COLLEGE OF ENGINEERING & TECHNOLOGY

Department : Mechanical Engineering.

Lecturers : Ass. Prof. Rola Afify **Marks: 40**

Course Name : Industrial Hydraulic System **Course Code: ME763E**

Date : 22/01/2023

Final Examination paper

Student Name	
I.D	**Model Answer**

Marks

Question	Actual	Available
1		10
2		10
3		10
4		10
Total		40
Lecturer	Name: Rola Samir Afify	Sign
	Date: 01/2023	

FINAL EXAMINATION PAPER

Question One [10M]

a) What are the advantages and disadvantages of fluid power? [3M]

Advantages

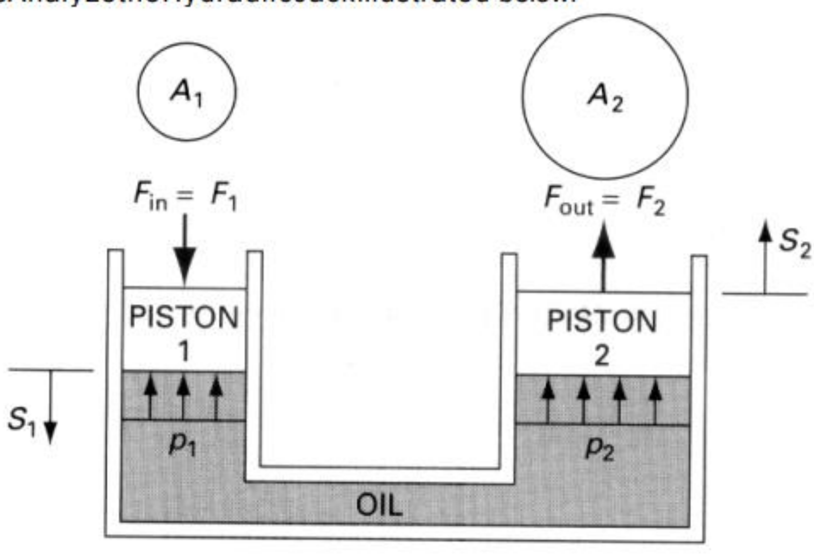
1 – Ease and accuracy of control.
2 – Multiplication of force.
3 – Constant force or torque.
4 – Simplicity, safety and economy.
5 – Protection against overloads.
6 – Infinitely variable speed control.
7 – Have the highest horsepower - per - weight ratio of any known power source.

Disadvantages

1 – Hydraulic oils are messy.
2 – Leakage is impossible to eliminate completely.
3 – Hydraulic lines can burst (high speed oil jets and flying pieces of metal).
4 – Loud noise from pumps (loss of hearing).
5 – Most hydraulic oils can cause fires if oil leaks in an area of hot equipment.

b) Does a Hydraulic Jack produce More Energy than it receives? [4M]

Answer:Let'sAnalyzetheHydraulicJackillustrated below.



$$P_1 = P_2$$

$$\frac{F_1}{A_1} = \frac{F_2}{A_2}$$

$$\frac{F_1}{F_2} = \frac{A_1}{A_2}$$

--------------→ (1)

$$\text{Volume}_1 = \text{Volume}_2$$

$$A_1S_1 = A_2S_2$$

$$\frac{S_2}{S_1} = \frac{A_1}{A_2}$$

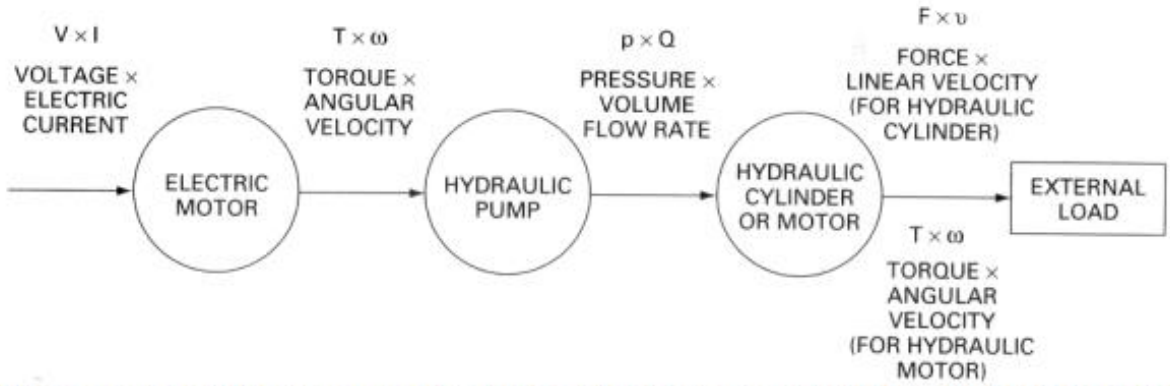
--------------→ (2)

