



WINTER- 18 EXAMINATION

Subject Name:

Model Answer

Subject Code:

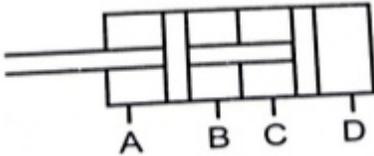
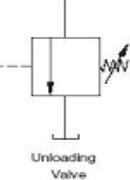
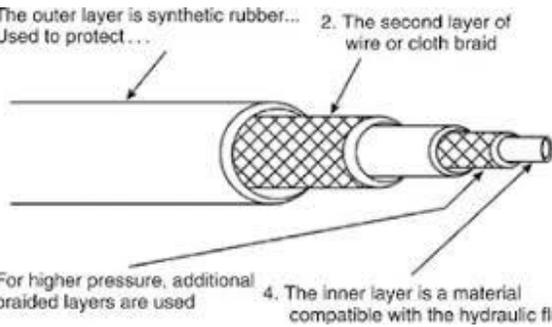
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**Important Instructions to examiners:**

- 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		Attempt any FIVE	
	(a)	Compare oil and air as a medium in fluid system	
	Ans:	<ul style="list-style-type: none"> <li>• When the system requirement is high speed, medium pressure (usually 6 to 8 bar) and less accuracy of position, then pneumatic system is preferred.</li> <li>• If the system requirement is high pressure and high precision, a fluid system with oil is good.</li> <li>• When the power requirement is high like in forging presses, sheet metal press, it is impossible to use air system. Oil hydraulics is the only choice .</li> <li>• Air is used where quick response of actuator is required.</li> <li>• If temperate variation range in the system is large, then use of air system may run into condensation problems and oil is preferred.</li> <li>• Air is non-explosive, it is preferred where fire/electric hazard are expected. Oil systems are more prone to fire and electrical hazards and are not recommended in such applications. Because air contains oxygen (about 20%) and is not sufficient alone to provide</li> <li>• Adequate lubrication of moving parts and seals, oil is usually introduced into the air stream near the actuator to provide this lubrication preventing excessive wear and oxidation. If the application requires only a medium pressure.(any four points)</li> </ul>	Four Points 4 Marks ( 01 mark to each point )
	(b)	State applications of hydraulic system	
	Ans:	<p>1)Industrial: Plastic processing machineries, steel making and primary metal extraction applications, automated production lines, machine tool industries, paper industries, loaders, crushes, textile machineries, R &amp; D equipment and robotic systems etc.</p> <p>2)Mobile hydraulics: Tractors, irrigation system, earthmoving equipment, material handling equipment, commercial vehicles, tunnel boring equipment, rail equipment,</p>	



	<p>building and construction machineries and drilling rigs etc. 3)Automobiles: It is used in the systems like breaks, shock absorbers, steering system, wind shield, lift and cleaning etc. 4) Marine applications: It mostly covers ocean going vessels, fishing boats and navel equipment. 5)Aerospace equipment : used in airplanes, rockets and spaceships (Any four applications)</p>	<p>Four Points 4 Marks ( 01 mark to each point )</p>
(c)	<p>Draw IS symbol for</p>	
<p>Ans:</p>	<p>i)Dead weight accumulator    DEAD WEIGHT</p> <p>ii)Tandem Cylinder  </p> <p>iii)Unloading valve    Unloading Valve</p> <p>iv)Heat Exchanger  </p>	<p>1 x 4 Marks</p>
(d)	<p>Show the layers of hydraulic hose with a neat sketch. State materials used for each layer.</p>	
<p>Ans:</p>	<p>Layers of hydraulic hose as shown in figure</p>  <p>1. The outer layer is synthetic rubber... Used to protect...</p> <p>2. The second layer of wire or cloth braid</p> <p>3. For higher pressure, additional braided layers are used</p> <p>4. The inner layer is a material compatible with the hydraulic fluid</p> <p>Material used for each layer:  Nitrile or synthetic rubber for petroleum-based hydraulic oil. alternatives like Viton or Teflon are used with synthetic fluids like phosphate ester.  The cover protects the reinforcement layer. One consideration when determining the cover material is resistance to attack from outside influences like chemicals, salt water, steam, UV radiation and ozone. Common cover materials include nitrile, neoprene and PVC.</p>	<p>2 Marks  2 Marks</p>
(e)	<p>Draw and explain meter in circuit</p>	



