



WINTER – 2022 EXAMINATION
Model Answer

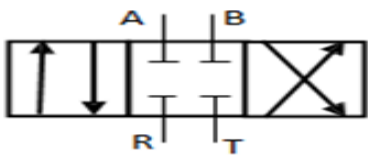
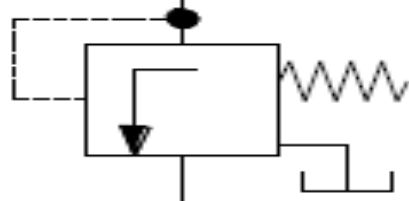
Subject Name: Industrial Hydraulics and Pneumatics

Subject Code:

22655

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.
- 8) As per the policy decision of Maharashtra State Government, teaching in English/Marathi and Bilingual (English + Marathi) medium is introduced at first year of AICTE diploma Programme from academic year 2021-2022. Hence if the students in first year (first and second semesters) write answers in Marathi or bilingual language (English +Marathi), the Examiner shall consider the same and assess the answer based on matching of concepts with model answer.

Q. No.	Sub Q. N.	Answer	Marking Scheme
1		Attempt any FIVE Of the Following	10
	a)	Draw IS symbol for	01 marks each
		i) 4/3 Directional control Valve	
		i) Sequence Valve	



Q. No.	Sub Q. N.	Answer	Marking Scheme				
	b)	<p>i)Viscosity: - The viscosity of a fluid is a measure of its resistance to shear or angular deformation.</p> <p>Or Viscosity is a measure of a fluid's resistance to flow.</p> <p>ii)Specific Weight :- Specific weight is defined as weight per unit volume</p>	01 marks each				
	c)	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%; padding: 5px;">Linear Actuator</td> <td style="padding: 5px;"> Material Handling. Robotics. ... Food and Beverage Manufacturing. ... Window Automation. ... Agricultural Machinery. ... Cutting Equipment. ... Valve Operation </td> </tr> <tr> <td style="padding: 5px;">Rotary Actuator</td> <td style="padding: 5px;"> Clamps or pick-and-place handlers farm applications for rotating arms, booms in industries for positioning, transferring & clamping parts. </td> </tr> </table>	Linear Actuator	Material Handling. Robotics. ... Food and Beverage Manufacturing. ... Window Automation. ... Agricultural Machinery. ... Cutting Equipment. ... Valve Operation	Rotary Actuator	Clamps or pick-and-place handlers farm applications for rotating arms, booms in industries for positioning, transferring & clamping parts.	01 marks each (Minimum 2 application of each.
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	d)	<p>Factors to be considered while selecting pump</p> <ol style="list-style-type: none"> 1. Liquid Properties- 2. Pump Capacity (Flow Rate and Pressure of oil) 3. Efficiency of the pump 4. Speed of pump 5. Ease of Use 6. Environmental Considerations 7. Control Systems 	Minimum 4 , half each.				
	e)	<p>Different functions of valves</p> <ol style="list-style-type: none"> 1 Industrial system, and in any piping system, valves are used to restrict stop or control the flow of fluid. 2 Regulating flow and pressure within a piping system. 3 Controlling the direction of flow within a piping system 4 Throttling flow rates within a piping system. 	Minimum 2 , 1 each.				



