Mansoura University Faculty of Engineering Dept. of Power Mech. Eng. Course Title: Fluid Mechanics		April 2016 Exam Type: mid-term Time: 60 Minutes Full Mark: 40

Answer all the following questions.

1- The device, based on the two concentric cylinders, shown in the Fig. 1 can be used to measure the viscosity of a fluid. Assuming that the shaft rotates at 200 RPM and the torque measured is 6 N m, calculate the viscosity of the fluid. (R_1 = 15.12 cm, R_2 = 15 cm, and h = 70 cm). [12 Marks]

2- For the setup shown in Fig. 2, what is the pressure P_A if the specific gravity of the oil is 0.82? [10 Marks]

3- A cylinder with negligible mass is held in a vertical position by a weight W = 200 N. If its dimensions are D = 0.4 m and l = 0.7 m, calculate how deep it will sink in the water. (Fig. 3) [10 Marks]

4- Gate AB has length L = 6 m , width b = 3 m into the paper, is hinged at B, and has negligible weight. The water level h remains at the top of the gate for an angle $\theta = 60^0$. Find the force P, perpendicular to AB, required to keep the gate in equilibrium (Fig. 4).[12 Marks]

Good Luck ***Dr. Mohamed Mansour***

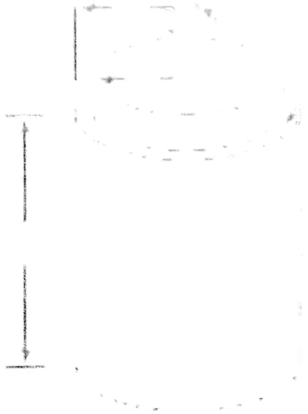

Fig. 1

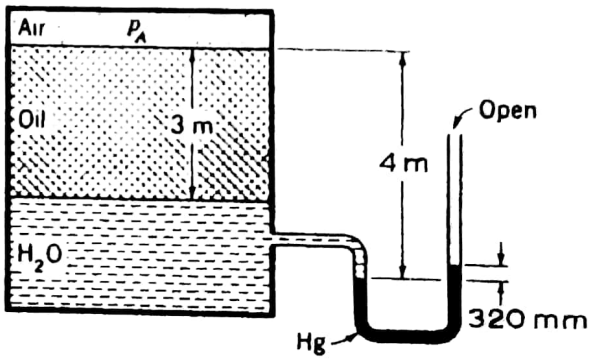

Fig. 2

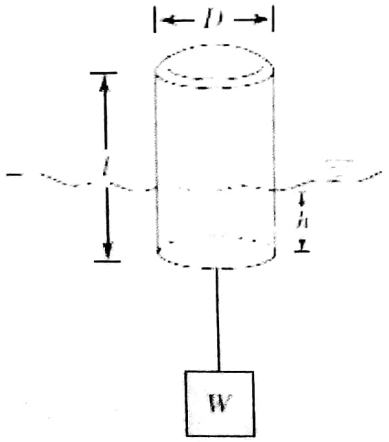

Fig. 3

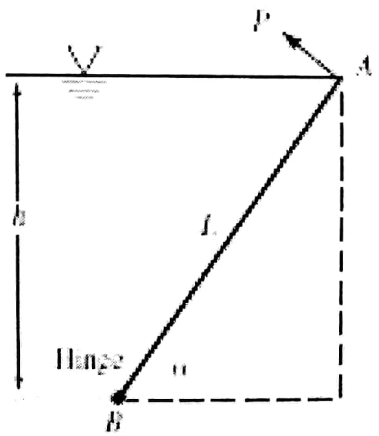

Fig. 4

Model Answer

1- The device, based on the two concentric cylinders, shown in the Fig. 1 can be used to measure the viscosity of a fluid. Assuming that the shaft rotates at 200 RPM and the torque measured is 6 N m, calculate the viscosity of the fluid. (R_1 = 15.12 cm, R_2 = 15 cm, and h = 70 cm).

Solution

$T = F*R_2$
$= \mu A(du/dy)\, R_2$
$= \mu A(u/y)\, R_2$

$A = \pi D_2 h = \pi*0.3*0.7 = 0.66\ m^2$
$u = 2\pi N R_2/60 = 2\pi*200*0.15/60 = 3.14$ m/s
$y = R_1 - R_2 = 0.1512 - 0.15 = 0.0012$ m

$6 = \mu\,(0.66)(3.14/0.0012)*0.15$

$\mu = 0.02316$ Pa.s

2- For the setup shown in Fig. 2, what is the pressure P_A if the specific gravity of the oil is 0.82?

Solution

$$p_A + [(0.82)(9.79)](3) + (9.79)(4-3) - [(13.6)(9.79)](0.320) = 0 \qquad p_A = 8.73\ \text{kPa}$$

3- A cylinder with negligible mass is held in a vertical position by a weight W = 200 N. If its dimensions are D = 0.4 m and l = 0.7 m, calculate how deep it will sink in the water. (Fig. 3)

Solution

W = 200 N
D = 0.4 m
l = 0.7 m

$W = F_b$
$200 = \rho\, g\, V_{immersed}$
$200 = 9810 * 3.14 *(0.2)^2 * h$
h = 0.16 m

4- Gate AB has length L = 6 m , width b = 3 m into the paper, is hinged at B, and has negligible weight. The water level h remains at the top of the gate for an angle $\theta = 60^0$. Find the force P, perpendicular to AB, required to keep the gate in equilibrium (Fig. 4).

Solution: The centroid of the gate remains at distance L/2 from A and depth h/2 below

the surface. For any θ, then, the hydrostatic force is $F = \gamma(h/2)Lb$. The moment of inertia of the gate is $(1/12)bL^3$, hence $y_{CP} = -(1/12)bL^3\sin\theta/[(h/2)Lb]$, and the center of pressure is $(L/2 - y_{CP})$ from point B. Summing moments about hinge B yields

$$PL = F(L/2 - y_{CP}), \quad \text{or:} \quad \mathbf{P = (\gamma hb/4)(L - L^2\sin\theta/3h)} \quad \textit{Ans.}$$

h = L sin (θ) = 6 * sin(60) = 5. 19 m

P = (9810*5.19*3*/4)(6 – 36*sin(60)/(3*5.19)) = 152.74 KN