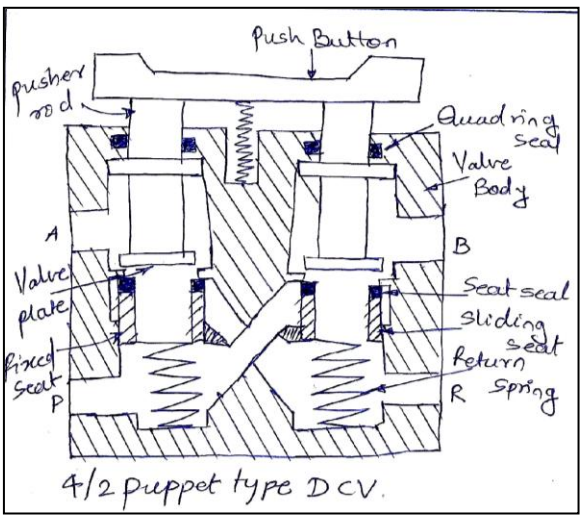
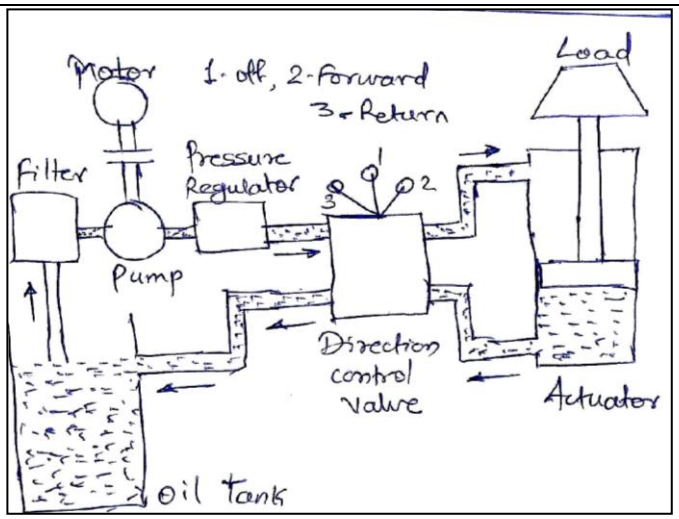
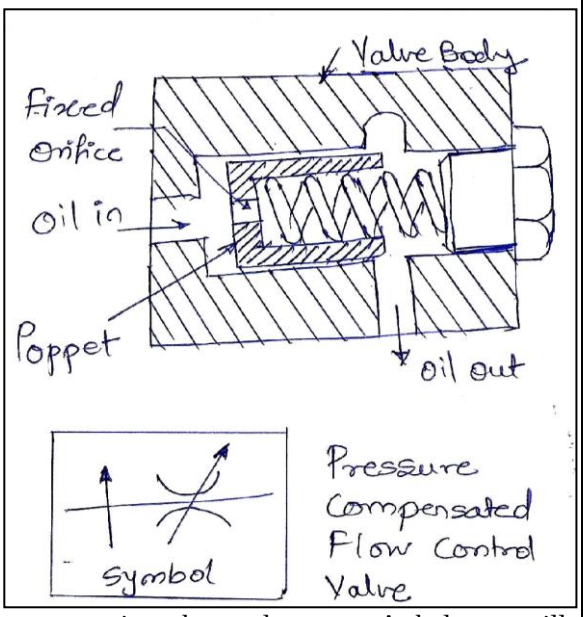
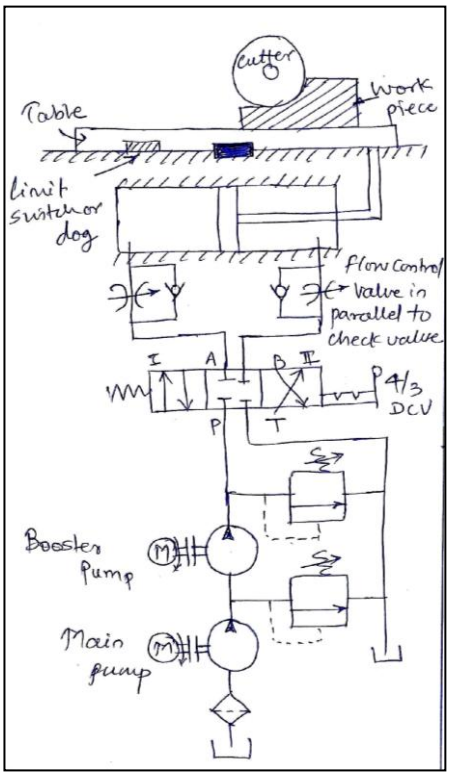
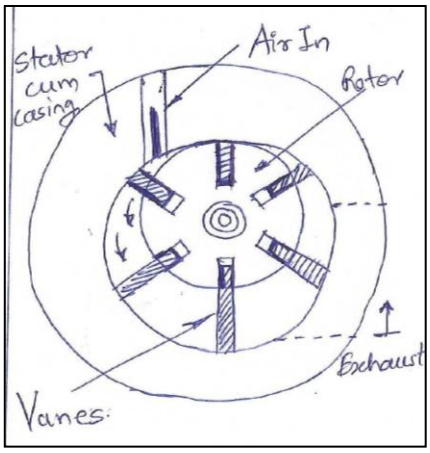
Important Instructions to examiners:

