COLLEGE OF ENGINEERING & TECHNOLOGY

Department: Mechanical Engineering

Lecturer : Dr. Rola Afify

Course : Fluid Mechanics I.

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

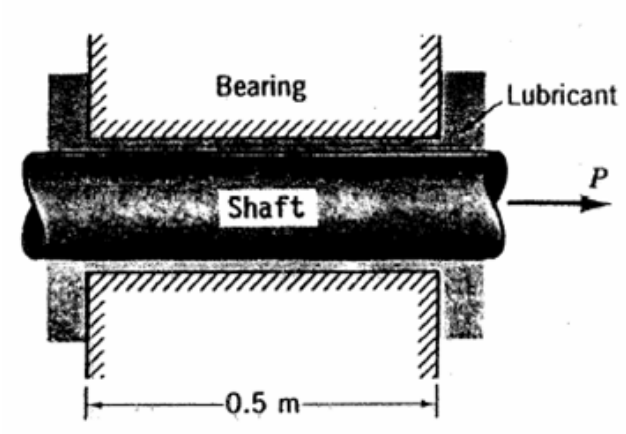
Date : 4 - 8 - 2015 **Time: 2 hours**

FINAL Examination Paper

Answer the following questions:

Question No. 1. [10 marks]

a) 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. [4M]



d = 25mm, y = 0.3 mm, $\upsilon = 8x10^{-4} m^2/s$, sp.gr. = 0.91
P = ?? , u = 3 m/s, linear velocity distribution.

$$\upsilon = 8x10^{-4} = \frac{\mu}{\rho}$$

$$\rho = sp.gr.x\rho_{water} = 0.91x1000 = 910kg/m^3$$

$$\mu = \upsilon x\rho = 8x10^{-4} x910 = 0.728Pa.s$$

$$F_{visc} = \mu\ A\ \frac{du}{dy}$$

$$P = 0.728x(\pi dl)x\frac{3}{0.3x10^{-3}} = 0.728x(\pi\ x25x10^{-3} x0.5)x\frac{3}{0.3x10^{-3}} = 286N$$

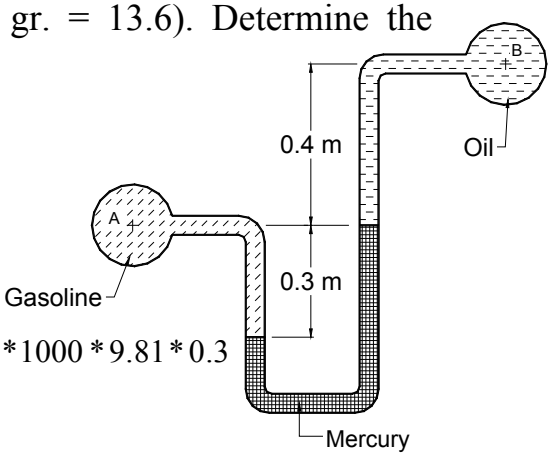
b) A diver is working at a depth of 18 m under sea water surface; calculate the pressure at this depth in gauge and absolute values if the specific gravity of sea water is 1.02. [2M]

$$P = \omega h = sp.\rho gh$$

$$= 1.02*1000*9.81*18 = 18101111.6\ N/m^2$$

$$P_{abs} = P_{gage} + P_{atm} = 1810111.6 + 101300 = 281411.6\ N/m^2$$

b) In Figure, pipe (A) contains gasoline (sp. gr. = 0.7), pipe (B) contains oil (sp. gr. = 0.9), and the manometer fluid is mercury (sp. gr. = 13.6). Determine the pressure difference between A and B. [4M]



$$P_I = P_{II}$$

$$P_A + \rho_{Gasoline} gx0.3 = P_B + \rho_{meercury} gx0.3 + \rho_{oil} gx0.4$$

$$P_A - P_B = \rho_{meercury} gx0.3 + \rho_{oil} gx0.4 - \rho_{Gasoline} gx0.3$$

$$= 13.6*1000*9.81*0.3 + 0.9*1000*9.81*0.4 - 0.7*1000*9.81*0.3$$

$$= 41496.3 \ N/m^2$$

Question No. 2. [10 marks]

a) State whether the following statements are true or false? For wrong statement, write down the correct one. [4M]

i. The flow is always from the point of higher pressure to the point of lower pressure.

x higher total energy to the point of lower total energy

ii. The only energy loss for a flow in a pipe is friction loss.

x friction loss and eddy loss

iii. In laminar flow, the fluid moves in parallel layers.

