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10ME/AU46B

Fourth Semester B.E. Degree Examination, June/July 2017
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. Differentiate between :
   (i) Weight density and mass density.
   (ii) Steady flow and unsteady flow.
   (iii) Gas and Vapour **(06 Marks)**

b. A cube of 0.25 m sides and mass 28 kg slides down a plane inclined at 2 V: 3 H covered by a thin film of oil of viscosity 2.2×10^{-3} pa-sec. If the thickness of the film is 0.02 mm determine the steady state velocity of the block. **(06 Marks)**

c. A vertical cylinder of diameter 180 mm rotates concentrically inside another cylinder of 181.2 mm. Both the cylinders are 300 mm high. The space between the cylinders is filled with a liquid whose viscosity is unknown. Determine the viscosity of liquid if a torque of 20 N-m is required to rotate the inner cylinder at 120 rpm. **(08 Marks)**

2 a. State and prove Pascal's law. **(06 Marks)**

b. Derive an expression for centre of pressure on a vertically plane submerged body. **(06 Marks)**

c. The diameters of a small piston and a large piston of a hydraulic jack are 3 cm and 10 cm respectively. A force of 80 N is applied on the small piston. Find the load lifted by the large piston when
   (i) The pistons are at the same level.
   (ii) Small piston is 40 cm above the large piston.
   Take density of liquid in the jack as 1000 kg/m^3. **(08 Marks)**

3 a. Derive an expression for continuity equation in 3D-flow and deduce it to 2D flow. **(10 Marks)**

b. A wooden cylinder of specific gravity 0.6 and circular in cross section is required to float in oil of specific gravity 0.9. Find the L/D ratio for the cylinder to float with its longitudinal axis vertical in oil, where L is the height of cylinder and 'D' is its diameter. **(10 Marks)**

4 a. Obtain an expression for Euler's equation of motion along a stream line and deduce it to Bernouli's equation. **(08 Marks)**

b. A pump has tapering pipe running full of water. The pipe is placed vertically with the diameters at the base and top being 1.2 m and 0.6 m respectively. The pressure at the upper end is 240 mm of mercury (vaccum), while the pressure at the lower end is 15 kN/m^2. Assume the head loss to be 20% of difference in velocity head. Calculate the discharge. The flow is vertically upwards and difference of elevation is 3.9 m. **(12 Marks)**

PART – B

5 a. Using Buckingham's π theorem, for a screw propeller. The relation between thrust 'F', torque 'T', diameter 'D', speed of travel 'U' , speed of rotation 'N', Density 'ρ' and viscosity 'μ' may be put in the form $F = \rho D^2 U^2 \phi \left[\frac{\rho D^3 U^2}{T}, \frac{DN}{U}, \frac{\rho UD}{\mu}\right]$. **(10 Marks)**

b. A venturimeter with a throat diameter 10 cm and Area ratio '4' is provided in a vertical pipe line carrying oil of specific gravity 0.9. The difference in elevation of throat section and entrance section of the venturimeter is 30 cm. The differential U tube mercury manometer shows a gauge deflection of 25 cm, calculate

(i) Discharge of oil.

(ii) The pressure difference between entrance section and throat section. Take $C_d = 0.98$. **(10 Marks)**

6 a. Derive Darcy's equation for the loss of head due to friction in a circular pipe. **(10 Marks)**

b. A horizontal pipe line 40 m long is connected to a water tank at one end and discharges freely into the atmosphere at the other end for the first 25 m of its length from the tank, the pipe is 150 mm diameter and its diameter is suddenly enlarged to 300 mm. The height of water level in the tank is 8 m above the centre of the pipe. Considering all losses of head which occur, determine the rate of flow, take f = 0.01 for both sections of pipe. **(10 Marks)**

7 a. Starting from first principles, show that for laminar flow between fixed parallel plates, the mean velocity is two-thirds of maximum velocity. **(10 Marks)**

b. The oil of specific gravity 0.82 is pumped through a horizontal pipe line 150 mm in diameter and 3 km long at the rate of 0.015 m^3/sec. The pump has an efficiency of 68% and requires 7.5 kW to pump the oil.

(i) What is dynamic viscosity of oil?

(ii) Is the flow is laminar? **(10 Marks)**

8 a. Explain the following:

(i) Stream line body (ii) Bluff body (iii) Mach number

(iv) Mach angle (v) Boundary layer thickness **(10 Marks)**

b. An aeroplane is flying at a height of 15 km where the temperature is -50°C. The speed of the plane is corresponding to M = 2.0. Assuming K = 1.4 and R = 287 J/kg-K, find the speed of the plane. **(04 Marks)**

c. Experiments were conducted in a wind tunnel with a wind speed of 50 km/hour on a flat plate of size 2 m long and 1 m wide. The density of air is 1.15 kg/m^3. The co-efficients of lift and drag are 0.75 and 0.15 respectively. Determine

(i) Drag force.

(ii) Lift force.

(iii) Resultant force. **(06 Marks)**

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