SUMMER – 16 EXAMINATION

Subject Code: **17608 (Industrial Fluid Power)** **Model Answer**

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills).
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. 1. a) Attempt any three

i) State the functions of: (1/2 x4= 2 marks) (1/2 mark for each function)

1) Actuator:

1) To produce motion in one line

2) To produce continuous rotary motion

3) To produce rotary or oscillatory motion less than 360^0

4) To apply a force and clamp the job.

2) Filter:

1) Take care of cleanliness of the components.

2) Reduce the maintenance.

3) To remove silting.

4) To increase the system reliability.

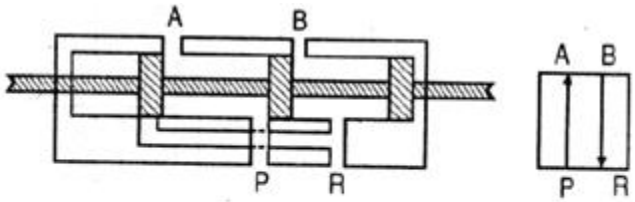
5) To prevent entrance of a solid contaminants to the system.

ii) Draw neat Sketch of 4X2 Valve. Explain working: (2 marks-sketches & 2 marks-working)

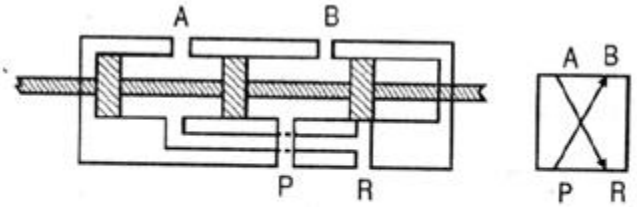
Working: - as shown in the figure below this valve is having 4 ports (A, B, P&R) and two positions.

In first position pressure port P is connected to application port A and application port B is connected to return port R. So the fluid in this position will flow from P towards A and some fluid will return from B.

In second position pressure port P is connected to application port B and application port A is connected to return port R. So the fluid in this position will flow from P towards B while some fluid will return from A.



(a) Flow path P-A & B-R



(b) Flow path P-B & A-R

iii) Enlist any four sources of heat generation in hydraulic system. (1 mark for each source)

1) Pump: If some energy from electric motor is not converted to work, there will be heat generation due to unutilized power.

2) Resistive pressure drops in hydraulic lines.

3) High ambient temperature.

4) Restriction in hydraulic pipe and components.

5) High pressures, high pressures being spilled through the relief valves.

iv) Use of Accumulator (2 Marks) Explanation of any one (02 Marks)

Accumulators are used mainly on the lift equipment to provide positive clamping action on the heavy loads when a pump's flow is diverted to lifting or other operations.

An accumulator acts as a safety device to prevent a load from being dropped in case of an engine or pump failure or fluid leak.

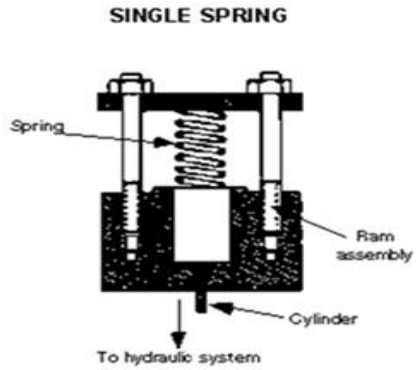
On lifts and other equipment, accumulators absorb shock, which results from a load starting, stopping, or reversal.

Types of Accumulator

. Spring-Loaded Accumulator. It uses the energy stored in springs to create a constant force on the liquid contained in an adjacent ram assembly.

Fig shows spring-loaded accumulator.

- The load characteristics of a spring are such that the energy storage depends on the force required to compress a spring.
- The free (uncompressed) length of a spring represents zero energy storage.As a spring is compressed to the maximum installed length, a minimum pressure value of the liquid in a ram assembly is established.
- As liquid under pressure enters the ram cylinder, causing a spring to compress, the pressure on the liquid will rise because of the increased loading required to compress the spring.



Spring-loaded accumulator

. Bag-Type Accumulator. This accumulator consists of a seamless, high-pressure shell, cylindrical in shape, with domed ends and a synthetic rubber bag that separates the liquid and gas (usually nitrogen) within the accumulator.