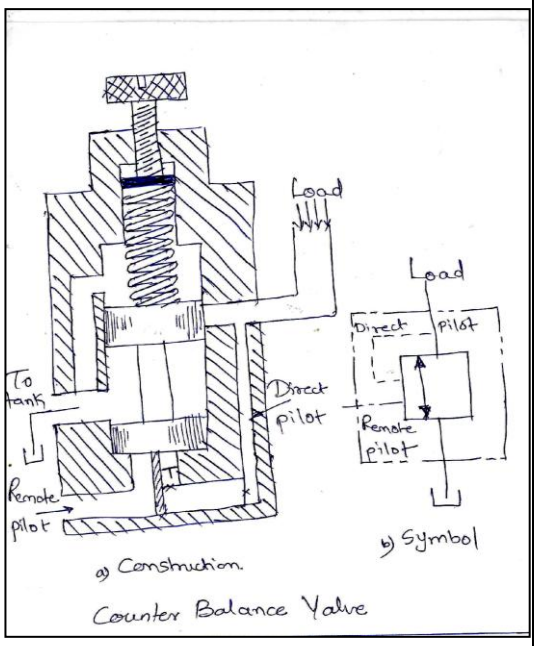
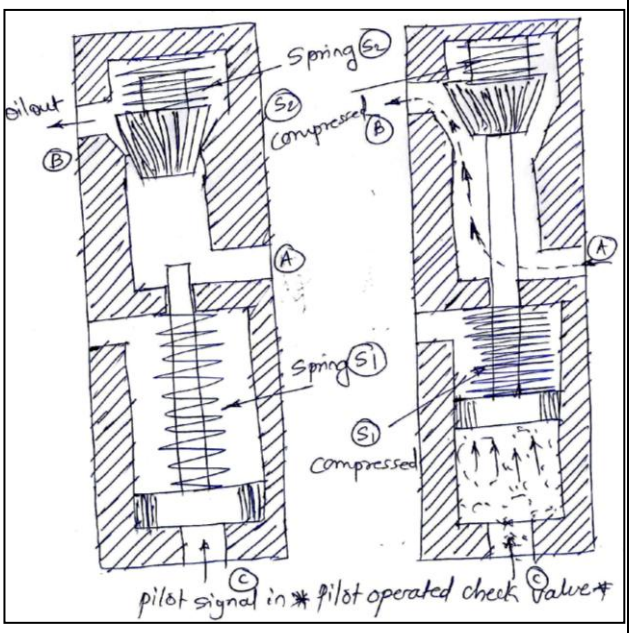
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling 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 N	Sub Q.N.	Answer	Marking Scheme
1	**(A)**	**Attempt any THREE:**	
	(a)	**Four advantages of screw pump** 1. Reliable performance 2. Operate at very high speed 3. Continuous discharge 4. Silent operation **Four disadvantages of screw pump** 1. Screw manufacturing difficult 2. Unsuitable for high viscosity oil 3. Low efficiency 4. Decrease in efficiency with increase in viscosity of oil	4
	(b)	**4/2 puppet valve** Figure shows a cross sectional schematic view of a poppet type 4/2 direction control valve. Inside the valve housing, a number of bores are engraved and interconnected through number of valve elements. The ports 'P', 'R', 'A', and 'B' shown in the diagram are designated as 'P- pressure port, 'A' and 'B' – cylinder port and 'R' – exhaust port. In the position shown in the sketch, it is found that 'P' connects to 'A' and 'B' to 'R', When the elements are actuated by means of the push button, they are unseat and 'P' connects to 'B' and 'A' to 'R'. The rated size of the valve depends on the cross-section of the valve port. Through proper shaping of the fluid ports or canals, the loss of pressure may be minimized. The actuating elements of the spool in zero position are spring controlled and for accurate controlling may be designed as pressure compensated.  4/2 puppet type DCV.	2 Figure 2 Explanation

