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10ME/AU36B

Third Semester B.E. Degree Examination, June 2012
Fluid Mechanics

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. What is capillarity? Derive expressions for i) capillary rise and ii) capillary depression. **(06 Marks)**

b. What is surface tension? Derive an expression between gauge pressure inside a free jet of liquid and surface tension. **(06 Marks)**

c. Explain bulk modulus of elasticity and vapour pressure. **(08 Marks)**

2 a. Show that in a fluid at rest pressure does not vary in horizontal direction but varies only in vertical direction. **(06 Marks)**

b. Define total pressure and centre of pressure. Prove that for an inclined surface submerged in a liquid the centre of pressure always lies below centre of gravity. **(08 Marks)**

c. A plane area in the form of right angle triangle of height 'h' base 'b' is immersed vertically in water with its vertex at the water surface. Calculate the total force on one side of the plane and the location of centre of pressure. **(06 Marks)**

3 a. With usual notations prove that

$$GM = \frac{I}{\forall} - BG$$ **(10 Marks)**

b. Discuss the conditions of stability of a floating body. **(04 Marks)**

c. Determine whether the specified flow is rotational or otherwise, if irrotational flow, determine an expression for the velocity potential function

$u = x\,y^2 \qquad v = x^2\,y$ **(06 Marks)**

4 a. State the different forces considered in studying the equations of motion of a fluid. State the conditions under which each is significant. **(05 Marks)**

b. Derive the Bernoulli's equation from
i) First principles ii) Euler's equation of motion. **(09 Marks)**

c. Water flows up a tapered pipe as shown in Fig.Q4(c). Find the magnitude and direction of the deflection 'h' of the differential mercury manometer corresponding to a discharge of 120 L.P.S. The friction in the pipe can be completely neglected. **(06 Marks)**

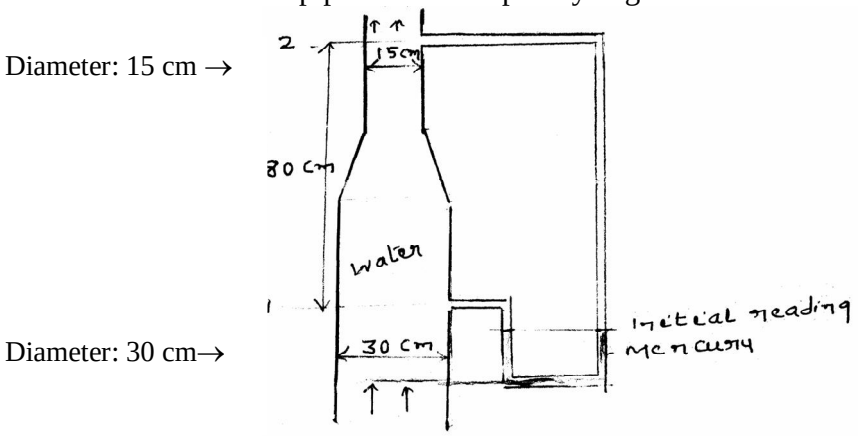

Fig.Q4(c)

PART – B

5 a. Derive an expression for discharge over a V-notch. **(10 Marks)**

b. Show by Buckingham π theorem, the thrust developed by a propeller is given by

$$F = \rho V^2 D^2 \phi\left[\frac{\omega D}{V}, Re, M\right]$$

where F = thrust developed, ω = angular velocity, V = advance speed, D = diameter, μ = viscosity, ρ = mass density and C = speed of sound. **(10 Marks)**

6 a. Differentiate between
i) Major and minor losses
ii) Hydraulic grade line and total energy line with the help of sketch. **(06 Marks)**

b. Derive Darcy-Weisbach expression for head loss due to friction in a pipe flow. **(08 Marks)**

c. A cast iron pipe 20 cm in diameter and 600 m long connects two reservoirs. If the difference of water levels in the two reservoirs is 30 m, find the discharge through the pipe. Friction coefficient for the pipe is 0.01. Ignore losses other than friction and velocity head. **(06 Marks)**

7 a. Starting from first principles derive Hagen-Poiseuille equation for steady laminar flow in a pipe. Further establish relation between Darcy-Weisbach friction factor and Reynolds number for laminar flow. **(12 Marks)**

b. Glycerine (μ = 1.5 Pa-s and ρ = 1260 kg/m^3) flows at a velocity of 5 m/s in a 10 cm diameter pipe. Estimate i) the boundary shear stress in the pipe due to flow ii) head loss in a length of 12 m length of pipe iii) power expanded by the flow in a distance of 12 m. **(08 Marks)**

8 a. Define the following and give expression for each:
i) Boundary layer thickness ii) Displacement thickness
iii) Momentum thickness iv) Energy thickness **(10 Marks)**

b. A metallic ball with diameter of 2 mm is dropped in a liquid of mass density 950 kg/m^3 and viscosity 15 poise. Specific gravity of ball is 12. Find
i) Drag force on the ball ii) the pressure drag iii) terminal velocity of the ball. **(05 Marks)**

c. Determine the velocity of a bullet fired in the atmosphere at 30°C if Mach angle is 30°. Take K = 1.4, R = 287 J/kg-K. **(05 Marks)**

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