EME 312

Final June 2013

Q1

A) i) specific weight ω

ii) Fluid

iii) vapour pressure of liquids ($P_{vap.}$)

iV) Kinematic ViscCosity (ν)

V) Ideal flow

B)

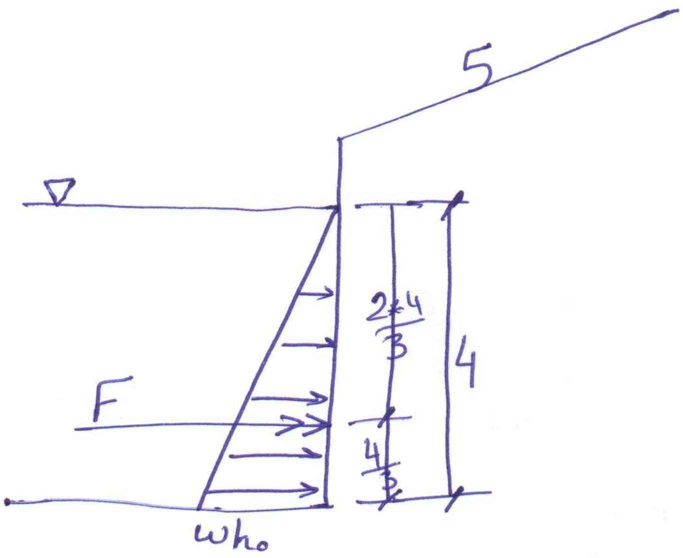
$F_p = w h_o * \frac{h_o}{2} * B$

$= 9800 * \frac{4^2}{2} * 5$

$= 392000 \ N$

$= 3.92 * 10^5 \ N$

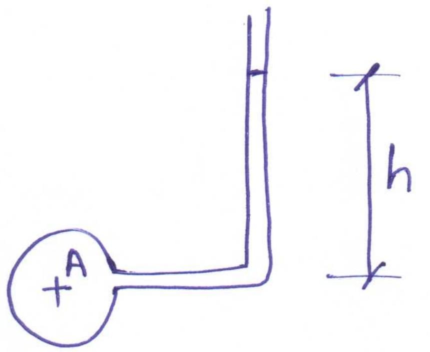
$\perp$ side at $\frac{4}{3}$ from bottom



Q2

a) 1. piezometer

It Consists of a single vertical tube



$P_A = wh$

restrictions
① gases
② Vacuum
③ short tubes

* U-tube with one leg enlarged

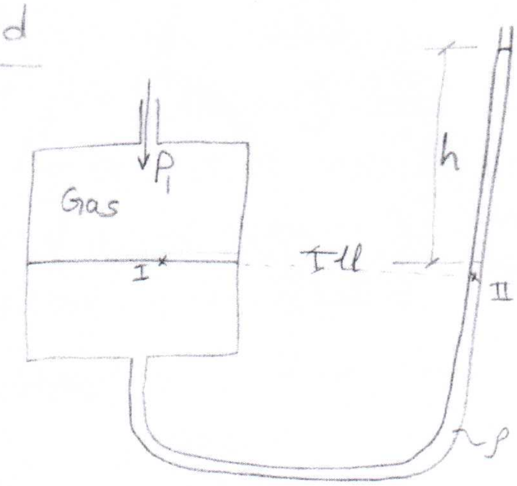
Volume = Volume

$$A * ll = a * h$$

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

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

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



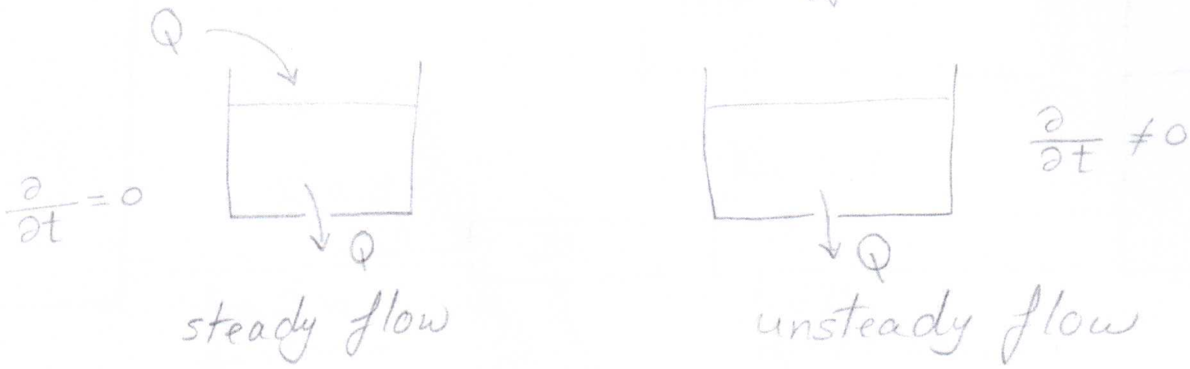
$$P_I = P_{II}$$

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

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

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

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.