(c)	**Essential properties of hydraulic fluids** 1. Compressibility 2. Viscosity 3. Stable viscosity index 4. Demulsibility 5. Low foaming tendency 6. Flash point	7. Oxidation 8. Good heat dissipation 9. Wear resistance 10. Corrosion resistance 11. Pour point 12. Non toxic	4 Marks
(d)	**1) Centreline mounting** Centreline mounts are used to take care of thrust that can occur linearly or along a centreline with the cylinder. Proper alignment is essential to prevent compound stresses that may cause excessive friction and bending, as piston extends. Additional holding strength may be essential with long stroke cylinders. **2) Foot mounting** It consists of mounting the cylinder with the help of side end lungs or side covers. These mountings are used where cylinders are to be mounted on to surface parallel to the axis of cylinder.		4 Marks
(B) (a)	a) **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. b) **Filter:** This element filters the oil before going to the next element i.e. pump. c) **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). Pump drives by prime mover. (i.e. Motor) d) **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. e) **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 transfers its power to actuator to create useful work or Mechanical Advantage. f) **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: a) Pipe which carry pressurized oil are called as pressure pipelines b) 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.		2 Figure 4 Explanation

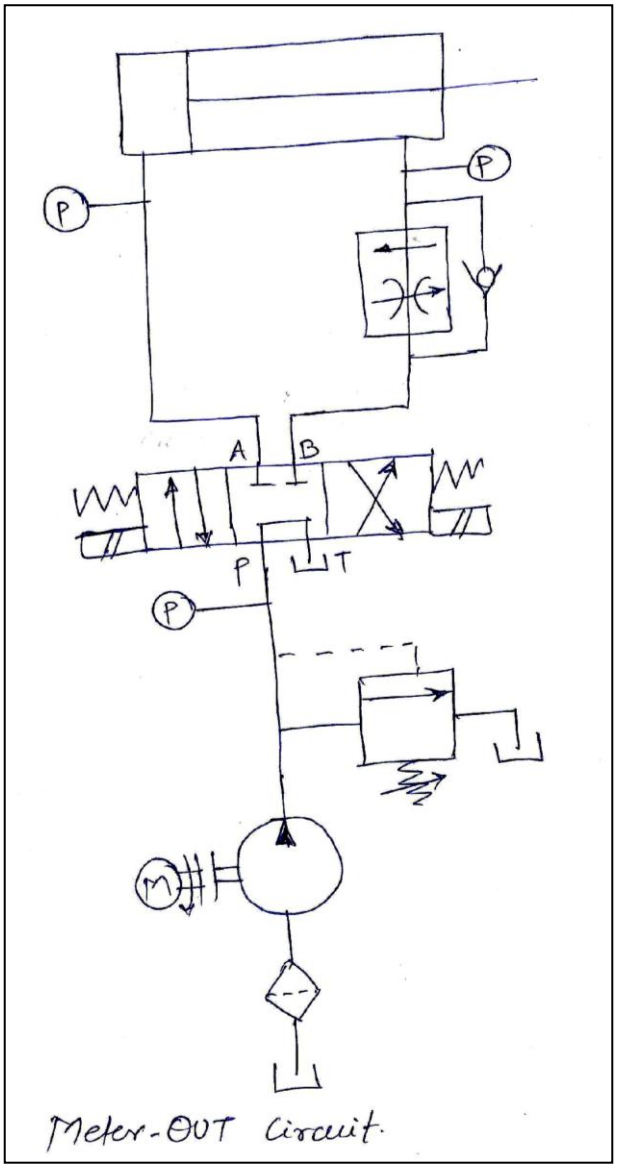
	(b)	**Pressure Compensated Flow Control Valve** In any hydraulic circuit there are slight variations in presence of oil. When pressure changes the rate of flow changes but many circuits requires constant flow regardless of input or output pressure variations in the circuit then the pressure compensated 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. 	2 Figure 3 Working 1 Symbol
2		**Attempt any TWO**	
	(a)	**Working of hydraulic circuit for milling machine.** 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. 	4 Circuit 4 Explanation

		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.	
	(b)	**Various Types of Air Motors** 1. Vane Motor 2. Gerotor Motor 3. Turbine Motor 4. Piston Motor  **Construction:** 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. With the help of these motors we can achieve the speeds up to 25000 r.p.m.	2 Types 3 Figure 3 Explanation
	(c)	**Seal:** The seal is an agent or element which prevents leakage of oil from hydraulic elements and protects the system from dust and dirt. **Classification of seals based on shape:-** a) 'O' Ring seal b) 'V' Ring seal c) U-packing seal d) T- ring seal e) Cup seal **Factors for seal selection:** 1) Type of fluid used in system 2) Maximum temperature of system in working condition 3) Functional reliability expected 4) Cost of seal 5) Working pressure of system 6) Environmental condition	2 Def. 3 Types 3 Factors

