The University of Jordan
Faculty of Engineering & Technology
Chemical Engineering Department

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(0905241) Fluid Mechanics **Summer Semester – 2016/2017**

Quiz # 1

Name: zain abu jassar **ID #** 0154344

Q1:

a) What is the hydrometer used for?

to measure viscosity of fluids which constant density such as water

b) How does viscosity of liquids and gases change with temperature?

Liquids : T↑ μ↓ "more space between molecules"

gases : T↑ μ↑ "interaction between molecules increase"

2

Q2: A thin 0.5-m x 2-m flat plate moves between two parallel, horizontal stationary flat surfaces at a constant velocity of 5 m/s. This plate is 1 cm from the bottom surface and 3 cm from the top surface (the two stationary surfaces are 4 cm apart). The medium between the surfaces and the plate is filled with oil whose viscosity is 0.9 N.s/m^2.
Determine the force that needs to be applied on the plate to maintain this motion.

$\Sigma F_y = 0$ $A = 1 m^2$

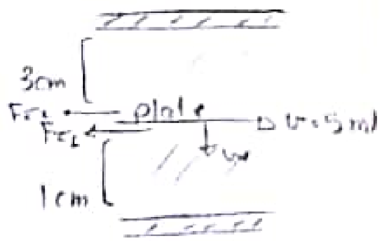
$F_\tau = \tau A$

$\tau_1 = \mu \frac{V}{H} = \mu \frac{dV}{dy}$

$\tau_1 = .9 \frac{N.s}{m^2} \cdot \frac{5 m}{s} \cdot \frac{1}{1 \times 10^{-3} m}$

$= 4500 N/m^2$

4



$\Sigma F = 4500 + 1125$

$= 5625 N$

$\tau_2 = .9 \frac{N.s}{m^2} \cdot \frac{5 m}{s} \cdot \frac{1}{4 \times 10^{-3} m}$

$= 1125$

$F_{\tau_1} = 4500 \frac{N}{m^2} \cdot 1 m^2 = 4500 N$

$F_{\tau_1} = 1125 \frac{N}{m^2} \cdot 1 m^2 = 1125 N$

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Quiz # 2

Name: Zain aba jaasar **ID #** 0154344

The figure below shows a gate hinged at its bottom and held by a simple support at its top. The gate separates two fluids; oil and water.

a) **Compute the net force on the gate due to the fluid on each side.**
b) **Compute the location of the center of pressure on each side.**
c) **Compute the force on the support.**

a)