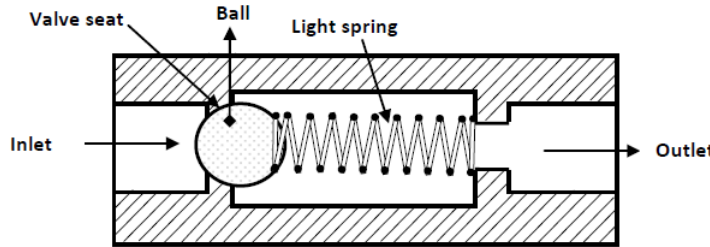
f)	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 40%;">Hydraulic Filter</td> <td>Pneumatic Filter</td> </tr> <tr> <td>Suction Filters and Strainers</td> <td>Air Filter Types Fiberglass, polyester, washable, pleated and electrostatic filters</td> </tr> <tr> <td>Spin-On Filters</td> <td>Water separators.</td> </tr> <tr> <td>Reservoir Breather Filters</td> <td>Particulate filters.</td> </tr> <tr> <td></td> <td>Adsorbing filters.</td> </tr> </table>	Hydraulic Filter	Pneumatic Filter	Suction Filters and Strainers	Air Filter Types Fiberglass, polyester, washable, pleated and electrostatic filters	Spin-On Filters	Water separators.	Reservoir Breather Filters	Particulate filters.		Adsorbing filters.	Minimum 4, half each.																		
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g)	<p>Common faults that can be observed in Pneumatic System</p> <ul style="list-style-type: none"> i) Low pressure ii) High Temperatures iii) Particulate Contamination iv) Compressor Stalling, Failure, And Faults v) Audible And Visible Leaks. 	Minimum 4, half each																												
2	a)	Attempt Any THREE of the following:	12																											
		<p>Advantages and limitations of hydraulic and pneumatic systems (reference points)</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 25%;">Parameters</th> <th style="width: 35%;">hydraulic systems</th> <th style="width: 40%;">pneumatic systems</th> </tr> </thead> <tbody> <tr> <td>Complexity</td> <td>Moderately complex system</td> <td>Simple system</td> </tr> <tr> <td>Peak Power</td> <td>Very high</td> <td>high</td> </tr> <tr> <td>Speed</td> <td>Moderate</td> <td>Very high</td> </tr> <tr> <td>Load Ratings</td> <td>Very high</td> <td>high</td> </tr> <tr> <td>Environmental</td> <td>Low</td> <td>High noise levels</td> </tr> <tr> <td>Purchase Cost</td> <td>High</td> <td>low</td> </tr> <tr> <td>Operating Cost</td> <td>High</td> <td>Moderate</td> </tr> <tr> <td>Maintenance Cost</td> <td>High</td> <td>low</td> </tr> </tbody> </table>	Parameters	hydraulic systems	pneumatic systems	Complexity	Moderately complex system	Simple system	Peak Power	Very high	high	Speed	Moderate	Very high	Load Ratings	Very high	high	Environmental	Low	High noise levels	Purchase Cost	High	low	Operating Cost	High	Moderate	Maintenance Cost	High	low	2 marks each
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	b)	<p>Tandem Cylinder:-</p> <p>A tandem cylinder, shown in Figure , is used in applications where a large amount of force is required from a small-diameter cylinder. Pressure is applied to both pistons, resulting in increased force because of the larger area. Hence at the piston rod, we can get double force during movement of pistons.</p>	02+02																											

c)

Check valve

The simplest DCV is a check valve. A check valve allows flow in one direction, but blocks the flow in the opposite direction. It is a two-way valve because it contains two ports.

In Figure light spring holds the ball against the valve seat. Flow coming into the inlet pushes the ball off the seat against the light force of the spring and continues to the outlet. A very low pressure is required to hold the valve open in this direction. If the flow tries to enter from the opposite direction, the pressure pushes the ball against the seat and the flow cannot pass through.



02+02

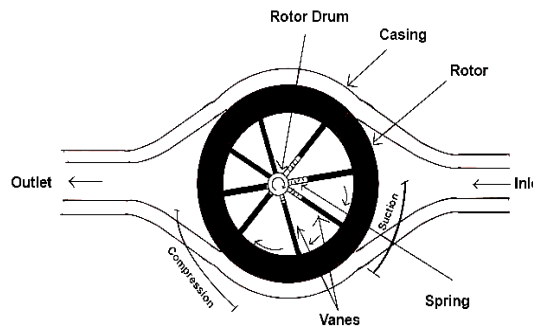
d)

Any one rotary compressor with sketch

Rotary compressor units are classified into three general groups, (Any one)

1. Slide vane-type,
2. Lobe-type, and
3. Screw-type.

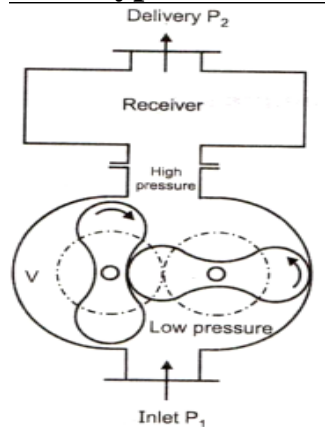
Slide vane-type,



- This is a positive-displacement pump that consists of vanes mounted to a rotor that rotates inside a cavity.
- The vane-type compressor consists of a cylindrical rotor with longitudinal slots in which radial sliding vanes are fitted.
- The rotor is positioned eccentrically within a cylindrical housing.
- The spaces between adjacent vanes form pockets of decreasing volume from a fixed inlet port to a fixed discharge port.

02+02

Lobe-type



Lobe type air compressor: it is a rotary type of compressor consisting of two rotors which are driven externally. One rotor is connected to drive and second is connected to gear. These two rotors have two or three lobes having epicycloids, hypocycloid or involutes profiles.