3		**Attempt any FOUR**	
	(a)	**Counter Balance Valve** It is basically a relief valve but it is used to set up a back pressure in a circuit to prevent load from falling. They are frequently employed in vertical presses, loaders, lift trucks and other machines that must maintain a particular position or hold a suspended load. In such applications, the counterbalance valve creates a back pressure to prevent the movement of piston rod of cylinder.  Figure shows a typical counterbalance valve. At the present pressure (due to load) acting at port A, the valve remains closed under the spring force. The fluid in the port A is trapped thereby prevents the movement of the load. When the pressure in the port A increases beyond certain value, it acts on the spool from downward direction. The spool moves against the spring force and provides the passage for the fluid to tank. This allows descending of the load. As this valve gets actuated line pressure, it is known as direct operated counterbalance valve.	2 Sketch 2 Working
	(b)	**Pilot Operated Check Valve** When pilot signal of pressurized oil is used to control movement of poppet in the check valve, it is called as pilot operated check valve. It is used when no flow characteristics of the valve is desired only for a portion of the system cycle. Figure shows the pilot operated check valve. A pilot piston is introduced below moving poppet. This pilot piston can move up by introducing pilot signal.  **Working:** In normal position there is no flow from (A) to (B) because the movable valve poppet has blocked the flow. Now pilot signal is given through port (C). This oil will push up the pilot piston upwards, thereby compressing springs (S_1). The piston rod of pilot piston will push the movable poppet in upward direction thereby compressing the spring (S_2). Now the flow from (A) to (B) will start. As and when we cut-off the pilot signal the flow from (A) and (B) will continue. When pilot signal will be cut-off, spring S1 and S2 will expand and moving poppet will again block the flow from (A) to (B).	2 Sketch 2 Working

(c)

Meter OUT Circuit



Meter-OUT Circuit.

2 Circuit

A typical meter out circuit is shown in figure. Here the flow control valve is installed in the return line metering the fluid being discharged. In that way, this circuit also gives the control over the actuating speed. But this way of control offers altogether different characteristics to the circuit.

Now, the circuit pressure has to overcome the load resistance and the pressure drop across the flow control valve. However, as the flow control valve is on the right side of the piston, the differential area will cause rise in the pressure. This increased pressure helps to overcome the pressure drop across the flow control valve. As the system pressure required will be relatively low, it makes this circuit marginally more efficient on the extend stroke.

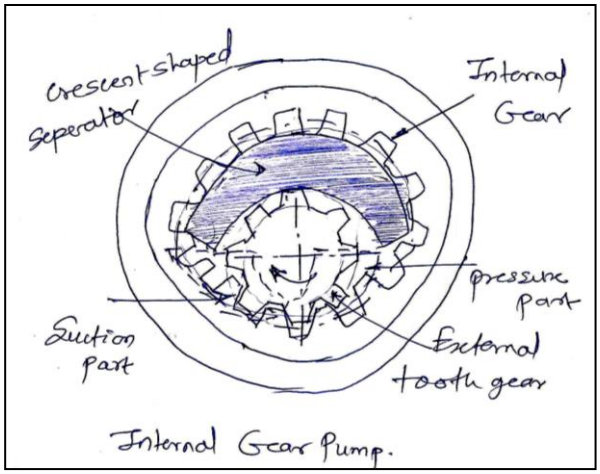
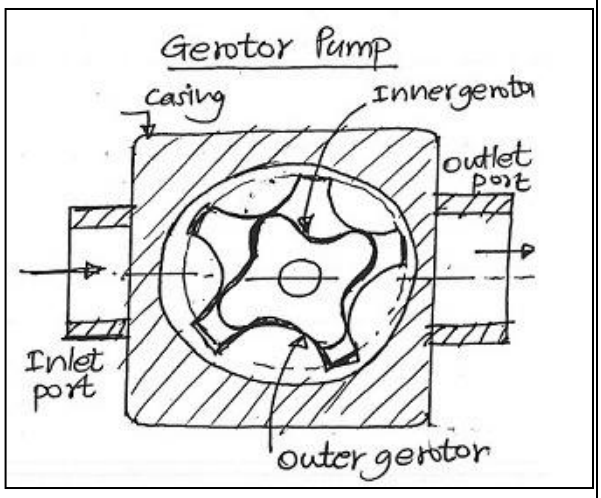
2 Working

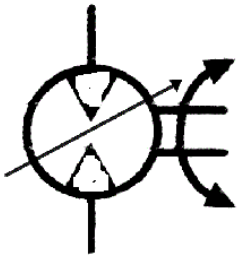
Initially, the compensatory spool is fully open, and full pump flow is passed into the cylinder until piston moves forward building up pressure at the flow control valve. The compensatory spool will now come into operation and restricts the flow to its correct value. Thus, there is an initial flow surge before the compensatory spool adjusts as in the case of 'meter-in'

When using meter-out system, the pressure in the rod-end of the cylinder must be carefully considered. With meter-out speed control, the quantity of oil leaving the cylinder is controlled. When the cylinder is extending, the oil from the rod-end is metered which a smaller quantity than that is flowing into the full bore end. Consequently, under extend conditions; meter-out flow control is not as sensitive as meter-in control. When the cylinder is retracting, the reverse is true.

