



**SUMMER – 19 EXAMINATION**

**Subject Name: Industrial Fluid Power**

**Model Answer**

Subject Code:

<b>17608</b>
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**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. No.	Sub Q. N.	Answer	Marking Scheme														
1. a)	(i)	<b>Attempt any THREE of the following:</b> Four Properties of hydraulic oil: <table style="width: 100%; margin-left: 20px;"> <tr> <td style="width: 50%;">1. Compressibility</td> <td style="width: 50%;">5. Low foaming tendency</td> </tr> <tr> <td>2. Viscosity</td> <td>6. Flash point</td> </tr> <tr> <td>3. Stable viscosity index</td> <td>7. Oxidation</td> </tr> <tr> <td>4. Demulsibility</td> <td>8. Good heat dissipation</td> </tr> </table>	1. Compressibility	5. Low foaming tendency	2. Viscosity	6. Flash point	3. Stable viscosity index	7. Oxidation	4. Demulsibility	8. Good heat dissipation	I/2 mark each  4 Marks						
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(ii)	Four Types of Pressure Control Valves with their application <table border="1" style="width: 100%; margin-left: 20px; border-collapse: collapse;"> <thead> <tr> <th style="width: 5%;">S. N.</th> <th style="width: 40%;">Pressure control valves</th> <th style="width: 55%;">Applications</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">1</td> <td><b>Pressure relief valves</b></td> <td>Relief valve opens and bypasses fluid when pressure exceeds its setting.  These are used mostly in all circuits.</td> </tr> <tr> <td style="text-align: center;">2</td> <td><b>Pressure-Reducing Valve</b></td> <td>This type of valve (which is normally open) is used to maintain reduced pressures in specified locations of hydraulic systems.</td> </tr> <tr> <td style="text-align: center;">3</td> <td><b>Unloading Valves</b></td> <td>high-low pump circuits where two pumps move an actuator at a high speed and low pressure, punching press,</td> </tr> <tr> <td style="text-align: center;">4</td> <td><b>Counter balance valves</b></td> <td>They are used to prevent a load from accelerating uncontrollably. This situation can occur in vertical cylinders in which the load is a weight. This can damage the load or even the cylinder itself when the load is stopped quickly at the end of the travel.</td> </tr> </tbody> </table>	S. N.	Pressure control valves	Applications	1	<b>Pressure relief valves</b>	Relief valve opens and bypasses fluid when pressure exceeds its setting.  These are used mostly in all circuits.	2	<b>Pressure-Reducing Valve</b>	This type of valve (which is normally open) is used to maintain reduced pressures in specified locations of hydraulic systems.	3	<b>Unloading Valves</b>	high-low pump circuits where two pumps move an actuator at a high speed and low pressure, punching press,	4	<b>Counter balance valves</b>	They are used to prevent a load from accelerating uncontrollably. This situation can occur in vertical cylinders in which the load is a weight. This can damage the load or even the cylinder itself when the load is stopped quickly at the end of the travel.	4 Marks
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(iii)	Four Field applications of fluid power <table style="width: 100%; margin-left: 20px;"> <tr> <td style="width: 50%;">1. Earth Moving equipment's</td> <td style="width: 50%;">2. Broaching machine</td> </tr> <tr> <td>3. CNC/VMC/HMC Machines.</td> <td>4. Hydraulic thread rolling machine</td> </tr> <tr> <td>5. Hydraulic press brake.</td> <td>6. Material handling equipment's</td> </tr> <tr> <td>7. Hydraulic thread rolling machine</td> <td>8. Hydraulic cranes</td> </tr> </table>	1. Earth Moving equipment's	2. Broaching machine	3. CNC/VMC/HMC Machines.	4. Hydraulic thread rolling machine	5. Hydraulic press brake.	6. Material handling equipment's	7. Hydraulic thread rolling machine	8. Hydraulic cranes	4 Marks							
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(iv)

**Sequence Valve**

A primary function of sequence valve is to direct flow to different components of the circuit in a predetermined sequence. It is a pressure actuated valve which senses a certain change in pressure from the set value. It then takes the actions to direct the fluid in a definite predetermined order. It also maintains the requisite minimum pressure in the primary line while the secondary operations occur.

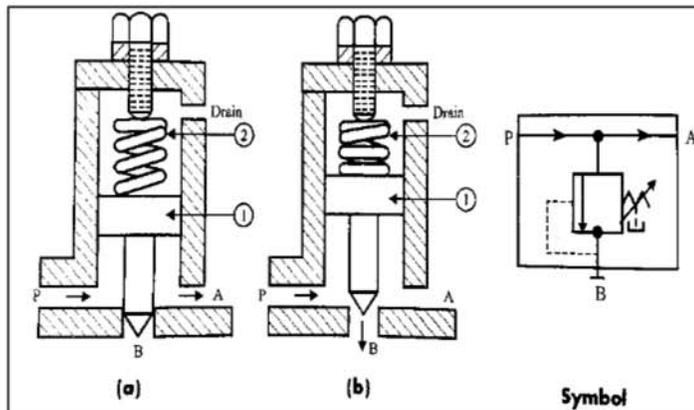


Figure 2 Marks

Working 2 Marks

Figure shows operating principle of a direct acting, normally closed sequence valve. In this position, fluid passes through the valve from the inlet port P to primary outlet port A at system pressure. When the first step in the sequence is completed, the system pressure increases to act against the exposed area of the piston. Continued increase in pressure causes the piston to compress the spring and unseat the valve, thereby directing the flow of fluid at high pressure through secondary outlet port B. Fluid pressure is maintained in both branches of the circuit so long as the sequence valve is open. Adjustment of the sequence valve is accomplished by compressing or extending the piston with the cap screw.