<p>Ans:</p>	<p>Meter-in circuit is a method by which a flow control valve is placed in a hydraulic circuit in such a manner that there is a restriction in the amount of fluid flowing to the actuator. If the flow control valve were not to be located, the extension and retraction of the actuator which in this case is a cylinder, would have proceeded at an unrestricted rate. The presence of the flow control valve enables restriction in the fluid flow to the cylinder and thereby slowing down its extension. In the event of the flow direction being reversed, the check valve ensures that the return flow bypasses the flow control valve. The inlet flow into the cylinder is controlled using a flow-control valve. In the return stroke, however, the fluid can bypass the needle valve and flow through the check valve and hence the return speed is not controlled. This implies that the extending speed of the cylinder is controlled whereas the retracing speed is not.</p>	<p>2 Marks</p> <p>2 Marks</p>
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<p>(f)</p>	<p>Draw general layout of pneumatic system and state function of each component in it.</p>	
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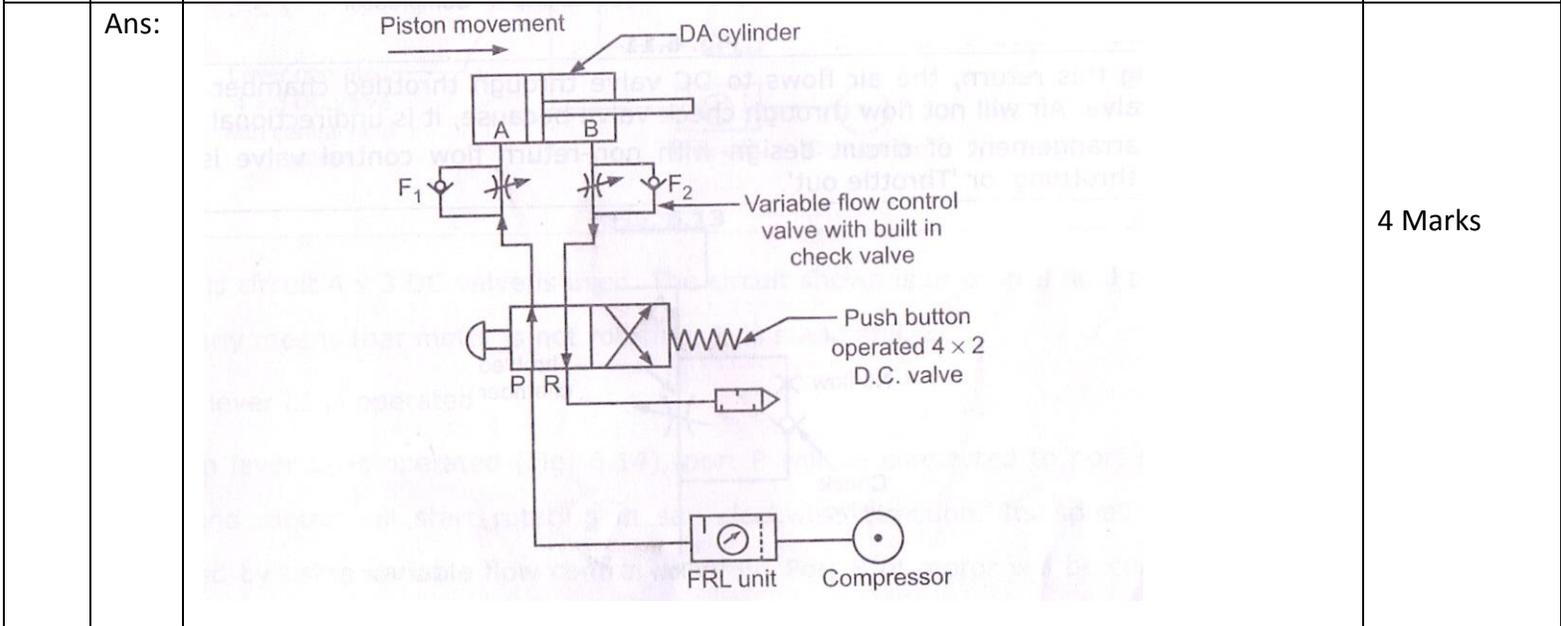
<p>Ans:</p>	<p>Layout of Pneumatic system fig.</p> <ul style="list-style-type: none"> <li>• Compressor: This unit compresses the air which is at atmospheric pressure. The pressure of air increases</li> <li>• Air reservoir/ Air Tank: This tank stores compressed air which is output of air compressors.</li> <li>• Moisture separator: moisture (water vapour ) is separated. Type-chemical or mechanical</li> <li>• Air filter-Air pressure regulator-Air lubricator: Filtered, pressure regulated fine</li> </ul>	<p>2 Marks</p> <p>2 Marks</p>
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particles helps in proper lubrication of sliding or rotary parts of actuator or valves.