Meter-out circuits are best where negative loads may occur, because back pressure is maintained on the exhaust side of the actuator preventing erratic motion. Meter-out circuits provide accurate speed control even with reversing loads. However, as with the meter-in system, considerable heat will be generated when used with a fixed delivery pump and a wide range of piston speeds.

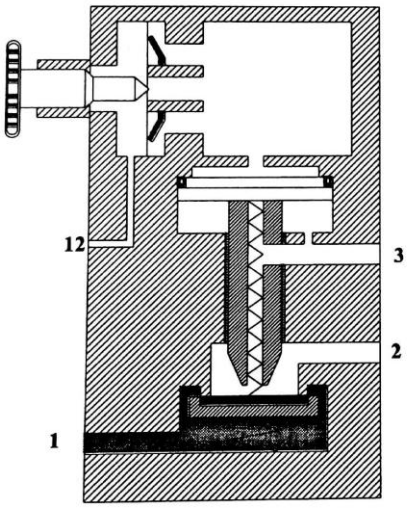
Applications: Drilling, Boring, Reaming and tapping operations.

	(d)	**(i) Internal Gear Pump**  **(ii) Gerotor pump** 	2 Each
	(e)	**FRL Unit:** It is service unit used in Pneumatic system which is combination of three devices named as Filter, Regulator and Lubricator. **Function of FRL unit** **Filter (F) –** 1) To remove the micron and sub-micron particles present in the entering air of compressor. It is Used to separate out contaminants like dust, dirt p[articles from the compressed air **Regulator (R) –** In pneumatic system the pressure of compressed air may not stable due to possibility of line fluctuation. Hence there is a need to maintain and regulate the air pressure. This function is performing by regulator. **Lubricator (L) –** Sliding components like spool, a pneumatic cylinder has sliding motion between parts. It may cause friction and wear and tear at mating parts. To reduce friction, lubricating oil particles are added in the compressed air with the help of lubricator.	2 Def. 2 Function

4	(A)	**Attempt any Three**	
	(a)	**State four merits and demerits of using a rubber hose in pneumatic circuit**	
		Merits: 1)Well equipped with quick connect or disconnect end fitting 2)Can be manufactured in long lengths 3)Capable of withstanding to very high pressures. 4)They can absorb very heavy shocks tha rigid tubes. **Demerits:** 1) Very poor in abrasion resistance 2) Poor in resisting whether condition. 3) Initial cost is very high 4) They can damage due to incompatible oil.	**04**
	(b)	**List any four application of pneumatic rotary actuator. Draw the symbol for variable speed bidirectional air motor**	
		In all pneumatic power tools like screw drivers, angle grinders, straight grinders. To rotate conveyor belts in food industry. Power device in printing press machine Agitators and mixers Vibrators. **symbol for variable speed bidirectional air motor** 	**02** **02**
	(c)	**Explain time delay valve with neat sketch**	
		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.	**04**

The time delay can be extended with the addition of external reservoir.

Time delay valve, NC type. The constructions of an on-delay timer (NC) type in the normal and actuated are shown in Figure It can be seen that 3/2 DCV operates in the on delay mode permanently. But, in some designs, the valve can be operated in the off-delay mode by connecting the check valve in reverse direction. For this purpose, the ports of the throttle check valve should be brought out



(a) Normal Position

Fig. Time delay valve

(Explanation 2 Marks and sketch 2 Marks)

(d) Draw speed control pneumatic circuit for bi-directional air motor

Speed control of bi-directional air motor: (Sketch 2 Marks and Explanation 2 Marks)

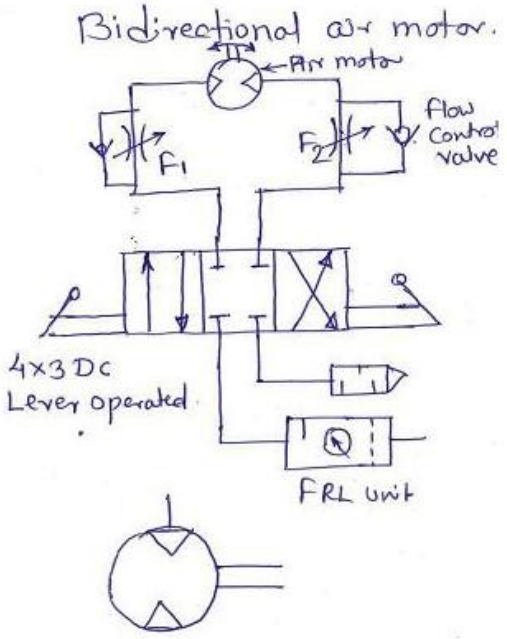


Fig. **Speed control of bi-directional air motor**

Bi-directional air motor rotates in clockwise as well as anti-clockwise direction. The speed of bi-directional motor is controlled as shown in fig. The speed control of motor by using variable two flow control valves having built-in check valve and 4x3 DC valve having zero position or central hold position with lever L1 and L2.

