B.E. CONSTRUCTION ENGINEERING SECOND YEAR FIRST SEMESTER SUPPLEMENTARY EXAM 2023

HYDRAULICS

Time: Three Hours **Full Marks:100**

Answer question No. 1 (compulsory) and any four questions from the rest

Answer to all parts of a question must be together

Assume any data, if not furnished, consistent with the problem

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1.(a) Draw the rheological curve for different types of fluids and give examples for each. 　5

(b) Define the following-

i)　Circulation

ii)　Velocity potential

iii) Vorticity

iv) Reynolds number

v)　Pathline 　5

(c) A thin moving plate is separated from two fixed plates by two fluids of unequal viscosity and unequal spacing. The contact area is A. Determine (a) the force required, and (b) is there a necessary relation between the two viscosity values? 　5

(d) What is material derivative? Write the expression for total acceleration in differential form. 　5

2.(a) The velocity field in a fluid flow is given by: $V = (x^2 - y^2)i + (y^2 - z^2)j + (2xz + 2yz)k$. Compute the rotation vector, vorticity and acceleration at point (1,2,3). 　2+8+2

(b) Water at 20°C flows upward at 4 m/s in a 6-cm-diameter pipe. The pipe length between points 1 and 2 is 5 m, and point 2 is 3 m higher. A mercury manometer, connected between 1 and 2, has a reading h = 135 mm, with p_1 higher. (a) What is the pressure change $(p_1 - p_2)$? (b) What is the head loss, in meters? (c) Is the manometer reading proportional to head loss? Explain. (d) What is the friction factor of the flow? 　8
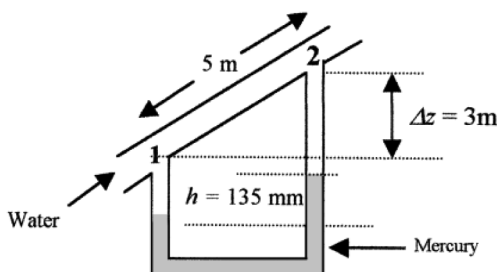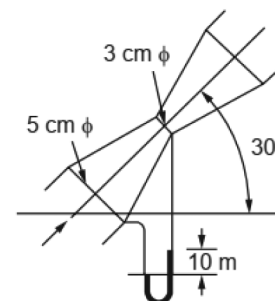

Figure 1

Figure 2

3.(a) Derive the Euler's equation of motion. What is the significance of continuity equation? 2+8
  (b) A tap discharges water evenly in a jet at a velocity of 2.6 m/s at the tap outlet, the diameter of the jet at this point being 15 mm. The jet flows down vertically in a smooth stream. Determine the velocity and the diameter of the jet at 0.6 m below the tap outlet. 10

4.(a) A venturimeter as shown in fig.2 is used measure flow of petrol with a specific gravity of 0.8. The manometer reads 10 cm of mercury of specific gravity 13.6. Determine the flow rate. 10
  (b) An open cylindrical vertical container is filled with water to a height of 30 cm above the bottom and over that an oil of specific gravity 0.82 for another 40 cm. The oil does not mix with water. If the atmospheric pressure at that location is 1 bar, determine the absolute and gauge pressures at the oil water interface and at the bottom of the cylinder. 10

5.(a) Derive the expression of viscosity for a laminar flow between parallel plates. 5
  (b) Determine the gauge pressure at A. Is it higher or lower than P_{atm} ? (refer fig.3) 7
  (c) Determine the flow rate of water across the shutter in an open canal if the water level upstream of shutter is 5 m and downstream is 2 m. The width of the canal is 1 m and flow is steady. 8

6.(a) Derive the expression for discharge through a venturimeter. 8
  (b) What are the properties of stream function and velocity potential function? 6
  (c) What is a notch? Derive an expression for discharge over rectangular notch. 2+4

7.(a) Classify weirs mentioning their usage. 4
  (b) Derive Hagen-Poiseuille equation for friction drop. 7
  (c) A velocity field is given by: V = (x^2-y^2+x)i – $(2xy+y)$j in arbitrary units. At (x, y) = (1, 2), compute (i) the accelerations a_x and a_y, (ii) the velocity component in the direction $\theta = 40°$, (iii) the direction of maximum velocity, and (iv) the direction of maximum acceleration. 4
  (d) Isosceles triangle gate AB in fig.4 is hinged at A and weighs 1500 N. What horizontal force P is required at point B for equilibrium? 5
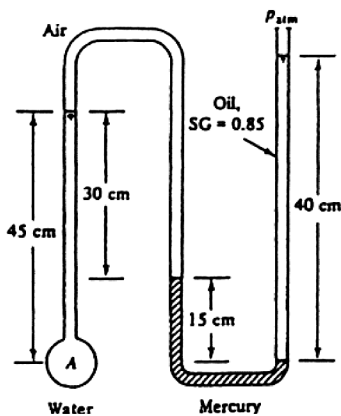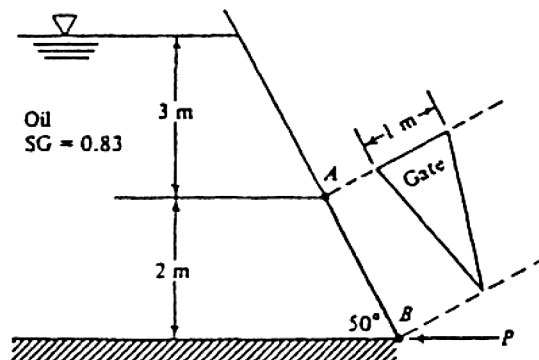

Figure 3   Figure 4