The University of Jordan
Faculty of Engineering and Technology
Department of Mechanical Engineering

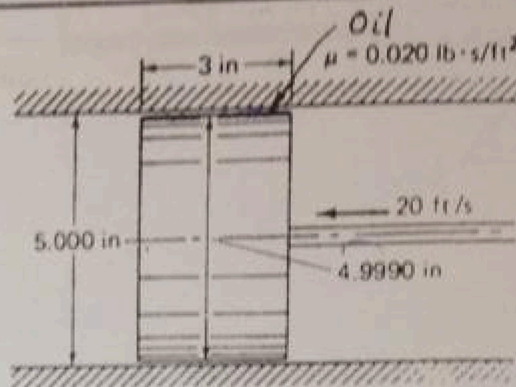
Fluid Mechanics(1)
Course No. 0904361
First Exam
Date: 25/3/2014

OPEN BOOK

Seat No.
Student Name: [illegible]
Student No. 0120361
Instructor: Prof. Ali Badran
Time: 60 Minutes

Prob. 1 (5 Points)

A piston is moving through a cylinder at a speed of 20 ft/s as shown. The film of oil separating the piston from the cylinder has a viscosity of 0.02 lb.s/ft^2. What is the force required to maintain this motion?
Hint: Assume a linear velocity profile for the oil layer.



$\mu = 0.020 \ lb.s/ft^2$

$u = 20 \ ft/s$

$y = \frac{5.000 - 4.9990}{2} \Rightarrow y = 5 * 10^{-4}$ in.

1 ft → 12 in
?? → ☐

$y = 0.4167 * 10^{-4}$ ft

$\tau = \mu \frac{du}{dy}$ → while linear velocity profile

$\frac{du}{dy} \approx \frac{\Delta u}{\Delta y}$

$\tau = \frac{0.020 * 20}{10^{-4} * 0.4167} = (\tau = 10^4 * 0.96 \ lb_f/ft^2)$

$\tau = \frac{F}{A} \Rightarrow A = 5 * 3 = 15 \ in^2$

$A = \frac{15}{(12)^2} = \boxed{0.1042 \ ft^2}$

-1

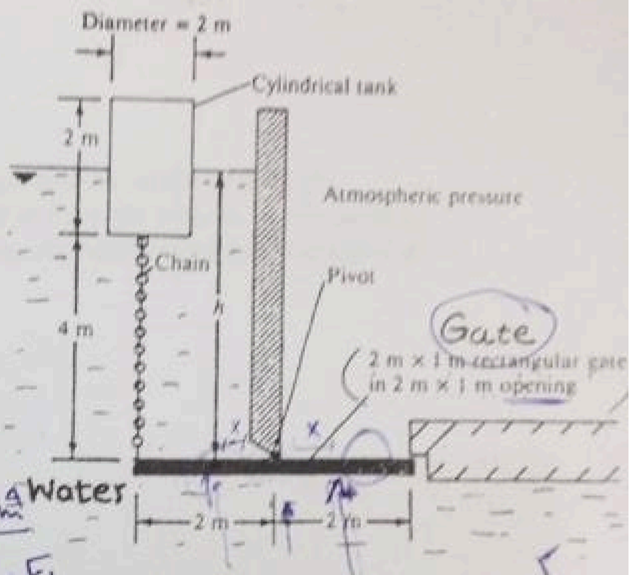
$0.96 * 10^4 * 0.1042 = F$

$\boxed{F = 0.1 * 10^4 \ Lb_f}$ #

4

Prob. 2 (7 Points)

The gate and mechanism shown are designed so that the gate will open when the level *h* reaches a certain value. Neglecting the weights of the gate, chain, and cylindrical tank, calculate the value of *h* at which the gate will start to open.



$A_{gate} = 2 \times 1 = 2\,m^2$

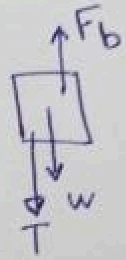
~~$\bar{X} = h + 0.5\,m$~~ . $\bar{X} = 1m$

$\bar{I}_{gate} = \frac{1}{12} bH^3 = \frac{1}{12}(4)(1)^3 = 0.33\,m^4$

taking the cylinder:

weight is Neglegebile

so



$\Sigma F_{cylinder} = 0$

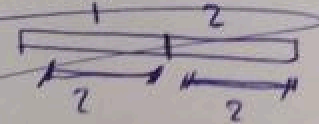
$T = F_b \Rightarrow T = \gamma_{fluid} * V_{object}$

$T = 9810 * (h-4) \frac{\pi}{4} D^2$

$= 9810 * (h-4)\, 3.14$

① — $T = 30819.0239\,(h-4)\,N$

~~F_v on Gate $\Rightarrow$ we cut The gat to Two peaces~~



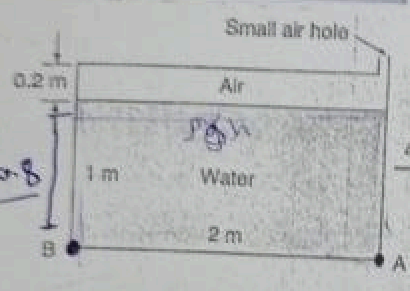
~~on peace 1 $\Rightarrow F_{v_1} = \gamma_{fluid} * V_{gat_1} - 9810 * ...$~~

Prob. 3 (8 Points)

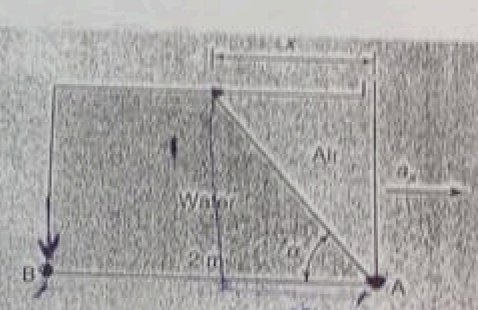
The tank shown in the Figure (a) is rectangular in shape and the width of the tank (perpendicular to the paper) is 1 m. The tank is moved to the right with an acceleration a_x such that the free surface of the water makes an angle α with the bottom and touches it at point A, as shown in Figure (b). Calculate:

a) The acceleration a_x.
b) The gage pressure at point B.
c) The total force acting on the bottom of the tank.

depth = 1m   0.8



(a)



(b)

$$-\frac{\partial}{\partial l}(P+\gamma z) = \rho a_l$$

$$\int_B^A \partial(P+\gamma z) = \int_B^A \partial l \, \rho a_x$$

$$\Rightarrow \quad P_A + \gamma z_A - P_B - \gamma z_B = -\rho a_x (x_A - x_B)$$

$$\cancel{P_A} + 0 - P_B - 0 = -\rho a_x (2)$$

P_A is Atm pressure. we need gage pressure

① — $\boxed{\cancel{P_B = \rho a_x * 2000}}$ $\rho = \frac{\gamma}{g}$