- The bag is fully enclosed in the upper end of a shell. The gas system contains a high-pressure gas valve. The bottom end of the shell is sealed with a special plug assembly containing a liquid port and a safety feature that makes it impossible to disassemble the accumulator with pressure in the system.
- The bag is larger at the top and tapers to a smaller diameter at the bottom. As the pump forces liquid into the accumulator shell, the liquid presses against the bag, reduces its volume, and increases the pressure, which is then available to do work.

Bag-type accumulator

Q1 b) Attempt any one

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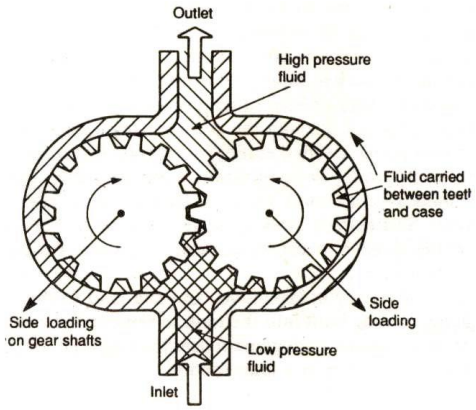
Subject Code: **17608 (Industrial Fluid Power)** **Model Answer**

i) Explanation of Gear Pump (03 Marks) Sketch with construction (03 marks)

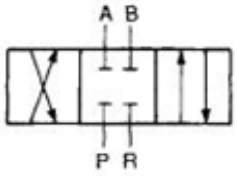


One of the gears is connected to drive shaft which in turn is coupled with prime mover. Second gear gets driven because of meshing (spur gears). Suction side teeth gets unmeshed and discharge side teeth gets mesh. Vacuum generation takes place due to evacuation of teeth. Line contact of the gear teeth over one another prevents flow through the mesh & the close fitting of the housing prevents flow back around the periphery.

Explanation should cover above important points in brief.

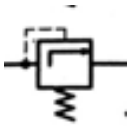
ii) Draw symbols of (2 Marks each)

1) 4X3 DC valve

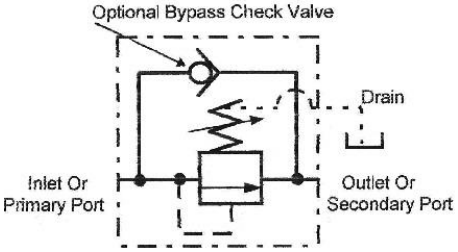


(b) Symbol

2) Pilot operated pressure relief valve



3) Sequence valve



Q2: Attempt any TWO

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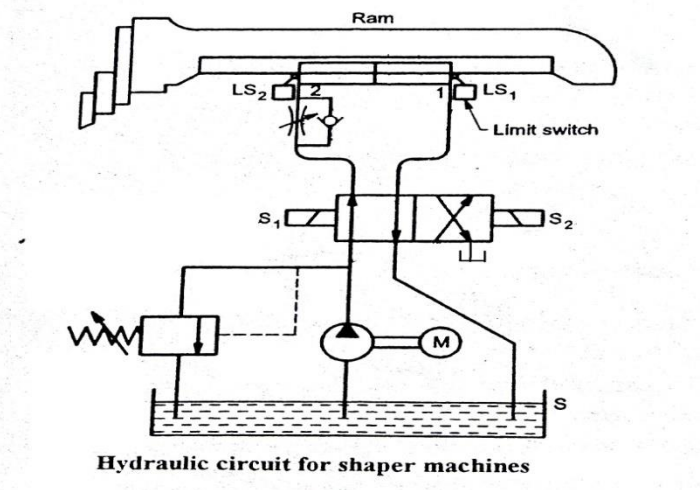
Subject Code: **17608 (Industrial Fluid Power)** **Model Answer**

a) Hydraulic circuit of shaping Explanation (04 Marks) and Sketch (04 Marks)



Hydraulic circuit for shaper machines

Hydraulic Circuit for Shaper Machines

- The Fig. shows the hydraulic circuit for shaping machine. In which the double acting cylinder with through piston rod and 4/2 direction control valve is used.
- Hydraulic power pack supplies the pressurised oil to the 4/2 valve.
- A pressure relief valve is provided in circuit to avoid over loading of circuit.
- In first position the oil is flowing through opening '2' of cylinder through check valve. This is free flow hence return stroke is fast.
- At the end of stroke, the piston actuates the limit switiser LS_2. Due to this solenoid 'S_2', it shift the spool to other position.
- In second position of 4/2 DC valve oil flow to opening 1 of cylinder oil present at rod side of piston flows out through flow control valve.

