USN

Internal Assessment Test I

Sub:	Fluid Power Systems					Sub Code:	18ME72	Branch:	Mech		
Date:	11/11/2021	Duration:	90 min's	Max Marks:	50	Sem / Sec:	7th		OBE		
	Answer any Five Questions								MARKS	CO	RBT
1	With a neat sketch explain the basic components of hydraulic system.								10	CO1	L1
2	Explain the construction and functioning of a pressure compensated variable displacement hydraulic vane pump.								10	CO2.	L2
3	Define hydraulic pumps. List the classification. Differentiate between positive displacement pump and non positive displacement pump								10	CO2	L2
4	What are the advantages, limitations and applications of hydraulic systems?								10	CO1	L1
5	State Pascal's law and explain the working of hydraulic jack using Pascal's law.								10	CO1	L2
6	List and explain types of hoses, pipes, and properties of Hydraulic fluids								10	CO1	L1
7	i) Two pistons of a hydraulic lift have diameters of 60 cm and 5 cm. What is the force exerted by the larger piston when 50 N is placed on the smaller piston?(5) ii) A force of 500N applied on a plunger of diameter 5cm of a hydraulic press moves the piston through a distance of 5cm as shown in the figure. What is the maximum weight of load that can be placed on the ram and what will be the displacement if the diameter of the ram is 40cm?(5)								10	CO1	L2

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Internal Assessment Test I Solution

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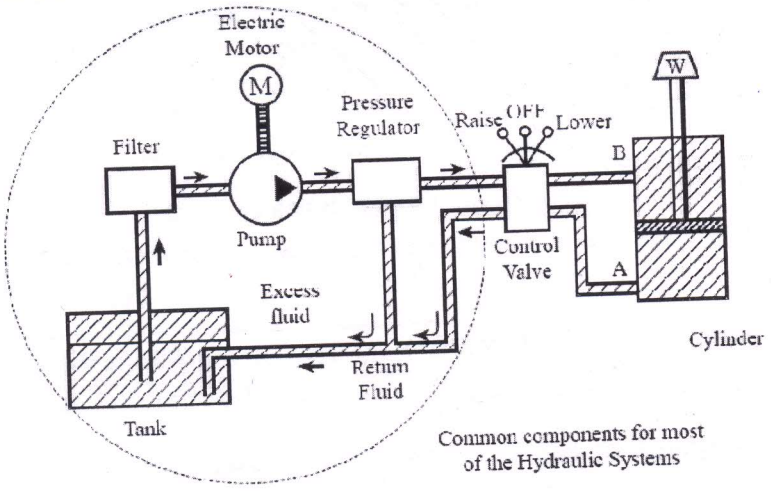
1. With a neat sketch explain the basic components of hydraulic system.

A hydraulic control system is a group of hydraulic components arranged in an order to transmit hydraulic power using oil to perform useful work.

There are eight basic components required in a hydraulic system.

1. A reservoir is used to hold the hydraulic oil.
2. An actuator to convert the fluid power into mechanical power to perform useful work.
3. A pump is used to force the fluid from the reservoir.
4. An electric motor is required to drive the pump.
5. Valves are used to control the direction, pressure and flow rate of a fluid.
6. Piping system carries the hydraulic oil from one place to another.
7. Filters are used to remove any foreign particles so as keep the fluid system clean and efficient.
8. Pressure regulator regulates (i.e. maintains) the required level of pressure in the hydraulic fluid.



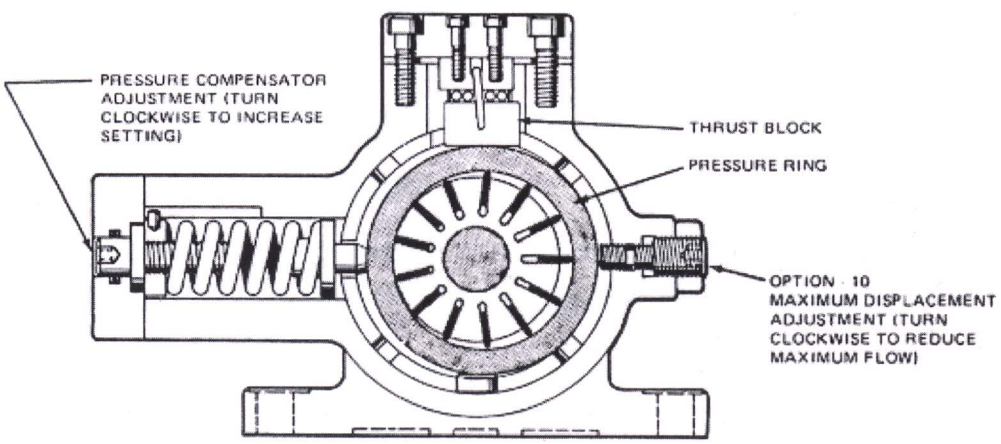
Common components for most of the Hydraulic Systems

The hydraulic system requires a liquid fluid to operate; this is expensive and messy. The piping must act as a closed loop, with fluid transferred from a storage tank to one side of the cylinder, and returned from the other side of the cylinder to the tank.

