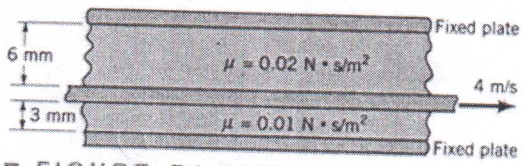
EME 312
Midterm
9 April 2013

Q1) B)

1.10R (Viscosity) A large movable plate is located between two large fixed plates as shown in Fig. P1.10R. Two Newtonian fluids having the viscosities indicated are contained between the plates. Determine the magnitude and direction of the shearing stresses that act on the fixed walls when the moving plate has a velocity of 4 m/s as shown. Assume that the velocity distribution between the plates is linear.

(ANS: 13.3 N/m² in direction of moving plate)

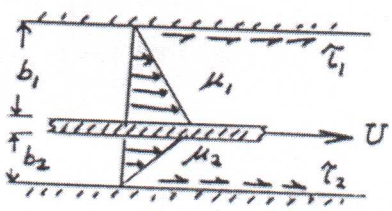


■ FIGURE P1.10R

[1] (a) نوبة : $\tau = \mu \frac{du}{dy} = \mu \frac{U}{b}$ so that

تعويض [1/2] $\tau_1 = \mu_1 \frac{U}{b_1} = \left(0.02 \frac{N.s}{m^2}\right)\left(\frac{4 \frac{m}{s}}{0.006 m}\right)$

نتائج [1/2] $= 13.3 \frac{N}{m^2}$



1/2 $\tau_2 = \mu_2 \frac{U}{b_2} = \left(0.01 \frac{N.s}{m^2}\right)\left(\frac{4 \frac{m}{s}}{0.003 m}\right)$

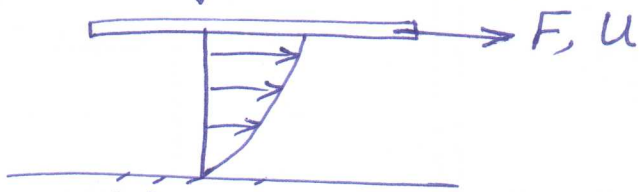
1/2 $= 13.3 \frac{N}{m^2}$ Stresses act on fixed walls in direction of moving plate.

A) Define with mentioning units :-

- specific weight : weight per unit volume $\omega = \frac{W}{V} = \rho g$ N/m³ $\omega_w = 1000 * 9.8$ N/m³

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

$\mu_w = 0.001$ N.s/m² or Pa.s



- Bulk modulus of Elasticity : $K = \frac{-\Delta P}{\Delta V / V}$ (Pa)

* large values of K means that big change of pressure causes small change in volume. The fluid is incompressible.