Q2:- b) **Functions of Pressure Relief valve for Pneumatic system (any two -02 Marks)**

In pneumatic system, pressure regulator is used to regulate the pressure supplied which is one of the element in FRL unit. Also a pressure switch provided in compressor acts as a safety device when the pressure goes above the set pressure. Pressure relief valve is also used in hydraulic system.

1) To relive excessive pressure of air for safety working of system.

2) To maintain the constant pressure of air in the system.

3) To protect the system against over pressure.

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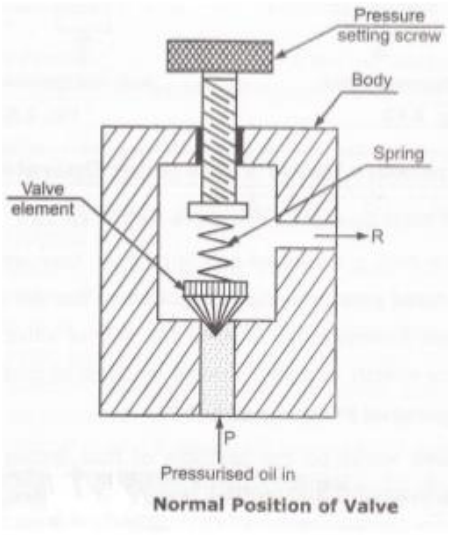
Subject Code: **17608 (Industrial Fluid Power)** **Model Answer**



(Sketch 03 marks)

Working: The compressed air pressure from FRL unit acts against the poppet (valve element) through inlet of pressure relief valve. When the force of air is greater than the spring force then poppet gets lifted from the valve seat and valve opens. Thus the excessive pressurized air will get release to the atmosphere through port R. **(03 marks)**

Q2:- c) Meaning of hose (02 marks)

Hoses are flexible connecting tubes or pipes to connect actuators, control valves.

Factors affecting selection of hose (Any three factors - 03 marks)

1) Flexibility to change the shape it helps to reduce the fittings required in piping layout.

2) It should have easy installation

03) It should be flexible in nature

04) Should have quick connecting & disconnecting ends.

05) Should be available in standard lengths.

06) It should absorb pressure shocks & vibrations.

Different layers of hose (03 marks)

1) Inner tube

2) Reinforcement

3) Outer protective cover

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Q3:- Any Four

a) Advantages of Poppet type DC control (any four advantages – 02 marks)

01) This type of valves tends to hold the valve tightly closed.

02) A slight force applied to the poppet stem opens the poppet.

03) The poppet stem usually has an O ring seal to prevent leakage.

04) Number of poppets in a valve can be used.

05) Poppets can be held in the seated position by springs which gives reliability.

06) Suitable for high pressure systems.

Disadvantages of Poppet type DC control (any four advantages – 02 marks)

01) Due to poppet type construction wear & tear is more.

02) Initial cracking moment of the poppet is difficult.

03) Internal construction is complicated.

04) Fine finishing of the seat is difficult.

05) Less suitable for large valve sizes.

b) Brief description about pipe materials (04 marks)

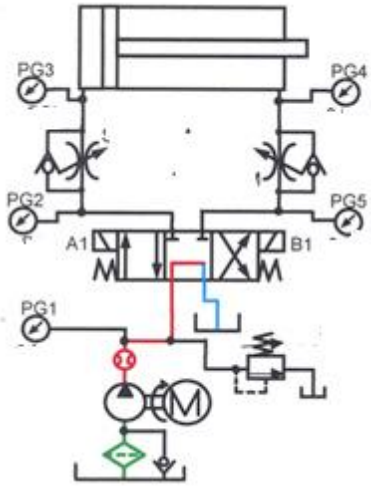
In hydraulic system iron pipe may be used for low to medium pressure range as they are widely available and economical. Steel pipes are commonly used in hydraulics system. Cuprous nickel alloys and stainless steel are also used. Copper pipes are also used in low pressure application.

Zinc coated galvanized pipes and copper tubes are used when oil does not react with them.

Other material includes aluminum, carbon steel, other ferrous nonferrous metals.

c. Working of meter in circuit (02 Marks to sketch and 02 marks to explanation)

Figure shows the components in a meter-in flow-control circuit. Notice that a bypass check valve forces fluid through an adjustable orifice just before it enters the actuator by extending hydraulic cylinder and indicates the pressures and flows in various parts of the circuit. With a meter-in circuit, fluid enters the actuator at a controlled rate. If the actuator has a resistive load, movement will be smooth and steady with a hydraulic circuit. This is because oil is almost non-compressible. On return line fluid passes through the check valve without any resistance. Therefore this circuit is called meter-in circuit



d) Enlist any four applications of hydraulic system (01 Mark to each).