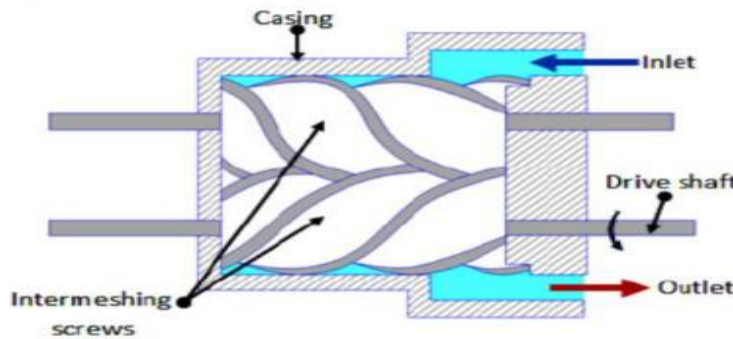
In the figure two lobes compressor is shown with a inlet arrangement and receiver. A very small clearance is maintained between surfaces so that wear is prevented. Air leakage through this clearance decreases efficiency of this compressor. During rotation a volume of air V at atmospheric pressure is trapped between left hand rotor and casing . this air is positively displaced with change in volume until space is opened to high pressure region. At this instant some high pressure air rushes back from the receiver and mixed with the blower air until both pressure are equalized.

Screw type

In a screw compressor one of the shafts is driving shaft and the other is driven shaft. The driving shaft is connected to the driven shaft via timing gears which help to match speeds of both the shafts. The driving shaft is powered by an electric motor generally. The two shafts are enclosed in an airtight casing.

The working cycle of the screw compressor has three distinct phases as following:

- i) Suction process
 - ii) Compression process
 - iii) Discharge process.
- i) **Suction process** - As the rotors rotate, air is drawn through the inlet opening to fill the space between the male lobe and the female flute. As the rotor continues to rotate, the air is moved past the suction port and sealed in the interlobe space.
- ii) **Compression process** -As the main rotor turns, the air trapped in the interlobe space is moved both axially and radially. The air is compressed by direct volume reduction as the enmeshing of the lobes progressively reduced the flute volume and compression occurs.
- iii) **Discharge process:** At a fixed point where the leading edge of the flute and the edge of the discharge port co-inside, compression ceases and the air is discharged into the delivery line, until the flute volume has been reduced to zero.



3

Attempt Any THREE of the following:

12

a)

Compare gear pump and vane pump on the basis of:-

Parameters	Gear pump	Vane pump
Construction	Construction Simple in construction than vane Pump.	Complex in construction.
Speed	1200 to 2500 RPM	1200 to 1800 RPM
Application	Pumping high viscosity fluids such as oil, paints, resins or foodstuffs	High-pressure hydraulic pumps and in automobiles, including supercharging, power-steering, air conditioning, and automatic-

01 mark each

		transmission pumps.	
Pressure	35 to 200 Bar	70 to 140 Bar	

b) **Explain the working of sequence valve with neat sketch.**

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.

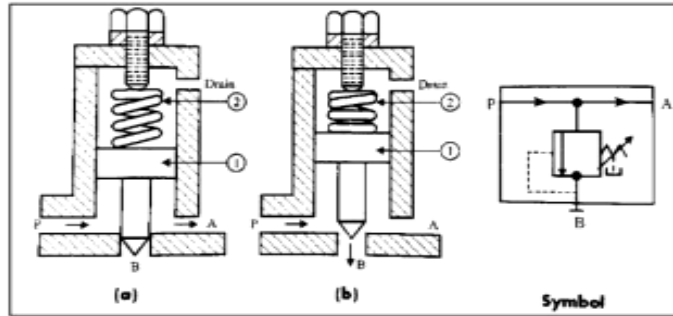


Figure shows operating principle of a direct acting, normally closed sequence valve. In this position, fluid passes through the valve from the inlet port P to primary outlet port A at system pressure. When the first step in the sequence is completed, the system pressure increases to act against the exposed 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.

02 +02

c) **Compare meter in and meter out Circuit.**

Sr No	Meter-IN	Meter-OUT
1	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.	When oil flow from pump to the actuator through D.C. valve it will push the piston in the forward direction. The oil from the piston rod side is pushed through the outlet of B of D.A. Cylinder through the return line
2	Flow control valve 'F' is placed in pressure line	Flow control valve 'F' is placed in return line
3	Give best result when used in higher pressure systems.	The actuator movement is very stable
4	Relatively small friction to face by piston which increases life of piston	Heat generated due to throttling at flow control valve is given to the oil tank.
5	Suitable for very low piston rod speeds	Provides positive speed control of the cylinder
6	Throttling of fluid takes place which heats the oil and hot oil into admitted into cylinder	Since both sides of piston there is pressure, there is possibility of higher friction.

