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06ME46B

Fourth Semester B.E. Degree Examination, December 2011
Fluid Mechanics

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. Define the following properties of a fluid and mention the phenomena associated with each property i) Capillarity and ii) Surface tension. **(04 Marks)**

b. Define compressibility. Derive an expression for the bulk modulus of elasticity for a perfect gas, undergoing the isothermal process. **(06 Marks)**

c. Calculate the capillary effect in mm in a glass tube of 3mm diameter, when, immersed in mercury. The value of the surface tension for mercury at 20°C in contact with air is 0.51 N/m. Contact angle for mercury = 130°. Also sketch the mercury surface inside and outside the tube indicating the angle of contact clearly. **(06 Marks)**

d. If the equation of velocity profile over a flat plate is $V = 2y^{2/3}$ where 'v' is the velocity in m/s and 'y' is the distance in m, determine shear stress at y = 75 mm. Take $\mu = 8.35$ poise. **(04 Marks)**

2 a. Define : i) Buoyancy and centre of buoyancy ; ii) Metacentre and metacentric height. **(04 Marks)**

b. Show that the centre of pressure lies below the centre of gravity of the vertical surface submerged in a liquid. **(08 Marks)**

c. As shown in the Fig.Q.2(c), pipe M contains carbon tetrachloride of specific gravity 1.594 under a pressure of 1.05 bar and pipe N contains oil of specific gravity 0.8. If the pressure in the pipe N is 1.75 bar and the manometric fluid is mercury, find the difference x between the levels of mercury. **(08 Marks)**

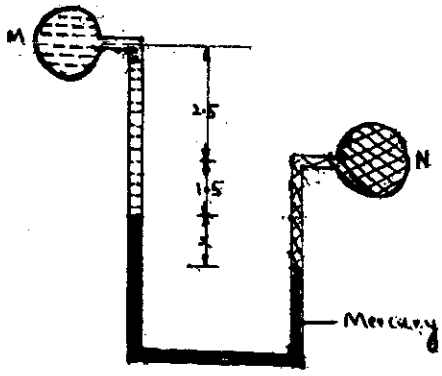

Fig.Q.2(c)

3 a. Differentiate between :
i) Lagrangian approach and Eulerian approach.
ii) Steady flow and uniform flow. **(04 Marks)**

b. Derive with usual notations, the continuity equation for 3 – D flow in the form $\frac{\partial \rho}{\partial t} + \frac{\partial(\rho u)}{\partial x} + \frac{\partial(\rho v)}{\partial y} + \frac{\partial(\rho w)}{\partial z} = 0$. Modify the equation for steady flow and incompressible flow. **(10 Marks)**

c. Sketch the streamlines represented by $\psi = x^2 + y^2$. Also find out the velocity and its direction at the point (1, 2). **(06 Marks)**

4 a. Explain the dimensional homogeneity, with an example. **(04 Marks)**

b. Define the following dimensionless numbers and mention their significance in fluid flow problems :

i) Reynold's no. ; ii) Froude's no. ; iii) Mach no. **(06 Marks)**

c. Prove that the discharge over a spillway is given by the relation using Buckingham's II – theorem.

$$Q = VD^2 \, f\left(\frac{\sqrt{gD}}{v}, \frac{H}{D}\right)$$

Where V = velocity of flow, D = Depth at the threat, H = Head of water, g = Acceleration due to gravity. **(10 Marks)**

PART – B

5 a. State Bernoulli's theorem for the steady flow of an incompressible fluid. Derive an expression for Bernoulli's equation from the first principles. **(10 Marks)**

b. Gasoline (sp.gr = 0.8) is flowing upwards through a vertical pipe, which tapers in diameter from 30cm to 15 cm. A gasoline mercury differential manometer is connected between 30cm and 15cm pipe section to measure the rate of flow. The distance between the manometer tapping is 1m and gauge reading is 50 cm of mercury.

i) Find the differential gauge reading in terms of gasoline head.

ii) Using Bernoulli's equation and the equation of continuity, find the rate of flow. Neglect the losses between tappings. **(10 Marks)**

6 a. Explain how velocity of flow at any point in a pipe or a channel can be measured, with a pitot tube. **(06 Marks)**

b. At a sudden enlargement of a water line from 240 mm to 480 mm diameter pipe, the hydraulic gradient rises by 10 mm. Estimate the rate of flow. **(08 Marks)**

c. An orifice meter with orifice diameter 10cm is inserted in a pipe of 20 cm diameter. The pressure gauges fitted upstream and downstream of the orifice meter give readings of 19.62 N/cm^2 and 9.81 N/cm^2 respectively. C_d for the meter is 0.6. Find the discharge of water through the pipe. **(06 Marks)**

7 a. There is a horizontal crack 40 mm wide and 2.5 mm deep in a wall of thickness 100 mm. Water leaks through the crack. Find the rate of leakage of water through the crack, if the difference of pressures between the two ends of the crack (fixed plates) is 0.02943 N/cm^2. Take the viscosity of water equal to 0.01 poise. **(06 Marks)**

b. Sketch the shear stress and velocity profile across a section of a circular pipe, for the viscous flow. Derive the expressions governing shear stress and velocity profile. **(14 Marks)**

8 a. Derive an expression for the velocity of sound in terms of bulk modulus (k). **(06 Marks)**

b. Define the following :

i) Boundary layer thickness

ii) Displacement thickness

iii) Momentum thickness. **(06 Marks)**

c. A flat plate 1.5m × 1.5m moves at 50 km/hr in stationary air of density 1.15 kg/m^3. If the co-efficients of drag and lift are 0.15 and 0.75 respectively, determine :

i) The lift force

ii) The drag force

iii) The resultant force

iv) The power required to keep the plate in motion. **(08 Marks)**

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