Brief explanation of each

1) Construction equipments

2) Machine tools

3) Material handling devices

4) Automobile

5) Agriculture Equipments

6) Mining

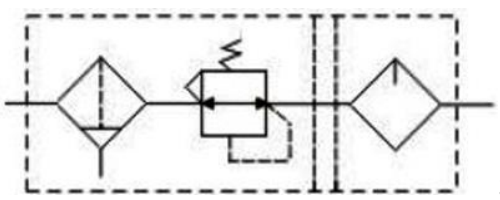
7) Earth moving equipment

e) FRL unit: **(02 marks)**

Filter: To enable the supply of clean, pure and contamination free compressed air, the air is required to be filtered.

Regulator: The system performance and accuracy depends on the pressure stability of the air supply. The regulator maintains this pressure.

Lubricator: The air is supplied with a lubricating film of oil which helps in lubricating the various parts in the downstream.



Symbol OR equivalent fig of FRL

Importance of FRL (02 Marks)

Air leaving a compressor is hot, dirty, and wet—which can damage and shorten the life of downstream equipment, such as valves and cylinders. Before air can be used it needs to be filtered, regulated and lubricated. Dry air may increase the system pressure and seal the moving components so lubrication is essential FRL unit is used for this purpose.

Q 4:- Attempt any THREE

i) Advantages of Pneumatic system (Four points 02 Marks)

1) Infinite availability of the source

2) Easy channeled and Temperature is flexible

3) Safe and clean

4) The transfer of power and the speed is very easy to set up

5) Can be stored and Easy utilized

Disadvantages of Pneumatic system (Four points 02 Marks)

1) Requires installation of air-producing equipment

2) Easy to leak

3) Potential noise

4) Easy condenses

5) Low operating pressure

6) Limited applications.

ii) Features of Air (Any four 04 Marks)

Major characteristics available in the air are termed as features of the air, because of those features air is widely used in industrial applications.

- Wide availability of air

•Compressibility of air

•Easy transportability

•Explosion proof characteristics of the medium

•Simple construction of pneumatic elements and easy handling

•High degree of controllability of pressure, speed and force

•Possibility of easy but reasonably reliable remote controlling

•Easier maintenance

•Comparatively cheaper in cost than other systems

iii) Bi-Directional Air Motor (02 marks Sketch and symbol and 02 marks for Explanation)

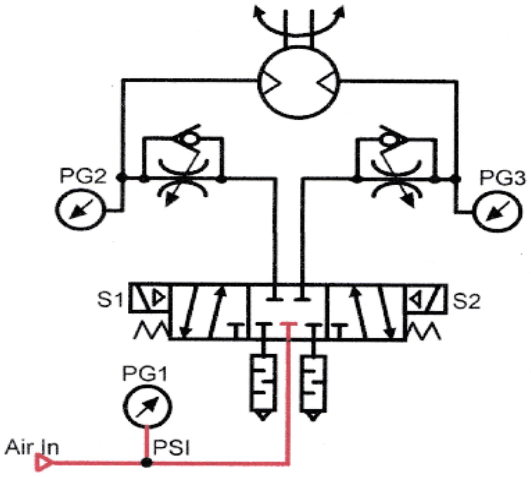
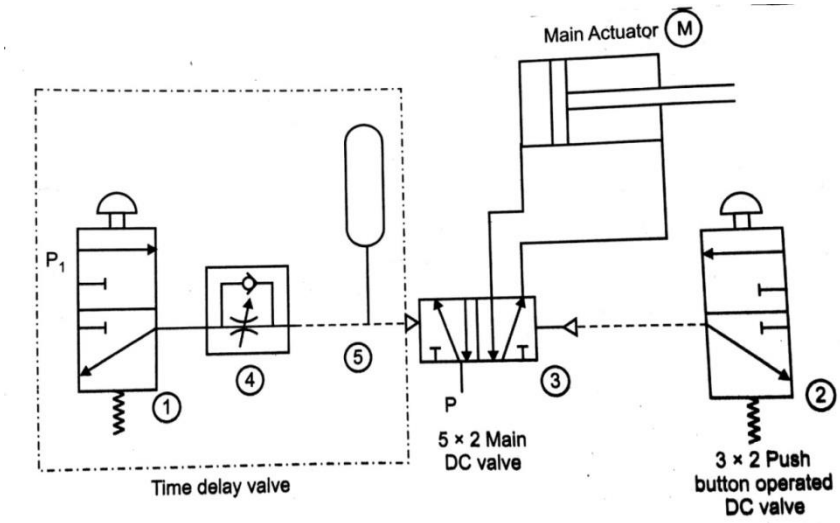