Any 04 points
(01 mark each)

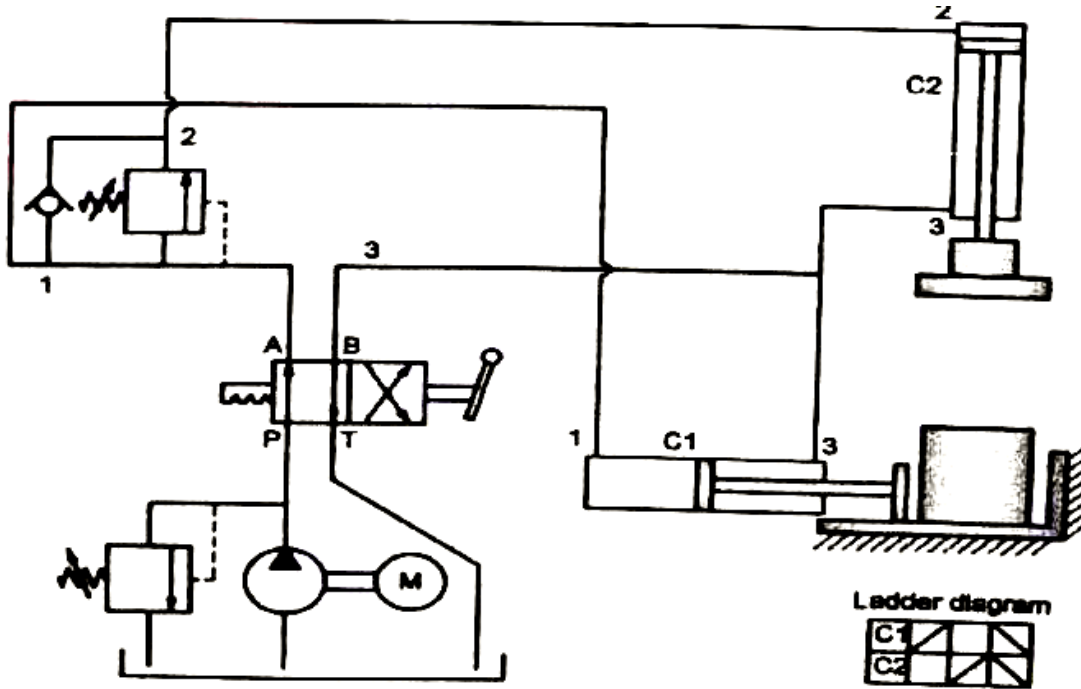


7	The circuit is used where finer speed control is required.	This circuit is used where very stable movements of actuators are needed.
8	Used in - Surface grinders, Welders, Milling Machines	Used in - Drilling, boring, reaming and tapping operations

d)

A machine holds the steel sheet and then punches a hole. The sheet is released when the punch goes back. Suggest and draw the suitable circuit for this situation.

Suggested circuit : - Sequencing Circuit



01 mark for circuit name

03 marks circuit diagram

4

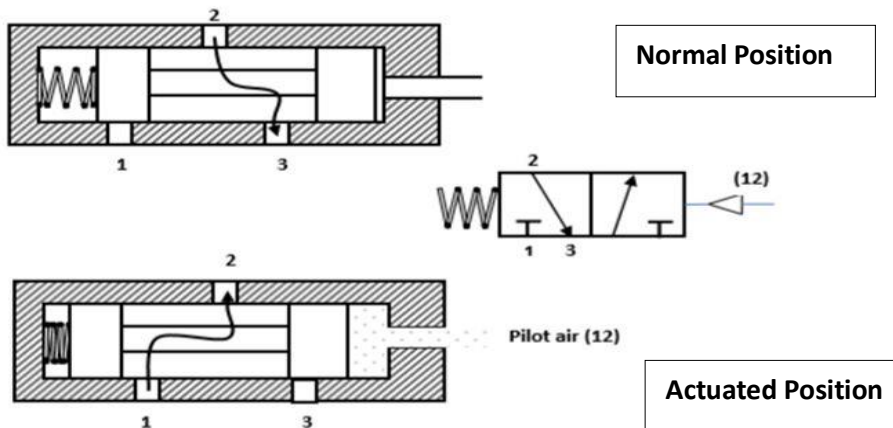
Attempt any THREE of the following:

12

a)

Explain with neat sketch working 3/2 DCV.

02 + 02





Working:-

Push button operated spring return type 3/2 sliding spool valve. It has spring loaded spool inside the valve body.

In actuated position there is connection from port 1 to port 2, oil flows from pump to SA cylinder & hence SAC extends.

In normal position there is connection from Port 2 to Port 3, Oil flows from SA cylinder to tank & SAC Retracts. Here inlet port 1 is closed.

b)

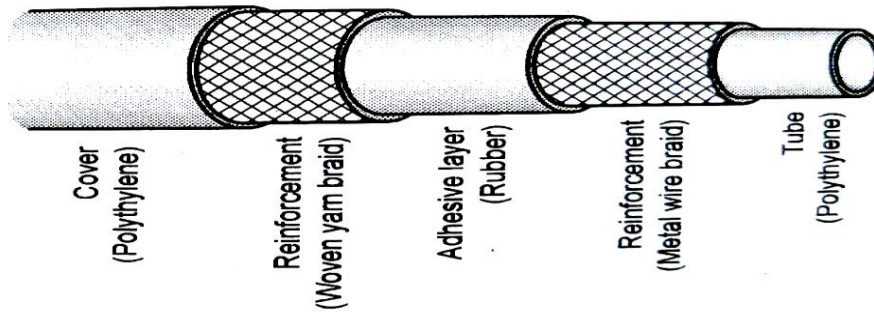
Give Classification of control Valve.

