Alexandria University
Faculty of Engineering
Electromechanical Department
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جامعة الأسكندرية
كلية الهندسة
قسم هندسه الكهروميكانيكا
يوليو2013

Fluid Mechanics 1 (EME206)
1st year
Time Allowed: 1.5 hr

ميكانيكا موائع
السنة الدراسية: الأولي
مدة الأمتحان: ساعة ونصف

Answer the following questions:

Question one (7 marks)

A)_ Define: Density, Bulk modulus of elasticity and viscosity.

A) Define:

- Density: mass per unit volume $\rho = \frac{m}{V}$ Kg/m

$\rho_w = 1000\ Kg/m^3$

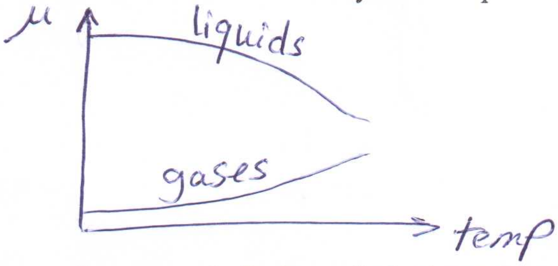
$K = \dots * 10^9$ - Bulk modulus of elasticity: $K = \frac{-\Delta P}{\Delta V / V}$

incomp. Fluid ⇒ large K means big change in pressure causes small change in volume, small K means small ~ ~ ~ ~ big ~ in vol. (Comp. fluid) $K = \dots \times 10^6$

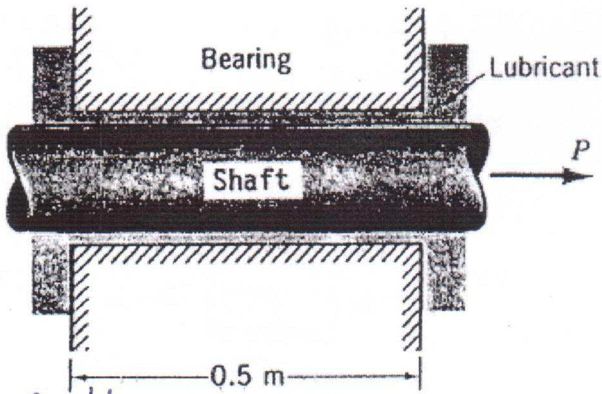
- Kinematic viscosity:

is defined as the ratio of dynamic viscosity to density $\nu = \frac{\mu}{\rho}$ m^2/sec

B) Sketch the relation between viscosity and temperature for a certain fluid.



C) A 25 mm diameter shaft is pulled through a cylindrical bearing as shown in Figure. The lubricant that fills the 0.3 mm gap between the shaft and bearing is oil having a kinematic viscosity of 8 x 10^{-4} m^2/s and a specific gravity of 0.91. Determine the force P required to pull the shaft at a velocity of 3 m/s. Assume the velocity distribution in the gap is linear.



$d = 25 * 10^{-3}\ m$

$y = 0.3 * 10^{-3}\ m$

$\nu = 8 * 10^{-4}\ m^2/s = \frac{\mu}{\rho}$

$\gamma = 0.91 = \frac{\rho_f}{\rho_w}$

$u = 3\ m/s$

$P = ?? = F_{vis}$

$\mu = \nu \rho = \nu * \gamma * \rho_w$

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

$P = [8 * 10^{-4} * 0.91 * 1000] * (\pi * 25 * 10^{-3} * 0.5) * \frac{3}{0.3 * 10^{-3}}$

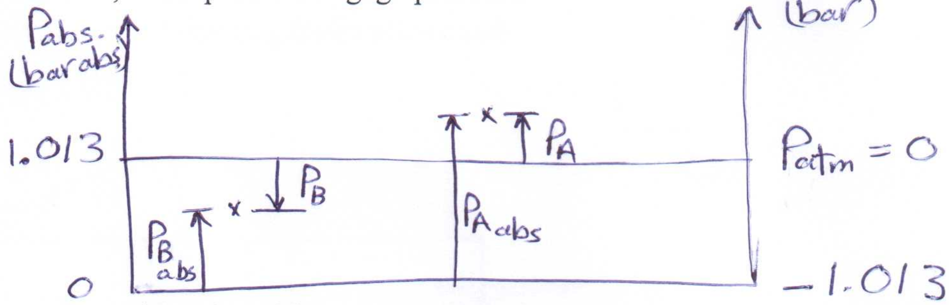
$P = 91\pi$ N

$= 285.88$ N

Question two (11 marks)

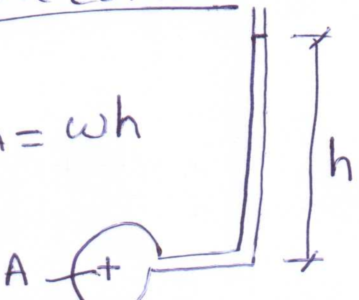
A) State the relation between absolute, atmospheric and gage pressure.

$$P_{abs} = P_{gage} + P_{atm}$$



B) Differentiate between Piezometer and U-tube with one leg enlarged.