From equations (1) and (2)

$$\frac{F_1}{F_2} = \frac{S_2}{S_1}$$

Then $F_1S_1 = F_2S_2$

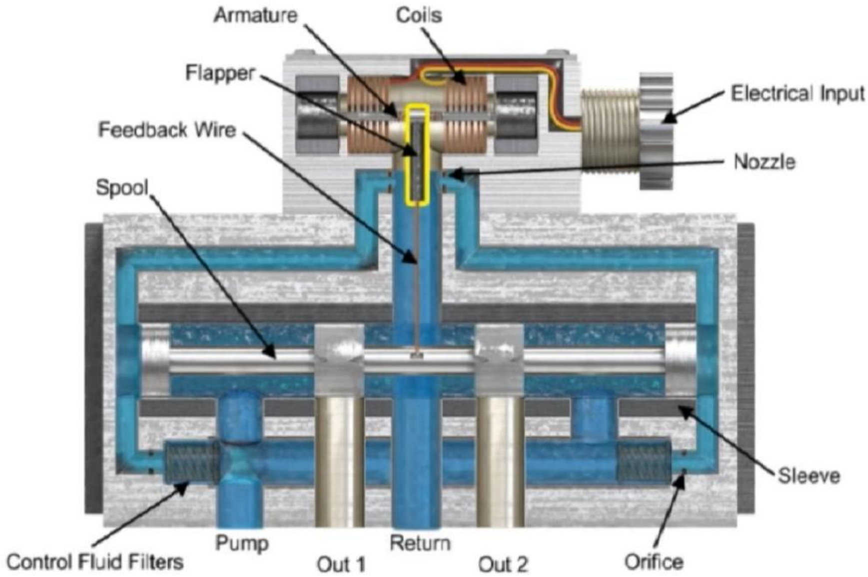
c) Draw the Conversion of Power from Input Electrical to Mechanical to Hydraulic to Output Mechanical in a Hydraulic System. [3M]



Conversion of Power from Input Electrical to Mechanical to Hydraulic to Output Mechanical in a Hydraulic System.

Question Two [10M]

a) Declare Servo Valve Working Principle. [3M]



The torque motor armature moves in response to the electrical flux created by the current flowing through the coils of the force motor. A flapper is connected to the armature by a thin-walled flexure sleeve. The flapper is positioned between two opposing nozzles. Fluid at system pressure flows through these nozzles. Branching off from the inlet passage of each of the nozzles is a connection to each end of the main spool. When no input current is applied to the torque motor, the flapper remains centered between the two nozzles, and pressure between each of the nozzles and the flapper remains balanced, and the pressures at the ends of the spool remain balanced. Also connected to the flapper is a thin length of stainless-steel wire, termed a feedback spring. The free end of the feedback spring rests in a groove in the main spool. In this way, the spool position is mechanically fed back into the flapper nozzle assembly.

b) Compare between Dynamic seals types. [3M]

The following represent the most widely used types of seal configurations:

1. <u>O-rings:</u> The O-ring is one of the most widely used seals for hydraulic systems. It is a molded, synthetic rubber seal that has a round cross section in its free state, for several different-sized O-rings, which can be used for most static and dynamic conditions. These O-ring seals give effective sealing through a wide range of pressures, temperatures, and movements with the added advantages of sealing pressure in both directions and providing low running friction on moving parts.
2. <u>Compression packings</u> (V- and U-shapes): V-ring packings are compression-type seals that are used in virtually all types of reciprocating motion applications. These include rod and piston seals in hydraulic and pneumatic cylinders, press rams, jacks, and seals on plungers and pistons in reciprocating pumps. They are also readily suited to certain slow rotary applications such as valve stems. These packings (which can be molded into U-shapes as well as V-shapes) are frequently installed in

multiple quantities for more effective sealing. These packings are compressed by tightening a flanged follower ring against them. Proper adjustment is essential since excessive tightening will hasten wear.