- 1) According to function.
 - a) Pressure control Valve.
 - i) Pressure relief valve.
 - ii) Pressure reducing valve.
 - iii) Unloading Valve.
 - b) Direction control valve
 - i) 2 x 2 DCV
 - ii) 3 x 2 DCV
 - iii) 4 x 2 DCV
 - iv) 4 x 3 DCV
 - c) Flow Control valve.
 - i) Fixed displacement FCV
 - ii) Variable displacement FCV
 - iii) Pressure compensated FCV
- 2) According to method of actuation
 - a) Manual operated
 - i) Push button operated.
 - ii) Hand lever operated.
 - iii) Pedal operated.
 - b) Pilot operated
 - i) Single Pilot operated.
 - ii) Double Pilot operated.
- 3) According to Construction.
 - a) Poppet type.
 - i) Ball type.
 - ii) Conical Poppet type.
 - b) Spool type
 - i) Sliding spool type.
 - ii) Rotary spool type.

Any 04
types

(1 mark
each)

c) Explain flexible hose. State its material and application



Explanation:- Flexible hose pipes are extensively employed in hydraulic systems and pneumatic systems. As they are easy to accommodate and to connect with in the available space. These pipes are made of elastic material and can be bent easily. Flexible pipe is made of several layers with metal wire braiding between them. Those metal wire reinforcement increases the strength of the pipe
Material:- Nylon braided hoses, Steel wire reinforced rubber hoses, poly-urethane tubes, poly-ethylene tubes.
Application:- Convey the hydraulic oil. It is used to transfer liquids under high pressure in the oil industry.