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iv. For a viscous flow in a small diameter pipe, the flow expected to be turbulent.

x for higher viscosity flow and a small diameter pipe, then Reynolds number is expected to be laminar

b) 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. [6M]

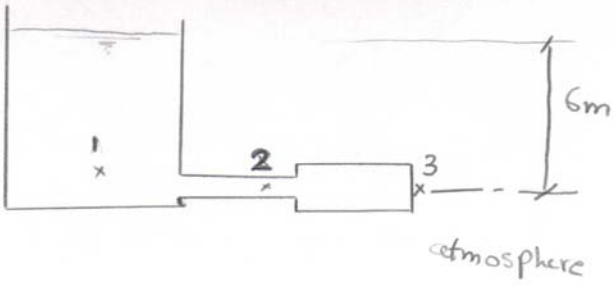
50 mm = 0.05 m

L = 45 m

d = 75 mm

L = 30 m

∴ K = 0.325



$$Q = a_1 v_1 = a_3 v_3$$

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

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

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

$$\therefore v_2^2 = 0.081$$

$$\therefore v_2 = 0.284 \text{ m/sec}$$

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

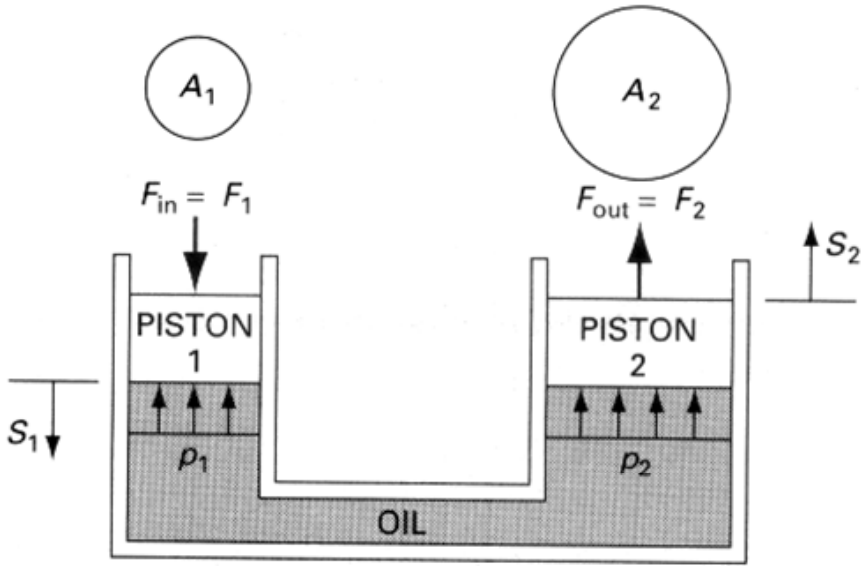
$$= 557.6 \times 10^{-6} \text{ m}^3/\text{sec}$$

Question No. 3. [10 marks]

a) For the Hydraulic jack shown in Figure, the following data are gives:-

$A_1 = 25cm^2$, $A_2 = 100cm^2$, $F_1 = 200N$, and $S_1 = 5cm$.

Determine: F_2 and S_2. [5M]



Solution

a. $$F_2 = \frac{A_2}{A_1} \times F_1 = \frac{100}{25} \times 200 = 800 \text{ N}$$

b. $$S_2 = \frac{A_1}{A_2} \times S_1 = \frac{25}{100} \times 5 = 1.25 \text{ cm}$$

b) A gear pump has a 75mm outside diameter, a 50 mm inside diameter, and a 25mm width. If the volumetric efficiency is 90% at rated pressure, what is the corresponding actual flow rate? The pump speed is 1000 rpm.