When lever L1 is operated, port P will be connected to port A of air motor and motor will start rotating in clockwise direction. Its speed can be controlled by using variable flow control valve F1. Port B of motor will be connected to exhaust R and air in motor will be exhausted through port R via DC valve.

When lever L2 is operated, pressure port P will be connected to port B of motor and naturally motor will start rotating in anticlockwise direction. Port A will be connected to port R and air in the motor will be exhausted through port R via DC valve.

(B) Attempt any ONE

(a) Explain variable displacement axial piston pump with neat sketch. **04**

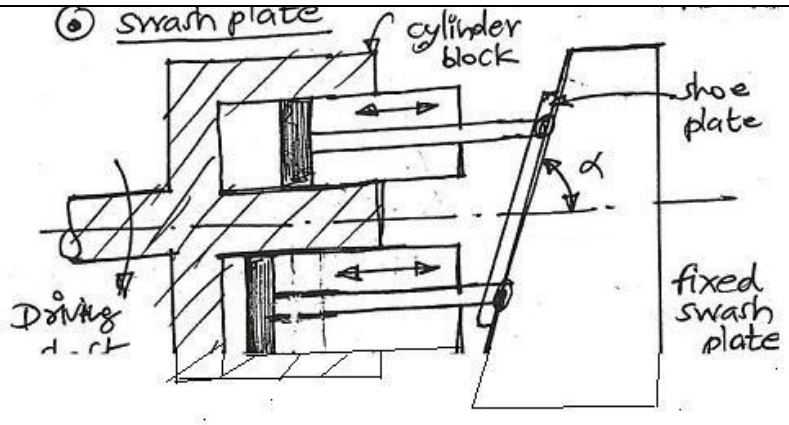


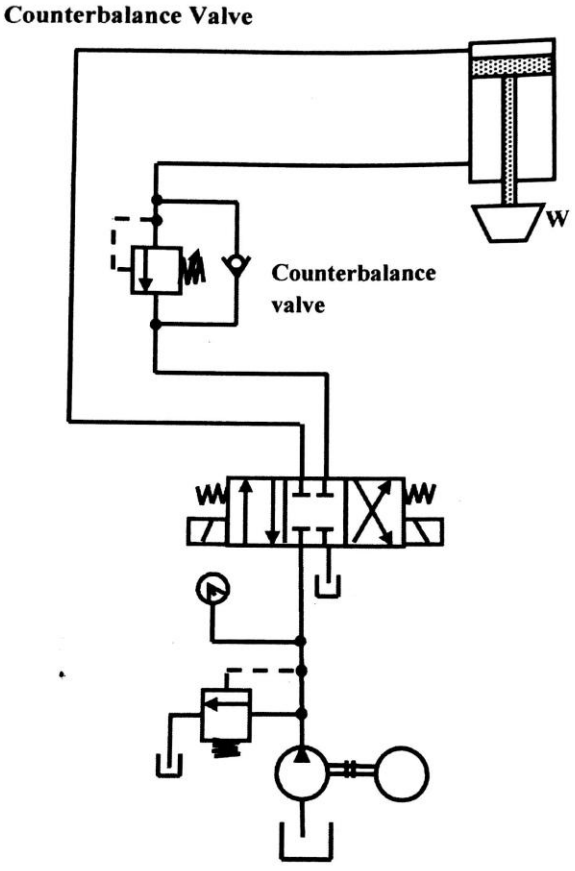
Fig. Variable displacement axial piston pump
(Sketch 2 Marks and Explanation 2 Marks)

Construction and Working:

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

(b) Explain working of counterbalance hydraulic circuit with heat sketch. **08**

Counterbalance valves are commonly used to counterbalance a weight or external force or counteract a weight such as a platen or a press and keep it from freefalling.Figure1.16 illustrates

		the use of a counterbalance or back-pressure valve to keep a vertically mounted cylinder in the upward position while the pump idles, that is, when the DCV is in its center position. During the downward movement of the cylinder, the counterbalance valve is set to open at slightly above the pressure required to hold the piston up (a check valve does not permit flow in this direction). The control signal for the counterbalance valve can be obtained from the blank end or rod end of the cylinder. If derived from the rod end, the pressure setting of the counterbalance valve equals the ratio of the load to the annulus area of the piston. If derived from the blank end, the pressure setting equals the ratio of load to the area of piston. This pressure is less and hence usually it has to be derived from the blank end. This permits the cylinder to be forced downward when pressure is applied on the top. The check valve is used to lift the cylinder up as the counterbalance valve is closed in this direction. The directional control valve unloads the pump.  Fig. **counterbalance hydraulic circuit**	
5		**Attempt any TWO**	
	(a)	**List different types of pressure regulator valves? Explain any one with neat sketch**	
		Types of pressure regulator valves (1 mark each -4 Marks) Pressure-relief valve.	**08**

Pressure-reducing valve.
Unloading valve
Counterbalance valve
Pressure-sequence valve
Brake valve.