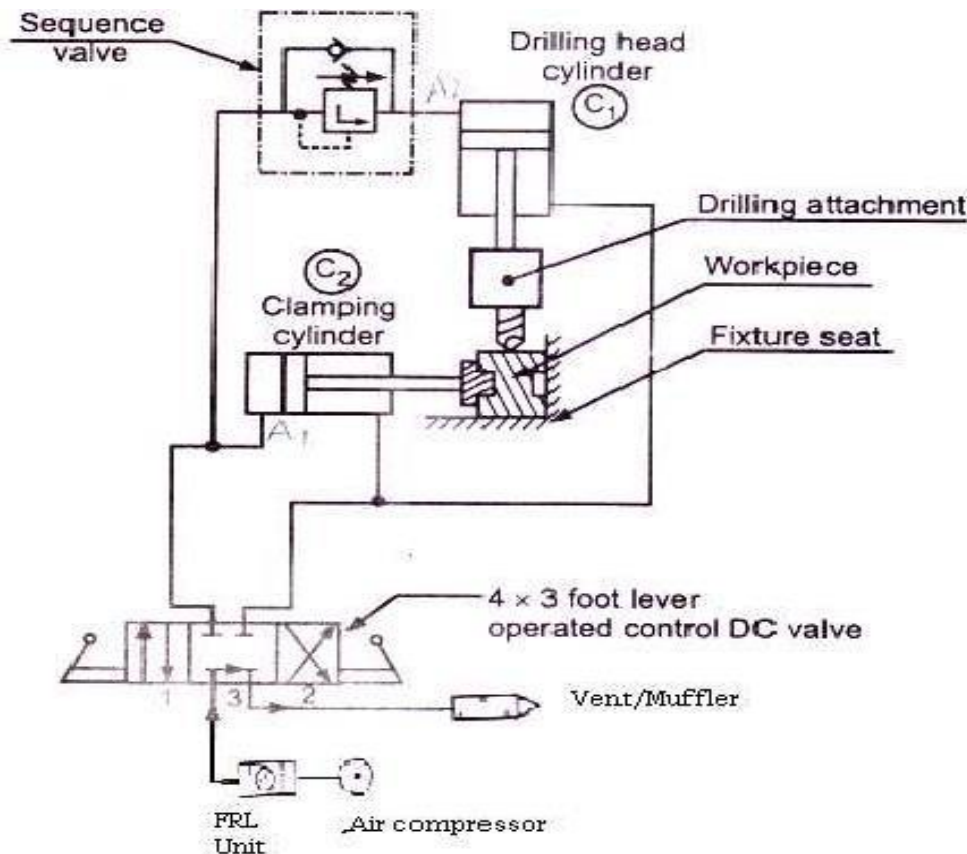
01 mark

01 mark

01 mark

01 mark

d) Pneumatic circuit using Sequence valve



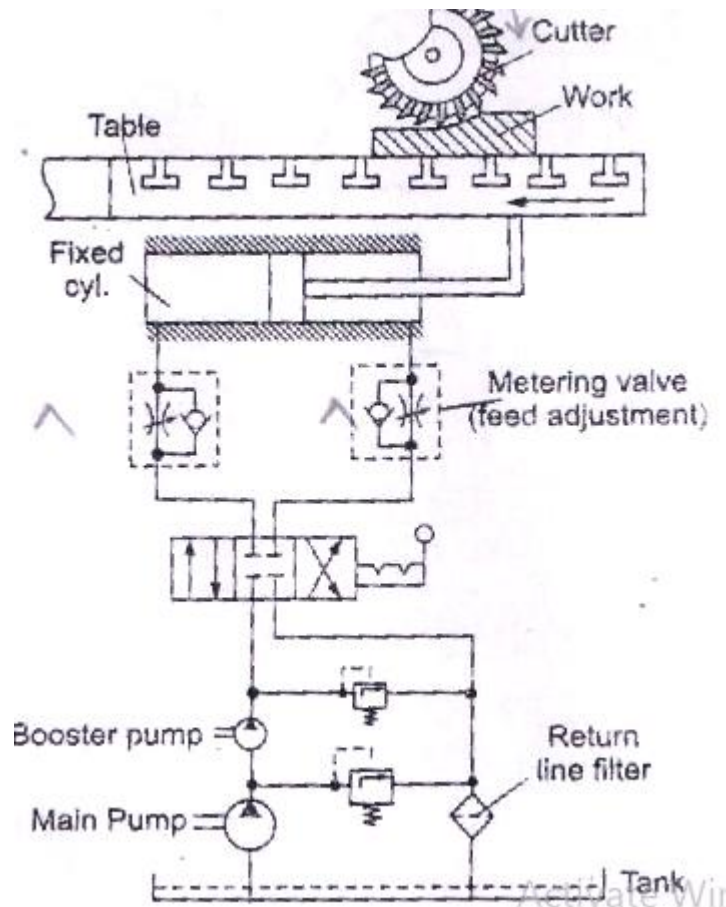
Explanation :- Pressure dependent sequencing circuit :

02 + 02

The circuit is used for drilling a hole in work piece.
The sequence operation is
a) Clamping of work piece
b) Drilling
c) Decamping and drill taken out from hole.
The DC valve takes centre position (no 3.) no compressed air supplied to either of cylinder C1 or C2. Now undrilled work piece is kept on fixture seat. The compressed air from compressor is going to vent via DC valve so no movement of cylinder C1 or C2.
Now compressed air start supplying directly to C2 and through sequence valve to C1
When compressed oil enters through port A2 of cylinder C2 piston will advance and immediately clamps the work piece.
At the same time compressed air flow towards port A1 of cylinder C1 but through the sequence valve.
Some higher pressure is set at pressure relief valve of sequence valve when the pressure of flowing air reaches this set value the sequence valve opens and air enters through port A1 into cylinder C1 due to this piston advances comes down so that drilling starts.
When operator again operate foot lever of DC valve it takes position 2 and both piston retracts and work piece de-clamps and drill comes out of drilled hole.

Hydraulic circuit of milling machine & explain its working.

e)



02 + 02

Explanation: - Hydraulic circuit for milling machine is comparatively different from other circuits. Table movement of milling machine is required to be adjustable for different feeds for different type of work. Therefore for both strokes of the cylinder, on both ends of cylinder flow control

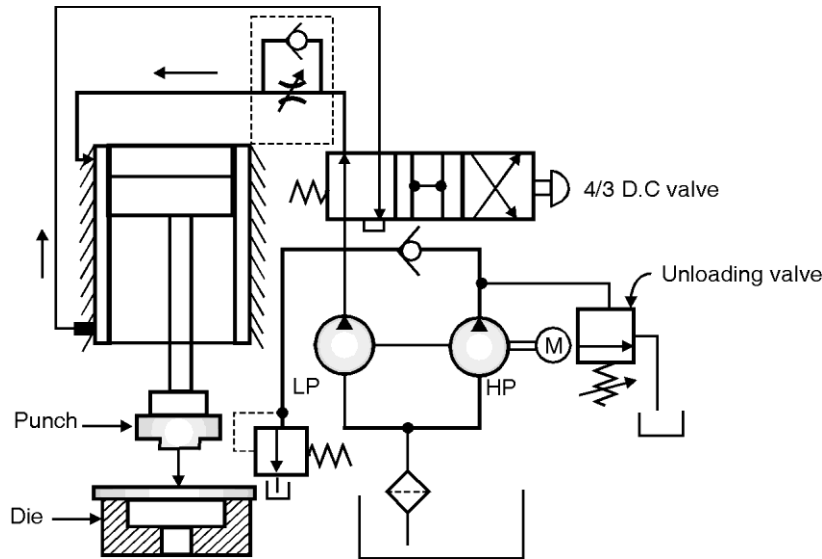
valves are used. Another feature of this circuit is that there are two pumps

