



SUMMER – 15 EXAMINATION

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 judgment 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 of the following:

(4 x 3=12)

(i) Describe essential properties of oils used in oil hydraulic circuits

(Any eight) (1/2 Marks for each point)

1. **Demulsibility:** The ability of a fluid that is insoluble in water to separate from water with which it may be mixed in the form of emulsion. Or it is the oil ability to release water.
2. **Lubricity:** it is the measure of the reduction in friction of a lubricant.
3. **High flash point:** Flash point is a temperature at which liquid catches fire automatically. The flash point of good hydraulic oil must be as high as possible so that fire possibility nullified.
4. **Minimum Toxicity:** Good hydraulic oil must be minimum toxic to human being working with them. Some fire resistance hydraulic oils are highly toxic which can cause occupational diseases.
5. **Low Foaming Tendency:** When oil returns to receiver, it comes in contact with air above the liquid surface. The oil has tendency to absorb air or gas which results in foam formation. Good hydraulic oil must release the air/gas very quickly so that it does not form foam.
6. **Fire resistance:** Good hydraulic oil must be fire resistant to avoid accidents.
7. **Viscosity:** It is the resistance offered by the liquid to flow. It is inherent property of the liquid and this resistance to flow depends on some other physical properties such as temperature, pressure, etc.
8. **Compressibility:** It is the ability of a fluid to get compressed and liquids are less compressible. Compressibility is the reciprocal of bulk modulus.

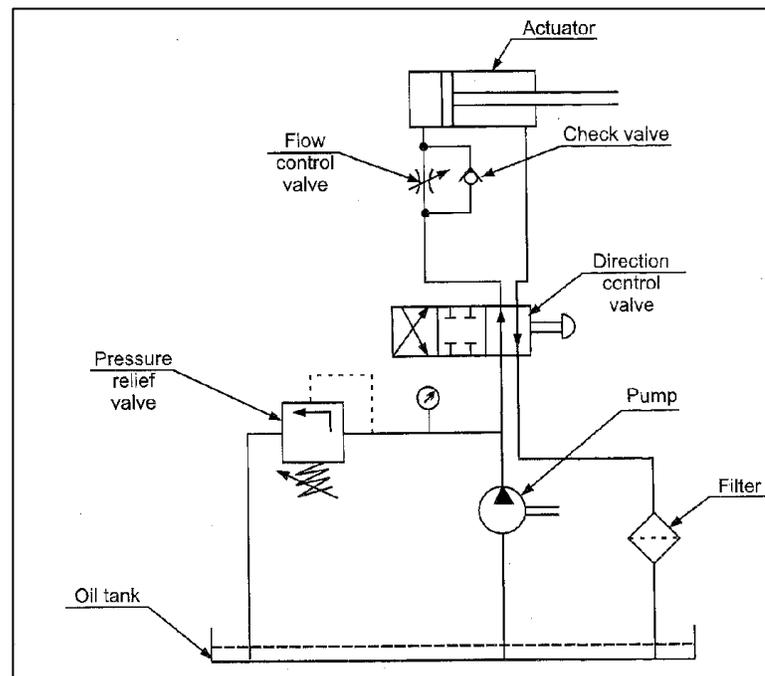
(ii) Draw sketch of a simple oil hydraulic circuit and write down the name and working function of each of the components used in it. (Sketch 2 marks, Function 2 Marks)

- Oil Tank or Reservoir:** This is an oil storage tank in which hydraulic oil is stored. The oil passes through various pipelines and after doing useful work in actuator; the oil returns back to oil tank. In the regions of low temperature, oil heaters are attached to air tanks.
- Filter:** This element filters the oil before going to the next element i.e. pump.
- Pump:** Hydraulic pump is heart of any hydraulic system. Its main function is to create the flow of oil under pressure through entire hydraulic system and hence to assist transfer of power and motion (i.e. useful work).
- Direction control valves/Flow control valves/ Pressure Relief Valves (Fluid Controlling Elements):** These valves are fitted in hydraulic system at particular locations. These valves control the flow of oil in the system. They also direct the flow of oil in system as also they control the speed of actuator.
- Actuators: (Fluid Power utilization elements):** These elements are known as actuators (either rotary or linear). The pressurized oil acts on actuator elements. The oil gives or transfer its power to actuator to create useful work or Mechanical Advantage.
- Pipelines (Fluid Conducting elements):** It is the functional connection for oil flow in the hydraulic system. The efficiency of oil flow is greatly influence by the physical characteristics of piping systems.

There are two pipes:

- Pipe which carry pressurized oil are called as pressure pipelines
- Pipes which carry low pressurized oil or used oil (are called as return pipelines).

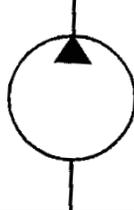
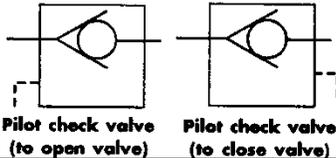
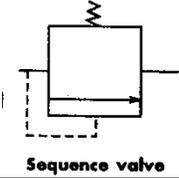
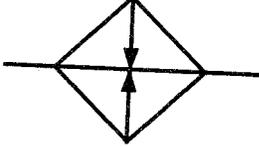
Hoses, pipes, pipe fitting are the parts of fluid power pipeline.



