College of Engineering & Technology

Department: Mechanical Engineering Marks: 20
Lecturer: Dr. Rola Afify Time: 11:30 – 12:10
Course Code: ME361 Date: 8/7/2015

Name: Model Answer R. N.:

Answer the following questions:
Question one (5 marks)

A) Define:

- Specific weight:

* specific weight : weight per unit volume

$$\omega = \frac{\text{weight}}{\text{Volume}} = \frac{m * g}{V} = \rho g$$

Dim. $\frac{ML}{T^2} * \frac{1}{T^3}$, for water $\omega = 1000 * 9.8 \frac{N}{m^3}$

N/m^3, $dyne/cm^3$, lb_f/ft^3

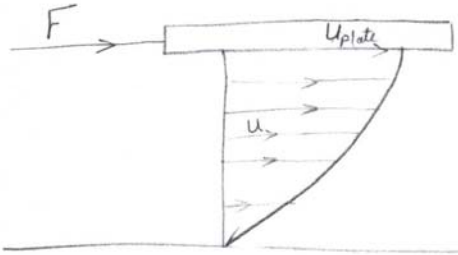
- Vapor pressure of liquid:

* 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 ~ ~ ~ ~

- Viscosity:

* Viscosity(μ) : The property which causes friction between Fluid and boundary or between fluid layers if there is velocity difference.



μ = Vis Cosity
= Absolute Viscosity
= Dynamic viscosity
= Coefficient of ~

B) A 25mm diameter shaft is rotated in a 26.2mm diameter 300mm long sleeve containing oil (μ = 0.44 Pa.s) as shown in Figure. Estimate the torque

required to rotate the shaft at a speed of 1800 rpm. Also, determine the power lost in viscous friction.

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

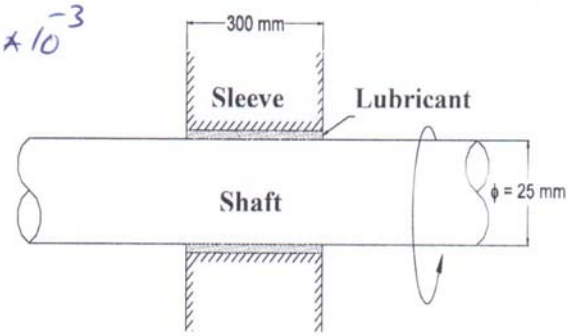
$D = 26.2 * 10^{-3}\ m$ $\Big\}$ $y = \frac{D-d}{2} = 0.6 * 10^{-3}$

$L = 300 * 10^{-3}\ m$

$\mu = 0.44\ Pa.s$

$T = ??$ if $N = 1800\ rpm$

Power = ??



$$F = \mu A \frac{du}{dy} = 0.44(\pi dL) * \frac{\omega r}{0.6*10^{-3}}$$

$$= 0.44 * \pi * 25 * 10^{-3} * 0.3 * \frac{2\pi * 1800 * \frac{25}{2} * 10^{-3}}{60 * 0.6 * 10^{-3}} = 40.7\ N$$

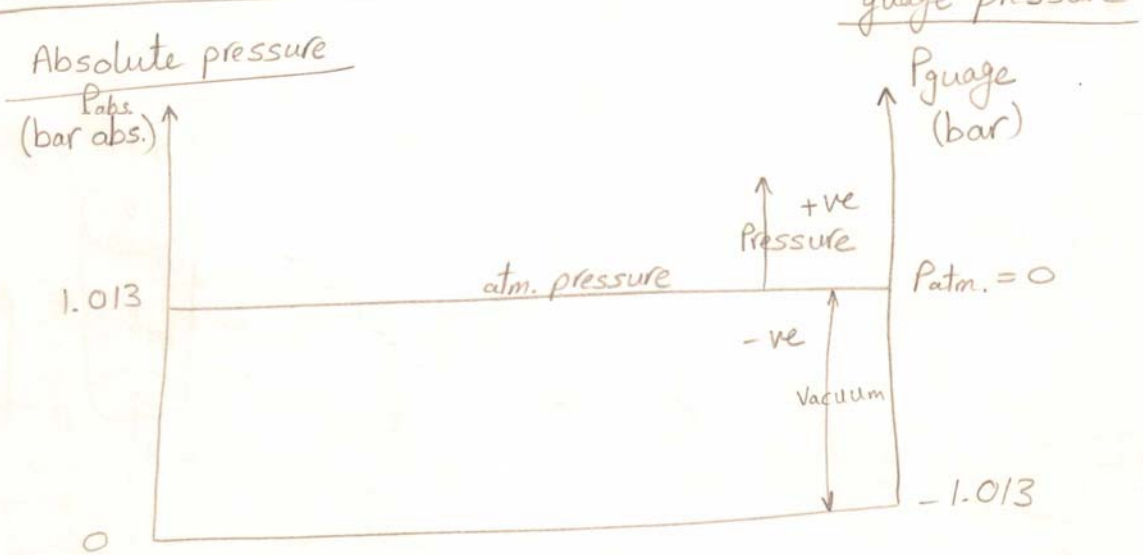
$$T = F * r = 40.7 * \frac{25}{2} * 10^{-3} = 0.51\ N.m$$

$$power = T * \omega = 0.51 * \frac{2\pi * 1800}{60} = 95.93\ Watt$$

Question two (5 marks)