(Sketch 2 Marks and Explanation 2 Marks)

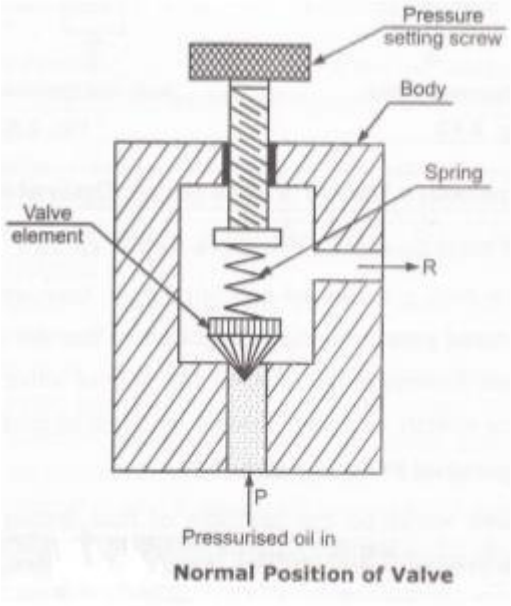


Fig.**Pressure relief valve**

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

OR

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

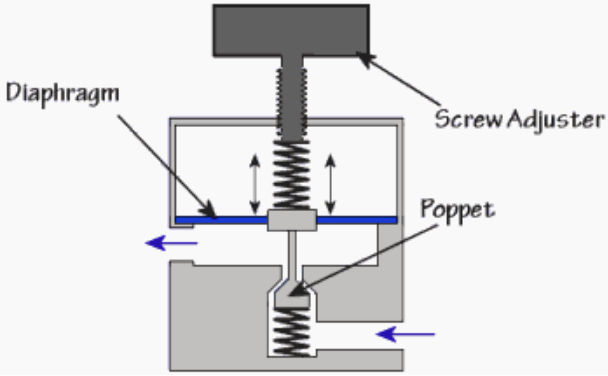
Types:

A) According to no. of stages
Single stage and two stage regulator

B) According to pressure relief
Non- relieving type and relieving type pressure regulator