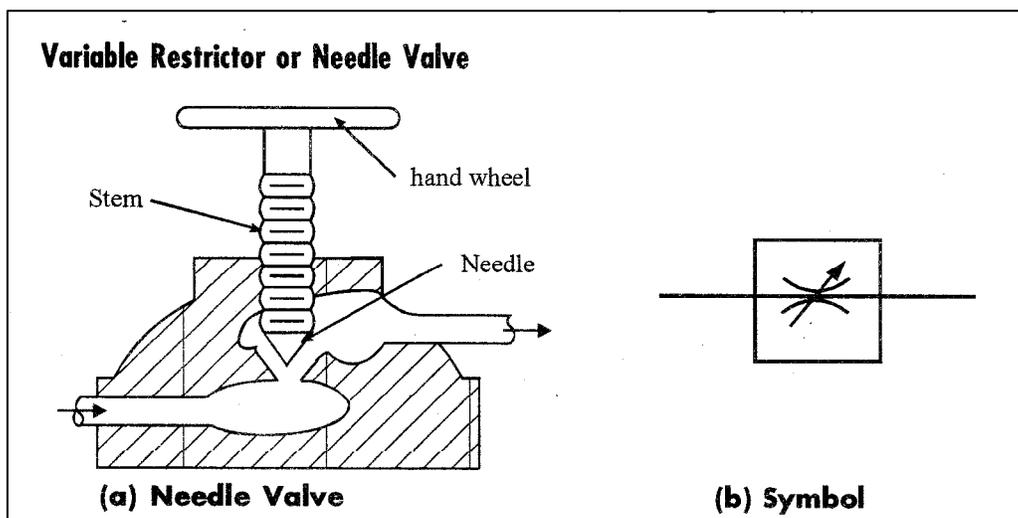
Block diagram of hydraulic circuit may be considered

(iii) Draw symbols of

(Each symbol 1 mark)

Name	Symbol
1) Unidirectional hydraulic pump	
2) Pilot operated check valve	
3) Sequence valve	
4) Heater	

(iv) Draw sketch of needle valve and explain its working. (Sketch 2 marks, Working 2 Marks)



A needle valve is a variable restrictor device which allows the orifice size to vary by adjustments. A needle has a pointed stem that can be adjusted manually to control the rate of fluid

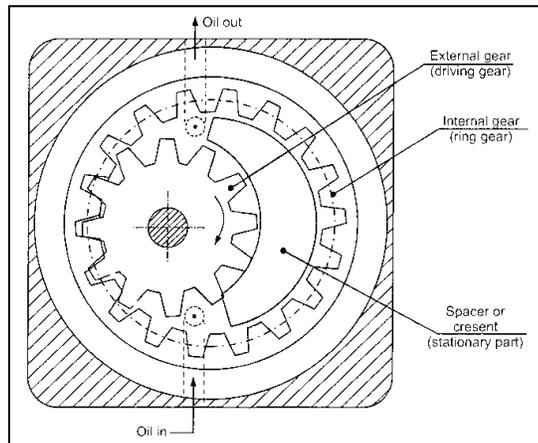
flow through the valve. The needle valve is used in hydraulic circuits to vary the flow rate from full flow to complete shut off the flow from one part of circuit to another part.

Generally a needle valve is coupled with a non return valve or check valve enabling regulated flow in one direction and free flow in the reverse direction

b) Attempt any ONE of the following:

(6 x 1=6)

(i) Explain construction and working principle of Internal Gear pump. (Sketch 3 marks, Working 3 Marks)

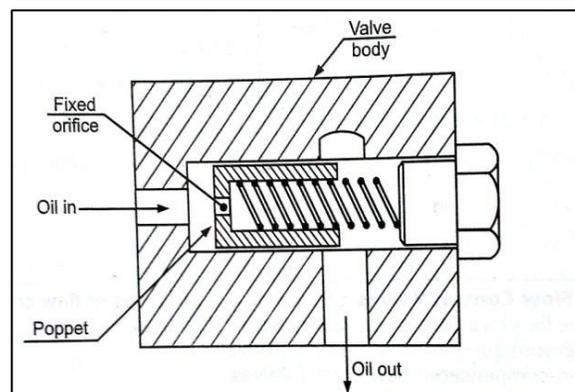


It consists of one external and one internal meshing gear pair. External gear is connected to electric motor and hence is driving gear. Internal gear or ring gear is driven gear which rotates in same direction as that of external gear. Between two gear a spacer called 'crescent' is located which is a stationary pieces connected to housing. Inlet and outlet ports are located in end plates.

External gear (driving gear) drives the internal gear (Ring Gear). Portion where teeth start meshing, a tight seal is created near port the vacuum is created due to quick un-meshing and oil enters from oil tank through inlet port. Oil is trapped between the internal and external gear teeth on both sides of crescent (spacer) and is then carried from inlet to outlet port. Meshing of gear near outlet port reduces the volume or gap and oil gets pressurized. These pumps make very less noise.

(ii) Describe with sketch pressure compensated flow control valve. (Sketch 3 marks, Working 3 Marks)

In any hydraulic circuit there are slight variations in presence of oil. When pressure changes the rate of flow changes but many circuits requires constant flow regardless of input or output pressure variations in the circuit then the pressure compensated FCV is used. It consists of hollow cylinder shaped poppet at the bottom of which there is a fixed orifice. There is a spring inside a poppet as shown in fig.



Pressurized oil entering through the inlet port will apply full force on the bottom of the poppet and will try to compress the spring by shifting the poppet to right the poppet will move to right and will close the outlet port. Then movement of the poppet

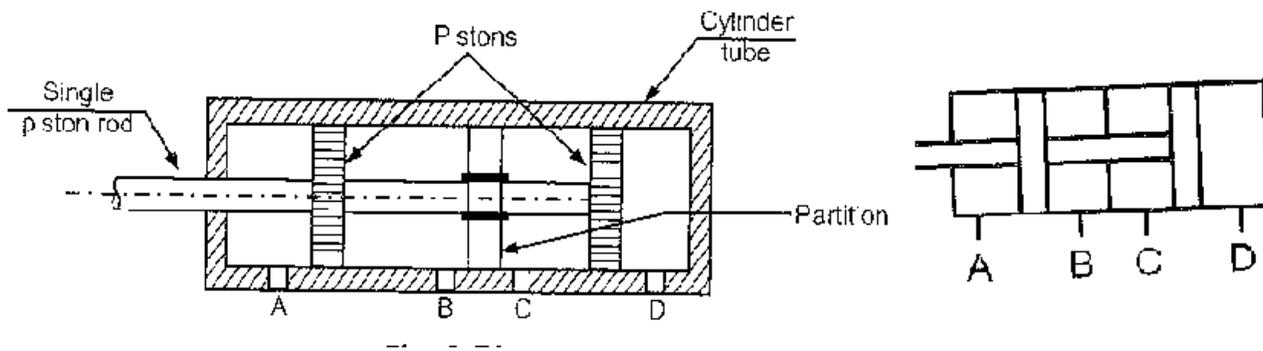
toward right will stop. Now flow of oil through the orifice will start. Oil will occupy the bore of cylinder this flow of oil will equalize the pressure on both ends of the poppet. The poppet will then balance.