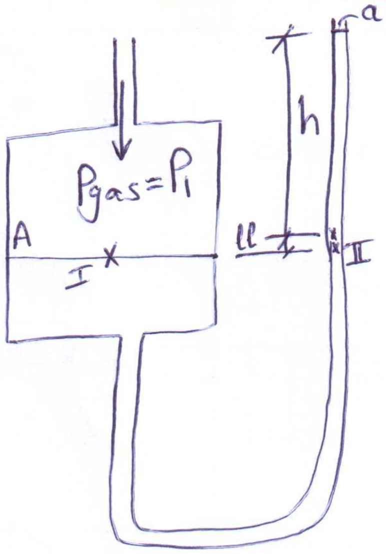
piezometer



$P_A = wh$

It consists of a single vertical tube, It isn't for ① vacuum ② gases ③ short tubes

U-tube with one leg enlarged



Volume = Volume

$A * ll = a * h$

$ll = \frac{a}{A} h = \frac{d^2}{D^2} h$

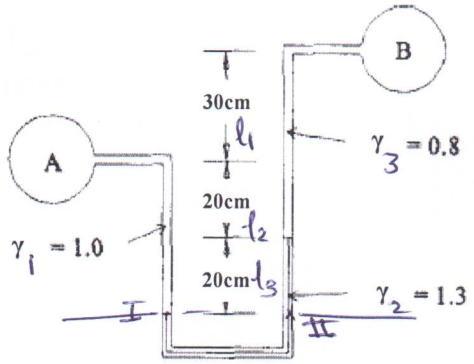
$P_I = P_{II}$

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

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

C) A manometer is connected between two pipelines, A and B shown in figure. What is the pressure difference between A and B expressed as meters of water?

$\gamma = \frac{\rho}{\rho_w}$



$P_I = P_{II}$

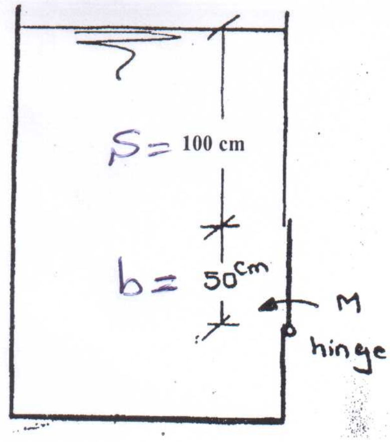
$P_A + \rho_1 g (l_2 + l_3) = P_B + \rho_3 g (l_1 + l_2) + \rho_2 * g * l_3$

$P_A - P_B = \rho_3 g (l_1 + l_2) + \rho_2 * g l_3 - \rho_1 g (l_2 + l_3)$

$\Delta P = 0.8 * 1000 * 9.8 (30 + 20) * 10^{-2} + 1.3 * 1000 * 9.8 * 20 * 10^{-2} - 1 * 1000 * 9.8 * (20 + 20) * 10^{-2}$

$= 2548$ Pa

$\Delta P = wh \quad \therefore h = \frac{\Delta P}{w} = \frac{2548}{1000 * 9.8} = 0.26$ m of water



Question three (6 marks)

A tank contains oil of sp. gr. 0.9 and has a rectangular hole in one of its vertical sides. The hole is 50 cm high and 70 cm wide and is covered from the outside with a plate hinged at the lower horizontal edge of the hole as shown in Fig. Find the required moment 'M' to keep the hole closed.

$\gamma = 0.9$ $a = 70\,cm$

rectangular hole $50\,cm = b$

$M = ??$ to Keep it closed.

Good Luck 1/1

Dr. Rola Afify and committee

$$F_R = (P_o + \rho g y_c \sin\theta) A$$

$$= \rho g (S + \frac{b}{2}) * a * b$$

$$= 0.9 * 1000 * 9.8 * (100 + \frac{50}{2}) * 10^{-2} * 50 * 70 * 10^{-4}$$

$$= 3858.75 \; N$$

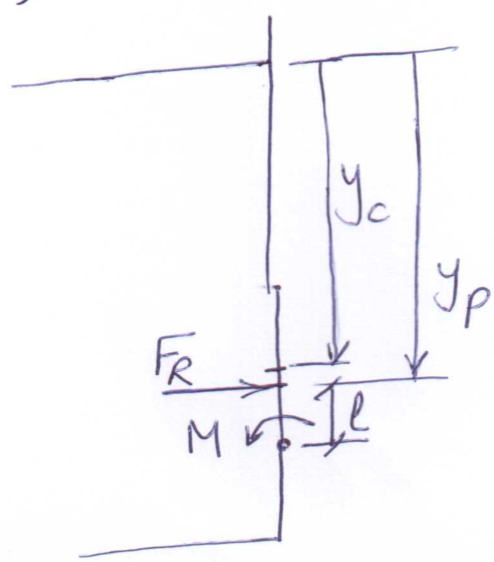
$$y_p = y_c + \frac{I_{xx,c}}{[y_c + \frac{P_o}{\rho g \sin\theta}] A} = (S + \frac{b}{2}) + \frac{\frac{a b^3}{12}}{(S + \frac{b}{2}) * a b}$$

$$= (100 + \frac{50}{2}) * 10^{-2} + \frac{(50)^2 * 10^{-4}}{12 (100 + \frac{50}{2}) * 10^{-2}}$$

$$= \frac{19}{15} = 1.2667 \; m$$

$$l = 150 * 10^{-2} - y_p$$

$$= \frac{7}{30} = 0.233 \; m$$



$$M = F_R * l$$

$$= 3858.75 * 0.233$$

$$= 900.375 \; N.m$$