$\Sigma F = F_{P1} - F_{P2} \rightarrow \Sigma F = 7798.75\ N$ ✓

$= \gamma h_c A - \gamma_{oil} h_c A$

$F_{P1}: 9810\ \frac{N}{m^3} * 1.25\ m * .6\ m * 2.5\ m = 18393.75\ N$ ✓ 4

$h_c = L_c \sin\theta$

$\theta = 90$

$h_c = L_c = \frac{h}{2} = \frac{2.5}{2} = 1.25\ m$

$F_{P2} = \gamma h_c A = 8829\ \frac{N}{m^3} * 1m * 2m * .6m = 10594.8\ N$

$h_c = L_c = \frac{H}{2} = 1m$

$\frac{\gamma_{oil}}{\gamma_w} = SG_{oil}$

$\gamma_{oil} = \gamma_w * SG_{oil}$

$= 9810\ \frac{N}{m^3} * .9 = 8829\ \frac{N}{m^3}$

b) $L_p = L_c + \frac{I_c}{L_c A}$

(1) $L_c = 1.25$

$I_c = W H^3/12$

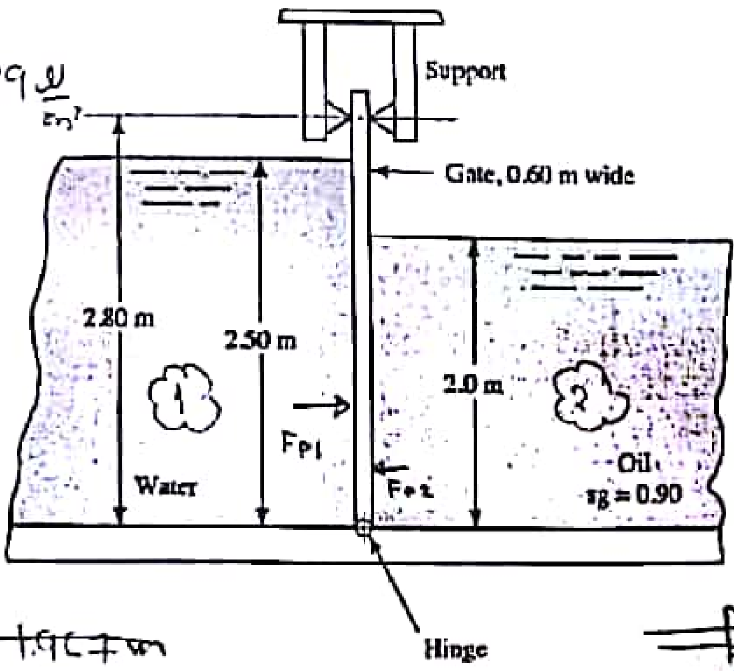
$I_c = .6\ m * (2.5)^3 m^3 / 12$

$I_c = .78125\ m^4$

$A = .6 * 2.5 = 1.5\ m^2$

L_{p1}

$= 1.667\ m$ ✓ ~~+ 3 = 1.967 m~~



(ⅱ) $I_c = WH^3/12 = .6m \times (2)^3 m^3 / 12 = .4 m^4$

$A = WH = 1.2 m^2$

$l_c = \frac{H}{2} = 1m$

$L_{P_2} =$ 3

$= 1.333 m$ ~~1.5 = 1.833 m~~

c) $\Sigma M = 0$

$F_{P_1}(2.5 - L_{P_1}) - F_{P_2}(2 - L_{P_1}) + 2.8 R = 0$

$18393(.533) - 8829(.667) + 2.8 R = 0$ 10595

$R = 3368.72 N$

O.K

2.5

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Quiz # 3

Name: Zain abu jassar **ID #** 0154344

Q1: A 1.0-m-diameter hollow sphere weighing 200 N is attached to a solid concrete block weighing 4.1 kN. If the concrete has a specific weight of 23.6 kN/m³, will the two objects together float or sink in water (γ = 9.81 kN/m³)?

D = 1 m
W = 200 N
W = 4.1 kN
γ_c = 23.6 kN/m³

$\Sigma F_{B,s} = \gamma_w V - W_{sphere}$

$\Sigma F_{con} = \gamma V - W_{conc}$

0.5

? (1 m) × 23.6 × 10³ N/m³ − 10³ × 4.1 N
19500 N
concrete will float

9.81 × (4π/3)(0.5)³ − 200 =
91 − 200 = 152.90
hollow sphere will sink

together ⇒ 19500 + −152.90 = 19182 N
why?
will float together

Q2: For the system shown in the figure below, calculate (a) the volumetric flow rate of water from the nozzle and (b) the pressure at point A.

[1] [2]

$\frac{1}{2}(u_2^2 - u_1^2) + g(z_2 - z_1) + \frac{P_2 - P_1}{\rho} = W_s - \Sigma F$
why?
no shaft work; negligible friction

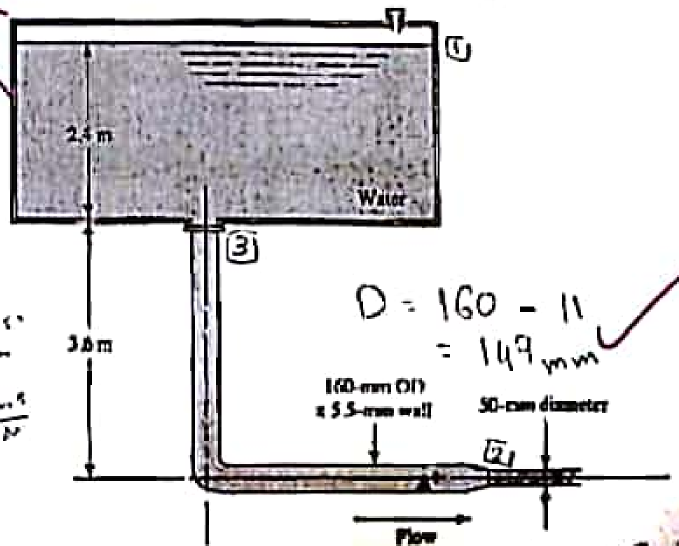
$\frac{1}{2}(u_2^2 - \text{zero}) + g(z_2 - z_1) + \frac{P_2}{\rho} = 0$

$u_2^2 \times \frac{1}{2} + g(-6) + \frac{P_2}{\rho} = 0$ (zero)

$Q_1 = Q_2$
$u_1 A_1 = u_2 A_2$
$u_1 = u_2 \frac{A_2}{A_1}$
$u_1 \approx 0$
$Q_2 = u_2 A_2$

2

[u_2 = 28.45 m/s]
[Q = 3.33 m³/s]



[3] [2]

$\frac{1}{2}(u_2^2 - u_3^2) + g(z_2 - z_1) + \frac{P_2 - P_3}{\rho} = 0$? ≠0

$0 - 3.6 \times 9.8 \frac{m}{s^2} + \frac{P_2}{9.81\ kN} = 0$

$P_2 = (3.6 \times 9.8) \times 9.81$

[P_2 = 346046 N/m²]

D = 160 − 11 = 149 mm

$A = \pi \frac{d^2}{4}$

$P_3 + \gamma_w h_w = P_2$ $P_2 - P_3 = 9.81 \times 3.6 = 35316$

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Quiz # 4

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Kerosene at 25°C ($\gamma = 8.07\ kN/m^3$) is flowing in the system shown in the figure below from tank A to tank B at the rate of 0.01 m^3/s. The total length of 60 mm OD x 2 mm wall hydraulic copper tubing is 50 m. The two 90° bends have a radius of 300 mm. Calculate the pressure above the kerosene in tank A, p_A.