1 b)

(i)

**Attempt any ONE of the following:**

General layout of hydraulic system

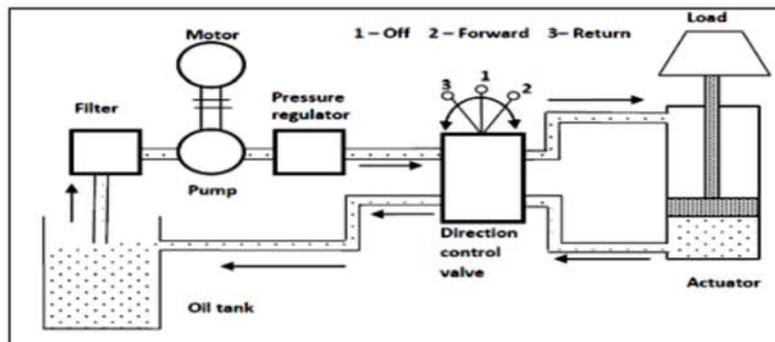
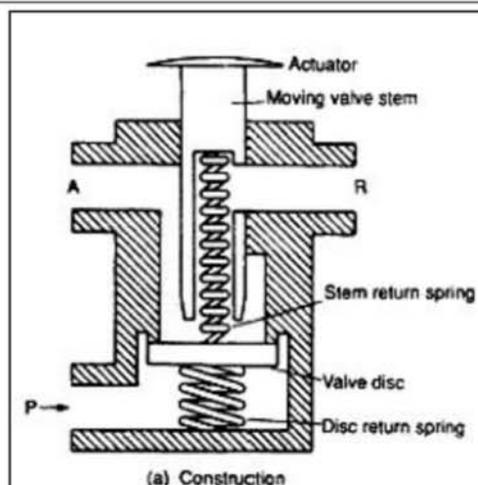


Figure 4 Marks

Label 2 Marks

(ii)

**Poppet Type 3/2 normally closed DCV**



Sketch 4 Marks

Symbol 2 Marks

Symbol



2

a)

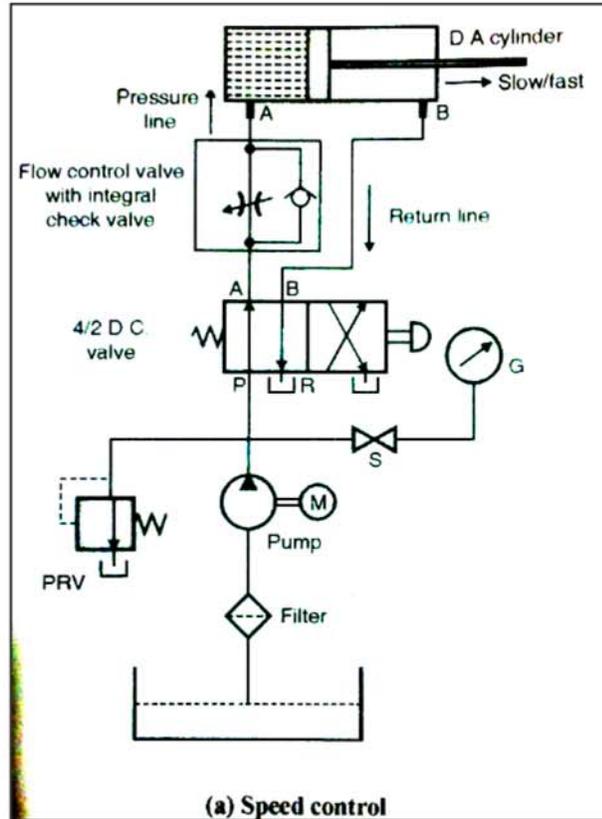
**Attempt any TWO of the following:**  
**Meter-IN Circuit**

When a pressurized oil flow through the circuit it passes through D.C. valve and enters in the flow control valve. The opening of the flow control valve is reduced to decrease the oil flow rate. Control of piston is achieved only in advance stroke.

Flow control valve is placed in pressure line. Give best result when used in higher pressure systems. Relatively small friction to face by piston which increases life of piston. Suitable for very low piston rod speeds.

