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B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

August 2023 Semester End Make-Up Examinations

Programme: B.E. | **Semester: III**
Branch: Aerospace Engineering | **Duration: 3 hrs.**
Course Code: 22AS3PCFMS | **Max Marks: 100**
Course: Fluid Mechanics Systems | **Date: 21.08.2023**

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.
3. Scientific calculator and steam data handbook are allowed to use.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

UNIT - I

1 a) Develop an expression for the Pascal's law. **6**

b) Define the terms mass density and specific weight of the fluids. **4**

c) A U-tube manometer is connected to a closed tank as shown in fig.1. The air pressure in the tank is 3.4 kPa and the liquid in the tank is oil (γ=8.5 kN/m^3). The pressure at a point A is 13.8 kPa. Determine (a) the depth of oil, z and (b) the differential reading, h on the manometer? **10**

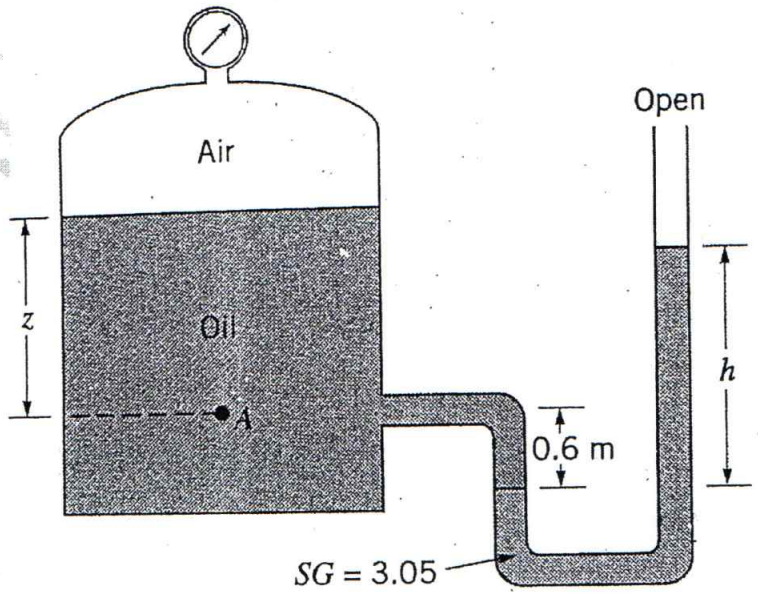

Fig. 1

OR

2 a) A surface is immersed in a fluid in an inclined position making an angle with the free surface of the fluid. Develop an expression for the total force acting on this surface and the position of it? **10**

b) A homogeneous 1.2m wide, 2.4 m long rectangular gate weighing 3.6 kN is held in place by a horizontal flexible cable as shown in fig. 2. Water acts against the gate which is hinged at point A. Friction in the hinge is negligible. Determine the tension in the cable. **10**

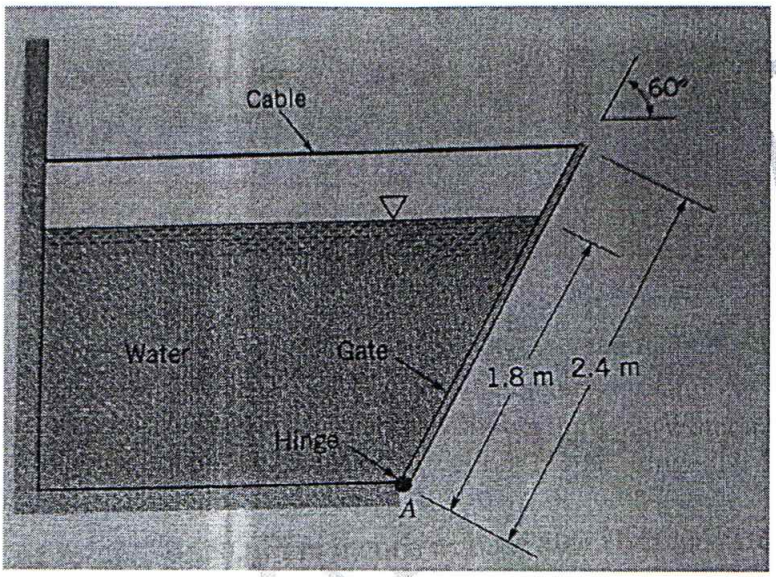

Fig. 2

UNIT - II

3 a) Derive Continuity equation for fluids in 3D by cartesian co-ordinate method? **10**

b) The velocity in a certain two-dimensional flow field is given by the equation $\vec{V}=2xt\hat{i}-2yt\hat{j}$, where the velocity is in m/s when x, y, and t are in meters and seconds, respectively. Determine expressions for the local and convective components of acceleration in the x and y directions. What is the magnitude and direction of the velocity and the acceleration at the point $x = y = 0.6$ m at the time $t = 0$? **10**

