46/50

First

جامعة بيرزيت
BIRZEIT UNIVERSITY
Faculty of Engineering
Mechanical Engineering Department

Fluid Mechanics - ME 335

Instructor: Mr. Adel Dweik *Summer Semester 2011/2012*

1st Hour Exam

Problem #1: (15 %)

A solid cylinder having a mass of 1 kg, 60mm diameter and a length of 100 mm slides down a 62 mm diameter pipe as shown in figure 1.An oil having viscosity of 0.08 N.s/m^2 keeps the cylinder concentric in the pipe.
Determine the terminal velocity of the falling cylinder.

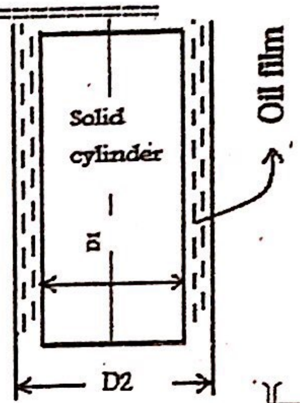


Fig.1

Problem #2: (20 %)

a) In Fig.2a; an open tube is connected to a tank. The water rises to a height of 900 mm in the tube. A tube used in this way is called Piezometer.
What are the pressures P_A and P_B of the air above the water? ($\gamma_{water} = 9790$ N/m^3)

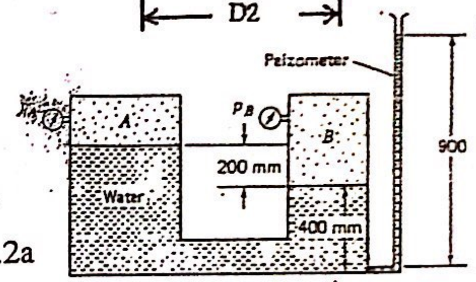


Fig.2a

b) A block of wood having a volume of 0.034 m^3 and weighing 300 N is suspended in water as shown in Fig.2b. A wooden rod of length 3.4 m and cross section of 2000mm^2 is attached to the weight and also to the wall. If the rod weighs 16 N, **what will the angle θ be for equilibrium?**

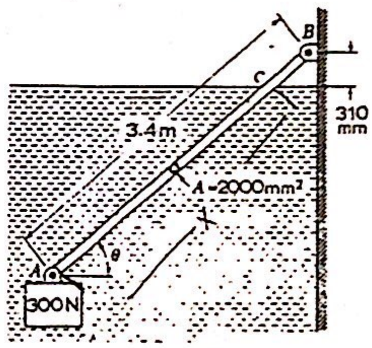


Fig.2b

Problem #3: (15 %)

depth=6ft

The gate AB in Fig.3 weighs 2000 lb$_f$ when submerged. It is hinged at B and rests against a smooth wall at A.
Determine the water level (h) which will just cause the gate to open.

$\gamma_{water} = 62.4$ lbf /ft^3

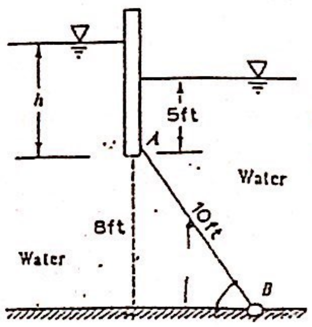
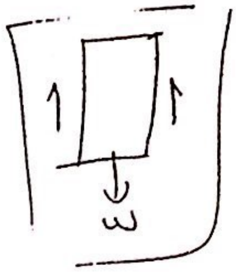


Fig.3

Q1) $\Sigma F_y = 0$



$\Sigma F_y = 0 = W - \tau A$

$0 = mg - \left(\frac{\mu V}{h}\right)(A)$

15

$mg = \left(\frac{\mu V}{R_2 - R_1}\right)(2\pi R_1 L)$

$mg = \frac{\mu V}{R_2 - R_1} 2\pi R_1 L \rightarrow V = \frac{mg(R_2 - R_1)}{\mu\, 2\pi R_1 L}$

$V = \frac{(1)(9.81)(0.062 - 0.06)}{(0.08)(2\pi)(0.06)(0.1)} = \frac{0.01962}{3.0159289 \times 10^{-3}}$

$\boxed{V = 6.50546 \text{ m/s}}$

Q2) A:

$P_A + \gamma_w h_1 = P_B + \gamma_w h_2 = P_{atm} + \gamma_w h_3$

$P_A + (9790)(0.6) = P_{atm} + (9790)(0.9)$

10

$P_A = P_{atm} + (9790)(0.9) - (9790)(0.6)$

$P_A = P_{atm} + (8811) - (5874) = P_{atm} + 2937$

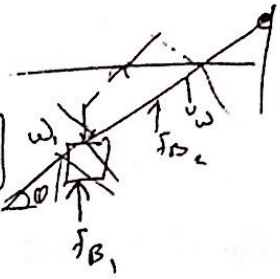
$\boxed{P_A = (P_{atm} + 2937)\, P_a} \rightarrow \boxed{(P_A = 2937\, P_a)\text{ gage}}$