Fluid is drawn from the tank by a pump which produces fluid flow at the required pressure. A prime move generally an electric motor is required to run the pump. Cylinder movement is controlled by a three-position direction control valve (DCV). To extend the cylinder, port A is connected to the pressure line and port B to the tank. To reverse the motion, port B is connected to the pressure line and port A to the tank. In its centre position the valve locks the fluid into the cylinder.

2. **Explain the construction and functioning of a pressure compensated variable displacement hydraulic vane pump.**

The design we see in Figure is a pressure-compensated one in which system pressure acts directly on the cam ring via a hydraulic piston on the right side (not shown). This forces the cam ring against the compensator spring-loaded piston on the left side of the cam ring. If the discharge pressure is large enough, it overcomes the compensator spring force and shifts the cam ring to the left. This reduces the eccentricity, which is maximum when discharge pressure is zero. As the discharge pressure continues to increase, zero eccentricity is finally achieved, and the pump flow becomes zero. Such a pump basically has its own protection against excessive pressure buildup, as shown in Figure 5



When the pressure reaches a value called Figure Variable displacement, pressure-compensated vane pump.

3. **Define hydraulic pumps. List the classification. Differentiate between positive displacement pump and non positive displacement pump**

A pump, which is the heart of a hydraulic system, converts mechanical energy into hydraulic energy. The mechanical energy is delivered to the pump via a prime mover such as an electric motor. Due to mechanical action, the pump creates a partial vacuum at its inlet. This permits atmospheric pressure to force the fluid through the inlet line and into the pump. The pump then pushes the fluid into the hydraulic

system. There are two broad classifications of pumps as identified by the fluid power industry.

Dynamic (nonpositive displacement) pumps. This type is generally used for low-pressure, high-volume flow applications. Because they are not capable of withstanding high pressures, they are of little use in the fluid power field. Normally their maximum pressure capacity is limited to 15 to 20 bars. This type of pump is primarily used for transporting fluids from one location to another. The two most common types of dynamic pumps are the

1. Centrifugal and

2. Axial flow propeller pumps.

Positive displacement pumps. This type is universally used for fluid power systems. As the name implies, a positive displacement pump ejects a fixed amount of fluid into the hydraulic system per revolution of pump shaft rotation. Such a pump is capable of overcoming the pressure resulting from the mechanical loads on the system as well as the resistance to flow due to friction. These are two features that are desired of fluid power pumps. Advantages of these pumps are a. High-pressure capability (up to 800 bar) b. Small, compact size c. High volumetric efficiency.

4. What are the advantages, limitations and applications of hydraulic systems?

Brief the various advantages of fluid power system.

1. High horsepower-to-weight ratio
2. Safety in hazardous environments because they are inherently spark-free and can tolerate high temperatures.
3. Force or torque can be held constant — this is unique to fluid power transmission.
4. High torque at low speed — unlike electric motors, pneumatic and hydraulic motors can produce high torque while operating at low rotational speeds. Some fluid power motors can even maintain torque at zero speed without overheating.
5. Pressurized fluids can be transmitted over long distances and through complex machine configurations with only a small loss in power.
6. Multi-functional control — a single hydraulic pump or air compressor can provide power to many cylinders, motors, or other actuators
7. Elimination of complicated mechanical trains of gears, chains, belts, cams, and linkages.
   Motion can be almost instantly reversed

Applications of fluid power systems

1. Fluid power systems find application in automobile industries, such as Power steering, power brakes, suspension systems, hydrostatic transmission.
2. Agriculture equipments such as tractors, mowers, ploughs, chemical and water sprayers, fertilizer spreaders, harvesters.
3. Construction equipments such as excavators, lifts, bucket loaders, crawlers.
4. Amusement park entertainment rides such as roller coasters.
5. Automated machine tools, numerically controlled(NC) machine tools, Automated transfer lines, robotics.
6. Medical equipment such as breathing assistors, heart assist devices, cardiac compression machines, dental drives.