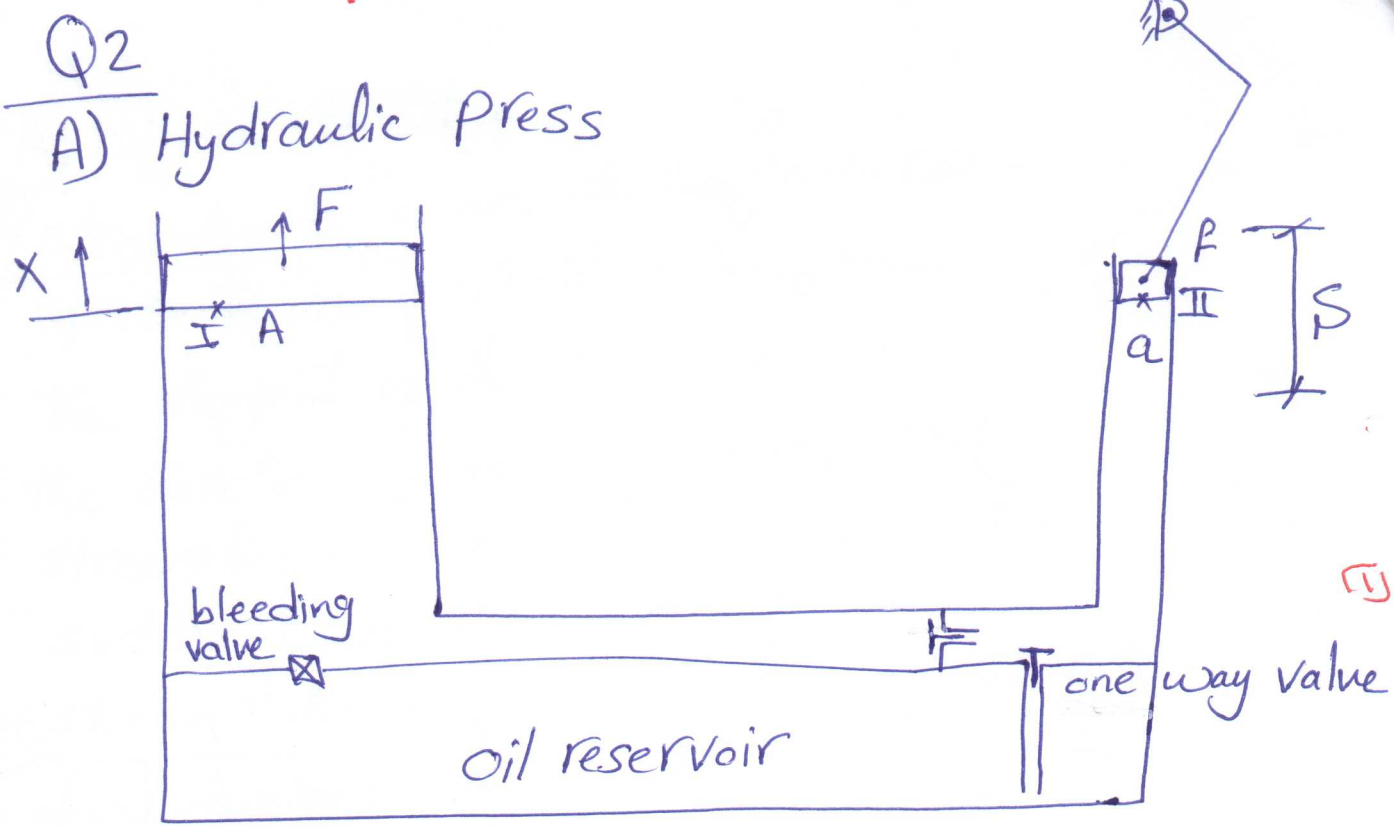
K = - - - * 10^9 Pa

* small values of K means that small change of pressure causes large change in volume. The fluid is compressible

K = - - - * 10^6 Pa

Q2

A) Hydraulic Press



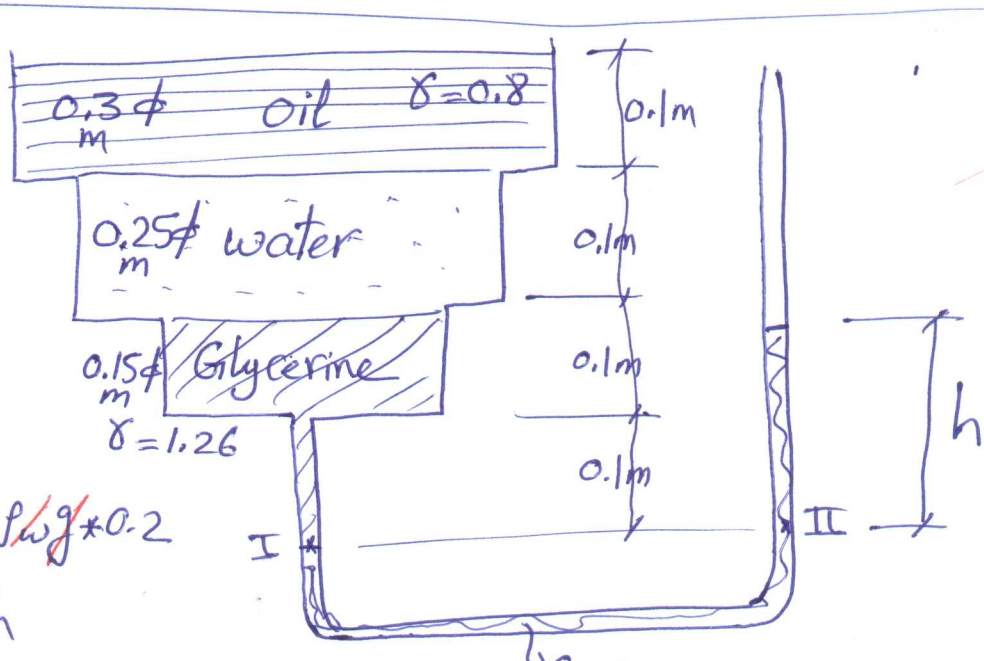
$$P_I = P_{II}$$

$$\frac{F}{A} = \frac{f}{a} \qquad \therefore F = f * \frac{A}{a}$$

$$\eta = \frac{o/p}{i/p} < 1 \qquad \therefore o/p = \frac{F X}{t} \text{ watt}$$

$$\therefore i/p = \frac{o/p}{\eta} = \frac{F X}{t \eta}$$

B) h = ??