During the process of poppet balancing, spring will expand and poppet will move toward left thereby uncovering the outlet port. A balance will automatically be established between quantity of oil through orifice and quantity of oil going out through the outlet port even if the pressure of incoming oil changes, the rebalancing will established automatically and constant flow of oil will come out.

Q. 2 Attempt any TWO of the following:

(8 x 2=16)

a) What is Tandem cylinder? What is its beneficial property? Explain with sketch and draw its symbol. (Sketch 3 marks, Symbol 2 marks, Working 3 Marks)



This is a special type of DA cylinder in which two cylinders are joined in Series. There is a sealed partition between two cylinders. Two pistons are fitted on a single piston rod. The arrangement is called 'Tandem array'. There are four ports A, B, C and D as shown.

Beneficial Property: Pressurized oil is admitted at a time through ports (B) and (D). Piston will move towards left with **double force**. Similarly, pressurized oil is admitted at time through ports (A) and (C), piston will move towards right with **double force**. The main advantage of this DA cylinder is that we can obtain double force with same size of cylinder.

a) Draw and explain working of bleed-off hydraulic circuit. (Sketch 4 marks, Working 4 Marks)

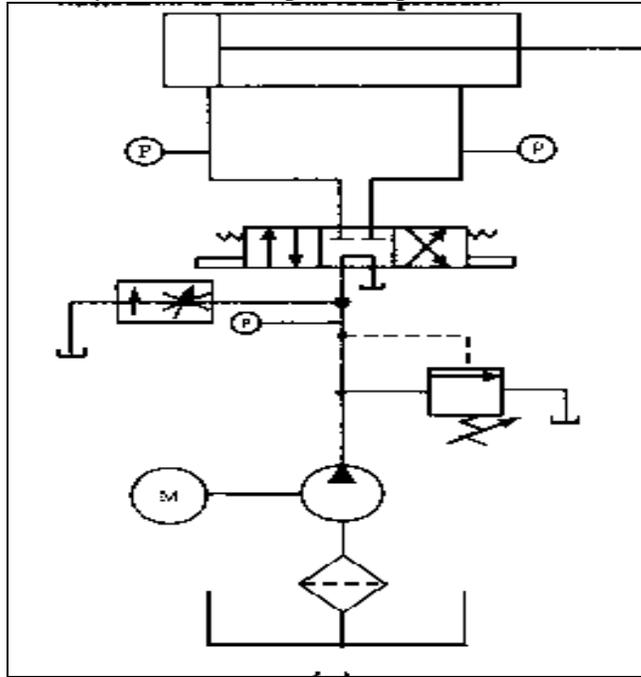
Fig shows typical bleed off circuit. Here, the flow control valve is arranged to bypass a part of the pump output directly to the tank. When the flow control valve is completely closed, the full flow from the pump would go into the cylinder. However, the moment the flow control valve is opened, some portion of the pump outlet will be bled off and the cylinder starts to slow down. Adjusting the size of the opening will bleed off any amount necessary to control the speed of piston.

Unlike the meter-in and meter-out circuit there is no excess flow going over the relief valve. The excess oil bleed-off circuits are more efficient in energy saving and work in a cooler environment.

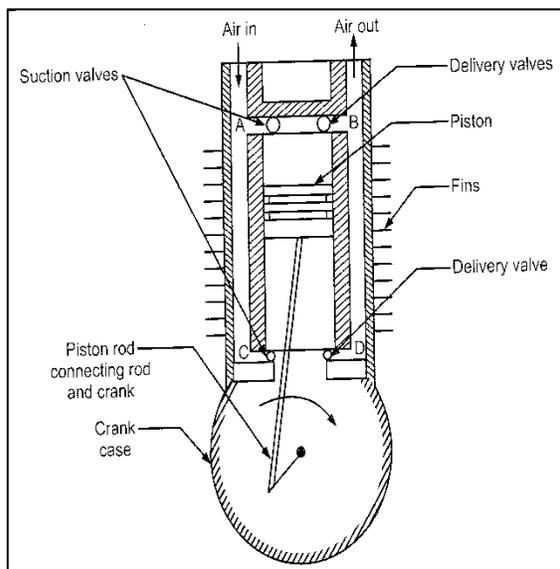
However, bleed off circuit provides less accuracy in speed control, because they don't compensate for any change in fluid losses due to pressure change. Here the measured flow goes to the tank rather than the cylinder. This makes the cylinder speed subject to change with the pump delivery and hydraulic system leakage which occur as work load pressure changes. To minimize these effects,

it is recommended to bleed-off no more than half the pump delivery and avoid using a bleed-off circuit completely where there is a wide fluctuation in the load pressure.

In general, bleed-off speed control is best employed when the majority of the pump outlet is utilized by the cylinder and only a small percentage is bypassed. Also it is employed in systems where the pressure is reasonably constant and precise speed control is not the criteria.



b) Write construction and working of double acting reciprocating compressor with neat sketch. (Sketch 4 marks, Working 4 Marks)



Double acting reciprocating air compressor is similar to double acting reciprocating pump. It is comprised of following parts:

- 1) Cylinder
- 2) Piston and piston rod and connecting rod.
- 3) Crank and crank case
- 4) Two suction valves and two delivery valves.
- 5) One inlet port and one outlet port

It uses four bar mechanism. There are 4 valves (2 suction valves and 2 delivery valves) shown at A, B, C, D in figure. There are cooling fans similar to single acting compressors. The crank rotates on electric motor/engine/turbine.

In this compressor, compression of air takes place on both side of the piston. When crank rotates, the piston starts reciprocating.

When piston comes down and attains, 'Bottom dead center piston' the air comes in through port 'A' due to vacuum created due to downward movement.

When piston starts moving upward, the air starts compressing. When piston attains, 'Top dead center piston', the stroke is complete and air is fully compressed which goes out through delivery valve 'B' to air receiver.