**Application:**

1. The circuit is used where finer speed control is required
2. Surface grinders, Welders, Milling Machines



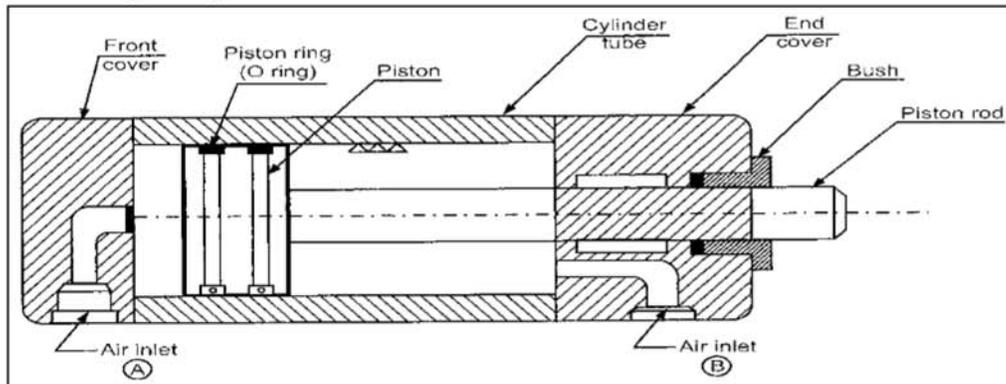
Sketch  
4 Marks

Working  
2 Marks

Application  
2 Marks

b)

**Double acting air cylinder**



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:

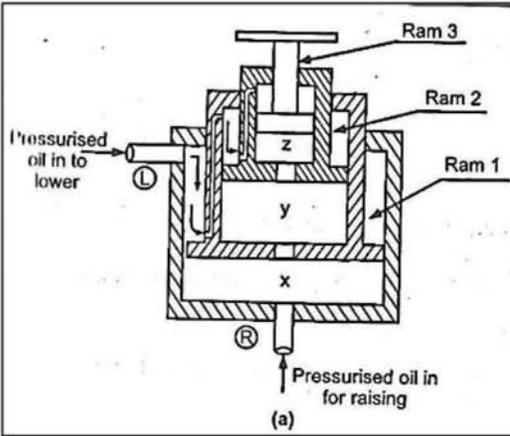
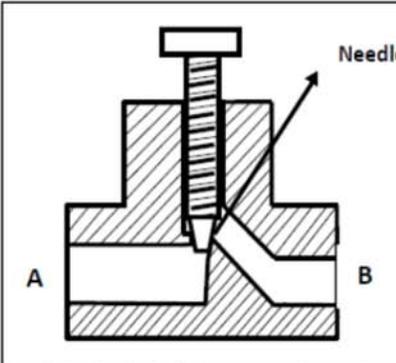
- 1) Cylinder body
- 2) End cover with bush and built in air-inlet port (B).
- 3) Piston with piston rings (O-rings) and piston Rod
- 4) Front cover threaded to cylinder tube with in-built air inlet port (A)

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.

Sketch  
4 marks

Working  
4 Marks



<p>c)</p>	<p><b>Telescopic cylinder</b> <b>Construction:</b> Figure shows three Rams assembled in each other like telescope. This arrangement provides relatively long stroke with good mechanical strength. There are two inlet ports through which pressurized hydraulic oil enters. Port (R) is raising the cylinder or extending the cylinders while port (L) is for cylinder lowering.</p> <p><b>Working:</b> <b>1. Raising or extending the cylinders:</b> hydraulic oil under pressure will enter through port (R). Space 'X' will be filled by oil and Ram 1 will start raising upwards. When its raising stops, the oil now will start entering through and will occupy space 'Y'. Due to this Ram 2 will raise. When raising of Ram 2 stops, the oil will start entering through and will occupy space 'Z'. This will raise final Ram 3 upwards.</p> <p><b>2. Lowering the rams:</b> When pressurized oil will enter through port (L), then Ram 1 will come down. After it's lowering Ram 2 will lower and then Ram 3 will lower.</p> <p><b>Application:</b> Dump trailers.</p>		<p>Sketch 4 Marks</p> <p>Working 2 Marks</p> <p>Application 2 Marks</p>
<p>3</p> <p>a)</p>	<p><b>Attempt any FOUR of the following:</b> <b>Type of flow control valve:</b> a) Needle valve b) Pressure compensated flow control valve. c) Non compensated flow control valve. d) Check valve</p> <p><b>Non compensated flow control valve:</b> Non-pressure-compensated flow-control valves are used when the system pressure is relatively constant and motoring speeds are not too critical. The operating principle behind these valves is that the flow through an orifice remains constant if the pressure drop across it remains the same. The rate of flow through an orifice depends on the pressure drop across it. The inlet pressure is the pressure from the pump that remains constant. Therefore, the variation in pressure occurs at the outlet that is defined by the work load. This implies that the flow rate depends on the work load. As shown in Fig. only the flow from A to B is controlled using the needle. In the other direction (B to A), the check valve permits unrestricted fluid flow.</p>		<p>Types 2 Marks</p> <p>Working 2 Marks</p>
<p>b)</p>	<p><b>Definition:</b> Hoses are flexible connecting tubes or pipes to connect actuators, control valves.</p> <p><b>layers of hose:</b> 1) Inner tube 2) Reinforcement 3) Outer protective cover</p> <p><b>Factors affecting selection of hose (Any four factors - 02 marks)</b> 1) Flexibility to change the shape it helps to reduce the fittings required in piping layout. 2) It should have easy installation 3) It should be flexible in nature 4) Should have quick connecting &amp; disconnecting ends. 5) Should be available in standard lengths. 6) It should absorb pressure shocks &amp; vibrations</p>	<p>Definition 1 Mark</p> <p>Factors 3 Marks</p>	