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

* Absolute, atmospheric and guage pressure



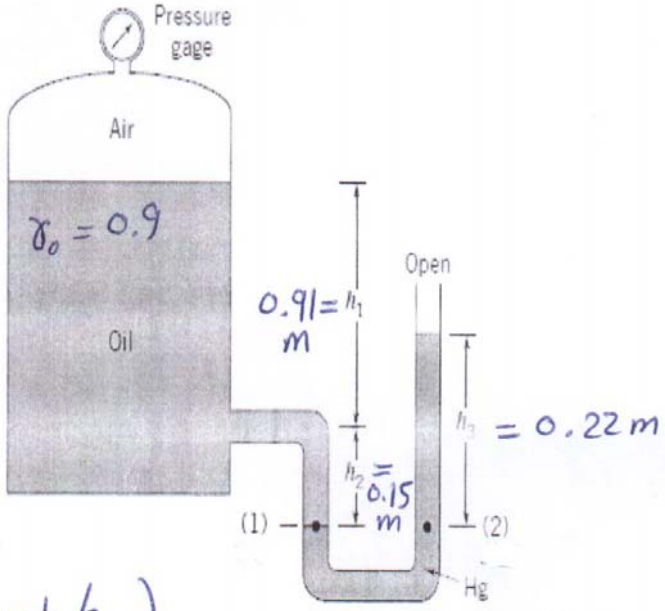
Absolute pressure = true pressure

$$P_{abs.} = P_{guage} + P_{atm.}$$

B) A closed tank contains compressed air and oil ($\gamma_{oil} = 0.9$) as shown in figure. A u-tube manometer using mercury ($\gamma_{mercury} = 13.6$) is connected to the tank as shown. For column heights $h_1 = 91$ cm, $h_2 = 15$ cm, $h_3 = 22$ cm, determine the pressure gage's reading.

$$P_1 = P$$

$$P_{gage} + \rho_o g (h_1 + h_2) = \rho_m g h_3$$



$$P_{gage} = \rho_m g h_3 - \rho_o g (h_1 + h_2)$$

$$= 13600 * 9.8 * 0.22 - 900 * 9.8 (0.91 + 0.15)$$

$$= 19972.4 \text{ Pa}$$

$$= 19.97 \text{ KPa}$$

Question three (4 marks)

Water discharged from a large tank into atmosphere through a pipe 50 mm diameter and 45 m long which is sharp edge at entry, after which there is a sudden enlargement to a pipe of 75 mm diameter and 30 m long. The point of delivery is 6 m below the surface of water in the tank. Determine the discharge in m^3/sec. Assume f = 0.02 for both pipes.

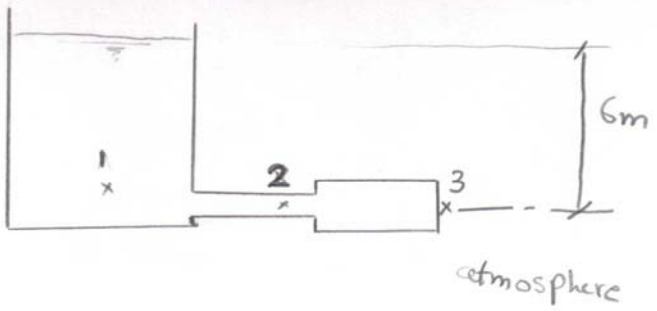
$= 50\ mm = 0.05\ m$

$L = 45\ m$

$d = 75\ mm$

$L = 30\ m$

$\therefore K = 0.325$



$$Q = a_1 v_1 = a_3 v_3$$

$$\therefore v_2 = \frac{a_3}{a_2} v_3 = \frac{(0.075)^2}{(0.05)^2} v_3 = 2.25\, v_3$$

$$z_1 + \frac{P_1}{\omega} + \frac{v_1^2}{2g} = z_3 + \frac{P_3}{\omega} + \frac{v_3^2}{2g} + 0.5\frac{v_2^2}{2g} + 0.325\frac{(v_2 - v_3)^2}{2g} + 0.02\frac{45}{0.05}\frac{v_2^2}{2g} + 0.02\frac{30}{0.075}\frac{v_3^2}{2g}$$

$z_1 = 6$, $z_3 = 0$, $P_1 = P_3 = 0$, $v_1 = 0$

$$6 = \left[\frac{5.0625}{19.6} + 0.5 + \frac{0.325\,(1.5625)}{19.6} + \frac{18}{19.6} + \frac{40.5}{19.6}\right] v_2^2$$

$$\therefore v_2^2 = 0.081$$

$$\therefore v_2 = 0.284\ m/sec$$

$$\therefore Q = a_2 v_2 = \frac{\pi}{4}(0.05)^2(0.284)$$

$$= 557.6 \times 10^{-6}\ m^3/sec$$