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06ME46B

Fourth Semester B.E. Degree Examination, December 2010
Fluid Mechanics

Time: 3 hrs. Max. Marks:100

Note: ***1. Answer any FIVE full questions, selecting at least TWO questions from each part.***
2. Assume suitable data, if required.

PART – A

1 a. Differentiate between gauge pressure and absolute pressure. Represent positive and negative gauge pressures on a chart. **(03 Marks)**

b. Give reasons for the following :
i) Viscosity changes with temperature rise.
ii) Mercury (H_g) is preferred as a manometric liquid.
iii) Free surface of water in a capillary tube is concave.
iv) Light weight objects can float on the free surface of liquids.
v) Metacentric height is positive for stable equilibrium of floating bodies. **(10 Marks)**

c. Derive the relation for capillary rise of water in a glass tube. **(03 Marks)**

d. A liquid bubble of 2cm radius has an internal pressure of 12.95 Pascals. Determine the surface tension of the liquid film. **(04 Marks)**

2 a. Derive the relations for hydrostatic forces on a curved surface, which is immersed in a liquid of specific weight 'W'. **(06 Marks)**

b. With a neat sketch, explain the working of an inverted u – tube manometer. **(06 Marks)**

c. A wooden block of size 6m x 4m x 2m floats on fresh water. Depth of immersion of the wooden block is 1.2 m. A concrete block is placed centrally on the surface of the wooden block, so that,
i) The top surface of the wooden block touches the free surface of water
ii) Both wooden block and concrete block submerge completely in water.
Assume specific gravity of concrete = 2.5. Find the volume of the concrete block in each case. **(08 Marks)**

3 a. Derive the continuity equation for a three dimensional flow, in Cartesian co-ordinates. **(08 Marks)**

b. Show that the streamlines and equipotential lines are orthogonal to each other. **(04 Marks)**

c. A stream function represents 2-D fluid flow, $\psi = 2xy$. Find the velocity at a point P(3, 4). Check whether the flow is rotational. Find the velocity potential function ϕ. **(08 Marks)**

4 a. Mention the applications of model similitude. **(02 Marks)**

b. Explain the significance of non – dimension numbers.
i) Mach number ; ii) Froude's number ; iii) Weber number ; iv) Reynolds' number. **(08 Marks)**

c. Using Buckingham π - theorem, show that the velocity of fluid flow through a circular orifice is given by $V = \sqrt{2gH}\ \phi\left(\frac{D}{H}, \frac{\mu}{\rho VH}\right)$, where

H = Head of fluid flow ; D = Diameter of the orifice
μ = Dynamic viscosity of the fluid ; ρ = Density of the fluid.
g = gravitational acceleration. **(10 Marks)**

PART – B

5 a. Derive the Bernoulli's equation for a steady, incompressible fluid flow. List the assumptions. Mention the significance of each term in Bernoulli's equation. **(10 Marks)**

b. Pipeline AB carries oil of specific gravity 0.90. Diameter of the pipe at A is 250 mm and that at B is 500 mm. End B of the pipe is 6 meters above the end A. The pressure intensities at A and B are 200 kN/m^2 and 120 kN/m^2 respectively. Discharge of oil is 450 lit/sec. Determine : i) Loss of head and ii) Direction of oil flow. **(10 Marks)**

6 a. Differentiate between a venturimeter and an orificemeter. **(04 Marks)**

b. A pitot – tube is used for measuring the velocity of air flow through a duct. A u – tube water manometer shows a deflection of 12 mm of water. If the coefficient of pitot tube is 0.98, find velocity of air flow and mass flow rate of air. Assume specific weight of air as 10 N/m^3. Diameter of the duct is 500 mm. **(06 Marks)**

c. Oil of specific gravity 0.90 flows through an inclined venturimeter. Inlet and throat diameters are 30 cm and 15cm respectively and the throat is 30cm above the inlet section. Pressure intensity at the inlet is 150 kPa and deflection in mercury manometer is 25 cm. Determine the rate of oil flow in lts/sec and also the pressure intensity at the throat. Assume $C_d = 0.98$ for the venturimeter. **(10 Marks)**

7 a. Derive a relation for the discharge through a circular pipe of diameter D, for the viscous flow. **(08 Marks)**

b. A 100 meters long pipeline connects two reservoirs. The difference in waterlevels is 15 meters. The pipeline has two equal sections of 50 meters each. Diameters of first and second sections are 25 mm and 50 mm respectively. If the friction coefficient of pipe material is 0.005, determine the velocity of water flow through the two sections and the rate of water flow in litres/sec. Represent TEL and HGL. **(12 Marks)**

8 a. Define drag force and lift force. **(04 Marks)**

b. Define and explain :
   i) Boundary layer thickness
   ii) Mach cone, Mach angle
   iii) Subsonic flow. **(08 Marks)**

c. A projectile travels in air of pressure 1.01×10^5 N/m^2 at 10°C. Speed of projectile is 1500 km/hour. Determine the Mach number and the Mach angle. Assume k = 1.4 and R = 287 J/kg k. **(08 Marks)**

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