3. Piston cup packings: Piston cup packings are designed specifically for pistons in reciprocating pumps and pneumatic and hydraulic cylinders. They offer the best service life for this type of application, require a minimum recess space and minimum recess machining, and are simply and quickly installed.
4. Piston rings: Piston rings are seals that are universally used for cylinder pistons. Metallic piston rings are made of cast iron or steel and are usually plated or given an outer coating of materials such as zinc phosphate or manganese phosphate to prevent rusting and corrosion. Piston rings offer substantially less opposition to motion than do synthetic rubber (elastomer) seals. Sealing against high pressures is readily handled if several rings are used.
5. Wiper rings: Wiper rings are seals designed to prevent foreign abrasive or corrosive materials from entering a cylinder. They are not designed to seal against pressure. They provide insurance against rod scoring and add materially to packing life.

c) A steel tubing has a 1.250-in outside diameter and a 1.060-in inside diameter. It is made of SAE 1010 dead soft cold-drawn steel having a tensile strength of 55,000 psi. What would be the safe working pressure for this tube assuming a factor of safety of 8? [3M]

Solution First, calculate the wall thickness of the tubing using $t = \frac{D_o - D_i}{2}$

$$t = \frac{1.250 - 1.060}{2} = 0.095 \text{ in}$$

Next, find the burst pressure for the tubing using $\text{BP} = \frac{2tS}{D_i}$

$$\text{BP} = \frac{(2)(0.095)(55{,}000)}{1.060} = 9860 \text{ psi}$$

Finally, using $\text{WP} = \frac{\text{BP}}{\text{FS}}$ calculate the working pressure at which the tube can safely operate:

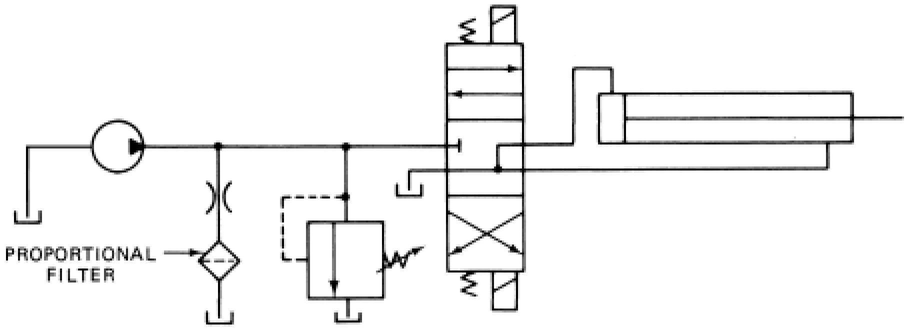
$$\text{WP} = \frac{9860}{8} = 1{,}230 \text{ psi}$$

If we use of Thick-Walled Conductors

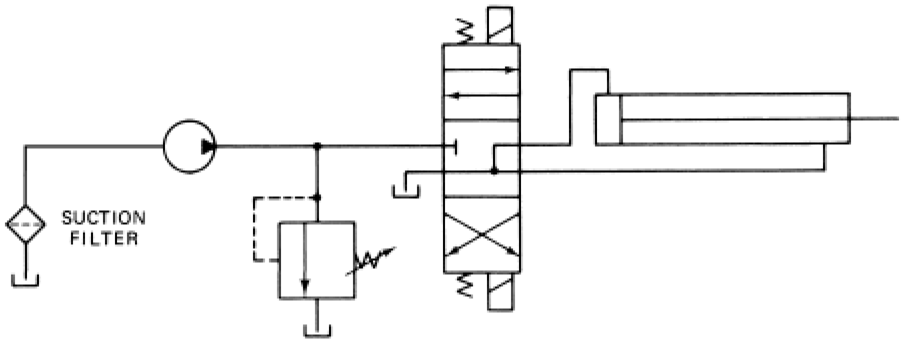
$$\text{BP} = \frac{2tS}{D_i + 1.2t}$$

$$\text{WP} = \frac{\text{BP}}{8} = \frac{tS}{4(D_i + 1.2t)} = \frac{0.095 \times 55{,}000}{4(1.060 + 1.2 \times 0.095)} = 1110 \text{ psi}$$

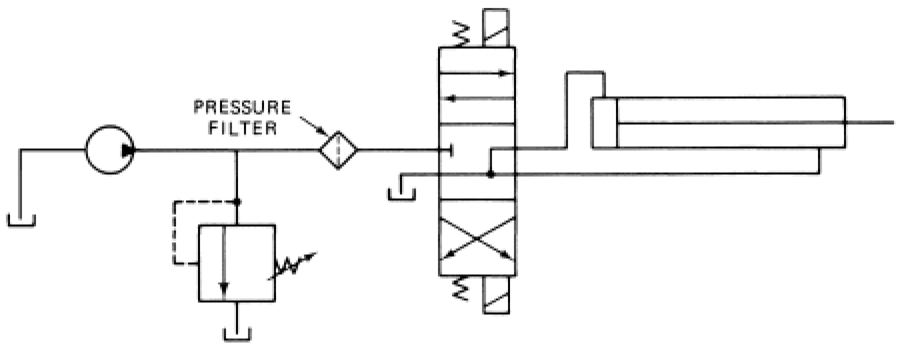
d) Mention four common filter locations in the hydraulic systems [1M]