Figure shows the speed control of bi-directional air motor. Two flow control valves control the speed of the motor in either direction. (Proper explanation 02 marks)

iv) Time Delay Pneumatic Circuit (02 Marks for circuit and 02 for Explanation)

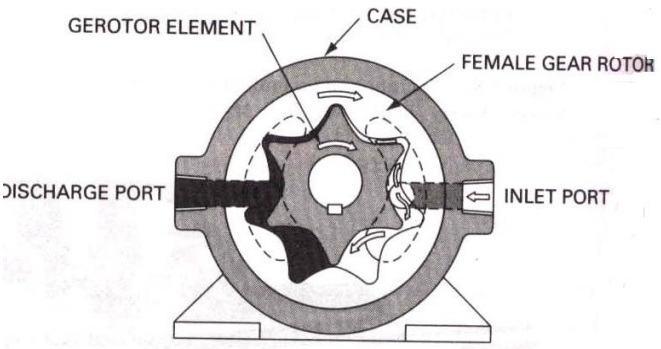


Explanation

Time delay valve is a combination valve used to set the operation time as per the requirement. The time delay can be increased or decreased by adjusting the flow through the non-return flow control valve. The change invariably increases or decreases the time taken to fill and pilot actuates the direction control valve.

b) Attempt any One

i) Sketch and Construction of Gerotor pump (03 M sketch and 03 M for explanation)



Explanation

- It operates much like the internal gear pump.
- Inner gear rotor (Gerotor element) is power driven which draws outer gear rotor
- Centers of the gears are offset by approximately one-half the tooth depth
- Inner gear has one tooth less than the outer one
- Formation of inlet & discharge pumping chambers between the rotor blades
- Sealing the pumping chamber because of meshing teeth
- More compact than the external gear pump
- Gears must be made to high precision

ii) Factors to be considered for selection of seal and causes of failure

(Any six 03 Marks Any three cases 03 Marks)

1. Shaft Speed

The maximum allowable shaft speed is a function of the shaft finish, runout, housing bore and shaft concentricity, type of fluid being sealed and the type of oil seal material.

2. Temperature

The temperature range of the mechanism in which the seal is installed must not exceed the temperature range of the seal elastomer.

3. Pressure

Most conventional oil seals are designed only to withstand very low-pressure applications (about 8 psi or less). If additional internal pressure is present or anticipated, pressure relief is necessary.

4. Shaft Hardness

Longer seal life can be expected with shafts having a Rockwell (RC) hardness of 30 or more. When exposed to abrasive contamination, the hardness should be increased to RC 60.

5. Shaft Surface Finish

Most effective sealing is obtained with optimum shaft surface finishes. The sealing efficiency is affected by the direction of the finish tool marks and the spiral lead. Best sealing results are obtained with polished or ground shafts with concentric (no spiral lead) finish marks. If you must use shafts with spiral finish leads, they should lead toward the fluid when the shaft rotates.

6. Concentricity

When the bore and shaft centers are misaligned, seal life will be shortened because the wear will be concentrated on one side of the sealing lip.

7. Shaft and Bore Tolerances

The best seal performance is achieved when close shaft and bore tolerances are present. Other factors include shaft eccentricity, end play and vibration.

8. Runout

Runout must be kept to a minimum. Movement of the center of rotation is usually caused by bearing wobble or shaft whip. When coupled with misalignment, this problem is compounded. Contrary to popular belief and common practice, the installation of flexible couplings cannot correct or compensate for misalignment.

9. Lubricant

Seals perform much better and longer when they are continuously lubricated with oil that has the correct viscosity for the application and that is compatible with the seal lip elastomer material. The consideration of seal incompatibility, particularly with certain additives and some synthetic lubricants, should not be ignored.

Causes of failure

1. Improper installation is a major cause of hydraulic seal failure. The important things to watch during seal installation are: (a) cleanliness, (b) protecting the seal from nicks and cuts, and (c) proper lubrication

2. Hydraulic system contamination is a another major factor in hydraulic seal failure

3. Chemical breakdown of the seal material .

4. heat degradation problems may involve reducing sea life.