$$P_I = P_{II}$$

$$P_{atm} + \rho_o g * 0.1 + \rho_w g * 0.1 + \rho_G g * 0.2 = P_{atm} + \rho_m g h$$

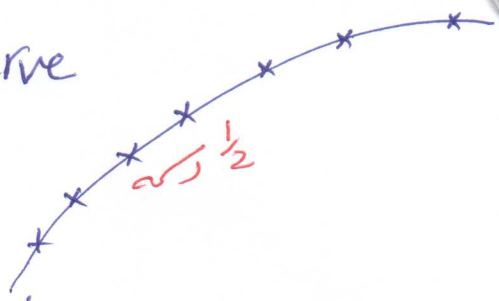
$$\gamma_o \rho_w g * 0.1 + \rho_w g * 0.1 + \gamma_G \rho_w g * 0.2 = \gamma_m \rho_w g h$$

$$h = \frac{0.8 * 0.1 + 0.1 + 1.26 * 0.2}{13.6} = 0.032 m$$

Q3

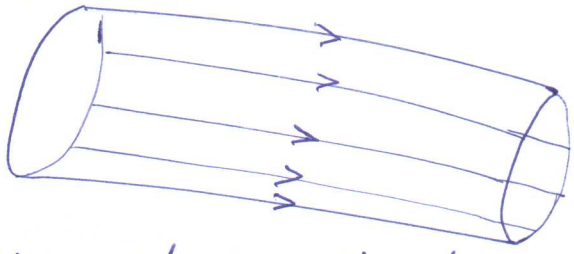
A) Differentiate between:

* streamline is a smooth imaginary curve represents one particle in the flow. The tangent of this line gives the direction of velocity at any point.



streamline can never intersect & they can never have sudden change in direction.

* stream tube is a tube formed of an infinite number of streamlines which are drawn passing through a closed curve in the flow. No flow can go in or out of the sides of this tube.



