EX/ME/T/124/2017

B. E. Mech. Engg. 1st Year 2nd Semester Examination, 2017

Fluid Mechanics-I

Time:-Three Hours Full Marks:-100

Answer Any Five Questions

Assume any data relevant to the questions if not provided

Answer all the parts of the same question together

1. a) Define Dynamic and kinematic viscosities. Give their SI units. (2+2+1=5)
   b) Explain why the temperature response of the viscosity is opposite for a liquid and a gas. (6)
   c) Two large fixed parallel planes are 12 mm apart. The space between the surfaces is filled with an oil of viscosity 0.9 N-s/m^2. A flat thin plate of 0.2 m^2 area moves through the oil at a velocity of 0.25 m/s. Calculate the force opposing the motion, when:
   i) The thin plate is equidistant from the planes
   ii) The thin plate is at a distance of 3.5 mm from one of the plane surfaces.
   iii) Draw the velocity profiles for both of the cases with proper justification. (3+3+3=9)

2. a) Define pressure at a point. What is static and dynamic pressure? What do you understand by Gauge pressure and absolute pressure. What is pressure head? What is the significance of the word 'head'? (2+1+1+1+1+1+1=08)
   b) With a neat diagram explain a differential manometer. (07)
   c) Fig. 1 shows a U-tube differential manometer connecting two pressure pipes X and Y. The pipe X contains a liquid of specific gravity 1.45 under a pressure of 120 KN/m^2 The pipe Y contains oil of specific gravity 0.8 under a pressure of 180 KN/m^2. Find the difference of the Mercury height in the U-tube. (05)

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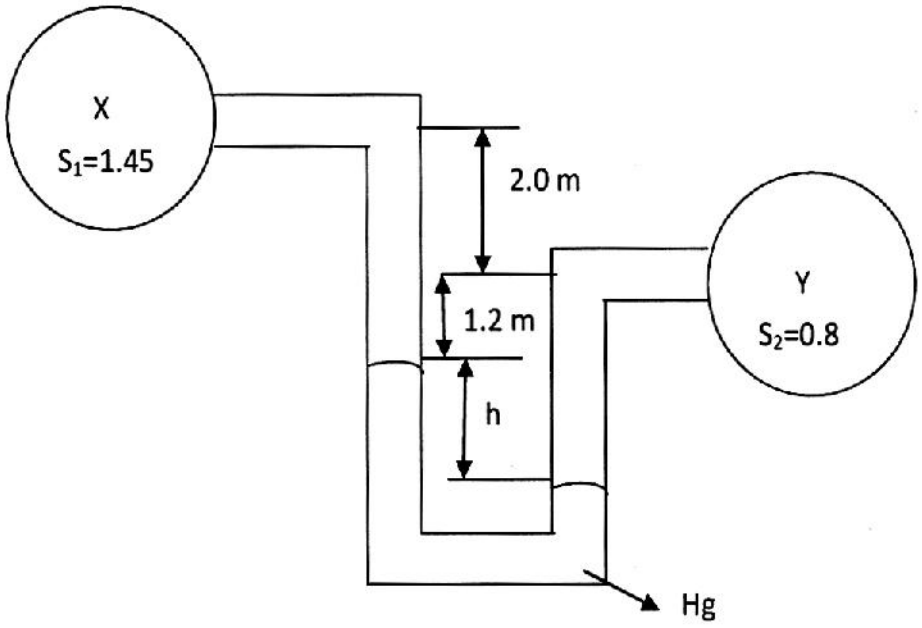

Figure-1

3. a) What is Meta centre? Explain the condition of stability for a floating body. (1+7=8)

b) A door in a tank is in the form of a quadrant of a cylinder of 2 m radius and 3m width as shown in the figure 2. Calculate the resultant force on the door and it's location. (08)