Q 5:- Attempt any TWO

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a) What are different types of pressure regulator? Explain any one of them with neat sketch. (Types – 02 marks, Explain with sketch – 03+03 Marks)

Pressure regulation in pneumatics is vital for the correct operation of circuits and for damage prevention to circuit components. As you would imagine all pneumatic components have a maximum operating pressure.

Types:

A) According to no. of stages

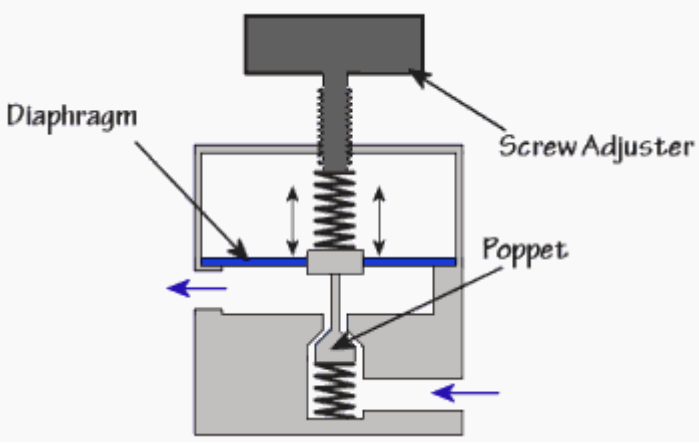
Single stage and two stage regulator

B) According to pressure relief

Non- relieving type and relieving type pressure regulator

Non-relieving pressure regulator

Non-relieving pressure regulators work by restricting flow rather then venting it should over pressure occur. The regulator restricts flow when the pressure gets too high because the pressure acts on the diaphragm forcing it up against the spring pressure, the diaphragm has what is called a 'poppet' attached on the end of it which is drawn up with the diaphragm and restricts the passing air flow.



Non-relieving pressure regulator

b) Explain with sketch working of double acting cylinder. (Sketch-04 marks, explain-04 marks)

A double acting cylinder means the working fluid is fed on both the sides of the cylinder. Initially on one side and after completion of movement the working fluid is fed on the other side of the piston.

It has cylindrical body with two inlet ports; the piston is having close tolerance with a cylinder bore and has piston seals in order to prevent the leakage of the fluid.

. When the working fluid enters through the port on the cover end it pushes the piston in the forward or extended position.

When the working fluid enters through the port on the rod end side it pushes the piston in the reversed or retracted position. It is used when the force is to be applied in both the directions

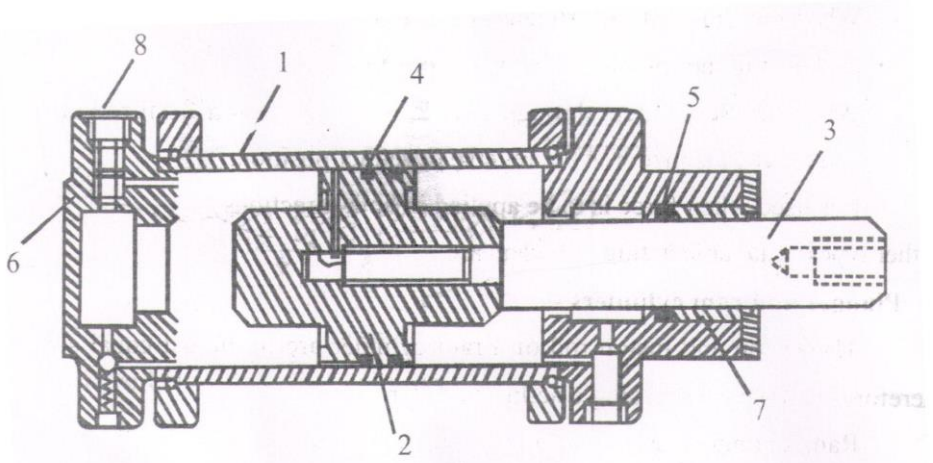
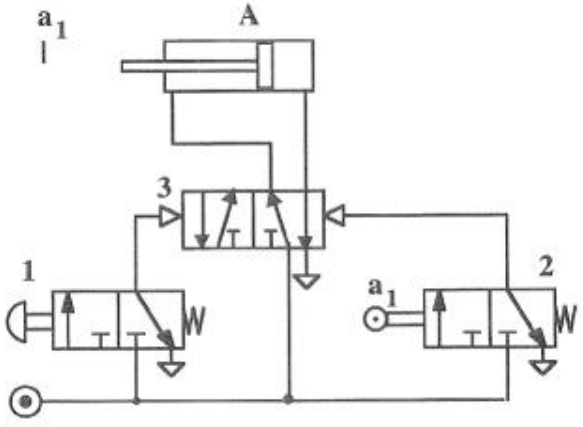


Fig. Double acting cylinder : 1. Tube 2. Piston 3. Piston rod 4. Double O-ring packing on piston 5. O-ring for piston rod 6. End cover 7. Bush 8. Cushion assembly

c) What is meant by an impulse circuit? Draw its circuit diagram.