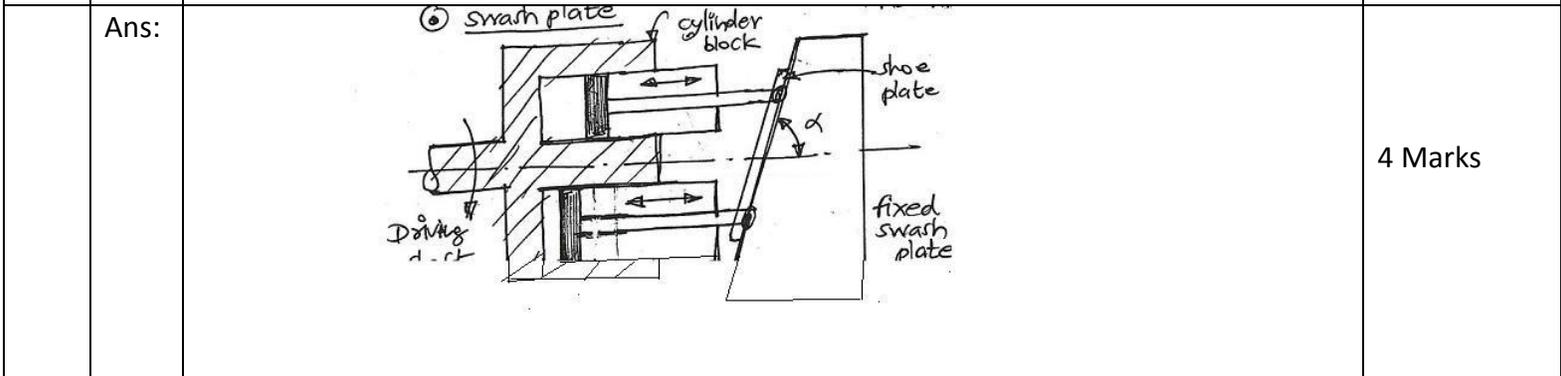
- DCV/FCV: These valves direct flow of air, control flow of air, speed of actuators.
- Air actuators: These items are the heart of pneumatic system. These are taking part in obtaining mechanical advantage. These are either linear or rotary actuators.
- Air conducting elements: The compressed air flow through pipes, valves are conducting elements.

(g) Forward stroke of double acting pneumatic cylinder needs to be controlled as requirement, Draw a suitable circuit and name each component in it.



2 Attempt any TWO

(a) Explain with sketch working of swash plate type axial piston pump.



**Working:**

It consists of swash plate which has angular surface with reference to the cylinder block axis. 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.

When driving shaft is rotated it will cause reciprocating movements of pistons

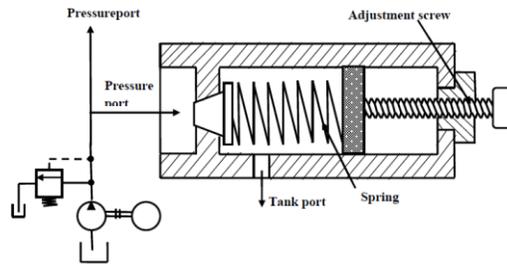
4 Marks



in cylinders depending upon the angular surface movement with respect cylinder barrel. Now since swash plate is inclined and block is rotating, the piston reciprocates inside the barrel. The reciprocating motion of piston causes suction and delivery of fluid through inlet and outlet ports which come in front of outlet of piston. (Sketch 4 marks & Working 4 Marks)

(b) Explain with sketch working of pilot operated pressure relief valve. How it is different from direct acting type?

Ans: Pilot operated pressure relief valve as shown in figure



Working:

It is simplest type valve contains a poppet held in a seat against the spring force as shown in figure. It consists of two ports and one of which is connected to the pump and another is connected to the tank. The fluid enters from the opposite side of the poppet. When the system pressure exceeds the preset value, the poppet lifts and the fluid is escaped through the orifice to the storage tank directly. It reduces the system pressure and as the pressure reduces to the set limit again the valve closes.

Different from direct acting type:

Direct-Operated Regulators respond directly to variations in downstream pressure to provide the necessary flow and pressure to satisfy the system set point. Outlet pressure opposes the balance force provided by the spring to determine the plug position. Therefore, for direct-operated regulators, Outlet pressure is also considered the loading force.

Pilot-Operated Regulators consist of the same essential components of direct-operated units (plug and seat, diaphragm, spring) with the addition of a pilot which separates Outlet pressure and the diaphragm loading force. The pilot requires an external sense line connected to the downstream piping. Measuring pressure further downstream of the valves allows for more accurate sensing of the true outlet pressure conditions as it moves the sense point away from the flow turbulence generated by the plug and seat. The pilot valve can simply and effectively be considered a second regulator, providing additional control to the main regulator, improving overall sensitivity and, ultimately, accuracy.

(c) State the meaning of pressure compensation in flow control valve. Draw a sketch of pressure compensated flow control valve and explain its working.

Ans: In any hydraulic circuit there are slight variations in presence of oil. When pressure changes the rate of flow changes but many circuits require constant flow regardless of input or output pressure variations in the circuit then the pressure compensated flow control valve is used.

3 Marks

3 Marks

2 Marks

2 Marks

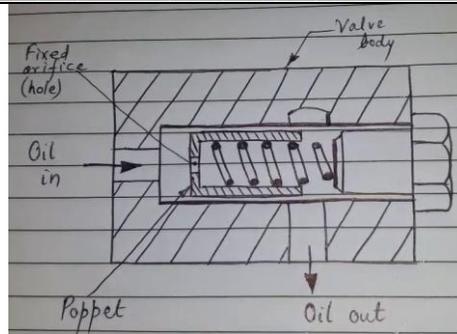


Figure  
3 Marks

Pressure compensated flow control valve as shown in fig.

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.