   Fluid power equipments in aviation such as landing wheels in aircraft, Helicopters, aircraft trolleys, aircraft test beds, luggage loading and unloading systems, ailerons, aircraft servicing, flight simulators

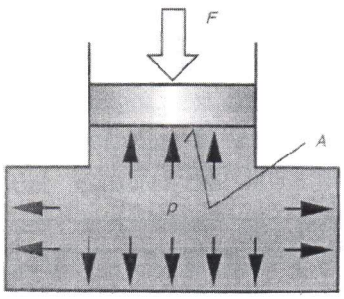
   Drawbacks of Fluid Power

   1. Hydraulic fluids are messy
   2. Susceptible to damage by dirt or contamination
   3. Physical injury from high speed particles
   4. Fire or explosion hazard
   5. Prolonged exposure to loud noise

5. State Pascal's law and explain the working of hydraulic jack using Pascal's law.

Pascal's Law is the most fundamental principle in fluid power. It deals with hydrostatics, the transmission of force through a confined fluid under pressure.

Pascal's law reveals the basic principle of how fluid power systems perform useful work. This law can be stated as follows: "Pressure applied to a confined fluid is transmitted undiminished in all directions throughout the fluid and acts perpendicular to the surfaces in contact with the fluid".



Pressure in an enclosed fluid can be considered uniform throughout a practical system. There may be small differences arising from head pressures at different heights, but these will generally be negligible compared with the system operating pressure. This equality of pressure is known as *Pascal's law,* and is illustrated in figure above.

The applied force develops a pressure, given by the expression:

$p = f/a$

The force on the base is:

$F = p \times A$

from which F can be derived as:

$F = f \times A/a$

The above expression shows an enclosed fluid may be used to magnify a force.

The principle of Pascal's law was successfully applied by an English engineer, Mr. Joseph Bramah, to develop a hydraulic press in which by applying a small input force a large output force was generated.

6. List and explain types of hoses, pipes, and properties of Hydraulic fluids

In a hydraulic system, the fluid flows through a distribution system consisting of conductors and fittings, which carry the fluid from the reservoir through operating components and back to the reservoir. Since the power is transmitted throughout the system by means of these conducting lines, it follows that they must be properly designed in ordered for the total system to function properly. Hydraulic system consists of four types of conductors:

1. Steel pipes
2. Steel tubing
3. Plastic tubing
4. Flexible hoses

Steel pipes are still extensively used in fluid power systems, although they are rapidly being supplemented by steel or plastic tubing. The major disadvantages of steel pipes are their weight and the large number of fitting requirement for connection and its greatest advantage is its mechanical strength. Steel pipes are sized according to the nominal diameter that is neither the outside nor the inside diameter, while the wall thickness is specified by a schedule number. Most of the industries seldom use metric designation while designing and buying pipes. The prime considerations for selecting conductors for a hydraulic power system are the type of materials, capacity and pressure rating. Steel pipe fittings are most often fabricated from malleable iron that has a sufficient strength and ductility to withstand forces encountered in a fluid power system. Steel tubing is the most widely used material for hydraulic system conductors. One major reason of its popularity is the fact that it can be easily formed to fit irregular paths so that fewer fittings are required.

Plastic tubing is now available in polyethylene, polypropylene, polyvinyl chloride and nylon. Each material has specific characteristics that make it more suitable for some services than for others

Hydraulic hose can be divided into two categories: fabric-reinforced and wirereinforced. The fabric-reinforced hose has a plastic (or rubber) inner tube covered by one or more layers of woven fabric.

Properties of hydraulic fluids

- Viscosity. Viscosity is a measure of a hydraulic fluid's resistance to flow. ...
- Compressibility. ...
- Wear Resistance. ...
- Oxidation Stability. ...
- Thermal Stability. ...
- Filterability. ...
- Rust and Corrosion Protection. ...
- Foam Resistance.

7. **i) Two pistons of a hydraulic lift have diameters of 60 cm and 5 cm. What is the force exerted by the larger piston when 50 N is placed on the smaller piston?(5)**

   ii) A force of 500N applied on a plunger of diameter 5cm of a hydraulic press moves the piston through a distance of 5cm as shown in the figure. What is the maximum weight of load that can be placed on the ram and what will be the displacement if the diameter of the ram is 40cm?(5)

Solution

Since, the diameter of the pistons are given, we can calculate the radius of the piston

$$r = \frac{D}{2}$$

$$\text{Area of smaller piston, } A_1 = \pi\left(\frac{5}{2}\right)^2 = \pi(2.5)^2$$

$$\text{Area of larger piston, } A_2 = \pi\left(\frac{60}{2}\right)^2 = \pi(30)^2$$

$$F_2 = \frac{A_2}{A_1} \times F_1 = (50N) \times \left(\frac{30}{2.5}\right)^2 = 7200N$$

This means, with the force of 50 N, the force of 7200 N can be lifted.