(Explain-04 marks, Diagram-04marks)

Figure shows a symbol circuit of an impulse-valve controlled double acting pneumatic cylinder (**A**). The position of the impulse-valve (**3**), which is controlled by the start/stop-valve (**1**) and the end position valve (**2**), determines if the cylinder piston shall make a positive (A^+) or negative (A^-) stroke. Positive piston stroke is initiated by manual activation of the start-valve (**1**). Negative piston stroking takes place when valve (**2**) is activated by the cylinder rod at the position $\mathbf{a_1}$.



Impulse control of a pneumatic cylinder.

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Q 6:- Attempt any THREE

a) Classify flow control valves with their application (Any four-04 marks)

Orifices — A simple orifice in the line, is the most elementary method for controlling flow. When used to control flow, the orifice is placed in series with the pump. An orifice can be a fixed type; or it may be a variable orifice. Both types are non-compensated flow-control devices.

Flow regulators — This device, which is slightly more sophisticated than a fixed orifice, consists of an orifice that senses flow rate as a pressure drop across the orifice; a compensating piston adjusts to variations in inlet and outlet pressures. This compensating ability provides closer control of flow rate under varying pressure conditions.

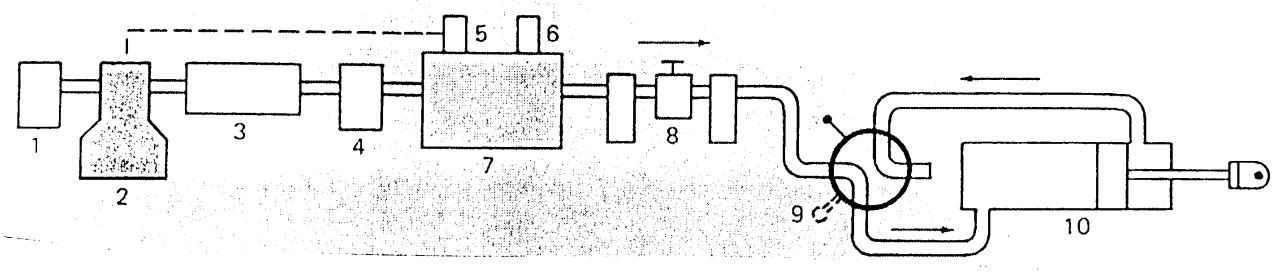
Bypass flow regulators-In this flow regulator, flow in excess of set flow rate returns to tank through a bypass port. Flow rate is controlled by throttling fluid across a variable orifice regulated by the compensator piston. The bypass flow regulator is more efficient than a standard flow regulator.

Demand-compensated flow control valve— Flow control can also bypass excess system flow to a secondary circuit. Fluid is routed at a controlled flow rate to the primary circuit, and bypass fluid can be used for work functions in secondary circuits without affecting the primary one. There must be flow to the primary circuit for this type of valve to function - if the primary circuit is blocked, the valve will cut off flow to the secondary circuit.

Pressure-compensated, variable flow valves — This flow control is equipped with an adjustable variable orifice placed in series with a compensator. The compensator automatically adjusts to varying inlet and load pressures, maintaining an essentially constant flow rate under these operating conditions to accuracy of 3% to 5%.

Pressure- and temperature-compensated, variable flow valves —because the viscosity of hydraulic oil varies with temperature (as do the clearances between a valve's moving parts), output of a flow-control valve may tend to drift with temperature changes. To offset the effects of such temperature variations, temperature compensators adjust the control orifice openings to correct the effects of viscosity changes caused by temperature fluctuations of the fluid. This is done in combination with adjustments the control orifice for pressure changes as well.

b) **Draw general layout of pneumatic system.**
(Layout-02 M, Label-02 M)



1 Intake filter and silencer 2 Compressor 3 After cooler 4 Separator 5 Pressure switch

6 Relief valve 7 Receiver tank 8 Filter, Regulator, Lubricator 9 Control valve 10 Actuator

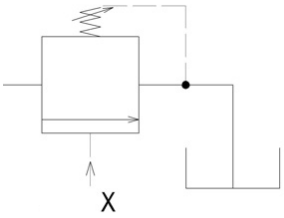
c) Enlist desirable properties of oil in hydraulics. (Any 8-04 marks)