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

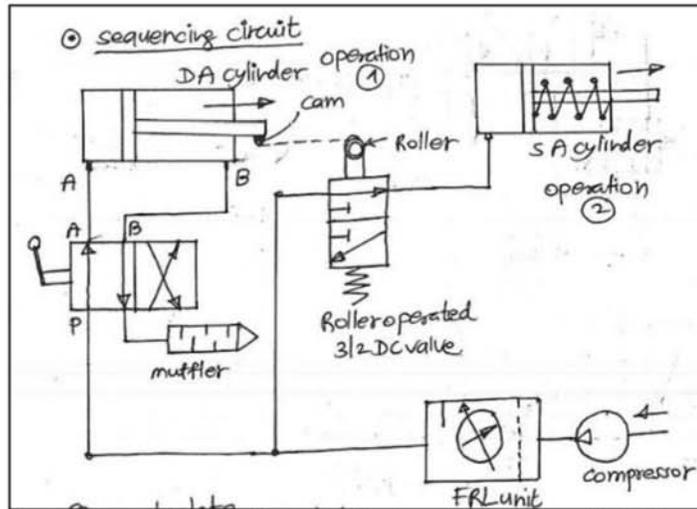
**Explanation:**

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 dependent sequencing circuit.

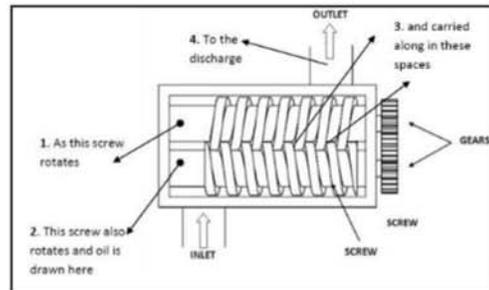


Circuit 2 Marks  
Working 2 Marks

d) **Screw Pump**

These pumps have two or more gear-driven helical meshing screws in a close fitting for develop the desired pressure. These screws mesh to form a fluid-type seal between the screws and casing. A schematic diagram of a screw pump is shown in Fig

A two-screw pump consists of two parallel rotors with inter-meshing threads rotating in a closely machined casing. The driving screw and driven screw are connected by means of timing gears. When the screws turn, the space between the threads is divided into compartments. As the screws rotate, the inlet side of the pump is flooded with hydraulic fluid because of partial vacuum. When the screws turn in normal rotation, the fluid contained in these compartments is pushed uniformly along the axis toward the centre of the pump, where the compartments discharge the fluid. Here the fluid does not rotate but moves linearly as a nut on threads. Thus, there are no pulsations at a higher speed; it is a very quiet operating pump.



Sketch 2 Marks  
Working 2 Marks

e) **Classification of filters:**

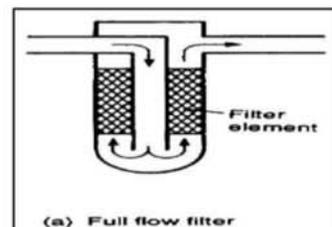
1- Full flow filter 2- Proportional flow filter

**Full flow filter:**

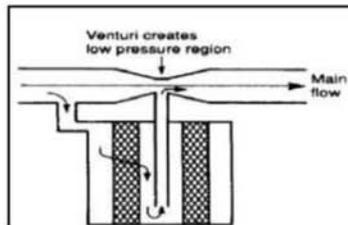
- Incurs a large pressure drop.
- A relief valve is needed which cracks when the filter becomes blocked.

**Proportional flow filter:**

- Localised low pressure area is formed at the venturi.



Sketch 2 Marks



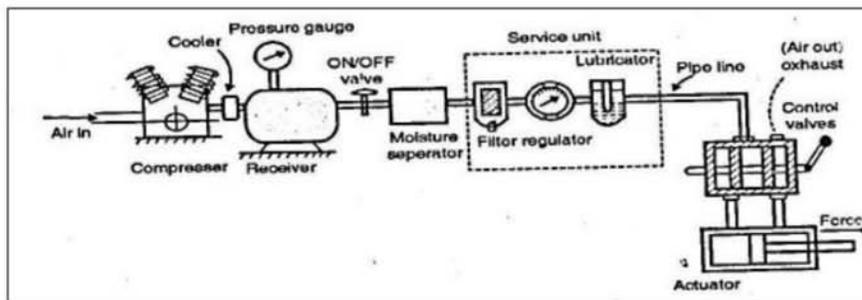
Working 2 Marks



4

a)  
(i)

**Attempt any FOUR of the following:**  
**General layout of pneumatic system.**



Sketch  
2 Marks

Working  
2 Marks

- 1) Air inlet filter – Free air from the atmosphere enters the compressor through an air-inlet filter which will essentially keep out the dust and dirt from entering the system.
- 2) Compressor: It is used to compress the air from atmosphere pressure to the desired higher pressure level. It can be single stage or multistage in operation.
- 3) Cooler: Removes the heat generated during the process of operation.
- 4) Pressure switch and control unit: Maintains the pressure in the receiver in the predetermined range by starting and stopping the prime mover.
- 5) Moisture separator: Cooling air in the cooler results in condensation of vapour in the air. The condensate in the form of water droplets are separated from air.
- 6) Service unit:
  - Filter** – Separates sub-micron level contamination.
  - Regulator** – Bring the pressure of air from receiver pressure to the device pressure.
  - Lubricator** – Adds lubricants to air.
- 7) Pipe Line: They carry the compressed air from one location to another.
- 8) Control Valves: They are required to control the air direction, pressure and flow rate. They are responsible for the smooth and precise control of the pneumatic actuator, and also for the safe operation of the system.
- 9) Actuator: They will convert the high pressure energy of the compressed air into mechanical force or do useful work. Actuators can either be pneumatic cylinders to provide linear motion or pneumatic motors to provide rotary motion.

