COLLEGE OF ENGINEERING & TECHNOLOGY

Department: Mechanical Engineering

Lecturer : Dr. Rola Afify

Course : Fluid Mechanics I.

Course No .: ME 361 **Marks : 40.**

Date : 3 - 8 - 2013 **Time: 2 hours**

FINAL Examination Paper

Answer the following questions:

Question No. 1. [10 marks]

a) The pressure of 1 m^3 of a fluid is increased 10 to 20 bar at a constant temperature, calculate the final volume of water ($k = 2 \times 10^9$ N/m^2). [3M]

$V_1 = 1 m^3$ $P_2 = 20$ bar , $P_1 = 10$ bar

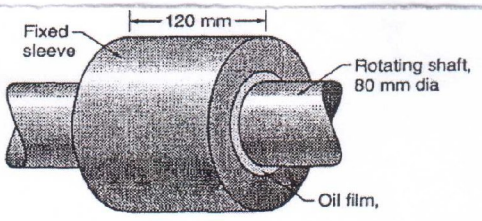
$V_2 = ??$ $K = 2 * 10^9$ N/m^2

$$K = \frac{-\Delta P}{\Delta V / V_1} = \frac{-(20-10) * 10^5}{\Delta V / 1} = 2 * 10^9$$

$$\Delta V = \frac{-10 * 10^5}{2 * 10^9} = -5 * 10^{-4}$$

$V_2 - 1 = -5 * 10^{-4}$ $\therefore V_2 = 0.9995$ m/sec

b) A journal bearing consists of an 80mm diameter shaft in an 80.4mm diameter and a 120mm long sleeve, the clearance space is assumed to be uniform and is filled with oil having an absolute viscosity of 0.11 N.s/m^2. Calculate the needed power to overcome viscosity when the shaft turns at 150 rpm. [4M]



$d = 80$ mm $D = 80.4$ mm $l = 120$ mm

$\mu = 0.11$ N.S/m^2 $N = 150$ rpm

$$\text{Power} = T * \omega = F * \omega * r \longrightarrow (1)$$

$$F = \mu A \frac{du}{dy} = \mu * \pi d l * \frac{\omega r}{\left(\frac{D-d}{2}\right)} \longrightarrow (2)$$

$$\omega = \frac{\pi d N}{60} = \frac{\pi * 80 * 10^{-3} * 150}{60} = \frac{\pi}{5} = 0.628 \frac{rad}{sec}$$

sub. in (2)

$$F = 0.11 * (\pi * 80 * 10^{-3} * 120 * 10^{-3}) * \frac{0.628 * \frac{80 * 10^{-3}}{2}}{\frac{0.4 * 10^{-3}}{2}}$$

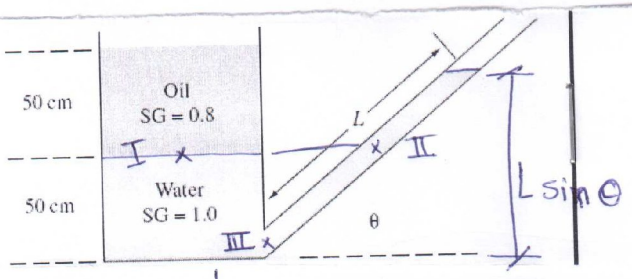
$$= 0.4167 \quad N$$

sub. in (1)

$$\text{power} = 0.4167 * 0.628 * \frac{80 * 10^{-3}}{2}$$

$$= 0.010467 \quad \text{Watt}$$

c) Both the tank and the tube are opened to atmosphere. If L = 2.13 m, what is the angle of tilt θ of the tube? [3M]



$L = 2.13$ m

$\theta = ??$

$$P_I = P_{II}$$

$$\gamma_o * 50 * 10^{-2} = \rho g (L \sin\theta - 50 * 10^{-2})$$

$$0.8 * 0.5 = 2.13 \sin\theta - 0.5$$

$$2.13 \sin\theta = 0.5 + 0.8 * 0.5$$

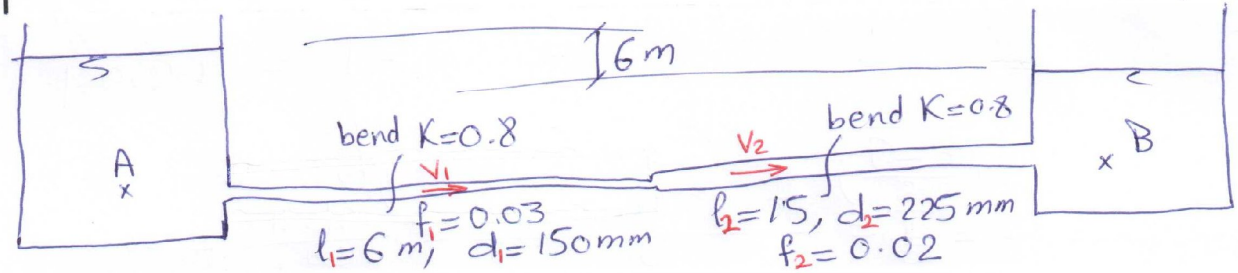
$$\sin\theta = \frac{30}{71} = 0.423 \qquad \therefore \theta = 25^\circ$$