3 Marks

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.

**Attempt any FOUR**

Compare gear pump and vane pump (Any four points)

3

a

Parameters	Gear pump	Vane pump
Viscosity	Ideal for high viscosity liquids	Ideal for low viscosity liquids
Maintenance	Easy to maintain	Not Easy to maintain
Moving parts	Two moving parts	Two moving parts
Construction	Simple in construction than vane pump	Complex in construction
Efficiency	higher efficiencies	Lesser efficiencies
Design	Simple designs	Complex designs

Any four  
1 marks each

**Define viscosity index and its significance**

**Viscosity index:** It is defined as rate of change of viscosity with respect to temperature.

**Significance:**

- It is the most important property which determines the performance of lubricating oils under operating conditions.
- **Viscosity index** used to characterize the viscosity-temperature behaviour of lubricating oils.
- The lower the **Viscosity index**, the more the viscosity is affected by changes in temperature.
- On machine part moving at slow speeds under high pressures, a heavy oil should be used as it better resists being squeezed out from between the rubbing parts light oils can be used for lower pressures and high speeds.

1 Mark

3 Marks

It is not possible to maintain a liquid oil film between two moving or sliding surfaces if the viscosity is too low.

c

Application of check valve with suitable circuit.

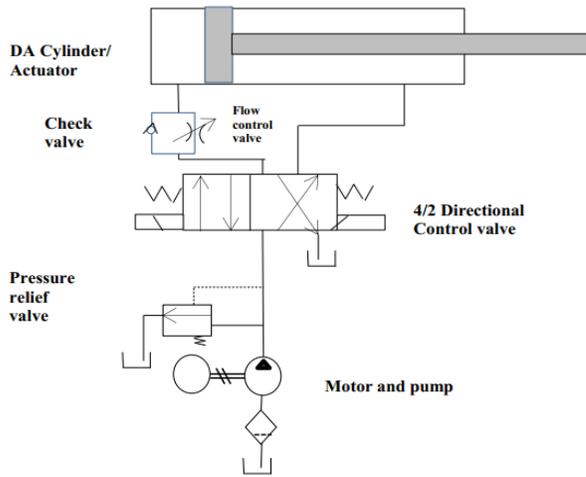
A **check valve** is the simplest type of directional **control valve** used in **hydraulic** systems.

**Check** valves allows flow of fluid in one direction and blocks in opposite direction.

**Application of check valve**

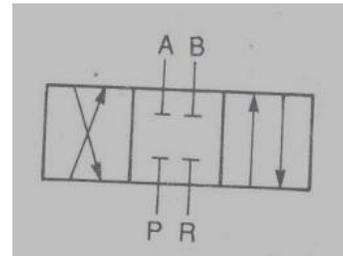
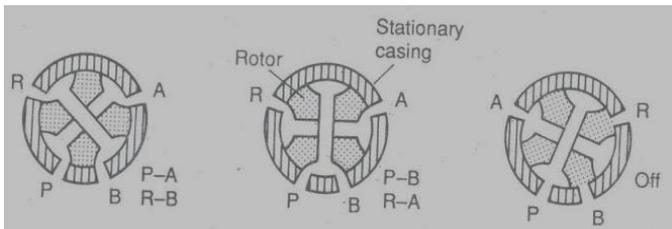
Meter in circuit, meter out circuit, sequencing circuit, loading and unloading circuits etc.

Figure shows a meter-in circuit with control of extend stroke. The inlet flow into the cylinder is controlled using a flow-control valve. In the return stroke, however, the fluid can bypass the needle valve and flow through the check valve and hence the return speed is not controlled. This implies that the extending speed of the cylinder is controlled whereas the retracing speed is not.



Any circuit with check valve can be considered

**4/3 rotary DC valve**



d

The rotary spool directional control valve has a round core with one or more passages or recesses in it. The core (rotor) is mounted within a stationary sleeve (casing). As the core is rotated within the stationary sleeve, the passages or recesses connect or block the ports in the sleeve. The ports in the sleeve are connected to the appropriate lines of the fluid system.

**Comparison of Meter out and bleed off circuit**

Parameter	Meter out circuit	Bleed off circuit
Use	More commonly used	less commonly used
Flow used	Flow is drain to tank	an additional line is run through a flow-control valve back to the tank
speed of the actuator	Speed remains constant	Speed decreases
Flow of fluid	Constant fluid flow through flow control valve	Less fluid through flow control valve