(ii)

**Advantages of Pneumatic system**

- 1) Infinite availability of the source
- 2) Easy channelled 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**

- 1) Requires installation of air-producing equipment
- 2) Easy to leak
- 3) Potential noise
- 4) Easy condenses
- 5) Low operating pressure
- 6) Limited applications.

2 Marks

2 Marks



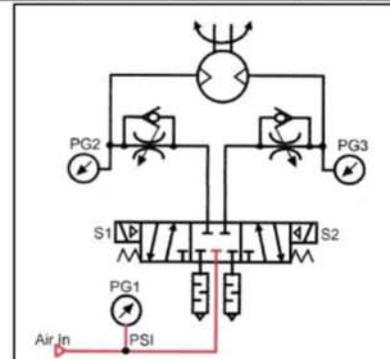
(iii)

**Meter-In circuit for Air Motor**

Air motor rotates in clockwise as well as anti clockwise direction.

**Components:**

Compressor, air receiver, FRL unit, 4/3 DC valve, Rotary actuator, variable flow control valve, hose pipes.



Circuit  
4 Marks

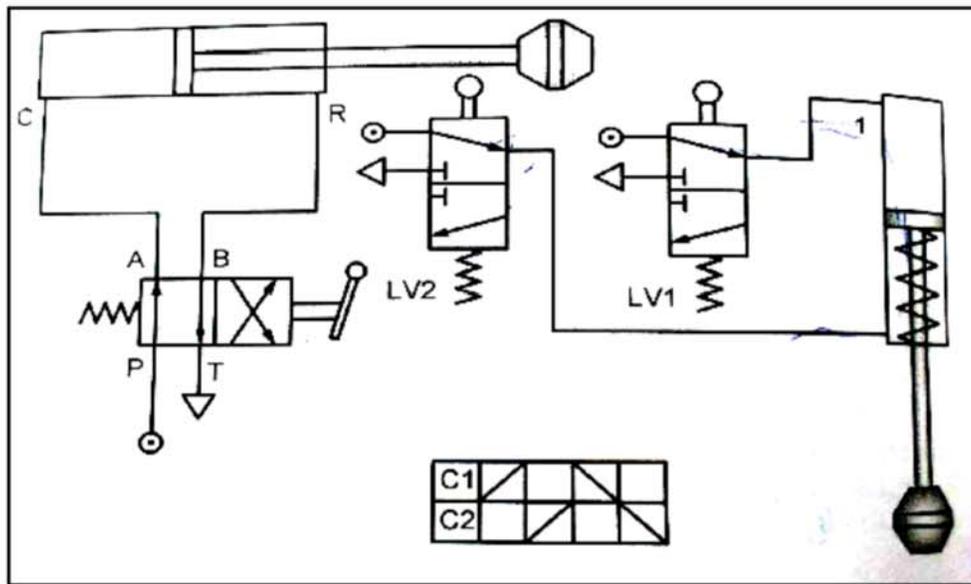
(iv)

**Position based sequencing is possible using roller operated DCV or solenoid operated DCV.**

Various components required for Position based sequencing using roller operated DCV are as follows.

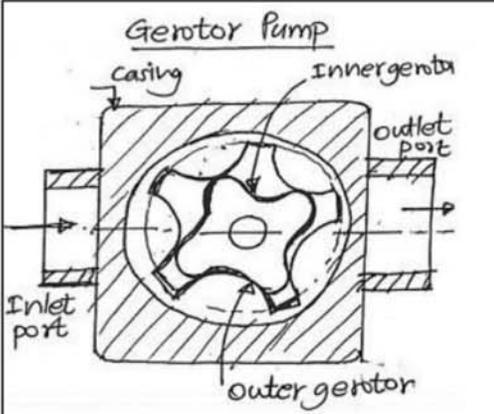
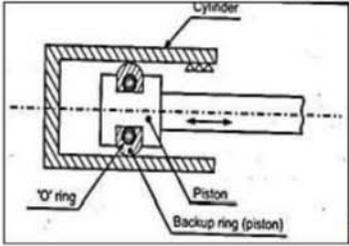
- Double acting cylinder - 02 Nos.
- 3/2 roller operated DCV – 02 Nos.
- 4/2 or 5/2 DCV – 01 No.
- IV. FRL Unit, Compressed air supply, hose pipes etc.

Components are connected as shown in figure.



