank is 5 m. Determine the speed of rotation about its vertical axis at which water will just spill out of the tank. What will be the depth at the centre and gauge pressure at the bottom 1 m from the centre ? [6]

5. (*a*) If $x^2 - y^2$ = constant represents equation of a streamline, determine magnitude and direction of velocity at point (3, 6). Show that the velocity potential function and exists for the flow and determine the same. [8]

(*b*) Derive the continuity equation for three-dimensional, steady, incompressible flow. [8]

Or

6. (*a*) Distinguish clearly between local accelleration and connective acceleration. [4]

(*b*) Prove that in a two-dimensional flow field, rotation of the element is given as :

$$\omega_z = \frac{1}{2}\left(\frac{\partial v}{\partial x} - \frac{\partial u}{\partial y}\right). \quad [7]$$

(*c*) Sketch the streamlines represented by $\psi = x^2 + y^2$. Also find the velocity and its direction at point (1, 2). [5]

SECTION II

7. (*a*) Obtain an expression for pressure drop from inlet to throat in a horizontally mounted venturimeter in terms of rate of flow Q and inlet diameter D. Take inlet diameter (D) twice the throat diameter. [4]

(*b*) In a vertical pipe conveying water, pressure gauges are inserted at A and B where the diameters are 150 mm and 75 mm respectively. The point B is 2.5 m below point A and when the rate of flow down the pipe is 0.02 m^3/s, the pressure at B is 10 kPa greater than that at A. Assuming that the losses in the pipe between A and B can be expressed as $\frac{KV_A^2}{2g}$, where V_A is the velocity at point A. Find the value of K. If the gauge at A and B are replaced by U tube differential mercury manometer (sp. gr. 13.6). Calculate the difference in the mercury levels. [10]

(c) Define coefficient of contraction, coefficient of velocity and coefficient of discharge. What is the relation between them ? [4]

Or

8. (a) What is a Pitot tube ? How is it used to measure the velocity of flow at any point in a pipe or channel ? [4]

(b) Oil of density 830 kg/m^3 flows through a pipeline which changes in size from 150 mm diameter at Section A to 300 mm diameter at Section B. Section B being 4.5 m higher than Section A. If gauge pressures at A and B are 200 and 140 kN/m^2, plot total energy line and hydraulic grade line for the pipe A – B and also determine direction of flow, when the pipe carries discharge of 100 lps. [8]

(c) What do you understand by kinetic energy correction factor ? Derive an expression for the same. [6]

9. (a) Starting from the first principle, show that for laminar flow between two fixed parallel plates, the average velocity is 2/3rd of the maximum velocity. [8]

Or

12. (*a*) The velocity of flow in a rough pipe, diameter 7.5 cm is found to increase by 15% as a pitot tube is moved from a point 1 cm to 1.5 cm from the wall. Estimate the height of roughness. [6]

(*b*) A compound pipe carries water from a reservoir and discharges in atmosphere. For the first 125 m length, the pipe is 25 cm in diameter and its diameter is suddenly reduced to 15 cm for the remaining 60 m length. If the discharge is let 40 m below the reservoir surface level, calculate the discharge considering all losses. Take $f = 0.03$ for both pipes and $C_C = 0.62$. [10]