During this upward movement the vacuum is created on other side (Piston rod side) of piston. Suction valve 'C' opens and air comes in.

When piston starting comes down, this air which came through valve 'C', gets compressed and compressed air goes out through delivery valve 'D' to air receiver. In this downward movement air comes in through valve 'A' and entire cycle repeats.

Q. 3 Attempt any FOUR of the following:

(4 x 4=6)

a) State any four merits and any four limitations of hydraulic system.

Four merits of hydraulic system (2 marks)

- 1) High pressure can be generated, so it can be used to lift, hold, and press very heavy loads.
- 2) Weight to power ratio of a hydraulic system is comparatively less than that of an Electro-Mechanical system.
- 3) With hydraulic actuators we can achieve highly accurate and precise motions.
- 4) Limiting and balancing of hydraulic forces can be easily performed.

Four limitations of hydraulic system (2 marks)

- 1) Elements of hydraulic machines system have to be machined to high degree of precision which increases manufacturing cost of the system.
- 2) Leakage of hydraulic oil during its flow in system causes heavy pressure drops.
- 3) The hydraulic system due to its leakages is dirty and we cannot use this system in food and pharmaceutical industry.
- 4) Petroleum based hydraulic oils can create fire hazards if the temperature of the system goes beyond its flash point.

b) State any four functions of seals and state any four reasons for seal failure.

Four functions of seals (2 marks)

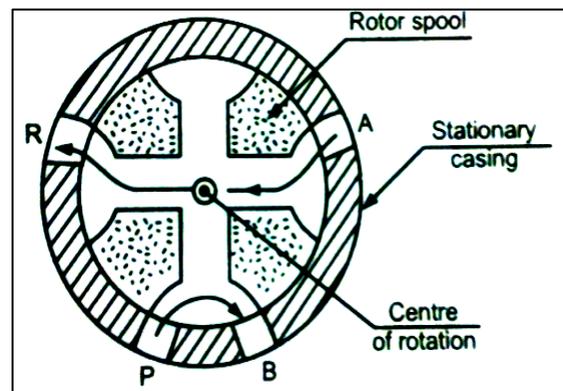
- 1) To stop leakage of oil.
- 2) To maintain the pressure
- 3) To keep out contamination in the system.
- 4) To enhance the functional reliability of the components over a longer period.
- 5) To enhance working life of the system.

Four reasons for seal failure (2 marks)

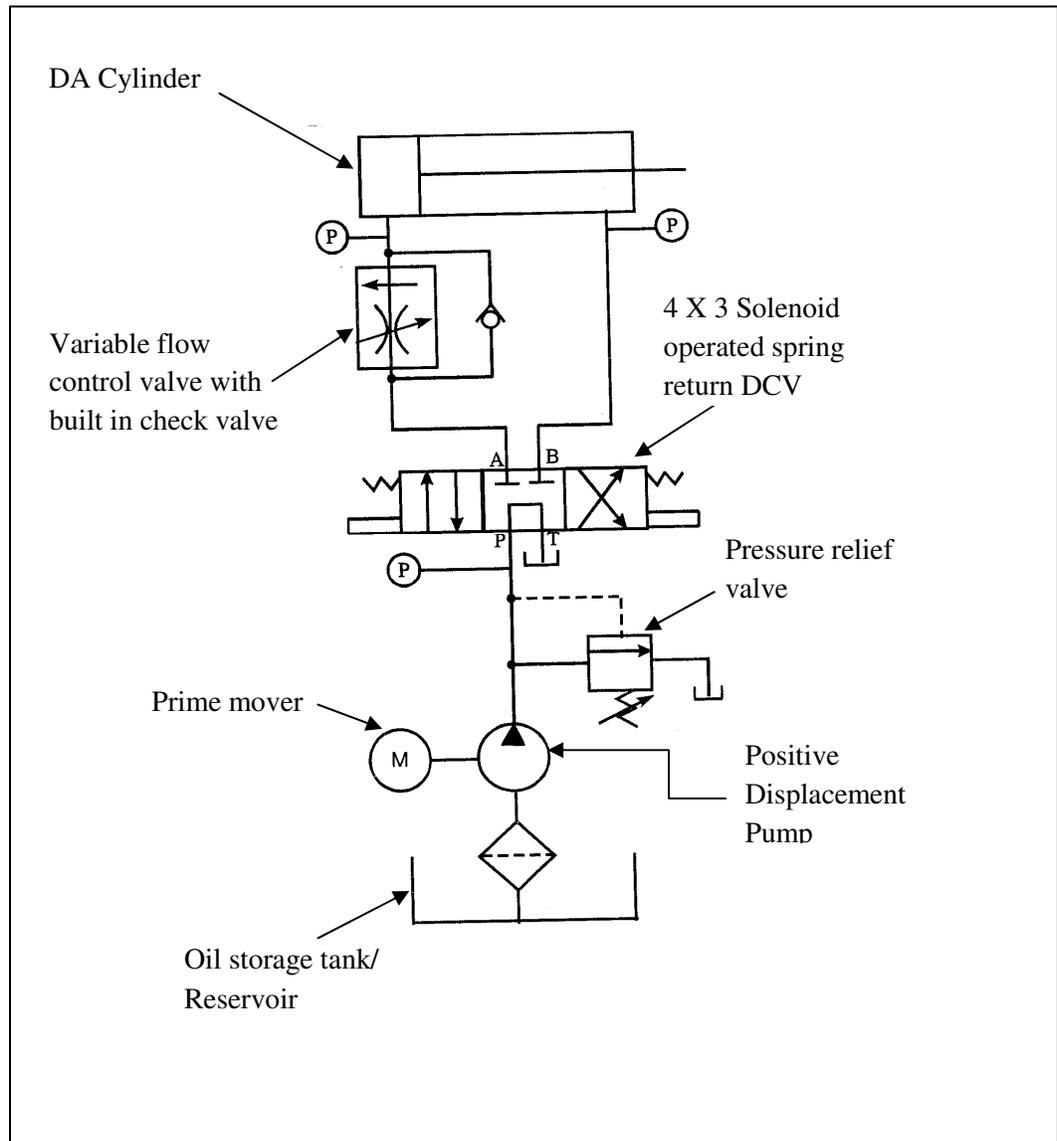
- 1) Incompatibility of seal material with oil.
- 2) Low speed of actuators
- 3) If seals are not correctly installed then there is possibility of seal failure.
- 4) High temperature of oil can burn the seals.
- 5) If seal is excessively squeezed then it can fail.