Correct  
Circuit  
4 Marks



<p>b) (i)</p>	<p><b>Attempt any ONE of the following:</b> <b>Gerotor Pump</b> These pumps have a pair of gear shaped elements, meshing each other. The teeth on inner rotor has always one tooth less than outer. The tooth form of the inner element is such that each tooth of the inner element is always in sliding contact with the surface of the outer element. Thus sealing between suction and discharge chamber. 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 teeth 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.</p>	 <p>The diagram shows a cross-section of a gerotor pump. It consists of an outer casing with an inlet port on the left and an outlet port on the right. Inside the casing, there are two gear-like rotors: an inner gerotor and an outer gerotor. The inner gerotor has five teeth, and the outer gerotor has six teeth. The rotors are offset from each other. Arrows indicate the flow of oil from the inlet port, through the meshing of the rotors, and out through the outlet port.</p>	<p>Sketch 4 Marks</p> <p>Working 2 Marks</p>
<p>(ii)</p>	<p><b>Classify seals:</b> i) Classification based on applications a) Static seals                      b) Dynamic seals ii) Classification based on degree of sealing a) 'O' Ring seal                      b) 'V' Ring seal c) U Packing seal                      d) T Ring seal                      e) Cup seal <b>'O' Ring seal:</b> These are most common and simple seals with circular cross section like O. Hence it is called as O ring. As shown in O ring seal. It is used as static as well as dynamic seal. The material used for O ring is synthetic rubber and is specified by its ID/OD. The round cross section of O ring changes to oval shape under low pressure. Hence O rings are non-positive seals. O rings are fitted with backup ring.</p>	 <p>The diagram shows a cross-section of an O-ring seal. It consists of a cylinder with a piston inside. The piston is pushed to the right, compressing the O-ring against the cylinder wall. The O-ring is shown in its original circular shape and its deformed oval shape under pressure. A backup ring is also shown, which is used to support the O-ring and prevent it from being extruded.</p>	<p>2 Marks</p> <p>Sketch 2 Marks</p> <p>Working 2 Marks</p>

5

a)

**Attempt any TWO of the following:**

- Pressure regulator is a pressure control valve falls in the category of pressure reducing valves.
- Pressure regulation in pneumatics is vital for the correct operation of circuits and for damage prevention to circuit components.

**Types of pressure regulator:**

**A) According to number of stages:**

1. Single stage: The pressure regulation is carried out in single stage as per requirement in the circuit.
2. Two stage regulator: The pressure regulation is carried out in two stages as per requirement in the circuit

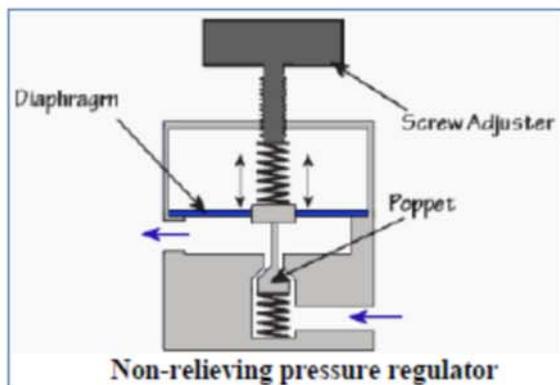
**B) According to pressure relief:**

1. Non-relieving type: The pressure is regulated by poppet movement through the application device like actuator or load.
2. Self-Relieving type :The pressure is regulated by venting air through regulator itself, it is known as self-reliving pressure regulator.

**Explanation of Non-relieving pressure regulator**

**Non-relieving pressure regulator:**

- Non-relieving pressure regulators work by restricting flow rather than 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 a 'poppet' attached on the end of it which is drawn up with the diaphragm and restricts the passing air flow.



Types  
2 Marks

Sketch  
3 Marks

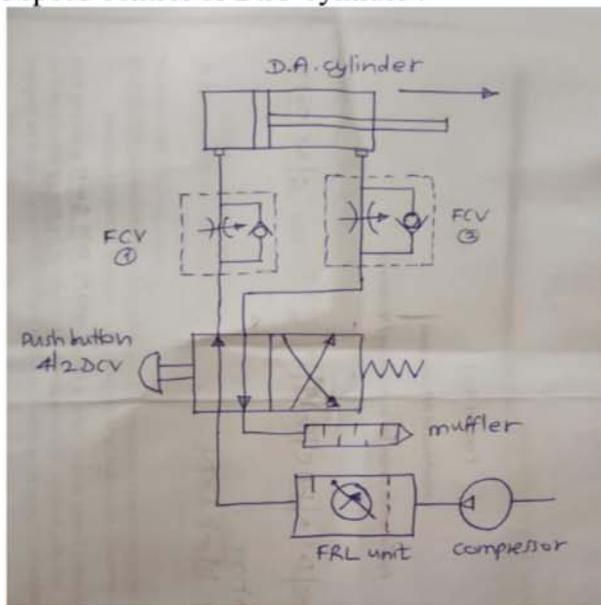
Working  
3 Marks

b)

**Circuit diagram:**

**Explanation:**

Pneumatic circuit for speed control of D.A cylinder :