e

1 Mark

1Mark

2 Marks

02 Sketches

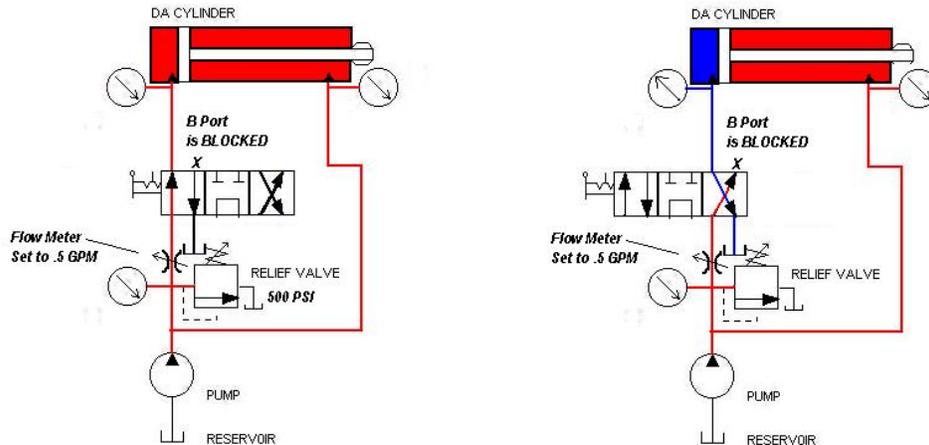
02 Working

4 Points

1 marks each

**Regenerative Circuit.**

Regenerative circuits are used when it is desirable to rapidly advance an actuator into position to reduce cycle time. When configured as a regenerative system, cylinders can be advanced more rapidly than in normal operation with the pump flow rate alone. In order to accomplish regeneration, the fluid leaving the rod end of the cylinder is routed back to the cap side of the cylinder to combine with the pump flow rate from the pump as shown in Figure.



Regenerative circuit ( during extension)

Regenerative circuit ( during retraction)

2 Marks

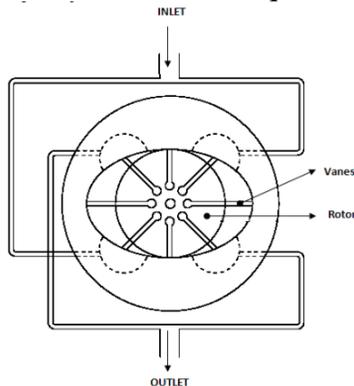
2 Marks  
( Single Fig is expected)

**Attempt any TWO**

**Balance vane pump , explanation with sketch**

If a net load on shaft bearings of pump is balanced then the pump is balanced vane pump. **explanation with sketch**

A balanced vane pump is a very versatile design . The basic design principle is shown in Fig. The rotor and vanes are contained within a double eccentric cam ring and there are two inlet segments and two outlet segments during each revolution. This double pumping action not only gives a compact design, but also leads to another important advantage: although pressure forces acting on the rotor in the outlet area are high, the forces at the two outlet areas are equal and opposite, completely canceling each other.



**Quick exhaust valve**

A quick exhaust valve is a typical shuttle valve.

It consist of a movable disc (also called flexible ring) and three ports namely, Supply port 1, which is connected to the output of the final control element (Directional control valve). The Output port, 2 of this valve is directly fitted on to the working port of cylinder. The exhaust port, 3 is left open to the atmosphere

**Forward Motion:** During forward movement of piston, compressed air is directly

1 Mark

4 Marks

3 Marks

Working

3 Marks



admitted behind the piston through ports 1 and 2, Port 3 is closed due to the supply pressure acting on the diaphragm. Port 3 is usually provided with a silencer to minimise the noise due to exhaust.

**Return Motion:** During return movement of piston, exhaust air from cylinder is directly exhausted to atmosphere through opening 3 (usually larger and fitted with silencer). Port 2 is sealed by the diaphragm. Thus exhaust air is not required to pass through long and narrow passages in the working line and final control valve.

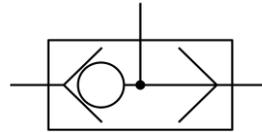
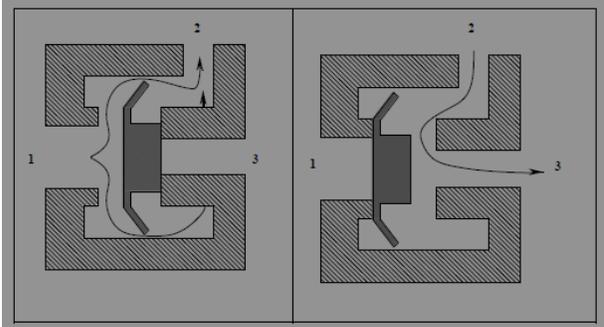


Fig.

2 Marks

Symbol

1 Mark

Application of a quick exhaust valve :

They are available in a variety of shapes and sizes and are used in the industry to speed up the performance of a moving cylinder, evacuate air directly out into the atmosphere and increase the cylinder rod reaction time, or valve actuator.

High quality quick exhaust valves are the key to efficient functions in the industrial segments.

