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Fluid Mechanics - I
(114112)

P. Pages : 3

Time : Three Hours **Max. Marks : 80**

Instructions to Candidates :
1. Do not write anything on question paper except Seat No.
2. Answer sheet should be written with blue ink only. Graph or diagram should be drawn with the same pen being used for writing paper or black HB pencil.
3. Students should note, no supplement will be provided.
4. Solve **any two** sub-questions from each of five units.
5. Each sub-question carries 8 marks.
6. It is advised to solve all parts of a unit in one stretch.
7. Assume suitable data, if necessary.

UNIT – I

1. a) On an inclined plane, inclined at 45º to the horizontal, a plate (having width 0.5m and length 1.0 m) of weight 100 N is kept. A lubricating oil film of 3 mm thickness is provided between the plane and the plate. Calculate the force required to pull the plate up on the plane at a velocity of 1.0 m/s. Assume the viscosity of the oil to be 3.0 poise. **8**

b) At a depth of 8.5 km in the ocean, the gauge pressure is 90 MPa. The specific weight of the ocean water at the surface is 10.2 kN/m3 and its average bulk modulus is 2400 mPa. Determine : **8**

i) The change is specific volume.

ii) The specific volume of ocean water at 8.5 km depth.

iii) The specific weight of ocean water at 8.5 km depth.

c) Define following fluid properties and write their dimensions. Also write their values in S.I. units for pure water at standard conditions : **8**

i) Mass density

ii) Specific weight.

iii) Specific gravity and

iv) Dynamic viscosity.

UNIT - II

2. a) The left leg of U-tube mercury manometer is connected to a pipeline conveying water. The level of mercury in the leg is 0.55 m below the centre of pipeline and the right leg is open to the atmosphere. The level of mercury in the right leg is 0.40 m above that in the left leg. The space above mercury in the right leg contains oil of specific gravity 0.90 to a height of 0.40 m. Find the pressure in the pipe in kPa. **8**

b) A horizontal cylindrical barrier of 2.5m diameter retains water up to its top on one side. Calculate the horizontal and vertical forces due to water per meter width of this barrier. **8**

c) A hollow cylinder, 1.0 m high, has internal and external diameters of 0.40 m and 0.60 m respectively. Both ends of the cylinder are open. Weight of the cylinder is 700 N. State whether the cylinder will float with stable equilibrium in water with its axis vertical. **8**

UNIT – III

3. a) Differentiate clearly between : **8**
i) steady and unsteady flow.
ii) uniform and non-uniform flow.
iii) streamline and pathline and
iv) local and convective accelerations.

b) A pipe, carrying water, has a tapering section where its diameter changes from 10 cm at section 1 to 08 cm at section 2. The flow is from section 1 to section 2. Gauge pressures at these sections are 25 kPa and 18 kPa respectively. Also the elevations above datum are 102.000 m and 102.5 m respectively. Neglecting energy losses between these sections, calculate the discharge in pipe in liters/ minute. **8**

c) A pitot tube is inserted in a pipe of diameter 30 cm. The static pressure in the pipe is 10 cm of mercury, vacuum. The stagnation pressure at the centre of pipe recorded by the pitot tube is 1.0 N/cm^2. Calculate the discharge of water through the pipe, if the average velocity of flow is 0.85 times the centreline velocity. Assume coefficient of the pitot tube to be 0.98. **8**

UNIT - IV

4. a) A small sphere of density ρ_S and diameter D settles at a terminal velocity V in a liquid of density ρ_f and dynamic viscosity μ. Also V depends on gravitational acceleration g. Express the functional relation of V on these variables in a non dimensional form using Buckingham Pi method. **8**

b) State Buckingham Pi theorem and solve Oil of specific gravity 0.90 and dynamic viscosity 3.0 poise flows in a pipe of diameter 15 cm at a velocity of 2.0 m/s. Find the velocity of flow of water in a 1.0 cm diameter pipe to make the two flows dynamically similar. Viscosity of water may be assumed as 1.0 centipoise. **8**

c) An oil of viscosity 1.5 poise and specific gravity 0.85 flows through a 30 cm diameter pipe. If the head loss in 3.0 km length of pipe is 20 m, calculate : **8**

i) The shear stress at the pipe wall.
ii) Shear stress at a radial distance of 10 cm from axis.
iii) The friction factor 'f' by assuming flow to be Laminar.

UNIT - V

5. a) An oil flows through a 25 cm diameter orifice under a head of 5.5 m at a rate of 3 l/s. The jet strikes a wall 1.5 m away and 0.120 m vertically below the centreline of the contracted jet. Estimate the coefficients of velocity, contraction and discharge. **8**

b) For an external cylindrical mouthpiece, calculate the value of coefficient of discharge if the coefficient of contraction, $C_c = 0.62$. Also write formula for calculation of discharge through the mouthpiece. **8**

c) The flow in a 2.0 m wide rectangular channel is measured by a rectangular notch, 1.0 m long and 0.60 m high. Find the discharge in the channel when the head over the crest of notch is 0.30 m. Assume $C_d = 0.62$. Consider end contractions and velocity of approach. Take two trials only. **8**

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