Register Number: …….

B.E. DEGREE EXAMINATIONS: NOV/DEC 2010

Third Semester

CIVIL ENGINEERING

U07CE304: Mechanics of Fluids

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

Answer ALL Questions:-

PART A (10 x 1 = 10 Marks)

1. The viscosity of

   A) liquids increases with temperature B) gases increases with temperature

   C) fluids decreases with temperature D) fluids increases with temperature

2. The capillary rise in a 3 mm tube immersed in a liquid is 15 mm. If another tube of diameter 4 mm is immersed in the same liquid the capillary rise would be

   A) 11.25 mm B) 20 mm C) 8.44 mm D) 26.67mm

3. In an isothermal atmosphere the pressure

   A) decreases linearly with elevation B) decreases exponentially with elevation

   C) increases logarithmically with elevation D) varies inversely as the density

4. If B = Centre of buoyancy, G = Centre of gravity and M = Metacentre of a floating body, the body will be in stable equilibrium if

   A) MG=0 B) M is below G C) BG=0 D) M is above G

5. The flow of a liquid at constant rate in a conically tapered pipe is classified as

   A) steady , uniform flow B) steady, non-uniform flow

   C) unsteady, uniform flow D) unsteady, non-uniform flow

6. If $\psi = 2xy$, the magnitude of the velocity vector at (2, -2) is

   A) $4\sqrt{2}$ B) 4 C) -8 D) $\sqrt{2}$

7. A venturimeter is used to measure

   A) pressure B) flow rate C) total Energy D) piezometric head

8. The difference between the total head line and the hydraulic grade line represents

   A) the velocity head B) the piezometric head

   C) the pressure head D) the elevation head

9. The Euler number E_u is written as E_u =

   A) $V/\sqrt{K/\rho}$ B) $\rho V^2 L/\sigma$ C) $Vp/\sqrt{\Delta p}$ D) $V/\sqrt{\Delta p/\rho}$

10. The time scale ratio for a model based on Froude law criterion in terms of length scale ratio L_r is

A) L_r B) $\sqrt{L_r}$ C) $1/\sqrt{L_r}$ D) $L_r^{1.5}$

PART B (10 x 2 = 20 Marks)

11. What are specific weight and specific gravity of a fluid?
12. Define Newton's law of viscosity.
13. State Pascal's law.
14. What is a manometer?
15. Define Center of Buoyancy and Metacentre.
16. Define Stream function.
17. State Bernoulli's theorem.
18. Explain the term Hydraulic grade line.
19. State Buckingham Pie-theorem.
20. What are distorted models?

PART C (5 x 14 = 70 Marks)

21. (a) (i) If the equation of a velocity distribution over a plate is given by $u = 2y - y^2$, in which 'u' is the velocity in m/s at a distance 'y', measured in metre above the plate, what is the velocity gradient at the boundary, at 7.5cm and at 15cm from it?. Also determine the shear stress at these points if absolute viscosity, μ = 8.6 poise. (8)

(ii) If the surface tension at the soap-air interface is 0.088N/m, calculate the internal pressure in a soap bubble of 3 cm diameter. (6)

(OR)

(b) (i) The space between two square parallel plates of size 75 cm is filled with oil. The thickness of the oil film is 10mm. The upper plate which moves 3 m/s requires a force of 100N to maintain that speed. Determine:

(i) The dynamic viscosity of the oil.