2 Marks

**Classification of pneumatic actuator**

**Based on application for which air cylinders are used**

- i) Light duty air cylinders
- ii) Medium duty air cylinders
- iii) Heavy duty air cylinders

**2. Based on the cylinder action**

- i) Single acting cylinder
- ii) Double acting cylinder
- Single rod type double acting cylinder
- Double rod type double acting cylinder

**3. Based on cylinder's movement**

- i) Rotating type air cylinder
- ii) Non rotating type air cylinder

Classification

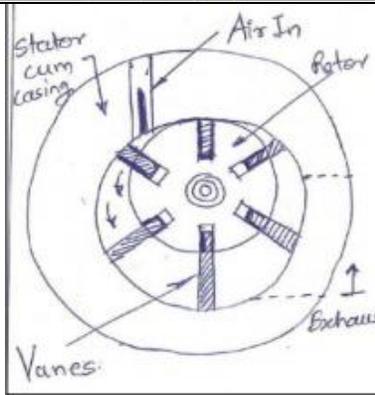
3 Marks

**Working of vane type air motor**

It consists of simple Vane rotor which is having slots in which vanes (flat piece of steel) slides freely. The rotor is eccentrically located inside the stator housing. Working: When pressurized air comes in through inlet port, the pressure of air distributes equal in all directions. Since vane is sliding freely in slots of rotator, the vane comes in to way of pressurized air and air pushes the vanes so that rotor starts rotating with speed. The used low pressure air is exhausted through exhaust port. This is unidirectional motor. Since vanes are freely sliding in slots, there is possibility of leakage of air.

Working

3 Marks



Sketch  
2 Marks

5

a

Attempt any FOUR

**Working of 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.

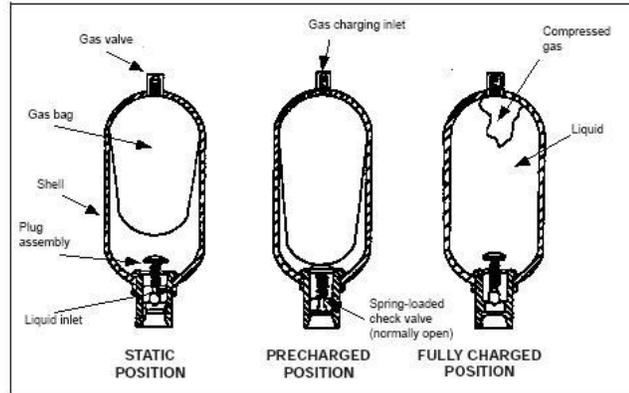


Figure 2-16. Bag-type accumulator

Figure  
2 Marks

Working  
2 Marks

**Pressure regulator in pneumatic system**

The body of regulator has inlet and outlet port. There are two springs one is light and other is main spring. The main spring can be compressed by spring adjusting screw. The diaphragm is attached to main spring.

The high pressure of the compressed air should be regulated to the requirement of the circuit. When main spring is compressed by adjusting the screw upward the diaphragm will move upward. This will lift the valve element upward, creating an opening to allow the air from inlet to outlet.

b

Working  
2 Marks

The opening of the valve and pressure flowing through it will be directly proportional to compression of the main spring. When spring pressure is less the amount of opening will be small and there will be slight pressure reduction. If spring compression is more then there will be more pressure reduction hence regulator will work like pressure reducing valve.

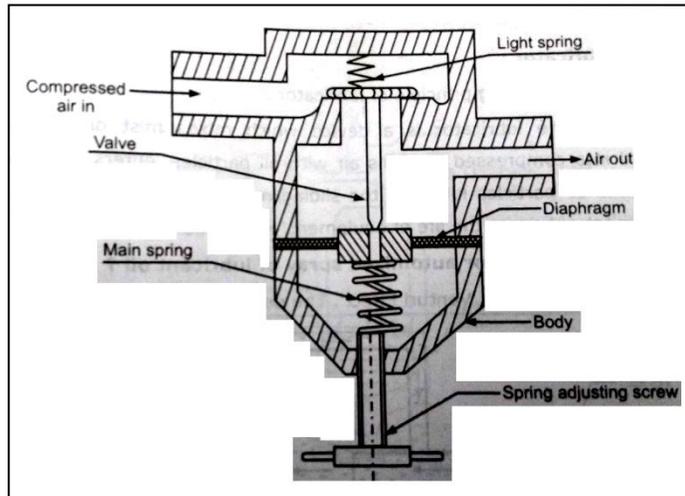


Figure  
2 Marks

**Advantages of Pneumatic system**

- 1) Pneumatic system provides cheaper and light weight equipment's as they work on air which is freely available and no robust construction is required.
- 2) No return lines are required.
- 3) Pneumatic system is fire proof, explosion proof and non-reactive thus a safer system. Hence can be used in fire prone area.
- 4) Pneumatic system is clean as air is dry. Hence it is widely used in food processing, electronic and automation industry
- 5) Pneumatic system provides cheaper and light weight equipment's as they work on air which is freely available and no robust construction is required.
- 6) No return lines are required.
- 7) Pneumatic system is fire proof, explosion proof and non-reactive thus a safer system. Hence can be used in fire prone area.
- 8) Pneumatic system is clean as air is dry. Hence it is widely used in food processing, electronic and automation industry

2 Marks  
Any Four

**Limitation of Pneumatic System.**

- 1) High cost of compression
- 2) Reduced accuracy
- 3) Noisy working
- 4) High operating cost
- 5) Low pressure application
- 6) Additional lubrication required.
- 7) High cost of compression
- 8) Reduced accuracy
- 9) Noisy working
- 10) High operating cost
- 11) Low pressure application