Circuit  
4 Marks

Working  
4 Marks

**Slow Speed:**

Compressed air is passed through DCV from port B to port A, it will enter in the



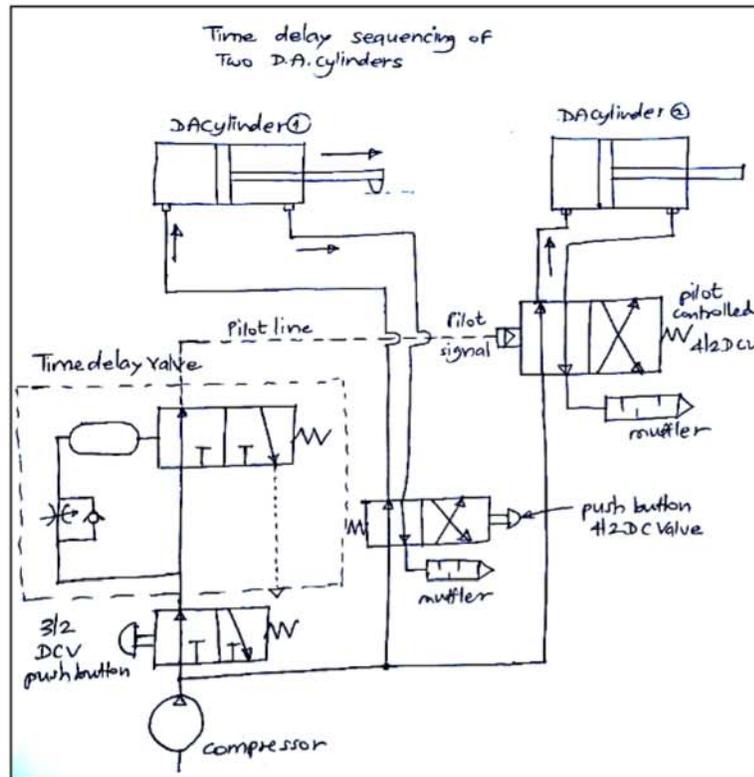
- Hence small quantity of air will enter in the D.A cylinder through inlet A. It will move the piston at slow speed.

**Fast Speed :**

- Similarly when flow area of the FCV1 is increased by fully opening the valve, it will supply full quantity of compressed air to the D.A cylinder through inlet A.
- As large quantity is supplied it will move the piston at high speed.
- We can control the speed in another direction using FCV2 and second position of DC valve.

Hence by varying the flow quantity of air we can change the flow quantity of air we can change the speed of D.A cylinder.

c)



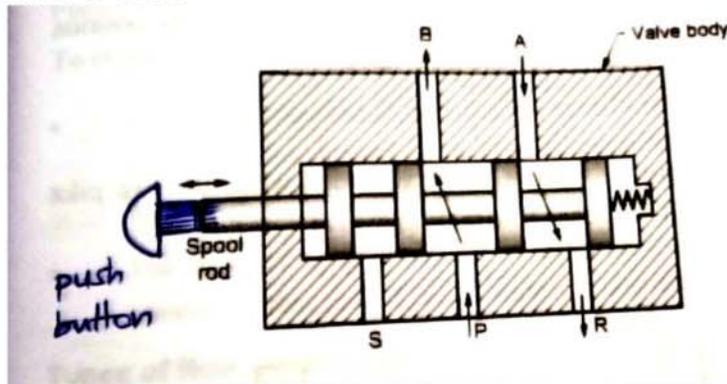
Correct  
Circuit  
6 Marks

Label  
2 Marks

6

a)

**Attempt any FOUR of the following:**  
**Sketch of 5 x 2 DC valve**



**Explanation:**

- Most 5/2-way valves have a movable spool with seals along the length in a cylinder.
- By moving the spool through the cylinder, the valve ports are connected or blocked.
- Also the valve can be direct operated or pilot operated. With direct operation, the actuator is directly connected to the spool.

They are quick to operate because of small switching movement.

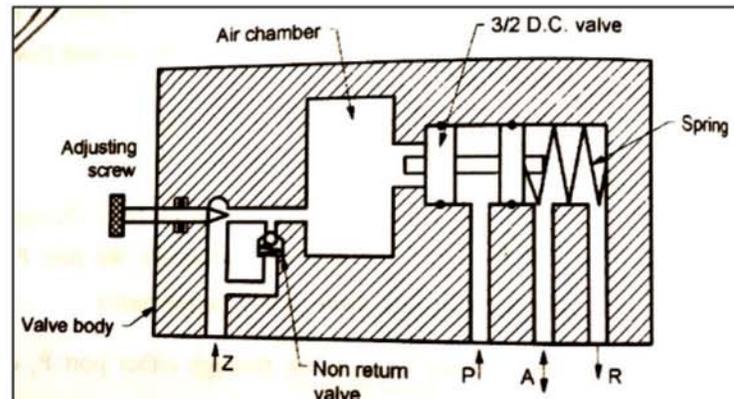
Sketch  
2 Marks

Working  
2 Marks

b)

**Time delay valve**

- 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.
- Time delay valve is a combination of a pneumatically actuated 3/2 direction control valve, an air reservoir and a throttle relief valve.
- The time delay function is obtained by controlling the air flow rate to or from the reservoir by using the throttle valve.
- Adjustment of throttle valve permits fine control of time delay between minimum and maximum times. In pneumatic time delay valves, typical time delays in the range 5-30 seconds are possible.