**c) Explain construction and working principle of Rotary Spool type DC valve with sketch.
(Sketch 2 Marks, Working 2 Marks)**

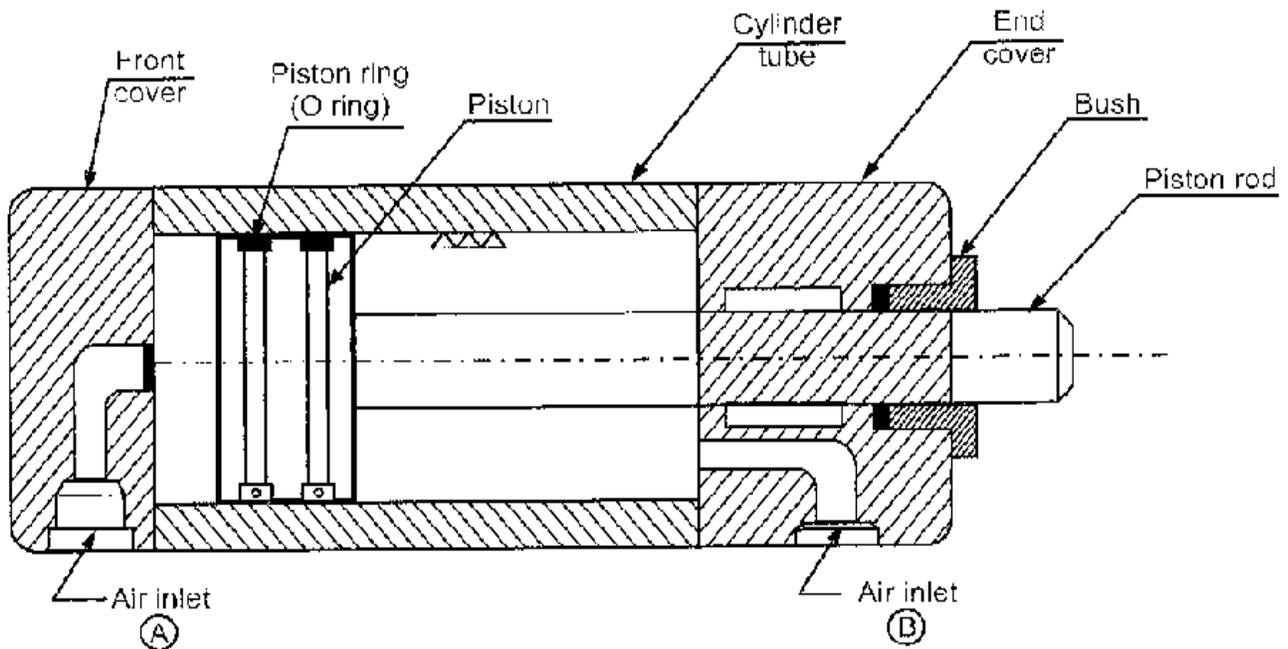
A rotary spool valve consists of a rotating spool which aligns with ports in stationary valve casing, so that fluid is directed to required port. A/B/P/R are the ports in casing. The port 'P' is a pressure port through which pressurized oil is coming in the valve. 'R' port is the port through which used oil is returning to oil tank. From fig port p is connected to port B and port A is connected to port R



c) Draw and label the components in meter-in hydraulic circuit. (Sketch 2 marks, label 2 Marks)



d) With neat sketch describe construction and working of pneumatic DA cylinder.
(Sketch 2 marks, Working 2 Marks)

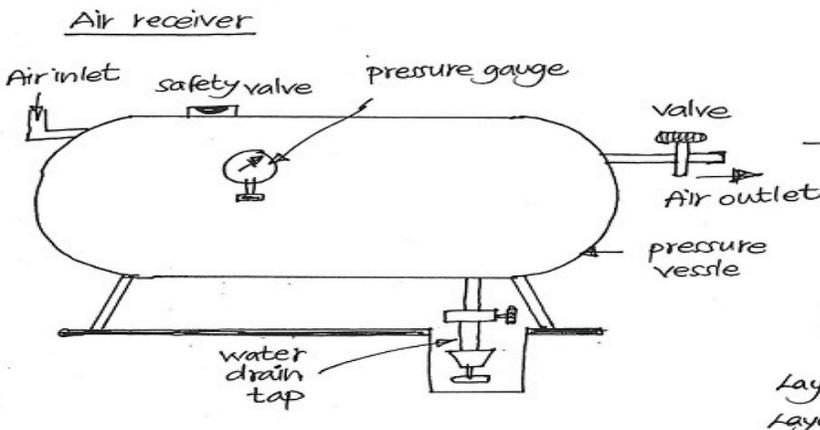
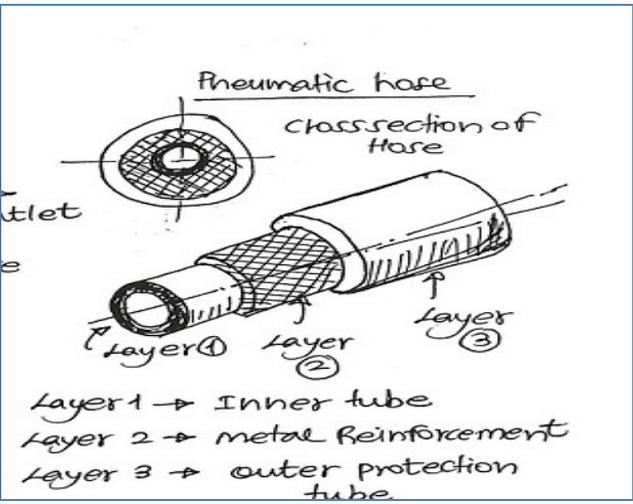


In this type of actuator, air is admitted on the both sides of piston. Hence this cylinder or actuator can perform useful work in both directions. There is no spring in this actuator.