2 Marks  
Any four



d

(i) Twin Pressure valve	
(ii) FRL Unit	
(iii) Silencer	
(iv) Shuttle valve	

1 Marks for each symbol

e

### Gear Type Air Motor

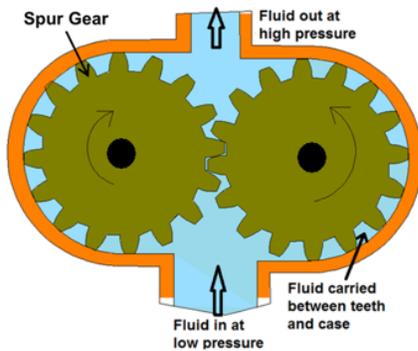


Diagram  
2 Marks

It consists of two inter meshing gears inside a housing with one gear attached to the drive shaft. Figure shows a schematic diagram of Gear motor. The air enters from the inlet, causes the rotation of the meshing gear due to difference in the pressure and produces the torque. The air exits from the exhaust port. Gear motors tend to leak at low speed, hence are generally used for medium speed applications.

Explanation  
2 Marks

**Circuit Diagram**

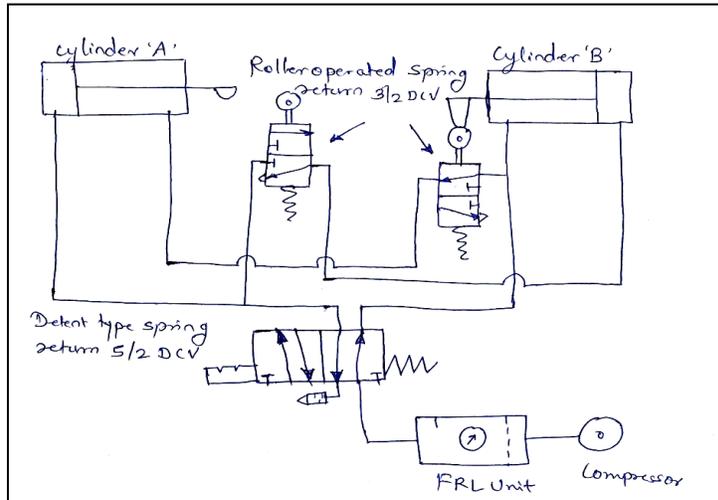


Diagram with Label  
4 Marks

**Attempt any TWO**

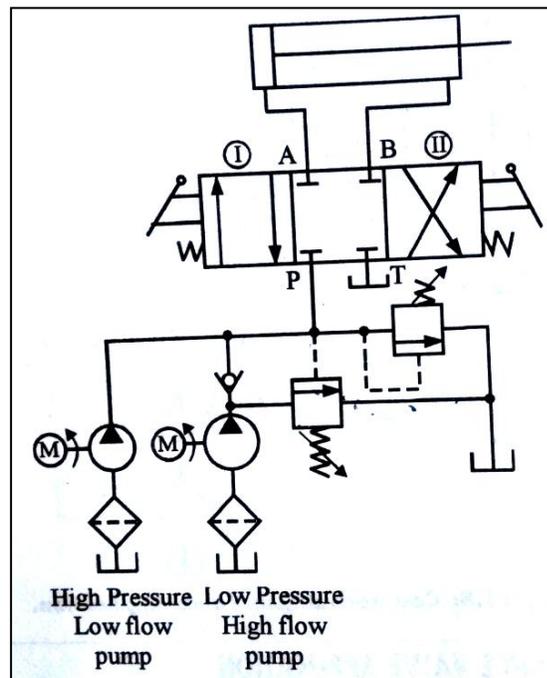
Figure shows a high low unloading circuit. It consists of two pumps. 1. High pressure, low flow pump 2. Low pressure, high flow pump.

In punching machine hydraulic ram are required to function in following manner:

- 1) It should initially extend rapidly over a large distance
- 2) Then during punching operation, it should extend through a very short distance with very high pressure.

The circuit shown in figure unloads both the pumps to drain when the 4/3 way D.C. valve is in central position. When 4/3 way DCV is shifted to position (1), during the rapid extension stroke, portion, both the pumps supply fluid to the system. When the punching operation begins, the system pressure rises. The increased pressure opens the unloading valve for the low pressure pumps. The check valve protects the low pressure pump 2 from high pressure which occurs during the punching operation stage of the extension stroke. The purpose of the relief valve B in to protect the high pressure at the end of the cylinder stroke.

