	Alexandria Higher Institute of Engineering & Technology (AIET)		
	Mechatronic Department		Third Year
	EME312	Fluid Mechanics	Midterm, April, 28, 2014
	Examiners:	Dr. Rola Afify and Committee	Time: 1.5 hours

Answer the following questions:

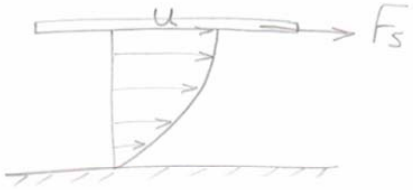
Question one (6 marks)

A) Define: Fluid, Specific gravity and Vapour pressure of liquids.

Fluid: is a substance which deforms continuously under the action of shearing forces, however small they are. This deformation is permanent even if the force is removed.

$$\tau = \frac{F_s}{A_s}$$

= shear stress



* specific gravity: $\gamma = \frac{\text{sp. weight of fluid}}{\text{sp. weight of water}}$

$$= \frac{\omega_f}{\omega_w} = \frac{\rho_f g}{\rho_w g} = \frac{\rho_f}{\rho_w}$$

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for water $\gamma_w = 1$

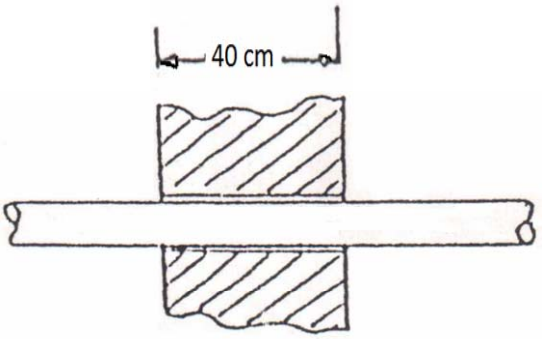
* Vapour pressure of liquids ($P_{vap.}$) : It is the pressure at which a liquid starts to boil at working temperature.

Boiling temp. increases by increasing pressure on liq. surface

~ ~ decreases ~ decreasing ~ ~ ~ ~

P	0.3	0.5	1	4	10	atm
boiling temp	40	70	100	120	180	°C

B) A shaft 6.00 cm in diameter is being pushed axially through a bearing sleeve 6.02 cm in diameter and 40 cm long. The clearance, assumed uniform, is filled with oil Problems whose properties are $\nu = 0.003$ m^2/s and $\gamma = 0.88$. Estimate the force required to pull the shaft at a steady velocity of 0.4 m/s.



steady velocity of 0.4 m/s.

$d = 6 * 10^{-2}$ m $D = 6.02 * 10^{-2}$ m

$l = 40 * 10^{-2}$ m $\nu = \frac{\mu}{\rho}$

$\mu = \rho \nu = 0.88 * 1000 * 0.003 = \frac{66}{25} = 2.64$ Pa.s

$v = 0.4$ m/sec $y = \frac{D-d}{2} = \frac{(6.02-6)*10^{-2}}{2}$

$= 0.01 * 10^{-2}$ m

$F_{vis} = \mu A \frac{v}{y}$

$= 2.64 * \pi d l * \frac{0.4}{0.01 * 10^{-2}}$

$= 2.64 * (\pi * 6 * 10^{-2} * 40 * 10^{-2}) * \frac{0.4 * 10^2}{0.01}$

$= 796.21$ Newton

Question two (7 marks)

A) Compare between:

1- Piezometer and U-tube with one leg enlarged.