A hydraulic fluid must have following desirable properties

1) Optimum viscosity-It is a measure of a fluid's resistance to flow.
2) Good lubricity to prevent friction and wear between the closely fitted working parts such as vanes of pumps, valve spools, piston rings and bearings.
3) The ability of a hydraulic fluid to separate rapidly from moisture and successfully resist emulsification is known as "demulsibility." Highly refined oils are basically water resistant by nature.
4) Good Chemical and Environmental Stability (Oxidation and Corrosion Resistance). It is because; most fluids are vulnerable to oxidation, as they come in contact with oxygen in air.
5) Neutralization number is a measure of the acidity or alkalinity of hydraulic oil. This is referred to as the pH value of the oil. High acidity causes the oxidation rate in oil to increase rapidly.
6) High incompressibility- Most mineral oils undergo reduction in the volume of about 0.7% for every 100 bar rise in pressure. In fact, the compressibility of a fluid is greatly influenced by temperature and pressure.
7) Low flammability-There are many hazardous applications where human safety requires the use of a fire-resistant fluid. A fire-resisting fluid is one that can be ignited but does not support combustion when the ignition source is removed. Flammability is defined as the ease of ignition and ability to propagate the flame.
8) Low Volatility-A fluid should possess low vapor pressure or high boiling point. The vapor pressure of a fluid varies with temperature and hence the operating temperature range of the system is important in determining the stability of the fluid.
9) Good Heat Dissipation - A hydraulic fluid should have a high heat dissipation capability. The temperature of a fluid shoots up if its heat dissipation characteristics are poor.
10) Low Density The relative density of a mineral oil is 0.9.

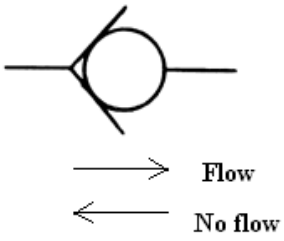
d) Draw symbols (Each 02 marks)

i) Unloading valve



X – Indicates pilot from a remote source

ii) Simple check valve



e) Explain the actuated position of control of single acting cylinder with neat diagram. (Sketch-02 marks, Explain-02 marks)

A single acting cylinder usually has a built in spring to either automatically in-stroke or out-stroke the cylinder when air supply is attached. Actuation is via a 3/2 D.C. valve.

Before actuation, cylinder is in retracted position. (Fig-a) As soon as, push button is operated, air from the reservoir is supplied to the cylinder and the piston rod extends. (Fig-b) Releasing the push button will retract the cylinder back to original position because of return spring.

Applications include shot bolts and simple clamps. Used especially when a loss of air supply must return the cylinder back to its un-operated state.

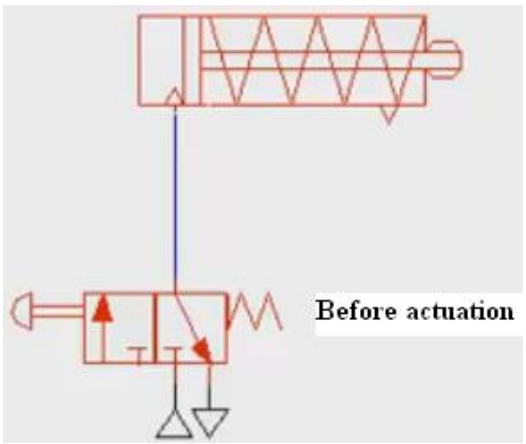


Fig-a

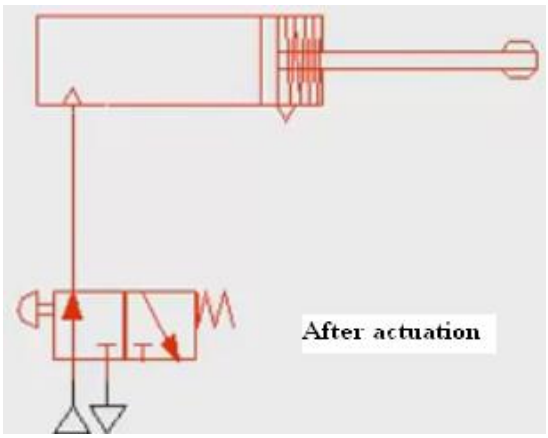


Fig-b