**Application:** Punching Press, Bench vice, Shaper Machine



Circuit Diagram  
3 Marks

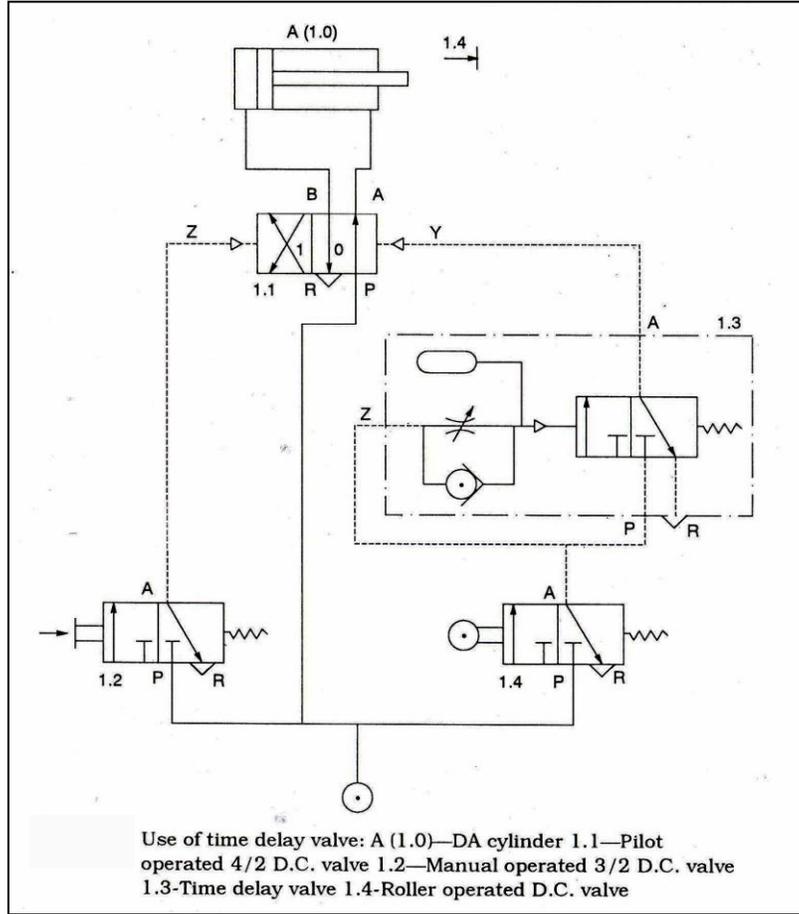
Working  
3 Marks

Application  
2 Marks

When valve 1.2 is manually actuated, pilot operated valve 1.1 is shifted in position 1 which brings the forward stroke of the DAC A. The end of the forward stroke is sensed by the roller operated valve 1.4 which can start the return stroke of the piston by shifting valve 1.1 to 0 position. However the return stroke is delayed by time delay valve 1.3 by certain time which can be adjusted. As soon as the signal pressure in the time delay valve reaches the adjusted value of



spring force of air operated 3/2 DCV, the valve opens and passes the signal to main pilot operated DCV 1.1 which resets and cylinder retracts after a particular dwell time.



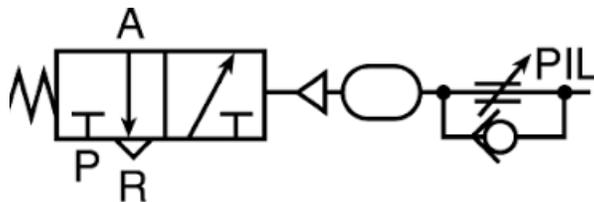
Symbol  
Circuit  
Diagram  
4 Marks

Applications:

- 1) Bottle filing system
- 2) Small component assemblies

Application  
2 Marks

Symbol

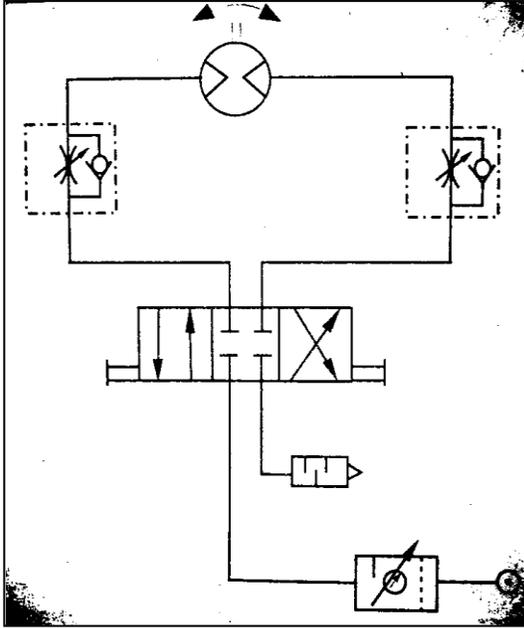


Symbol  
2 Marks



6

c



### Pneumatic circuit for speed control of bidirectional motor

Compressed air is passed through DCV from port P to port A. it will enter in the FCV1 where flow area of FCV1 is reduced by partially closing the valve. Hence small quantity of air will enter in the air motor through inlet A. It will rotate the motor at slow 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 air motor through inlet A. As large quantity is supplied it will rotate the motor 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 bi-directional motor.

The check valve of circuit allows flow of air into the motor while regulate the outward flow hence it is 'meter out' circuit

Circuit Diagram

4 Marks

Working

4 Marks