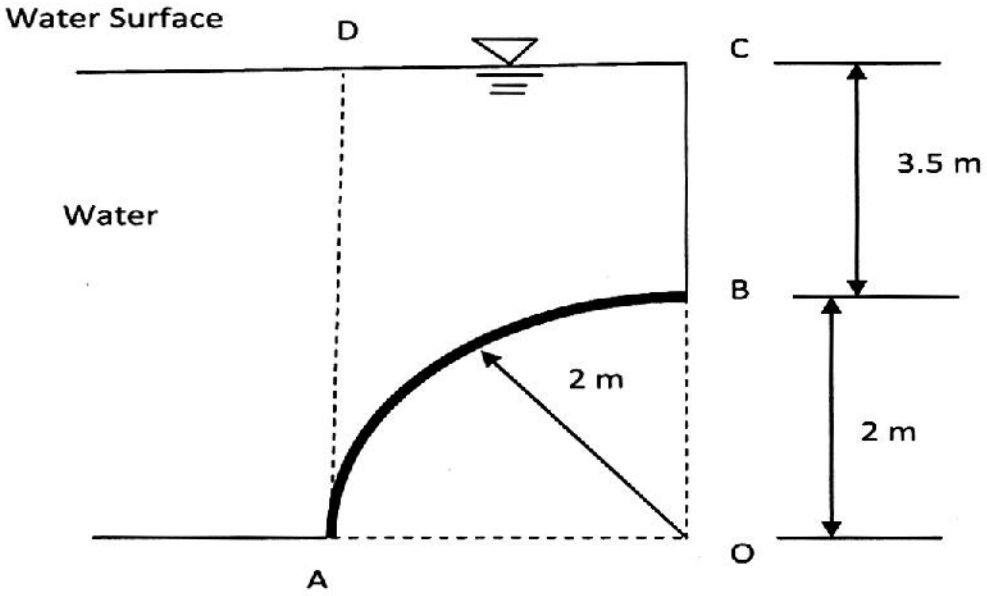

Fig. 2

c) A solid cylinder 2m in diameter and 2m high is floating in water with it's axis vertical as shown in figure 3. If the specific gravity of the material of cylinder is 0.65 find it's metacentric height. State whether the equilibrium is stable or unstable. (04)

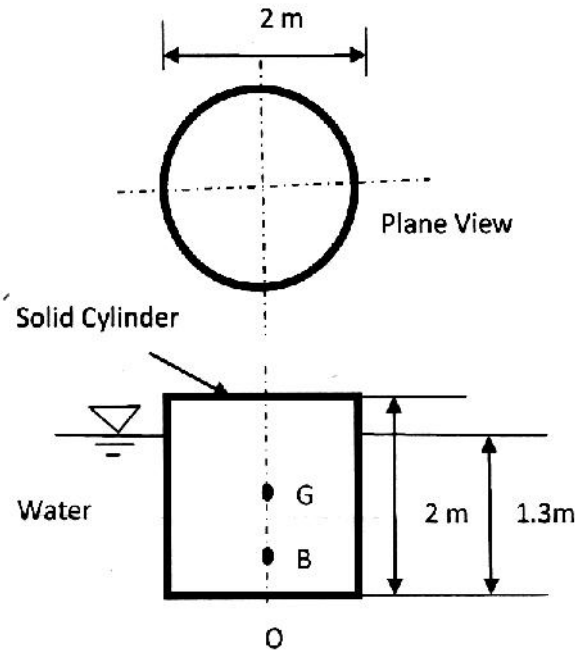

Figure 3

4. a) Define the following:

i) Laminar and Turbulent Flow
ii) Stream line and stream Function
iii) Vorticity and circulation. (3+3+3=9)

b) Show that stream line and equi potential lines are orthogonal to each other. (04)

(c) The flow field of a fluid is given by $V = xy\hat{i} + 2yz\hat{j} - (yz + z^2)\hat{k}$.
(1) Show that it represents a possible 3-D steady incompressible continuous flow.
(2) Is this flow rotational or irrotational?
(3) If rotational determine the angular velocity and vorticity at a point (2,4,6).
(3+3+1=07)

5. a) Derive Euler equation of motion and clearly indicate the assumptions. How you get Bernoulli's equation from it? State the significance of each term of Bernoulli's equation. (10)

b) Water is flowing through a pipe having diameters 600 mm and 400 mm at the bottom and upper end respectively. The pressure at the bottom end is 350 KN/m^2 and the pressure at the upper end is 100 KN/m^2. Determine the difference in datum head if the rate of flow through the pipe is 60 litre/s. If the loss of head is 0.8 m what is the difference in datum head? (6+1=7)

c) Explain stagnation a point for a solid bluff body and draw the streamlines. (03)

6. a) Derive the theoretical discharge through a Venturimeter with a neat sketch. What is coefficient of discharge? (10)

(b) A horizontal venturimeter 20 cm X 10 cm is used to measure the flow of oil of specific gravity 0.7. Determine the deflection of the oil mercury gauge, if the discharge of the oil is 60 litre/s. Assume coefficient of discharge =1.0. If the deflection of mercury gauge is 0.2 cm, find the coefficient of discharge. (08)

(c) What is vena-contracta? (02)

7. a) What do you understand by fully developped flow? What is the type of fully developed velocity profile for a laminar and a turbulent flow? (2+1=3)

b) With proper assumptions derive Hagen-poiseuille equation. When it is valid? (07+1=08)

(c) What is friction factor? Show that $f = \frac{64}{\text{Re}}$, where f is the friction factor and Re is the Reynolds number. (01+05=06)

(d) Explain Darcy-Weischbach equation. Is it valid for turbulent flow? (02+01=03)

8. Write Short notes on any two of the following: (2 X 10=20)

1) Orifice meter 2) Specific energy Curve for open channel flow 3) Pitot tube
4) Moody's diagram 5) Rectangular weir