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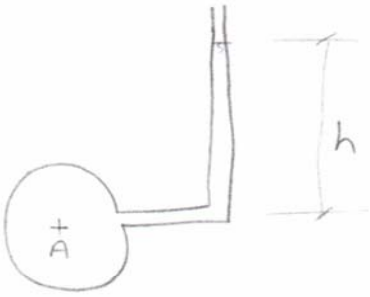
* pressure measurements by manometers

* piezometer

pressure tube or piezometer

Consists of a single vertical tube.

$$P_A = \omega h$$



* U-tube with one leg enlarged

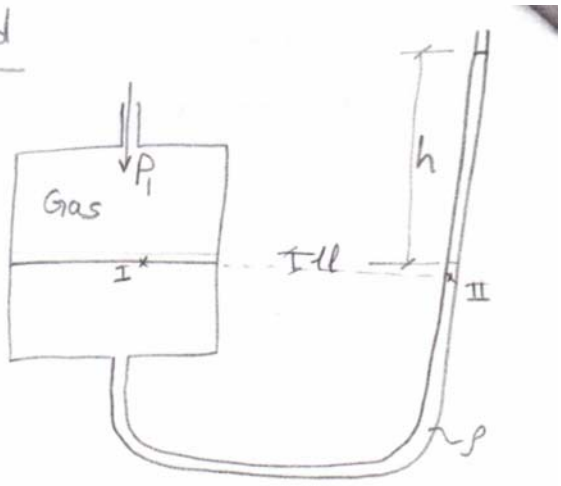
Volume = Volume

$$A * ll = a * h$$

$$ll = \frac{a}{A} * h$$

$$= \frac{\pi/4\, d^2}{\pi/4\, D^2} * h$$

$$\boxed{ll = \frac{d^2}{D^2} * h}$$



$$P_I = P_{II}$$

$$P_1 = \rho g\, ll + \rho g h$$

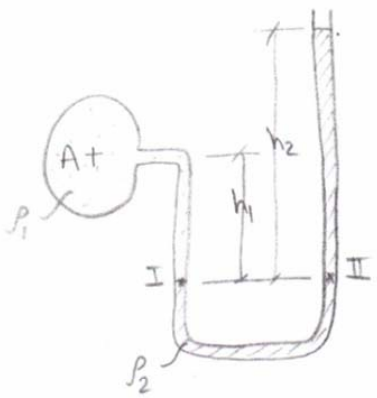
$$= \rho g * \frac{d^2}{D^2} h + \rho g h$$

$$= \rho g h \left(\frac{d^2}{D^2} + 1\right)$$

+ h with an inclined leg

2- U-tube and Inverted U-tube.

* U- tube manometer



* to make pressure equivalence

① still liquid

② Continued liquid

③ same liquid

$$P_I = P_{II}$$

$$P_A + \rho_1 g h_1 = \rho_2 g h_2$$

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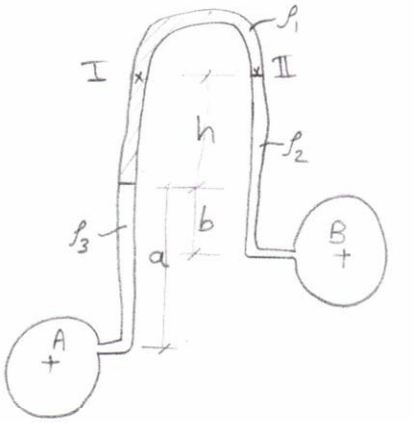
*Inverted U-tube

