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06ME46B

Fourth Semester B.E. Degree Examination, January 2013
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. Explain the following properties:
i) Cavitation ii) Vapour pressure iii) Surface tension iv) Viscosity. **(06 Marks)**

b. Explain the phenomenon of capillarity. Obtain an expression for capillary rise of a liquid. **(06 Marks)**

c. A cylinder of 0.30m diameter rotates concentrically inside a fixed cylinder of 0.31 m diameter. Both the cylinders are 0.3m long. Determine the viscosity of the liquid which fills the space between cylinders if a torque of 0.98 N-m is required to maintain a rotational speed of 60 rpm. **(08 Marks)**

2 a. State Pascal's law and give two examples where this principle is applied. **(04 Marks)**

b. With a neat sketch, explain the working of a U-tube differential manometer. **(06 Marks)**

c. Explain the following terms:
i) Metacentre ii) Buoyancy **(04 Marks)**

d. Find the total pressure and position of centre of pressure on a triangular plate of base 2 m and height 3 m which is immersed in water such a way that the plan of the plate makes an angle of 60° with the free surface of the water. The base of the plate is parallel to water surface and at a depth of 2.5 m from water surface. **(06 Marks)**

3 a. Distinguish between:
i) Steady flow and unsteady flow
ii) Laminar flow and turbulent flow
iii) Rotational flow and irrotational flow. **(06 Marks)**

b. Derive the general form of continuity equation for a three dimensional fluid flow. **(06 Marks)**

c. The velocity components in a two-dimensional flow field for an incompressible fluid are expressed as $u = \frac{y^3}{3} + 2x - x^2y$; $v = xy^2 - 2y - \frac{x^3}{3}$
i) Show that these functions represent a possible case of an irrotational flow.
ii) Obtain an expression for stream function. **(08 Marks)**

4 a. Explain the following :
i) Geometric similarity ii) Kinematic similarity iii) Dynamic similarity. **(06 Marks)**

b. Define and derive expressions for the following dimensionless numbers:
i) Reynolds number ii) Froud's number. **(06 Marks)**

c. The pressure difference ΔP in a pipe of diameter D, and length L due to turbulent flow depends on the velocity V, viscosity μ, density ρ, and roughness k. Using Buckingham's π-theorem, obtain an expression for ΔP. **(08 Marks)**

PART – B

5 a. Derive Euler's equation of motion for steady flow and obtain Bernoulli's equation from it. State the assumptions made in the derivation of Bernoulli's equation. **(12 Marks)**

b. A conical tube is fixed vertically with its smaller end upwards. The velocity of flow down the tube is 4.5 m/s at the upper end and 1.5 m/s at the lower end. The tube is 1.5m long and the pressure head at the upper end is 3.1m of the liquid. The loss in the tube expresses as ahead is $\frac{0.3(V_1 - V_2)^2}{2g}$, where V_1 and V_2 are the velocities at the upper and lower ends respectively. What is the pressure head at the lower end? **(08 Marks)**

6 a. Derive Darcy-Weisbach equation for head loss due to friction in pipe flow. **(10 Marks)**

b. 215 litres of gasoline (specific gravity 0.82) flow per second upwards in an inclined venturimeter fitted to a 300 mm diameter pipe. The venturimeter is inclined at 60° to the vertical and its 150 mm diameter throat is 1.2m from the entrance along its length. Pressure gauges inserted at entrance and throat show pressures of 0.141 N/mm^2 and 0.77 N/mm^2 respectively. Calculate the coefficient of discharge of venturimeter. If instead of pressure gauges the entrance and throat of the venturimeter are connected, determine its reading in mm of differential mercury column. **(10 Marks)**

7 a. Derive Hagen-Poiseuille equation for pipe flow through circular pipes. **(10 Marks)**

b. Water at 15°C flows between two large parallel plates at a distance of 1.6mm apart. Determine i) the maximum velocity ii) the pressure dropper unit length and iii) the shear stress at the walls of the plates if the average velocity is 0.2 m/s. The viscosity of water at 15°C is given as 0.001 N-s/m^2. **(06 Marks)**

c. Sketch velocity and shear stress distribution across the section of two fixed parallel plates. **(04 Marks)**

8 a. Define the following terms:
i) Displacement thickness ii) Momentum thickness iii) Energy thickness. **(06 Marks)**

b. Distinguish between:
i) Streamlined body and bluff body ii) Friction drag and pressure drag. **(08 Marks)**

c. Calculate the Mach number at a point on a jet propelled aircraft, which is flying at 1100 km/hour at sea-level where air temperature is 20°C. Assume $\gamma = 1.4$ and R= 287 J/kgK. **(06 Marks)**

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