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CE 181303

15/2/23

Roll No. of candidate | | | | | | | | | | |

2023

B.Tech. 3rd Semester End-Term Examination

Civil Engineering

FLUID MECHANICS

(New Regulation and New Syllabus)

Full Marks – 70 Time – Three hours

The figures in the margin indicate full marks for the questions.

Answer Question No. 1 and any *four* from the rest.

1. Answer the following (MCQ) : $(10 \times 1 = 10)$

(i) If specific gravity of a liquid is 0.85, specific weight is

(a) 850 kg/m^3 (b) 8338 KN/m^3

(c) 8338 N/m^3 (d) 833 Kg/m^3

(ii) Surface tension is caused by the force of ———— at the free surface.

(a) Cohesion (b) Adhesion

(c) Both Cohesion and Adhesion (d) None of the above

(iii) For a solid sphere falling under gravity in a fluid at terminal velocity

(a) Buoyant force = drag

(b) Weight of the body = buoyant force

(c) Weight of the sphere = buoyant force + drag

(d) Drag = Weight of the body

(iv) The acceleration f required to acclerate a rectangular tank containing water horizontally such that the slope of its free surface is 45°, is

(a) $f = g/2$ (b) $f = g$

(c) $f = 2g$ (d) $f = 3g$

[Turn over

(v) A tank 2 m^2 contains 1 m of water. If the tank is accelerated in the horizontal direction parallel to a pair of sides at the rate of 4 m/s^2, then for no spilling of water the minimum height of the tank should be

(a) 1 m (b) 1.8155 m
(c) 2 m (d) 1.4077 m

(vi) The flow in river during the period of heavy rainfall is

(a) Steady, non-uniform and three-dimensional
(b) Steady, uniform and two-dimensional
(c) Unsteady, non-uniform and three-dimensional
(d) Unsteady, uniform and three-dimensional

(vii) Discharge through an internal mouthpiece running free is give by

(a) $0.5 \times a \times \sqrt{2}\, gH$ (b) $0.707 \times a \times \sqrt{2}\, gH$
(c) $0.4 \times a^2 \times \sqrt{2}\, gH$ (d) $0.3 \times a^2 \times \sqrt{2}\, Gh$

(viii) In case of turbulent flow, the loss of head is approximately proportional to

(a) Velocity (b) $(\text{Velocity})^2$
(c) $(\text{Velocity})^{1/2}$ (d) $(\text{Velocity})^{3/4}$

(ix) The point velocity measured by a pitot tube in a stream was found to be 3.8 m/s. If the height of water level in the pitot tube above the water surface of the stream is 0.75 m, the pitot tube coefficient is

(a) 1.01 (b) 0.94
(c) 0.97 (d) 0.99

(x) A differential U-tube manometer containing mercury is connected to the inlet and to the throat of a venturimeter and shows a differential column height of 30 cm. The venturi head is equal to

(a) 3.78 m (b) 4.08 m
(c) 0.3 m (d) 30 m

2. (a) Determine the specific gravity of a fluid having viscosity of 0.05 poise and kinematic viscosity of 0.035 stokes. (3)

(b) State Newton's law of viscosity. Give the classification of fluids with examples based on above law. (4)

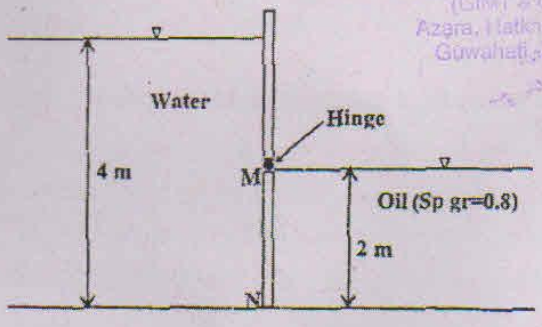
(c) Determine the pressure at a depth of 10 m below the surface of the sea. Also find the absolute pressure if the barometer reading on the surface is 750 mm of mercury. (Take the specific gravity of sea water to be 1.03). (4)

(d) When in an inverted U-tube manometer used? Draw a neat sketch of an inverted U-tube manometer and form a gauge equation for the same. (4)

3. (a) If the velocity distribution over a plate is given by $u = (2/3)\,y - y^2$ in which u is the velocity in m/s at a distance y metre above the plate, determine the shear stress at $y = 0$ and $y = 1.5$ m. Take dynamic viscosity of fluid as 8.63 poises. (3)

(b) The stream function for a two-dimensional flow is given by $\psi = 2xy$, calculate the velocity at the point $P(2, 3)$. Find the velocity potential function ϕ. (7)

(c) Figure shows a gate MN hinged at the top M. If the gate is 1 m wide, calculate the horizontal force required at N to keep the gate in equilibrium. (5)



4. (a) A block of wood floats in water with 6 cm projecting above the surface of water. If the same block is made to float in glycerin of specific gravity 1,4, it projects 10 cm above the surface of glycerine. Find the specific gravity of wood. (4)

(b) Derive the continuity equation for 3-D unsteady compressible flow. (7)

(c) A 50 mm diameter tube gradually expands to 100 mm diameter tube in a length of 10 m. The tube makes an angle of 30° in upwards direction with the horizontal. Determine the pressure p_2 at section 2 if the tube carries a discharge of 0.004 m^3/s and the inlet pressure p_1 is 60 kN/m^2. Assume no energy loss. (4)

5. (a) How is vena-contracta defined? Explain the hydraulic co-efficients. (4)

(b) An orifice, in one side of a large tank, is rectangular in shape 2m broad and 1.2 m deep. The water level on one side of the orifice is 3 m above its top edge. The water level on the other side of the orifice is 0.5 m below its top edge. Calculate the discharge through the orifice, if C_d is 0.64. (7)

(c) Derive the expression for discharge over a broad-crested weir. (4)

6. (a) A venturimeter is to be fitted in a pipe 0.25 m diameter where the pressure head is 7.6 m of the flowing liquid and the maximum flow is 0.14 m^3/s. Find the least diameter of the throat to ensure that the pressure head does not become negative. Take $C_d = 0.97$. (4)

(b) Derive Darcy-Weisbach formula for calculating loss of head due to friction in pipe. (5)

(c) The rate of flow of water through a horizontal pipe is 0.25 m^3/s. The diameter of the pipe which is 200 mm is suddenly enlarged to 400 mm. The pressure intensity in the smaller pipe is 11.772 N/cm^2. Determine :

(i) Loss of head due to sudden enlargement

(ii) Pressure intensity in the large pipe

(iii) Power loss due to enlargement. (6)

7. (a) What do you mean by dimensional homogeneity? Explain with an example. (3)

(b) Assuming that the rate of discharge Q of a centrifugal pump is dependent upon the mass density ρ of fluid, pump speed N (rpm), the diameter of impeller D, the pressure p and the viscosity of the fluid μ, show by Rayleigh method of dimensional analysis that it can be represented by

$$Q = ND^3 f\left[\left(\frac{p}{\rho N^2 D^2}\right), \left(\frac{\mu}{\rho N D^2}\right)\right] \quad (7)$$

(c) Explain Froude model law. The water velocity at a certain point along a 1 : 20 scale model of a dam spillway is 6 m/s. What is the corresponding prototype velocity if the model and prototype flow fields are to be similar? (5)