1. Main pump – low pressure high discharge
2. Booster pump - high pressure low discharge

The function of booster pump is to boost the hydraulic pressure to a higher level than given by main pump. Reason behind using this type is to save power as well as use of high pressure high discharge pump is avoided. 4/3 DCV used manually operated stroke length of cylinder is adjustable through limit switch. In centre position of 4/3 DCV all the ports are close therefore, total hydraulic system is lock. In position (I) pump flow is given to cylinder blank end and extension starts and oil from rod end is discharge to tank In (II) position, pump flow diverted to rod end for retraction and blank end side flow pass to tank.

5	Attempt any TWO of the following:	12
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a) **Draw and Explain two pump unloading circuit**



02 +04

Importance of circuit:

- High-low system of pump consists of two pumps in which one pump has high flow rate and other has low flow rate. They are used to save the system power. Both pumps can be used simultaneously depending upon system requirement or high flow rate is diverted through unloading valve if needed in the system.
- It is useful when combination of rapid and slow movement required in the circuit.

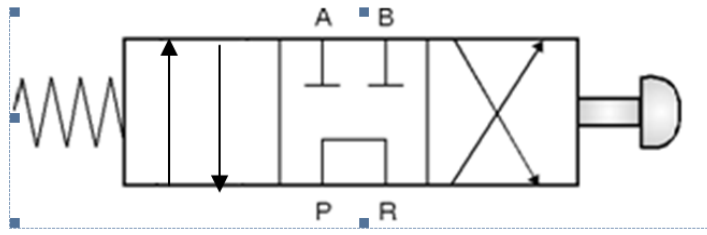
Explanation of Circuit :

- The circuits has low pressure (LP) and high pressure (HP) pumps are provided as shown in Fig.
- When rapid movement of the punch is required, both LP and HP supply the oil so that the piston retraction will be faster compared to advanced cutting stroke.
- Initially slow movement is required when punch starts movement towards the workpiece, the flow of HP is diverted through unloading valve and only LP will supply the oil to the actuator.
- When punch reaches near the workpiece, high force is needed for press



	<p>operations, HP supply will be started to combine with LP and high pressure is generated for performing press operation.</p> <p>Applications : Hydraulic press machines.</p>	
b)	<p>Two faults detected in Pneumatic circuit and its causes and remedies</p> <p>1)Fault: No pressure in the pressure side. Causes: Air leakage, pressure gauge faulty Remedies: Check pressure gauge working properly and repair it.</p> <p>2)Fault: Service unit (FRL) failed to work properly Causes: Filter stopped, Pressure regulator reads differently, Absence of oil drops in lubricator Remedies: Clean filter to remove clogging, Set regulator properly, Fill up oil container of lubricator</p> <p>3) Fault: Operating trouble of compressor Causes: Dirt in suction filter, Worn out piston rings Remedies: clean the filter, replace Worn out piston rings</p>	<p>1 mark each for fault, causes and remedies Any two</p>
c)	<p>Situations in which following Centre positions of DC valves are used</p> <p>1) All ports open (Open centre position) :</p> <ul style="list-style-type: none"> In this position, all ports are connected internally. Here oil flows through all ports P, A, B and R. The open centre condition is used to unloads the pump and allows the actuator to stop or float. It causes little shock during changeover to other conditions of valve. Fixed volume pumps are used for this centre condition. <div data-bbox="630 1507 1052 1717" data-label="Diagram"> </div> <p>2) Tandem Centre position :</p> <ul style="list-style-type: none"> This center is very common in applications like the simple press circuit, to allow the pump's flow to go straight to the tank, rather than forcing it over the relief valve. In this position, Port P of pump is connected to port R to divert flow of pump to the tank. Port A and B of actuator are closed. 	<p>Each position 3 marks for explanation With symbol</p>

- It will unload the pump to the reservoir while blocking the cylinder ports A and B. Fixed volume pumps are used for this centre condition.