Solution The volume displacement is

$$V_D = \frac{\pi}{4}[(0.075)^2 - (0.050)^2](0.025) = 0.0000614 \text{m}^3/\text{rev}$$

Since 1 L = 0.001 m^3, V_D = 0.0614 L.

Next, combine Eqs. (5-2M) and (5-3) to find the actual flow-rate:

$$Q_A = \eta_v Q_T = \eta_v V_D(\text{m}^3/\text{rev}) \times N(\text{rev/min})$$

$$= 0.90 \times 0.0000614 \times 1000 = 0.0553 \text{ m}^3/\text{min}$$

Since 1 L = 0.001 m^3, we have

$$Q_A = 55.3 \text{ Lpm}$$

Question No. 4. [10 marks]

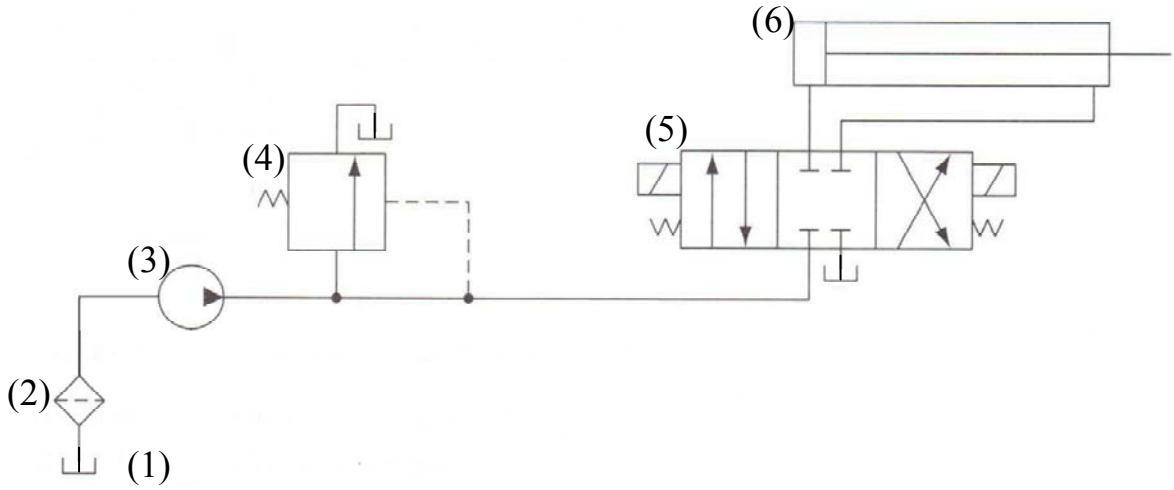
For the hydraulic circuit shown in figure:-

a) Write the name of each component and its function. [6M]

b) What will happen to (6) when:-

i- the left solenoid in (5) is activated. [2M]

ii- the right solenoid in (5) is activated. [2M]



1 – Oil tank
Its Functions:
1 – Storing oil
2 – Cooling oil
3 – Separation of air from oil
4 – Draining of impurities from the bottom of tank.

2- Filter
Its functions: It separates impurities from the hydraulic oil.

3- Single fixed displacement hydraulic pump
Its functions: It transfers mechanical energy into hydraulic energy.

4 – Relief Valve
5- Directional control valve, three positions, four ports, solenoid actuated, spring centered
Their functions:
1 – protect the components of the circuit .
2 – Control oil direction.
3 – Control pressure.

6 – Hydraulic cylinders
Its functions: They transfer Hydraulic energy into mechanical energy translation motion.

b) What will happen to (6) when:-
i- the left solenoid in (5) is activated.
The cylinder will retract.
ii- the right solenoid in (5) is activated.
The cylinder will extend.

Exam committee

Head of department	Prof. Elsayed Saber	
Course coordinator	Prof. Kamal Abd ElAziz	
Course instructor	Dr. Rola Afify	