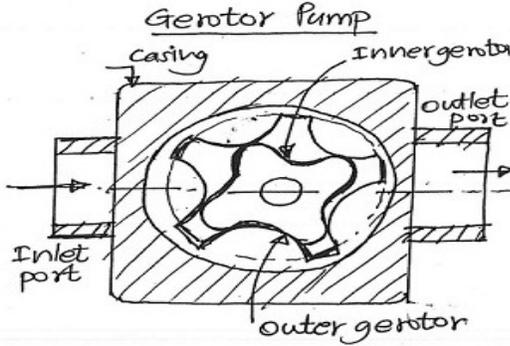
When air admitted through port 'A' piston will move towards right and when air comes in through port 'B' piston will move right to left. It consists of following parts:

- 1) Cylinder body
- 2) End cover with bush and built ion air-inlet port (B).
- 3) Piston with piston rings (O-rings) and piston Rod
- 4) Front cover threaded to cylinder tube with in-built air inlet port (A)

Compressed air will admit first through port (A). Due to pressure force piston will advance i.e. will move from left to right. Then airflow from port (A) will stop and flow from port (B) will start. Now piston will retract i.e. it will move from right to left. During this movement air present in the cylinder during advance stroke will move out through port (A). This movement repeats.

Q.NO	Solution	Marks
4.a)	Attempt any THREE of the following	12
(i)	Constructional details of Air receiver 	Sketch- 2M Labels- 2 M Lay Lay
(ii)	Constructional details of Pneumatic Hose  <p>Layer 1 → Inner tube Layer 2 → metal Reinforcement Layer 3 → outer protection tube</p>	Sketch- 2M Labels- 2 M
(iii)	Name of Circuit: Speed control of Bi-directional Pneumatic(Air) Motor	1 M

	<p>Application: Pneumatic hand tools, Pneumatic screw drivers</p> <div style="text-align: center;"> <p>Fig. No. 1</p> </div>	<p>1 M</p> <p>Labels- 2 M</p>
<p>Q.NO</p>	<p>Solution</p>	<p>Marks</p>
<p>(iv)</p>	<p>5/2 D.C. Pneumatic Valve</p> <p>Sketch:</p> <div style="text-align: center;"> </div> <p>Working:</p> <ol style="list-style-type: none"> Normal position: The spool is located such that port P and Port A get connected and port B and 	<p>2 M</p> <p>2 M</p>

	<p>port S is connected while Port R is closed.</p> <p>2. Actuated position: When the spool is shifted the port P is get connected with port B and Port S remain closed, while the port A get connected with port R</p>	
4.b)	Attempt any ONE of the following	6
(i)	<p>Gerotor Pump</p> <p>Sketch:</p>  <p>Working:</p> <ol style="list-style-type: none"> 1. When inner gerotor rotates with the help of motor, it creates partial vacuum near the suction port when it meshes with outer gerotor. The oil enters through the suction port. 2. Due to difference in number of tooth of outer and inner gerotor there is offset movement and volume near the delivery port decreases. The oil with high pressure is forced out through discharge port. 3. The gerotors are to be manufactured with high precision otherwise internal leakage may occur. 4. It can generate oil pressure up to 125 bar, maximum speed of 200-3600 rpm with maximum discharge of 200 lit/min. 5. They are more compact than external gear pump. 	3 M
(ii)	<p>Function of Accumulator:</p> <p>It is a pressure vessel used in hydraulic system for following function</p> <ol style="list-style-type: none"> 1. Primary function is to store hydraulic energy of pressurized oil during idle period and make available again when it is required by the system. 2. To meet peak demands of hydraulic energy, smooth out pressure shocks/surges 	1 M

Different types of accumulator:

According to element used for store oil under pressure types of accumulator are:

1. Dead weight type accumulator:

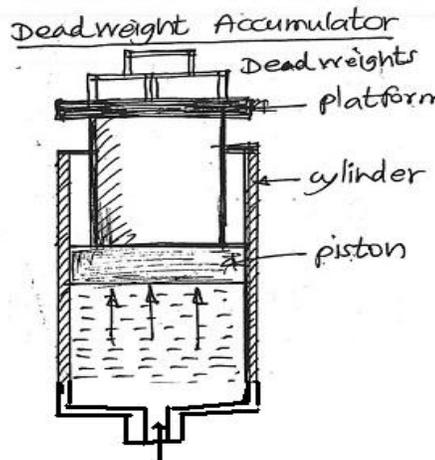
The dead weights may be of some heavy materials like iron or concrete blocks are placed on the piston platform.

2. Spring loaded Accumulator:

The compression spring with high stiffness is used to exert force on the piston to store hydraulic energy of oil.

3. Gas charged Accumulator:

The gas bladder is charged with dry nitrogen gas and force is created with the help of gas pressure inside the bladder.

Sketch and explanation of any one**1. Dead weight type****Working;**

1. It consists of piston loaded with dead weight and moving within a cylinder which exerts pressure on the oil.
2. The oil will enter from the inlet provided at the bottom and pushes the piston in upward direction against the load exerted by the dead weight placed on the platform.
3. When piston moves to the upper end the accumulator get charged and it can be used whenever oil energy is needed.