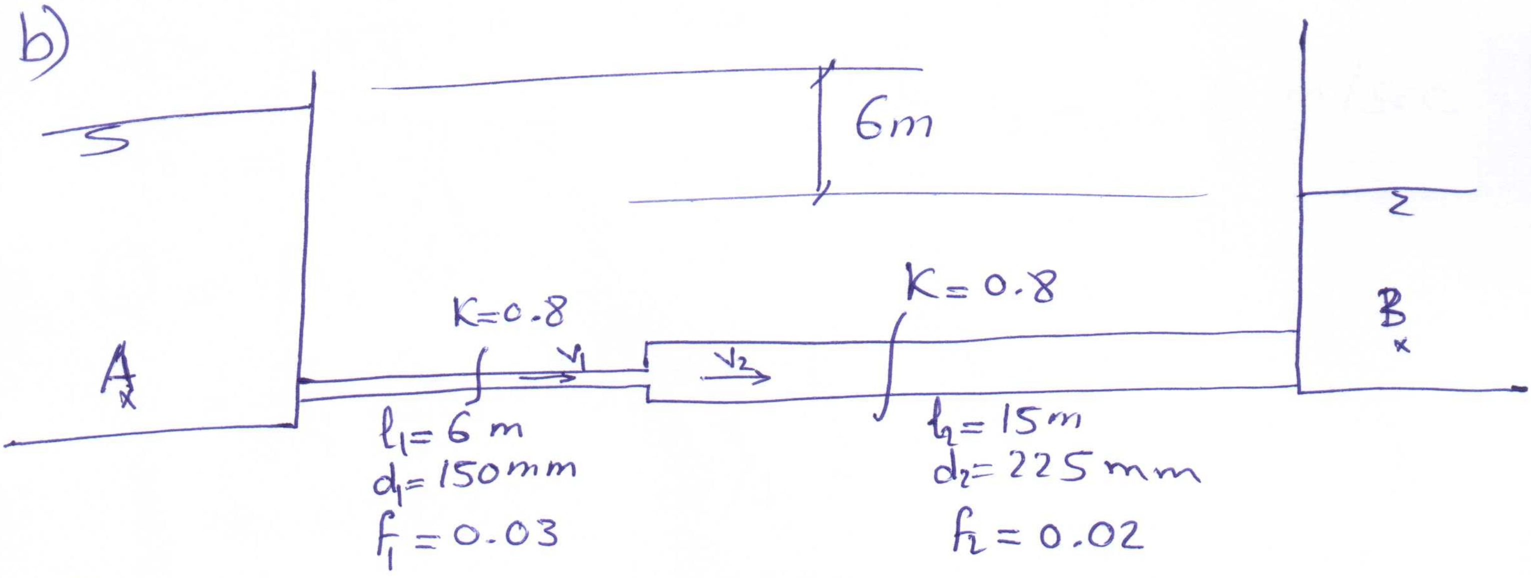
* unsteady flow: any of the flow parameters change with time.

(3)

* Friction losses : This type of losses exists for any flow as a result of fluid viscosity and velocity difference between fluid layers. As a result of friction, part of the fluid's mechanical energy is Converted into heat energy (decipated into atmosphere) and is Considered as an energy loss.

* Eddy losses : occurs due to any change in the velocity vector (magnitude or direction). This change causes some of energy to be transfered from main flow to the eddies formed at corners. This part of energy is Considered as energy losses.

b)



Q = ??

$$E_A - E_B = h_{loss\ A \to B}$$

$$6 = K_{ent\ max} \frac{V_1^2}{2g} + f_1 \frac{l_1}{d_1} \frac{V_1^2}{2g} + K_b \frac{V_1^2}{2g} + K_{enl.\ max} \frac{(V_1 - V_2)^2}{2g} +$$

$$f_2 \frac{l_2}{d_2} \frac{V_2^2}{2g} + K_b \frac{V_2^2}{2g} + K_{enl.\ max} \frac{(V_2 - 0)^2}{2g} \longrightarrow (1)$$