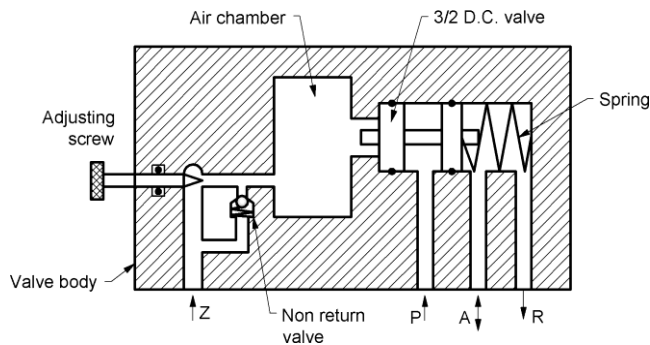
6 Attempt any TWO of the following:

12

a)

Valve selection for delay the controlling action :

Time Delay valve is used for **delay the controlling action by sometime after the actuation od Dc valve.**



Working:

- Initially when compressed air is supplied to the port P of the valve, it is prevented from flowing to port A from port P, as the spool blocks this port A.
- When air is allowed to enter through pilot port Z, it flows through needle operated flow control valve where its flow can be regulated.
- The air then enters in the air chamber where pressure starts building here. when sufficient amount of pressure is generated, it pushes the spool of 3/2 D.C. valve.
- Now the opening port P is get connected port A and port R is closed. Air can flow easily from port P to port A to actuate the actuator.
- The time required to build up the pressure in the reservoir is the amount of time delay of the time delay valve.

The time delay can be set by using needle adjustment screw to control flow rate of air.

Selection : 2 marks

Figure 2 marks

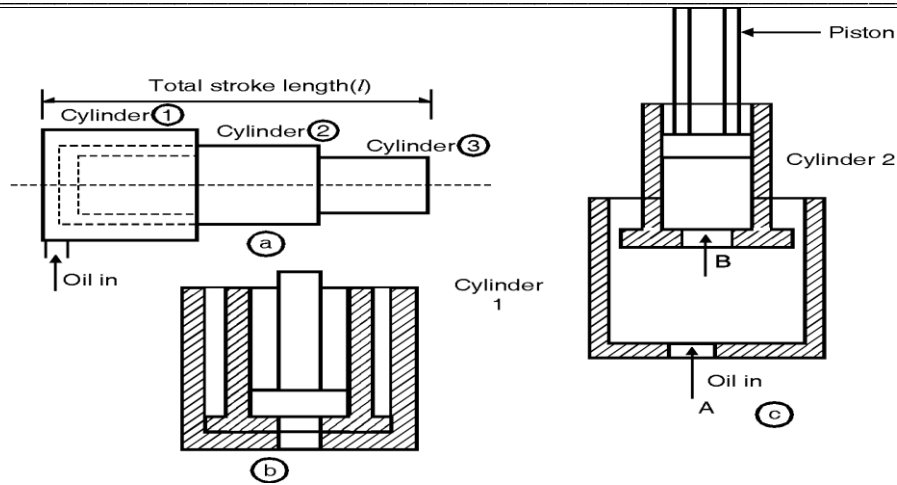
Working 2 marks

b)

Selection of an actuator for longer stroke length:

- Telescopic cylinder is used for longer stroke length and can be accommodated in less space after retraction.
- The cylinders are arranged in a short envelope hence space required is less.

Selection



: 2 marks
Figure 2 marks
Working 2 marks

Working :

- When pressurized oil enters in the main cylinder 1 it will push the cylinder 2 in the upward direction when sufficient oil pressure is generated.
- Now the cylinder 2 is completely lifted and oil will enter into the inlet of cylinder 2.
- The oil will flow in the cylinder 2 and push the piston in upward direction. It will raise the piston for stroke length of cylinder 2.
- In this manner, the total length of stroke through which the load is lifted is $(L_1 + L_2)$.
- It is suitable where less space is available for mounting of actuator.
- Used in equipment like tilting of truck dump bodies, fork lift trucks, hydraulic cranes.

Difference Between Hydraulic and Pneumatic system

Sr. No.	Point	Hydraulic	Pneumatic
1.	Medium used	Hydraulic system uses Oil	Pneumatic system uses Air
2.	Storage of medium	Reservoir is required to store oil	Air is free from atmosphere hence storage of input medium not required
3.	Storage device	Reservoir of suitable capacity in liters	Air receiver to store compressed air under pressure
4.	Reuse	Re circulated again to save cost	Freely available hence not necessary to recirculate.
5.	Cost of medium	Hydraulic oil is Costly	Freely available from nature. But cost of compression
6.	Power device	Pump is used to increase pressure of an oil	Compressor is used to increase pressure of an air
7.	Return lines	Required for recirculation	Not required direct exhausted to atmosphere
8.	Lubrication	Self lubricated as oil is	Separate lubricator needed for

Any 06 points (01 mark each)



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				having lubrication characteristics.	smooth working of system			
		9	Operating pressure	300 to 700 bar	Limited to 10 bar			
		10	Application	Heavy equipments cranes, lifts, farm equipments, JCB bulldozer, etc	Hand tools, press machines, foundry machines, small cranes, etc			
		-----END-----						