$$P_I = P_{II}$$

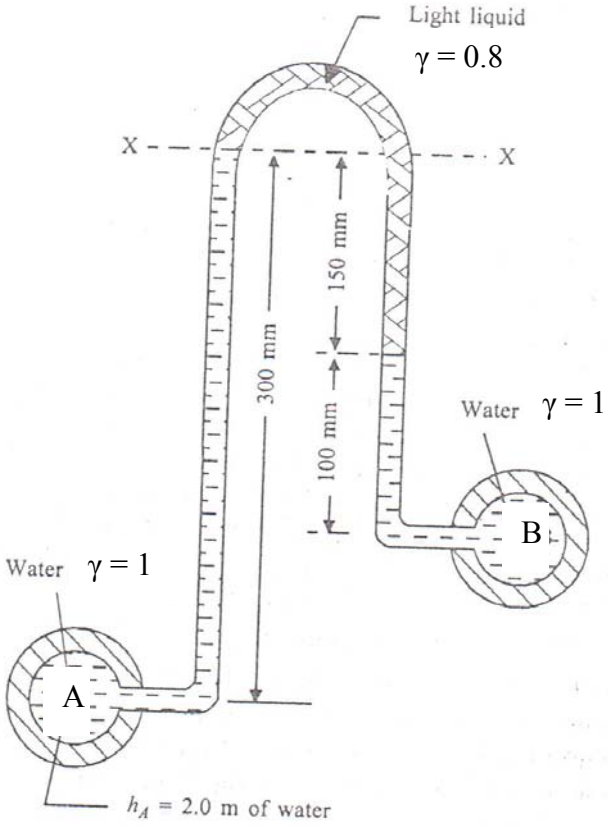
$$P_A - \rho_3 g a - \rho_1 g h = P_B - \rho_2 g (h+b)$$

$$P_A - P_B = \rho_3 g a + \rho_1 g h - \rho_2 g (h+b)$$

$$\Delta P = \_\_\_\_$$



B) The inverted differential manometer have an oil of specific gravity 0.8 connected to two different pipes carrying water under pressure. Determine the pressure in the pipe B. The pressure in pipe A is 2.0 meters of water.



water.

$$P_I = P_{II}$$

$$P_A - \rho_w g * 0.3 = P_B - \rho_w g * 0.1 - 0.8 \rho_w * g * 0.15$$

$$P_B = P_A + \rho_w g [0.1 + 0.8 * 0.15 - 0.3]$$

$$= \rho_w g [2 + 0.1 + 0.12 - 0.3]$$

$$= 9800 * 1.92$$

$$= 18816 \text{ Pa}$$

Question three (7 marks)

A) Compare between:

1- Ideal and Real flows.

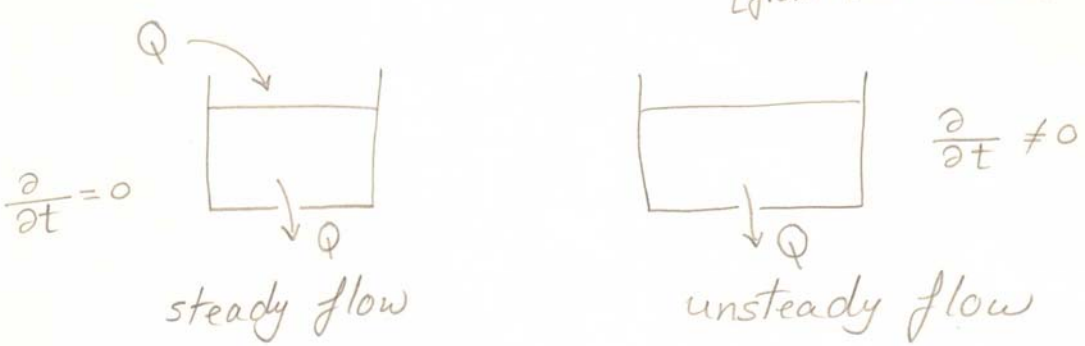
① Ideal and real flow

* Ideal flow: means frictionless flow, no energy is lost, the viscosity is considered zero.

* Real flow: viscosity can't be neglected, there is friction. Friction causes some of the mechanical energy to be converted into heat energy & can't be restored.

2- Steady and Unsteady flows.

② steady and unsteady flow (with respect to time) [from time to time)



* steady flow: pressure, velocity, flow rate (flow parameters) are constant with respect to time.

* unsteady flow: any of the flow parameters change with time.

B) The diameter of a pipe changes from 20cm at a section 5m above datum, to 5cm at a section 3m above datum. The pressure of water at first section is 5bar. If the velocity of flow at the first section is 1m/s, determine the pressure at the second section. Assume ideal flow.