$P_B + \gamma_w h_2 = P_{atm} + \gamma_w h_3 \rightarrow P_B = P_{atm} + \gamma_w h_3 - \gamma_w h_2$

$P_B = P_{atm} + (9790)(0.9) - (9790)(0.4)$

$= P_{atm} + 8811 - 3916 = (P_{atm} + 4895)\, P_a \rightarrow \boxed{(P_B = 4895\, P_a)\text{ gage}}$

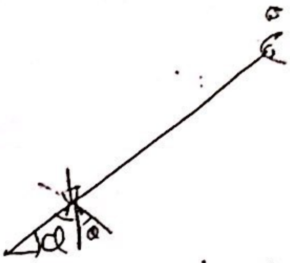
Q2 B)



$F_{B_1} = \gamma_w (V_{Block}) = (9790)(0.034) = \boxed{332.86\,N}$

$\boxed{W_{Block} = 300\,N}$

$W_{rod} = 16\,N$



$F_{B_2} = \gamma_w (A)(x) = (9790)\left(\cancel{\frac{2000}{10000}}\right)(2\times10^{-3})(x)$

$F_{B2} = (19.58x)\,N \qquad x = \left(3.4 - \frac{0.31}{\sin\theta}\right)$

$\Sigma M_B = 0 = (F_{B_1})(\cos\theta)(3.4) + (300)\cos\theta(3.4) - (F_{B_2})(\cos\theta)(3.4 - x/2) + (W_{rod})\left(\frac{3.4}{2}\right)(\cos\theta)$

$0 = -(F_{B_1})(3.4) + (300)(3.4) - (F_{B_2})(3.4 - \frac{x}{2}) + (W_{rod})\left(\frac{3.4}{2}\right)$

$0 = -(332.86)(3.4) + (300)(3.4) - (19.58x)(3.4 - \frac{x}{2}) + (16)\left(\frac{3.4}{2}\right)$

$0 = -111.724 + 27.2 - (19.58x)(3.4) + \left(\frac{19.58x^2}{2}\right)$ 7.5

$84.52 = -66.572x + 9.79x^2$

$\Rightarrow \boxed{9.79x^2 - 66.572x - 84.52 = 0}$

$\frac{(66.572) \pm \sqrt{(66.572)^2 - (4)(9.79)(-84.52)}}{(2)(9.79)} = \frac{66.572 \pm 87.986}{19.58}$

$\cancel{x = 7.89366\,m}$

$\cancel{\boxed{x = 1.09366\,m}}$ $\rightarrow x = 1.09366\,m \qquad \theta = ?$

$\cancel{\theta = \sin^{-1}\left(\frac{3.1}{1.09366}\right)}$

$\cancel{\theta = \sin^{-1}\left(\frac{3.1}{3.4 - 1.09366}\right)}$

$\rightarrow$? where to?

Q3)

to calculate the force from the Right side:-

$$h_{CG} = 5 + (\cancel{5}(8-(5)(\tfrac{8}{10}))) = \boxed{9\ ft}$$

$$A = (6ft)(10)ft = \boxed{60\ ft^2}$$

$$F_p = \gamma_w h_{CG} \cdot A = (62.4)(9)(60) = \boxed{33696\ lb_f}$$

$$y_{cp} = \frac{(\frac{1}{12})(6)(10)^3(\frac{8}{10})}{(9)(60)} = \boxed{0.74\ ft}$$

$F_1 = 33696\ lb_f$ act on $9 + 0.74 = 9.74\ ft$ from the surface

to calculate the force from the left side:

$$h_{CG} = h + (8 - 5(\tfrac{8}{10})) = \boxed{h+4}\ ft$$

$$A = (6)(10) = \boxed{60\ ft^2}$$

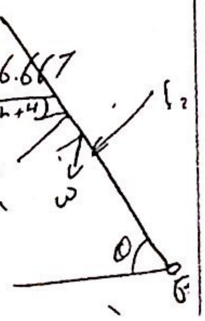
$$F_2 = \gamma_w h_{CG} \cdot A = (62.4)(h+4)(60) = \boxed{3744(h+4)\ lb_f}$$

$$y_{cp_2} = \frac{-I_{xx}\sin\theta}{h_{CG}\cdot A} = -\frac{(\frac{1}{12})(6)(10^3)(\frac{8}{10})}{(h+4)(60)} = -\frac{6.667}{(h+4)}$$

F_2 act on $(h+4) + \frac{6.667}{(h+4)}$ from the surface.

$$\sum M_B = 0 = (W)\cos\theta)(5) - (F_1)(13 - 9.74) + (F_2)(13 - (h+4) - \frac{6.667}{(h+4)})$$

$$0 = (2000)(\tfrac{6}{10})(5) - (33696)(3.26) + 3744(h+4)(13-(h+4) - \frac{6.667}{(h+4)})$$



$$103848.96 = (3744)(13)(h+4) - (3744)(h+4)^2 - (6.667)(3744)$$