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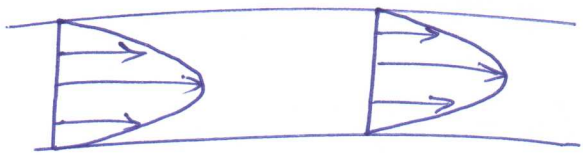
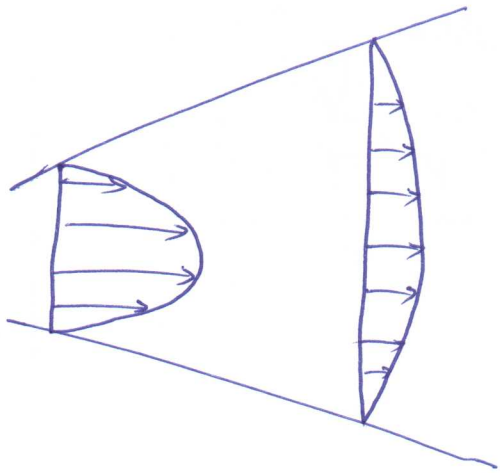
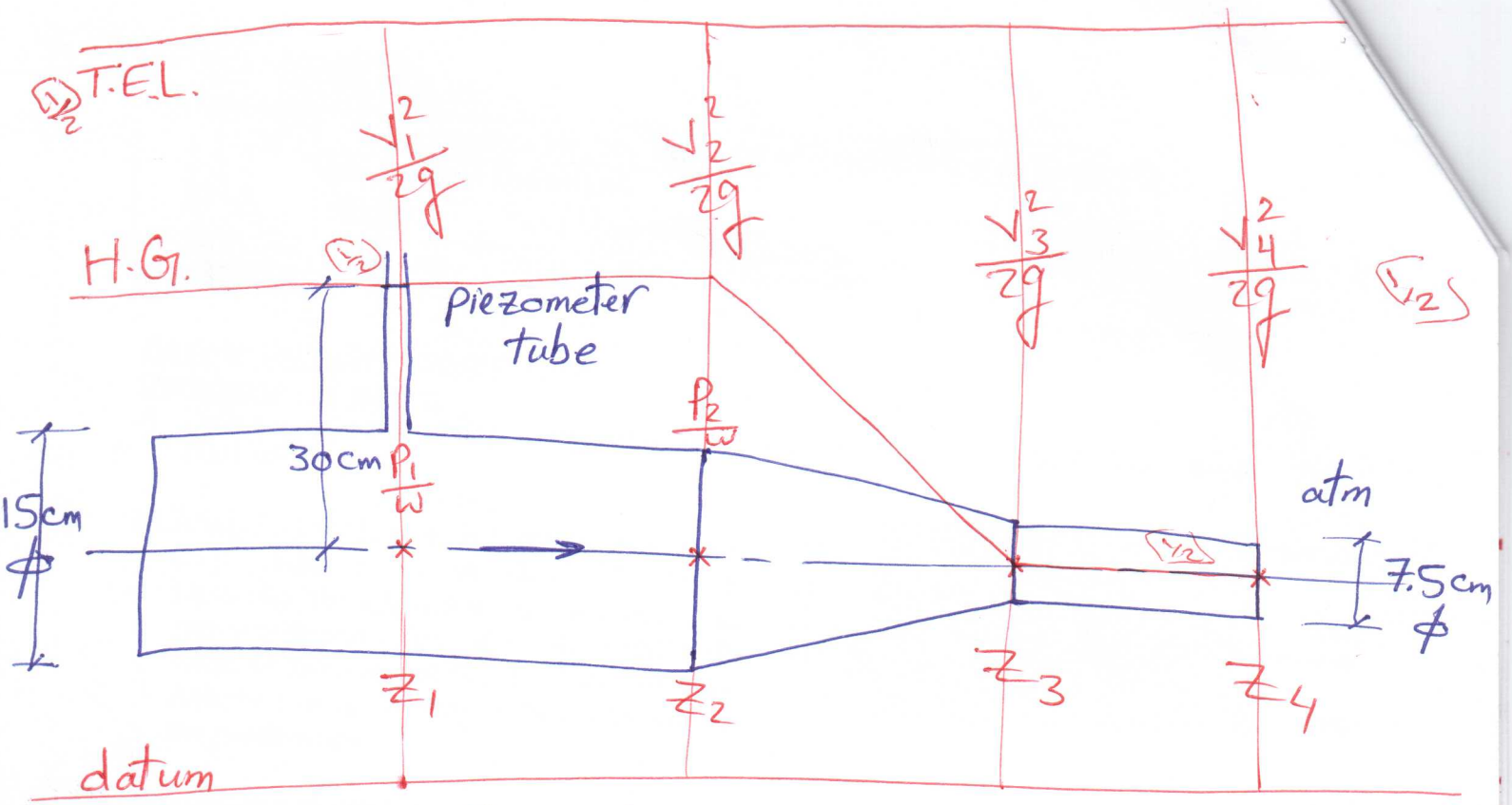
2) * uniform flow: the velocity at a given instant is the same in magnitude and direction at every point in the fluid.



→ from point to point

* Non-uniform flow: the velocity at a given instant changes from point to point.





$$E_1 = E_4 + \cancel{h_{loss}}^{\,0}_{1\to4} \quad \text{ideal flow} \quad (1)$$

$$\cancel{Z_1} + \frac{P_1}{\omega} + \frac{V_1^2}{2g} = \cancel{Z_4} + \cancel{\frac{P_4}{\omega}}^{\,0\ \text{atm}} + \frac{V_4^2}{2g}$$

same horizontal line

$$\frac{P_1}{\omega} = \frac{V_4^2 - V_1^2}{2g} \quad (1/2)$$

$$\boxed{\frac{P_1}{\omega} = 30\,cm} \quad (1)$$

$$Q = A_1V_1 = A_4V_4$$

$$\frac{\pi}{4}(15)^2 V_1 = \frac{\pi}{4}(7.5)^2 V_4$$

$$V_1\frac{(15)^2}{(7.5)^2} = V_4$$

$$\boxed{4V_1 = V_4} \quad (2) \quad (1/2)$$

from (1) & (2)

$$30*10^{-2} = \frac{16V_1^2 - V_1^2}{2*9.8}$$

$$\therefore V_1 = 0.626 \ m/sec$$

$$Q = A_1V_1 = \frac{\pi}{4}(15*10^{-2})^2 * 0.626$$

$$= 0.011064 \ m^3/sec$$

$$= 11.064 \ lit/sec \quad (1/2)$$

14.5