(Sketch and explanation of any other type may be considered)

Q.5 Attempt any TWO of the following

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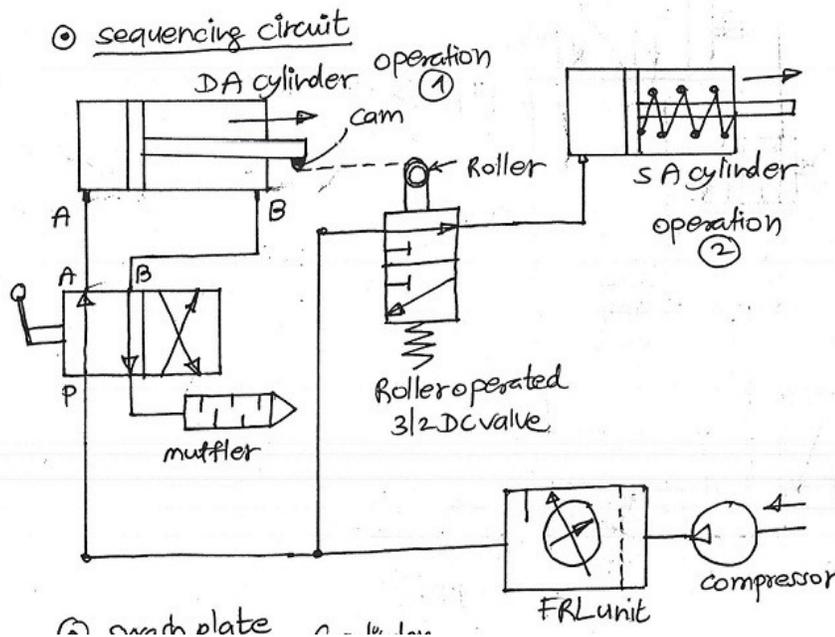
<p>(a)</p>	<p>Classification of Pneumatic actuators:</p> <ol style="list-style-type: none"> 1) Motion: <ol style="list-style-type: none"> a) Linear (Reciprocating motion)actuators(Air Cylinders) b) Rotary (Angular motion) actuators(Air Motors) 2) Mode of action: <ol style="list-style-type: none"> a) Linear actuators: 1) Single acting cylinders 2) Double acting cylinders b) Rotary actuators: 1) Unidirectional air motor 2) Bi-directional air motor 3) Displacement: <ol style="list-style-type: none"> a) Air Cylinders –Linear displacement (stroke length of 100mm,150mm,etc) b) Air Motors- 1.Angular displacement in RPM 2. Limited rotary displacement <p>Telescopic cylinder:</p> <p>Sketch:</p> <div style="text-align: center;"> </div> <p>Construction and Working:</p> <ol style="list-style-type: none"> 1. It consists of number of cylinders with decrease in size. Main cylinder accommodates the number of cylinders arranged one inside the other. 2. The inlet is provided to main cylinder to enter pressurized oil and corresponding inlets are provided to each cylinder. 3. It has longer stroke length which makes suitable for lifting platforms,cranes,etc 4. The oil will flow from main cylinder to the next small size cylinder successively and then enter in next smaller size cylinder to complete large stroke length(L1+L2+L3) 	<p>4 M</p> <p>2M</p> <p>2M</p>
<p>(b)</p>	<p>FRL Unit:</p>	

	<p>It is service unit used in Pneumatic system which is combination of three devices named as Filter, Regulator and Lubricator.</p> <p>Function of FRL Unit:</p> <ol style="list-style-type: none"> 1. Filter: It is used for separate out or filter out contaminants present in the compressed air. 2. Regulator: It is pressure control device used for regulating pressure of compressed air to the desired pressure at a steady state condition. 3. Lubricator: It is a device which is used for addition of lubricating oil particles in compressed air for lubrication of sliding or moving pneumatic components. <p>Sketch:</p> <div data-bbox="435 821 1284 1108" data-label="Diagram"> </div> <p>Separate symbol</p> <div data-bbox="354 1430 792 1703" data-label="Diagram"> </div> <p>combined Symbol</p> <div data-bbox="883 1430 1256 1650" data-label="Diagram"> </div>	<p>1 M</p> <p>1 M</p> <p>2 M</p> <p>2 M</p> <p>+</p> <p>2 M</p>
<p>(c)</p>	<p>Sequencing Operation:</p> <p>When more than one operations are carried out one after another in a predetermined manner it is known as sequencing operation.</p>	<p>1M</p>

e.g. Clamping of job and then drilling operation

Sequencing of DA pneumatic cylinder with one SA pneumatic cylinder using roller operated DC Valve:

Circuit:



4 M

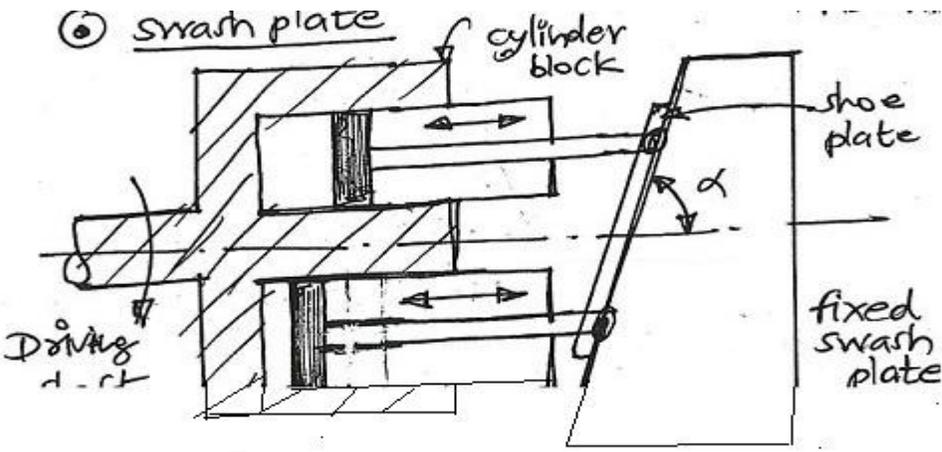
Explanation:

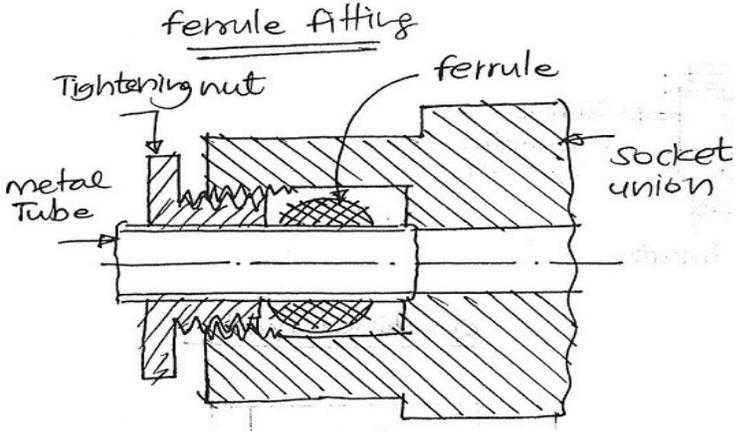
1. In this sequencing circuit, the compressed air from 4/2 DC valve will enter from port A of DA cylinder and push the piston in the forward direction. The first operation of DA cylinder is completed. The air from B port is exhausted to the atmosphere through port R.
2. The piston rod is provided with cam to press roller of 3/2 D.C valve as shown in figure. The movement of piston will reach to the roller and press it for actuation of Roller operated 3/2 D.C valve.
3. Now the compressed air will flow from 3/2 DC valve to the port C of SA pneumatic cylinder. The compressed air will enter in SA cylinder for movement of piston. Thus second operation is completed in a sequence.
4. This circuit is an example of Travel dependant sequencing circuit.