UNIT - III

4 a) Derive an expression for discharge through orifice meter? **10**

b) Water flows steadily through a variable area horizontal pipe a shown in the fig. 3. The centerline velocity is given by V=3(1+3x) i m/s, where x is in meters. Viscous effects are neglected. (a) Determine the pressure gradient, $\partial p/\partial x$ (as function of x) needed to produce the flow. (b) If the pressure at section (1) is 345 kPa, determine the pressure at (2) by (i) integration of the pressure gradient obtained in (a), (ii) application of the Bernoulli equation. **10**

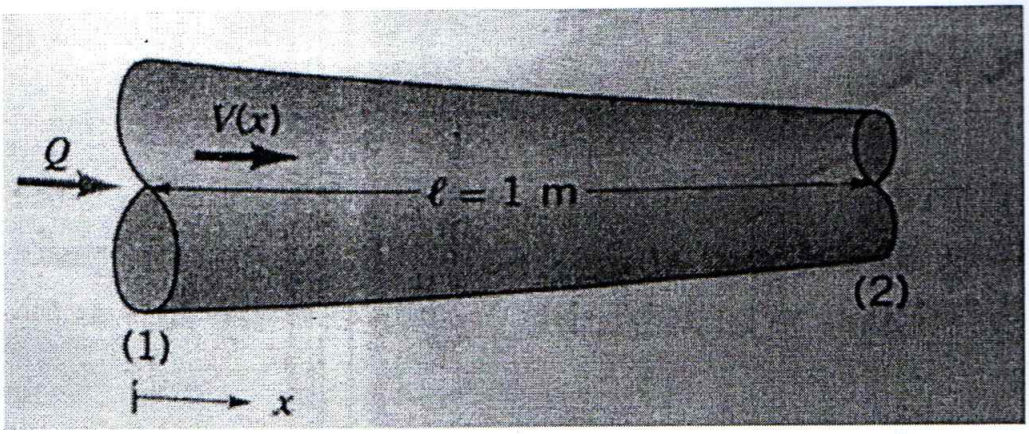

Fig. 3

UNIT - IV

5 a) Prove that the head loss due to friction is $\frac{4flv^2}{2gd}$. **10**

b) An oil of viscosity 0.1 Ns/m^2 and relative density 0.9 is flowing through a circular pipe of diameter 50 mm and length 300 m. The rate of flow of fluid through the pipe is 3.5 litres/s. Find the pressure drop in a length of 300 m and also the shear stress at the pipe wall. Also find the maximum velocity and velocity at 4 mm from the pipe wall. **10**

UNIT - V

6 a) A thin rectangular plate having width 'w' and a height 'h' is located so that it is normal to a moving stream of fluid. Assume the drag 'D', that the fluid exerts on a plate is a function of 'w' and 'h', the fluid viscosity and density 'μ' and 'ρ' respectively and the velocity of the fluid 'V' approaching the plate. Determine the suitable set of pi terms and the related expression to study this problem? (Use 'w', 'V' and 'ρ' are repeating variables). **12**

b) Define i) Displacement ii) Momentum and iii) Energy thickness. **8**

OR

7 a) State Buckindham π theorem. Explain its step by step procedure to solve the fluid dynamic problems. **10**

b) Advertisement signs are commonly carried by taxicabs for additional income, but they also increase the fuel cost. Consider a sign that consists of a 0.30 m high, 0.9 m wide, and 0.9 m long rectangular block mounted on top of a taxicab such that the sign has a frontal area of 0.3 m by 0.9 m from all four sides. Determine the increase in the annual fuel cost of this taxicab due to this sign. Assume the taxicab is driven 60000 km a year at an average speed of 50 km/h and the overall efficiency of the engine is 28 percent. Take the density of air to be 1.28 kg/m^3 and C_D=2.2. Also assume the density, unit price and heating value of gasoline to be 0.72 kg/L, $ 1.10/L and 42000 kJ/kg respectively. **10**

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