$$Q = A_1 V_1 = A_2 V_2$$

$$\frac{\pi}{4}(0.15)^2 V_1 = \frac{\pi}{4}(0.225)^2 V_2$$

$$V_1 = 2.25 V_2$$

sub. in ①

$$6 = 0.5 \frac{(2.25V_2)^2}{2*9.8} + 0.03 * \frac{6}{0.15} * \frac{(2.25V_2)^2}{2*9.8} + 0.8 \frac{(2.25V_2)^2}{2*9.8}$$

$$+ 1 * \frac{(2.25V_2 - V_2)^2}{2*9.8} + 0.02 * \frac{15}{(0.225)} \frac{V_2^2}{2*9.8} + 0.8 \frac{V_2^2}{2g}$$

$$+ 1 * \frac{V_2^2}{2*9.8}$$

$$6 = \frac{V_2^2}{2*9.8}\left[(2.25)^2 * \left(0.5 + 0.03 * \frac{6}{0.15} + 0.8\right) + (1.25)^2 + 0.02 * \frac{15}{0.225} + 0.8 + 1\right]$$

$$6 = \frac{V_2^2}{2*9.8} * 17.35$$

$$V_2^2 = 6.777 \qquad \therefore V_2 = 2.6 \text{ m/sec}$$

$$Q = A_2 V_2$$

$$= \frac{\pi}{4}(0.225)^2 * 2.6$$

$$= 0.1035 \text{ m}^3/\text{sec}$$

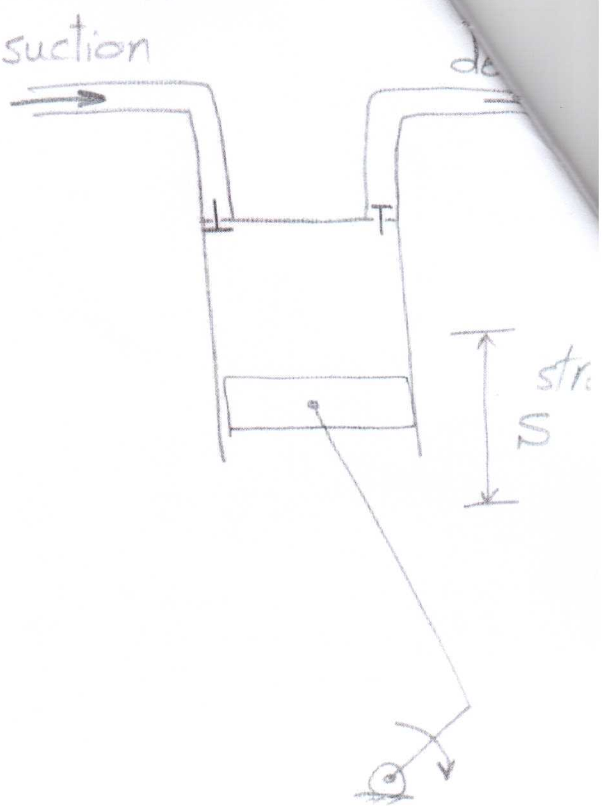
$$= 103.5 \text{ lit/sec}$$

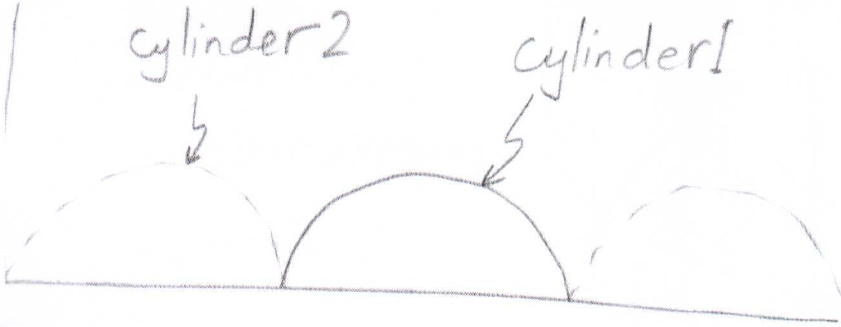
Q3 a)

Positive displacement pumps

a- Reciprocating pumps

*) piston pump





$$Q_{ideal} = \frac{\pi}{4} D^2 * S * \frac{N}{60}$$

N: rpm of motor

S: stroke

$Q_{act} < Q_{ideal}$ due to leakage

$$Q_{act} = \eta_{vol} Q_{ideal}$$

η_{vol} : volumetric efficiency $\simeq 97\%$

- This pump is a type of positive pumps which gives the max. discharge.

If the delivery valve is closed, the motor or the pu
Can be destroyed.

when this pump rotates at constant speed, it should give constant discharge.

