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15ME44

Fourth Semester B.E. Degree Examination, Jan./Feb. 2023
## Fluid Mechanics

Time: 3 hrs.

Max. Marks: 80

Note: *Answer any FIVE full questions, choosing ONE full question from each module.*

Module-1

1   a.   Explain the phenomenon of capillarity. Obtain an expression for Capillary Rise.   **(04 Marks)**
    b.   With a neat sketch, explain the working of differential U – tube manometer and derive an expression for pressure difference between two points at different levels.   **(06 Marks)**
    c.   An inverted U – tube differential manometer is connected to two pipes A and B. Manometric fluids is oil of specific gravity 0.85. Find the pressure difference between two points A and B. Refer Fig. Q1(c).   **(06 Marks)**

Fig. Q1(c)
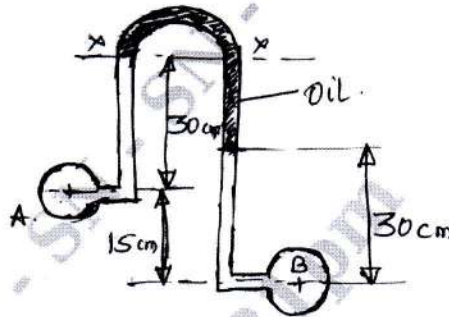
OR

2   a.   A circular plate diameter 3 mtr with a concentric circular hole of diameter 1.5m is immersed in water in such a way that its greatest and least depth below the free surface are 4m and 1.5m respectively. Determine the total pressure and centre of pressure on one face of the plate.   **(05 Marks)**
    b.   Briefly explain the three conditions of equilibrium for a floating bodies.   **(05 Marks)**
    c.   A solid cylinder of 10cm diameter and 40cm long consists of two parts made of different materials. The first part is 1cm long and of specific gravity 6.0. The other part of the cylinder is made of the material having specific gravity 0.6. State if the cylinder can float vertically in water.   **(06 Marks)**

Module-2

3   a.   Define the following : i) Stream line   ii) Stream tube   iii) Streak line.   **(06 Marks)**
    b.   A stream function is given by $\Psi = 2x^2 - 2y^2$.
        i)   Show that the flow is irrotational.
        ii) Find the resultant velocity at a point denoted by x = 1 and y = 3.
        iii) Find the velocity potential ϕ.   **(06 Marks)**
    c.   A 25cm diameter pipe carries oil of specific gravity 0.9, at a velocity of 3m/s. At another section the diameter is 20cm. Find the velocity at this section and also mass rate of flow of oil.   **(04 Marks)**

OR

4 a. State Bernoullis theorem for steady flow of an incompressible fluid. Derive an expression for Beroullis equation from first principle. **(07 Marks)**

   b. Water flowing through a pipe of 30cm diameter is placed in an inclined position where a venturimeter is inserted. The throat diameter of venturimeter is 15cm. The pressure difference between the inlet and throat is measured by a mercury differential manometer which gives a reading of 40cm. The loss of head between the inlet and throat is 0.5 times the kinetic head of the inlet. Determine the flow rate in litres/sec. **(07 Marks)**

   c. Find the discharge over a triangular Notch of angle 60° when the head over the V – Notch is 0.3m. Assume $C_d = 0.6$. **(02 Marks)**

Module-3

5 a. Sketch the shear stress and velocity profile across a section of a circular pipe for laminar flow. Write the expressions for max. shear stress and max velocity. **(03 Marks)**

   b. Derive Hagen – Poiseuilles equation for viscous flow through a circular pipe, given the expression for average velocity

   $$V_{avg} = \left(\frac{-\partial p}{\partial x} \right) \frac{R^2}{8\mu}.$$ **(07 Marks)**

   c. An oil of viscosity 1 Pa-S flow between two parallel fixed plates which are kept at a distance of 50mm apart. Find the rate of flow of oil between the plates if the drop of pressure in a length of 1.2m be $0.3 N/cm^2$. The width of the plates is 200mm. **(06 Marks)**

OR

6 a. Briefly discuss about the types of energy or Head losses through pipe. **(04 Marks)**

   b. A piping system consists of three pipes arranged in series. The lengths of pipes being 1200m, 750m and 600m and diameters 750mm, 600mm and 450mm respectively.
      i) Calculate equivalent length of system for an equivalent diameter of 450mm pipe.
      ii) Calculate equivalent diameter of the system for an equivalent length of 2550m long. **(06 Marks)**

   c. A pipeline of 600mm diameter is 1.5km long, to increase the discharge another pipeline of same diameter is introduced parallel to the first in the second half of the length. If darcy friction factor f = 0.04 and head at the inlet is 300mm. Calculate the increase in discharge. Neglect minor losses in pipelines. **(06 Marks)**

Module-4

7 a. Differentiate between :
      i) Pressure drag and friction drag.
      ii) Stream line body and Bluff body. **(04 Marks)**

   b. Briefly explain the effects of Boundary Layer Separation and methods of controlling the separation. **(04 Marks)**

   c. A flat plate 1.5m × 1.5m moves at a speed of 50 kmph in stationary air of density 1.15 kg/m^3. Coefficient of drag and lift are 0.15 and 0.75 respectively. Determine
      i) Lift force on plate.
      ii) Drag force on plate.
      iii) Resultant force
      iv) Power required to keep the plate in motion. **(08 Marks)**

OR

8 a. A frictional torque 'T' of a disc of diameter 'D' rotating at a speed 'N' in a fluid of viscosity 'μ' and density 'e' in a turbulent flow. Obtain an expression using Buckingham π theorem in the form.

$$T = D^5 N^2 e \, \phi \left[\frac{\mu}{D^2 Ne} \right].$$

(06 Marks)

b. What do you mean by dimensionless numbers? Derive an expression for Froudes Number.

(04 Marks)

c. Briefly explain about Model Analysis and Similitude. (06 Marks)

Module-5

9 a. Define Compressible flow. Derive the continuity equation for one dimensional compressible flow in differential form. (05 Marks)

b. Derive an expression for the velocity of sound in terms of bulk modulus (K). (05 Marks)

c. An Aeroplane is flying at a height of 15km where the temp is -50 °C. The speed of plane corresponding to Mach number M = 2.0. Assuming K = 1.4 and R = 287 J/kg. K. Find the speed of the plane. (06 Marks)

OR

10 a. Briefly discuss the steps performed in CFD Analysis. (08 Marks)

b. Briefly explain the need for using CFD and the areas where CFD is used. (08 Marks)

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