(ii) The kinematic viscosity of the oil, if the specific gravity of oil is 0.9. (8)

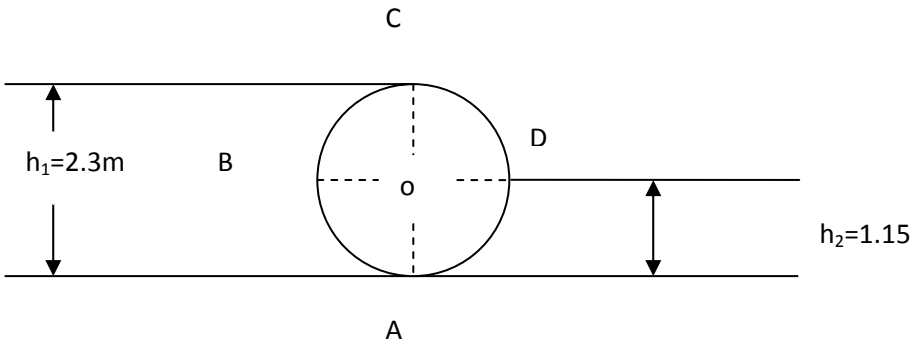
(ii) A glass tube of diameter 2.5 mm is immersed in a liquid with a surface tension of 0.4 N/m. The angle of contact of the liquid with the glass can be assumed to be 135^o. The density of the liquid is 13600 kg/m^3. What would be the level of liquid in the tube relative to the surface of the liquid outside the tube. (6)

22. (a) (i) Derive expression for the force exerted and centre of pressure for a completely submerged inclined plane surface. (7)

(ii) A U tube containing mercury has its right hand limb open to atmosphere and left limb connected to a pipe conveying water under pressure, the difference in levels of mercury in the two limbs being 200mm. If the mercury level in the left limb is 400mm below the centre line of the pipe, find the absolute pressure in the pipe line. (7)

(OR)

(b) (i) Find the horizontal and vertical component of the hydrostatic forces on the cylinder (Figure Below) of length 6.75 m having diameter 2.3m. (10)



(ii) Find the pressure represented by a column of (i) 10cm of water (ii) 2 cm of mercury. (4)

23. (a) (i) List the types of fluid flow (6)

(ii) The velocity potential function for a two dimensional flow is given by $\phi = x(4xy - 3)$. Determine the velocity at the point (2, 3). Also determine the stream function at this point. (8)

(OR)

(b) (i) Derive the continuity equation for three dimensional flow in x, y and z co-ordinate system. (7)

(ii)The velocity potential function, ϕ is given by an equation $\phi = x^3y/3 - xy^3/3 - x^2 + y^2$. Find the velocity components in x and y direction and also check ϕ represents a possible case of flow. (7)

24. (a) (i) Derive the Euler's equation and show that Bernoulli's equation can be obtained by integrating Euler's equation. (7)

(ii) A horizontal venturimeter with inlet and throat diameter 300mm and 100mm respectively is used to measure the flow of water. The pressure intensity at inlet is 130 KN/m^2 while the vacuum pressure head at throat is 350 mm of mercury. Assuming that 3 percent head is lost between the inlet and throat, find the value of coefficient of discharge for the venturimeter and also determine the rate of flow. (7)

(OR)

(b) (i) Derive Darcy Weisbach equation for head loss due to friction in flow through pipe. (7)

(ii) A compound piping system consists of 1800 m length with 0.5 m diameter, 1200 m length with 0.4 m diameter and 600 m length with 0.3m diameter, pipes being connected in series. Determine the

(a) equivalent length of 0.4m diameter pipe

(b) equivalent size of pipe of 3600 m length. (7)

25. (a) (i) Define Reynold's number and Mach number. (4)

(ii) The frictional torque of a disc of diameter 'D' rotating at a speed 'N' in a fluid of viscosity 'μ' and density 'ρ' in a turbulent flow is given by $T = D^5 N^2 \rho f\left[\frac{\mu}{D^2 N \rho}\right]$.

Prove this by Buckingham's π – theorem. (10)

(OR)

(b)(i) Define dynamic similarity with suitable example. (4)

(ii) The pressure drop in an aero-plane model of size $\left[\frac{1}{10}\right]$ of its prototype is 80 N/cm^2.

The model is tested in water. Find the corresponding pressure drop in the prototype. Take densities of air and water to be 1.24 kg/m^3 and 1000 kg/m^3. The viscosity of air and water are 0.000018 Ns/m^2 and 0.001 Ns/m^2 respectively. (10)

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