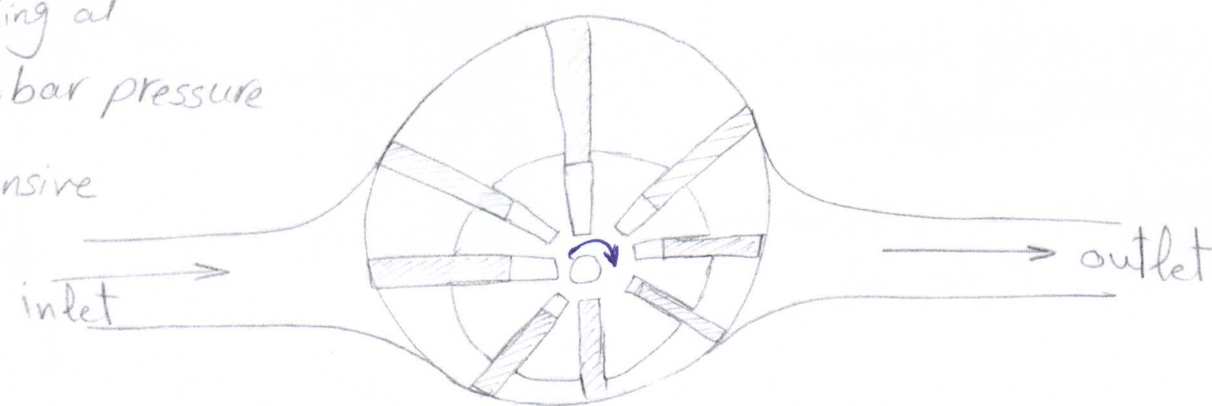
+ve displacement pumps

b- Rotary pumps

*) vane pump

* working at 500bar pressure

* expensive



b) water 3 cylinders

$d = 100\ mm$ $S = 300\ mm$ $N = 500\ rpm$

$\eta_{vol} = 0.95$ $\eta_m = 0.8$ $h = 20m$

shaft power = ??

Sol^n

$$Q_{act} = \eta_{vol} \frac{\pi}{4} d^2 * S * \frac{N}{60} * n$$

$$= 0.95 * \frac{\pi}{4} (0.1)^2 * 0.3 * \frac{500}{60} * 3$$

$$= 0.056 \quad m^3/sec$$

$$sh.p = \frac{wQh}{\eta_m} = \frac{9800 * 0.056 * 20}{0.8}$$

$$= 13710.1 \quad watt$$

$$= 13.7 \quad KW$$

Q4

a) to avoid cavitation for non-positive displace[ment] pumps

$$h_{ss} - h_{ls} - \frac{V^2}{2g} - NPSh > h_{vap} - h_{atm}$$

1) $h_{ss} \uparrow$ وذلك بوضع المضخه فى أقل منسوب ممكن بالنسبه لمستوى السحب

2) $h_{ls} \Downarrow$

- *) $l_s \downarrow$ — عن طريق وضع المضخه فى اقرب مكان ممكن بالنسبه لخزان السحب
- *) $d_s \uparrow$ — زياده قطر ماسوره السحب لتقليل السرعه
- *) eddy loss $\downarrow$ — تجنب استخدام اى مصدر من مصادرها بقدر الامكان

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b) $h_{st} = 50$ m $h_{ls} = 5$m $h_{ld} = 10$ m

$\frac{V^2}{2g} = 0.2$ $h_{ss} = -3$ m

i) $h_{pump} = ??$

$$h_{pump} = h_{st} + h_{lt} + \frac{V^2}{2g}$$
$$= 50 + (5+10) + 0.2$$
$$= 65.2 \text{ m}$$

ii) $Q = ??$ $Q = 15 \frac{lit}{sec}$ نجد أن $h = 65$m من الجدول عند

iii) shaft power = ??

$$sh.p. = \frac{\omega Q h}{\eta} = \frac{9800 * 15 * 10^{-3} * 65.2}{0.72}$$
$$= 13311.67 \text{ Watt}$$
$$= 13.3 \text{ KW}$$

iv) manometric suction = ??

$$H_{ms} = h_{ss} - h_{ls} - \frac{v^2}{2g}$$

$$= -3 - 5 - 0.2$$

$$= -8.2 \text{ m}$$

Q5

a) Functions of oil tank are :-

1- storing oil 2- Cooling oil

3- separation of air from oil

4- draining impurities from the bottom of tank.

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b) 1- vented oil tank

2- electric motor

3- filter

4- single fixed displacement pump

5- relief valve

6- directional control valve - three position - four Connection - spring centered - push-pull lever

7- check valve

8- Flow Control valve - variable displacement

9- Cylinder - double acting - differential