Sketch  
2 Marks

Working  
2 Marks

c) **Criteria for selection of Hydraulic pump**

1. **Maximum operating pressure.** This is determined by the power requirement of the circuit, the particular application, availability of components, type of fluid and to some extent the environment and level of labor both using and maintaining the equipment
2. **Maximum Flow/delivery.** The pump system selected must be capable of delivering the maximum flow rate demanded by the circuit. If the circuit demand is constant, a fixed displacement pump is chosen.
3. **Type of control.** Various types of pump controls are available such as manual servo control; Pressure compensated control, constant power control and constant flow control. The choice of control is dependent upon the circuit requirement such as complexity, accuracy of control, cost, type of machining operation, etc. The designer has to choose carefully the type of control after a detailed study of system characteristics.
4. **Pump drive speed.** The fluid delivery rate is proportional to the speed of rotation. Each design has a minimum and maximum operating speed: the faster the pump runs, the shorter its life
5. **Type of fluid.** Pumps are designed to operate within a particular range of fluid viscosity. Mineral oils of the correct viscosity work satisfactory with most pumps provided the oil is clean
6. **Pump noise.** The actual efficiency depends on design, operating pressure, speed and fluid viscosity.
7. **Cost.** The initial cost of a pump is usually of secondary importance to running and maintenance costs. Gear pumps are cheaper, vane and piston pumps are expensive.

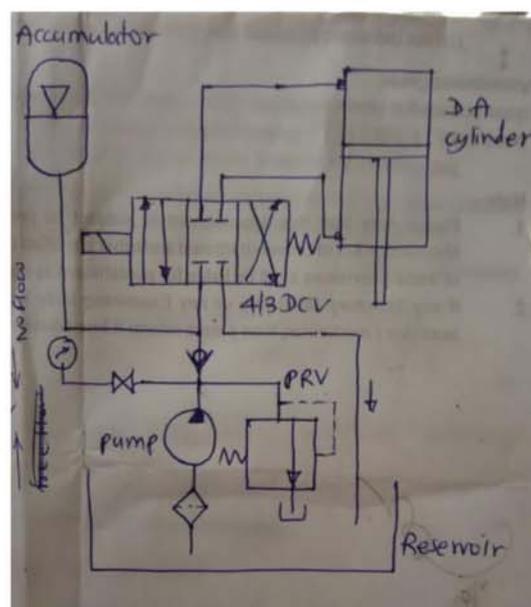
4 Marks

d) **Use of accumulator in hydraulic circuits.**

**Ans:**

A hydraulic accumulator is a device that stores the potential energy of an incompressible fluid held under pressure by an external source. The figure shows use of an accumulator in hydraulic press circuit.

Correct Usage  
4 Marks



- In hydraulic press circuit supplementary flow of oil with pressure is sometimes required during press operations.
- To achieve the desired cycle speed in the punching operation, during dwell time of press functioning, the accumulator gets charged from the pump flow to store energy in the accumulator.



- as per demand for short period of time.
- It will help to save the energy by using smaller pump to achieve higher demand instead of using large pump.

**Functions:**

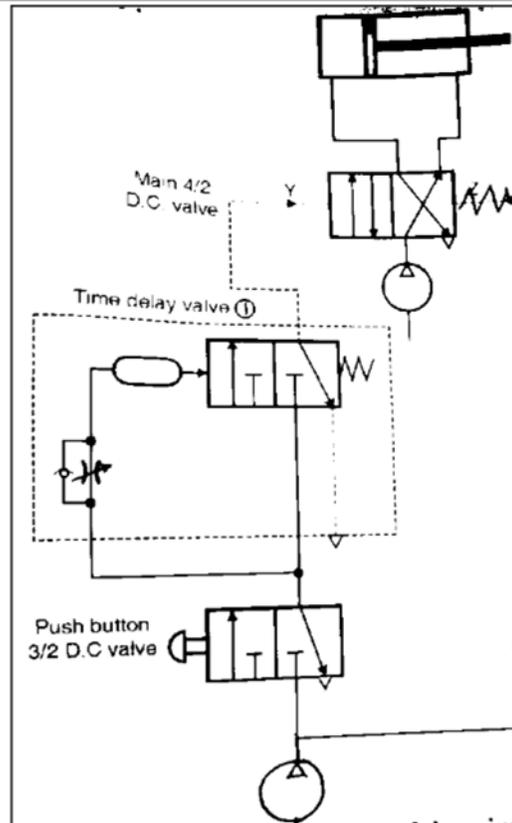
- 1. Store fluid energy:** The stored potential energy in the accumulator is a quick secondary source of fluid power.
- 2. To meet peak demand of power:** Energy stored by accumulator can be used for peak or more demand of power from the system.
- 3. To smooth out pressure shocks/Surges:** Accumulator helps to reduce pressure shocks and fluctuations caused due to uneven flow and pressures.
- 4. Emergency power source:** It will give energy backup during pump failure or whenever required.

e) **Circuit diagram: Time delay for Double acting cylinder**

**Explanation:**

- This circuit is designed for delayed operation of DA cylinder using time delay valve.
- The time delay valve is mounted after 3/2 DC valve so that required time delay can be set for movement of actuator in the advanced stroke.
- The circuit shows that pilot signal from time delay valve is given to the pilot operated 4/2/Dc valve and air will enter in DA Cylinder as per the delay set in the time delay valve.

The retraction stroke is performed by spring movement of the spool in the 4/2 Dc Valve.



Sketch  
2 Marks

Working  
2 Marks