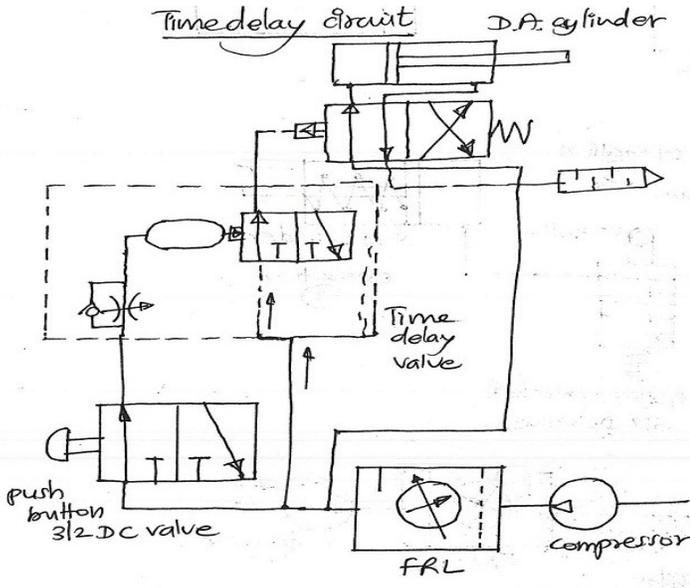
3 M

Q.6 Attempt any FOUR of the following

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<p>a)</p>	<p>Swash Plate Axial Piston pump:</p> <p>Sketch:</p>  <p>Construction and Working:</p> <ol style="list-style-type: none">1. It consists of swash plate which has angular surface with reference to the cylinder block axis. It is used to obtain reciprocating movement of pistons in the cylinder bores.2. The two or more cylinders are mounted parallel to the axis of driving shaft, the piston rod ends are attached to the angular surface of swash plate with the help of shoe and shoe plate.3. When driving shaft is rotated it will cause reciprocating movements of pistons in cylinders depending upon the angular surface movement with respect cylinder barrel.4. It will cause suction of the oil in one cylinder while discharge of high pressure oil in another cylinder. This cycle is repeated for cylinders to give high pressure oil through discharge ports.	<p>2 M</p> <p>2 M</p>
<p>b)</p>	<p>Importance of Filters in Hydraulic system:</p> <ol style="list-style-type: none">1. Filters are mediums used to remove or filter out impurities or contaminants present in the oil.2. It supplies clean and pure oil to the system to improve efficiency.3. It helps to reduce wear and tear, corrosion which may be caused by contaminants present in the oil.4. Filter is necessary to avoid blockage of small ports, flow area of pipes because of solid impurities present in the oil. <p>Different locations Of Filters:</p>	<p>2 M</p>

	<p>1. Intake or suction Filter: A full flow filter is provided before the pump in the suction line to restrict impurities entering in the pump trough suction pipe.</p> <p>2. Return Line Filter: Oil circulated through various components may contain wear partials hence return line filter is provided before the reservoir in the return line to remove impurities.</p> <p>3. Pressure line filter: Filter is provided after pump to remove impurities created by the pump during its working.</p> <p>4. Off Line Filter: It is separate filter provided which may work offline for standby system.</p>	2 M
c)	<p>Pneumatic Ferrule fitting :</p>  <p>Sketch:</p> <p>Explanation:</p> <ol style="list-style-type: none"> In ferrule fittings, the ferrule is the device which is used for making joints by compression force. The pinching action of ferrule on the pipe not only prevents the leakage of compressed air but also helps to held tube firmly. The nut is tightened to obtain correct grip by using ferrule touching to the surface of the tube which exerts compressive force on the tube. It is also known as compression type fitting used for semi rigid piping. 	2 M
d)	<p>Eight industrial applications of pneumatic systems:</p> <ol style="list-style-type: none"> Industrial automation: loading, unloading, clamping, etc Automotive field: air brakes, spray painting of panels, etc Construction equipments: Rock drilling, Vibrators, etc Hand tools: hand drills, grinders, screw drivers, nut runners, etc 	Any eight

	<p>5. Foundry shop: cleaning of moulds ,jolting machines 6. Material handling: small cranes, conveyors, material movement systems 7. Press machines for sheet metal operations 8. Drilling bore wells: underground of the earth surface 9. Paper/pharmaceutical industries: for packaging of products 10. Dentist: For tooth cleaning pneumatic motors are used.</p>	<p>4 marks</p>
<p>e)</p>	<p>Time delay pneumatic circuit (any correct circuit) for DA Cylinder</p>  <p>Explanation:</p> <ol style="list-style-type: none"> 1. When cylinder is to be operated after predetermined time delay then this circuit is used. In this circuit time delay valve is used which is mounted after 3/2 DC valve and It will decide the time delay for actuation of cylinder. 2. When compressed air flows through 3/2 DC valve it will pass through flow control valve of time delay valve and its flow can be controlled to set time delay valve. 3. The air flows through the time delay valve for decided time period delay and then gives air signal for pilot control of 4/2 DC valve. 4. Now the air from compressor will flow through 4/2 DC valve and actuates the DA cylinder to complete its forward stroke. This movement of cylinder is carried out with time delay hence circuit is known as time delay circuit. 5. Time delay valve is useful in sequencing operations with required time delay between operations. 	<p>2 M</p> <p>2 M</p>