$\gamma = 8.07 \times 10^3\ N/m^3$

$Q_B = .01\ m^3/s$

$L = 50\ m$

$\epsilon = 1.5 \times 10^{-6}\ m$

$d = .057\ m$

$r/d = 5.2$

$Q_B = u_B A_B$

$u_B = \frac{Q}{A} = \frac{.01}{\pi d^2/4} = 3.91\ m/s$

$d = 60 - 2 \times 1.5 = 57\ mm$

apply MEB

$\frac{1}{2}(u_2^2 - u_1^2) + g(z_2 - z_1) + \frac{P_2 - P_1}{\rho} + W_P = -h_f$ (zero gage; no shaft work)

large reservoir $u_1 \approx 0$

$\frac{1}{2g}u_2^2 + z_2 - z_1 + \frac{-P_1}{\gamma} = -h_f$

$\gamma(8 + h_f + \frac{1}{2g}u_2^2) = P_1 \Rightarrow P_1 = 5.875967\ kPa$

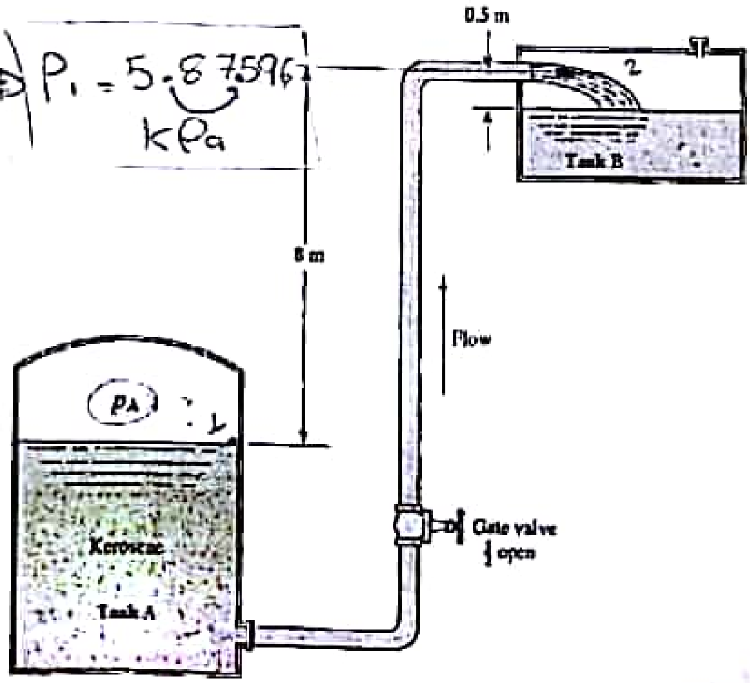
h_f = ① h_f contraction $= \frac{Ku^2}{2g}$

② h_f expansion $= \frac{Ku^2}{2g}$

③ h_f pipe $= 4f\frac{L}{D}\frac{u^2}{2g}$

④ h_f 2 elbow $= K\frac{u^2}{2}$

⑤ h_f valve $= K\frac{u^2}{2}$



h_f cont $= K \frac{u^2}{2}$

$= .5 \times \frac{(3.91)^2}{2g} = .39$ m

h_f expan $= 1 \times \frac{(3.91)^2}{2g} = .75$ m ∝

h_f pipe $= 4f \frac{L}{D} \frac{u^2}{2g} = 57.56$ m → f ← $\frac{\varepsilon}{d}$ —

0.K

→ $Re = \frac{\rho u d}{\mu} = \frac{ud}{\nu} =$

$= \frac{3.91 \text{ m}}{s} \Big| \frac{57 \times 10^{-3} \text{ m}}{2.39 \times 10^{-4} \text{ m}^2}$

$= 760.79$ ∝

laminar - - - (A)

$f = \frac{16}{Re} = .02103$

0.K

h_f elbow $= 2 \times K \frac{u^2}{2g}$

bend NOT elbow

$2 \times (.9) \times \frac{(3.91)^2}{2g} = .9345$ m ∝

h_f valve $= K \frac{u^2}{2g}$

$= 5.6 \times \frac{(3.91)^2}{2g} = 4.368$ m

h_f tot $= 64.0325$ m

0.K

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