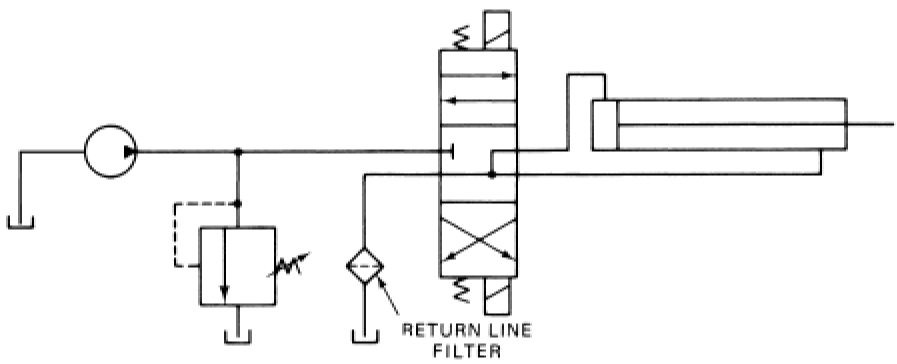
(a) PROPORTIONAL FLOW FILTER IN SEPARATE DRAIN LINE



(b) FULL FLOW FILTER IN SUCTION LINE



(c) FULL FLOW FILTER IN PRESSURE LINE



(d) FULL FLOW FILTER IN RETURN LINE

Question Three [10M]

a) Mention five Selection standards of pipe materials [1M]

1. Operating pressure
2. Flow rate
3. Operating temperature
4. Type of fluid
5. Vibration

b) Mention how to Control of Noise Levels. [3M]

Noise reduction can be accomplished as follows:

1. Make changes to the source of the noise, such as a noisy pump. Problems here include misaligned pump/motor couplings, improperly installed pump/motor mounting plates, pump cavitation and excess pump speed or pressure.
2. Modify components connected to the primary source of the noise. An example is the clamping of hydraulic piping at specifically located supports.
3. Use sound-absorption materials in nearby screens or partitions. This practice will reduce the reflection of sound waves to other areas of the building where noise can be a problem.

c) Mention Probable Causes of Hydraulic System Problems. [3M]

- Noisy pump
- Air entering pump inlet
- Misalignment of pump and drive unit
- Excessive oil viscosity
- Dirty inlet strainer
- Chattering relief valve
- Damaged pump
- Excessive pump speed
- Loose or damaged inlet line.

- Low or erratic pressure
- Air in the fluid
- Pressure relief valve set too low
- Pressure relief valve not properly seated
- Defective or worn pump
- Defective or worn actuator

- No pressure
- Pump turning in wrong direction
- Ruptured hydraulic line
- Low oil level in reservoir
- Pressure relief valve stuck open
- Broken pump shaft
- Full pump flow bypassed to tank due to faulty valve or actuator

- Actuator fails to move
- Faulty pump
- Directional control valve fails to shift
- System pressure too low
- Defective actuator

- Pressure relief valve stuck open
- Actuator load is excessive
- Check valve in backwards

- Slow or erratic motion of actuator
- Air in system
- Viscosity of fluid too high
- Worn or damaged pump
- Pump speed too low
- Excessive leakage through actuators or valves
- Faulty or dirty flow control valves
- Blocked air breather in reservoir
- Low fluid level in reservoir
- Faulty check valve
- Defective pressure relief valve

- Overheating of hydraulic fluid
- Heat exchanger turned off or faulty
- Undersized components or piping
- Incorrect fluid
- Continuous operation of pressure relief valve
- Overloaded system
- Dirty fluid
- Reservoir too small
- Inadequate supply of oil in reservoir
- Excessive pump speed
- Clogged or inadequate-sized air breather.

d) Mention why Reactive Maintenance is the least effective method and what are other possible methods? [3M]

- Because , plant personnel take Corrective Action only after some type of breakdown has Already Occurred . In Process Industry , allowing Failures to happen means that Consequences and Costs of Failure will be Greatly magnified due to Lost Production associated with having Equipment Out of Service .
- Other types:
    i. Preventive Maintenance
    ii. Predictive Maintenance
    iii. Preemptive Maintenance

Question Four [10M]

For the following hydraulic circuit (sequence cylinders), shown in the figure, write down the full name [3M] and the function of each component [4M] also, explain (using sketches) the operation of the hydraulic circuit. [3M].