Question No. 2. [10 marks]

a) State the scientific expression of the following:- [5M]

i. Weight per unit volume (specific weight)
ii. It is a substance which deforms continuously under the action of shearing forces. (Fluid)
iii. It is the pressure at which a liquid start to boil at working temperature. (vapor pressure)
iv. The fluid property that is measured by m^2/s. (Kinematic viscosity)
v. It means frictionless flow, no energy is lost, and viscosity is considered Zero. (Ideal flow)

b) Two reservoirs are connected by a pipeline which is 150 mm diameter for the first 6 m and 225 mm diameter for the remaining 15 m. The entrance and exit are sharp and the change of section is sudden. The water surface in the upper reservoir is 6 m above that in the lower. Each pipe contains a bend (k = 0.8), take f = 0.03 for the 150 mm pipe and f = 0.02 for the 225 mm pipe. Calculate the discharge. [5M]



$Q = ??$

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

$$6 = K_{max.\ cont.} \frac{V_1^2}{2g} + f_1 \frac{l_1}{d_1} \frac{V_1^2}{2g} + K_{max.\ ent.} \frac{(V_1 - V_2)^2}{2g} + f_2 \frac{l_2}{d_2} \frac{V_2^2}{2g} +$$

vel. in tank $= 0$

$$K_{max.\ ent.} \frac{(V_2 - V_B)^2}{2g} + K_{bend} \frac{V_1^2}{2g} + K_{bend} \frac{V_2^2}{2g} \longrightarrow (1)$$

$$Q = A_1 V_1 = A_2 V_2$$

$$\frac{\pi}{4} (150 * 10^{-3})^2 * V_1 = \frac{\pi}{4} (225 * 10^{-3})^2 * V_2$$

$$\frac{(150)^2}{(225)^2} V_1 = V_2$$

$$\therefore V_2 = \frac{4}{9} V_1 = 0.444\, V_1 \longrightarrow (2)$$

sub. in (1)

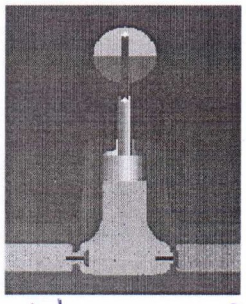
$$6 = \frac{V_1^2}{2g} \left[0.5 + 0.03 * \frac{6}{0.15} + 1 \left(1 - \frac{4}{9}\right)^2 + 0.02 * \frac{15 * \left(\frac{4}{9}\right)^2}{0.225} + 1 * \left(\frac{4}{9}\right)^2 + 0.8 + 0.8 * \left(\frac{4}{9}\right)^2 \right]$$

$$V_1^2 = \frac{6 * 2 * g}{[3.43]} = 34.31 \qquad \therefore V_1 = 5.857 \frac{m}{sec}$$

$$Q = \frac{\pi}{4} (0.15)^2 * 5.857 = 0.1035\ m^3/sec$$

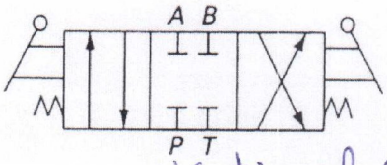
Question No. 3. [10 marks]

a) Write down the words that represent each of the following: [5M]

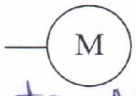


piston pump
(i)

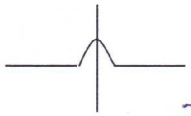
uni-directional variable displacement hydraulic Motor
(ii)



directional control valve 3 envelops, 4 ways, Spri Centered, manually actuated
(iii)



electric Motor
(iv)



Passing line (piping)
(v)

b) Write the functions of:-
i. Oil tank. [2M]
ii. Valves. [2M]
iii. Piping. [1M]

i) functions of oil tank:-
① storing oil
② cooling oil
③ separation of air from oil
④ draining of impurities from the bottom of tank.

ii) functions of valves
① protect the components of circuit.
② control oil direction
③ control pressure
④ control discharge.

iii) function of piping is transmitting oil between the hydraulic circuit components.

Question No. 4. [10 marks]

a) Draw a complete hydraulic circuit used to move a cylinder forward and backward with a controllable velocity. This circuit contains:- [7M]

i. Vented reservoir with line under oil surface.
ii. Single variable displacement hydraulic pump.
iii. Electric motor.
iv. Filter.
v. Check valve
vi. Relief valve.
vii. Directional control valve two envelops four ways using solenoid actuated.
viii. Variable flow control valve.
ix. Differential double acting cylinder.

b) Mention how the previous hydraulic circuit works. [3M]

b) when the left solenoid in (vii) activated oil flows from the pump through (viii) to (ix) then the cylinder goes right (extened)

- the same when the right solenoid activated the cylinder goes left (retracted).

(a)