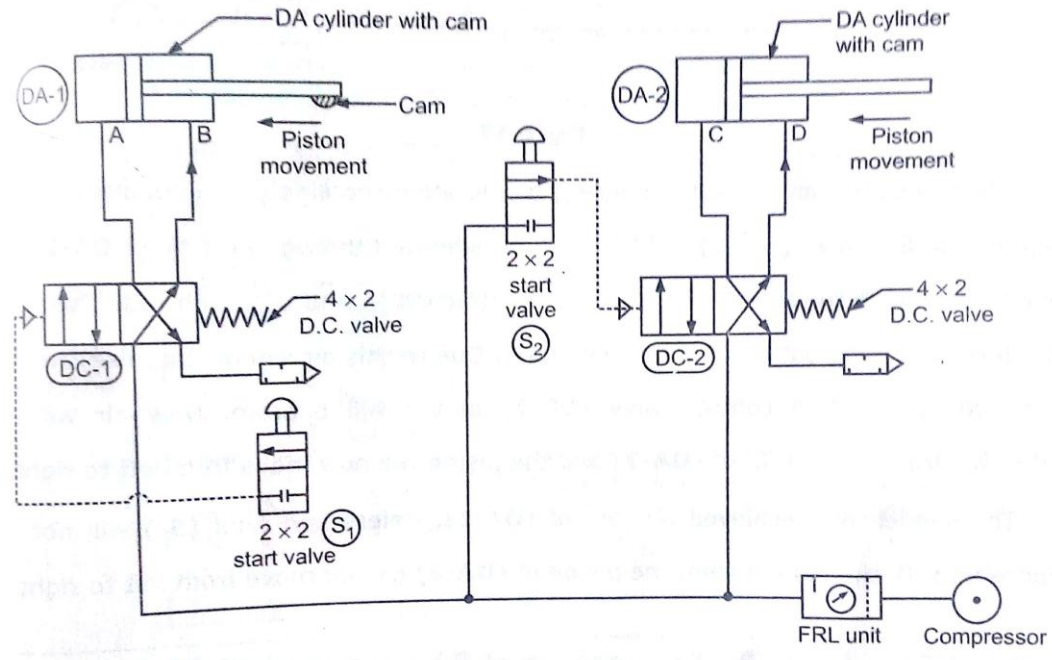
Non-relieving pressure regulator

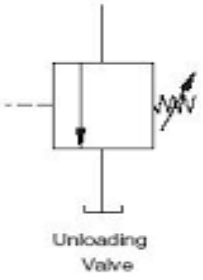
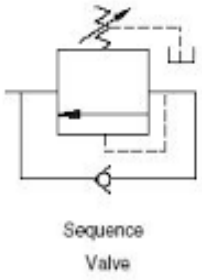
Non-relieving pressure regulators work by restricting flow rather then venting it should over pressure occur. The regulator restricts flow when the pressure gets too high because the pressure acts on the diaphragm forcing i t up against the spring pressure, the diaphragm has what is called a 'poppet' attached on the end of it which is drawn up with the diaphragm and restricts the passing air flow.

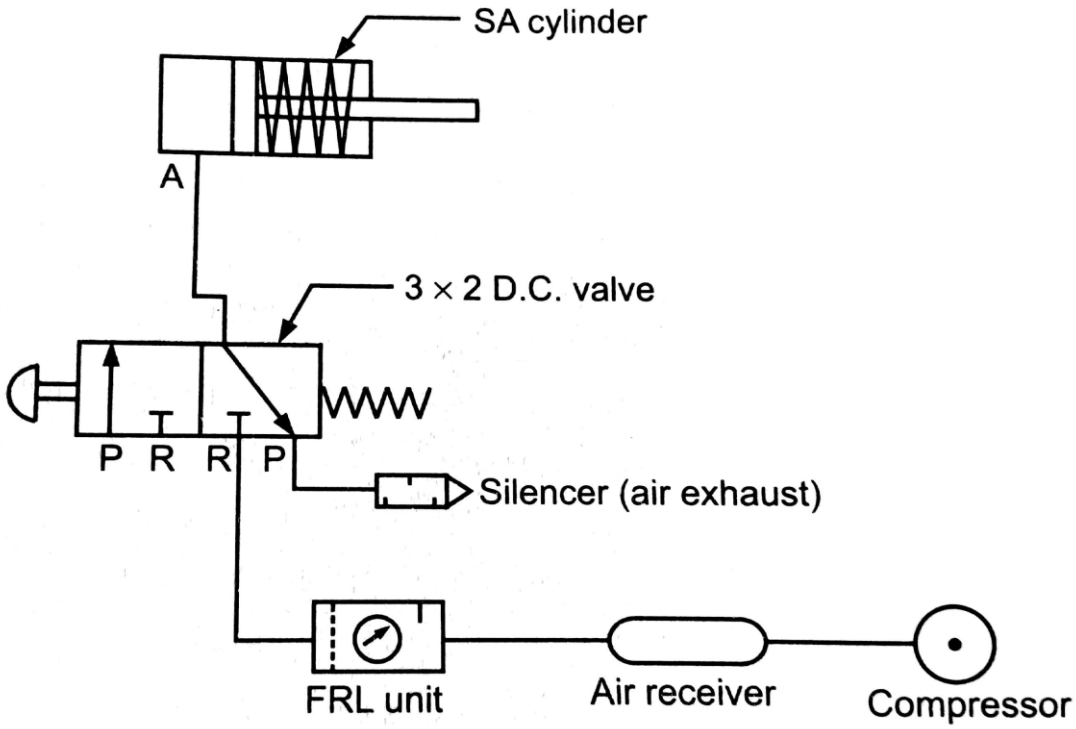


Non-relieving pressure regulator

	(b)	**Develop a pneumatic circuit for operation of two DA cylinders such that one operates after other using travel dependant sequencing.**	**08**
		Answer: a pneumatic circuit for operation of two DA cylinders such that one operates after other using travel dependant sequencing as shown in fig.	
	(c)	**Explain pneumatic impulse circuit with neat sketch.**	**08**
		(Explain-04 marks, Diagram-04marks) Figure 1 shows a symbol circuit of an impulse-valve controlled double acting pneumatic cylinder (A). The position of the impulse-valve (3), which is controlled by the start/stop-valve (1) and the end position valve (2), determines if the cylinder piston shall make a positive stroke and negative	



		stroke. Positive piston stroke is initiated by manual activation of the start valve (1). Negative piston stroking takes place when valve (2) is activated by the cylinder rod at the position a1.	
6		**Attempt any FOUR**	
	(a)	**State at least four advantages and disadvantages of pneumatic systems.**	
		Advantages of Pneumatic system (Four points 02 Marks) 1) Infinite availability of the source 2) Easy channeled and Temperature is flexible 3) Safe and clean 4) The transfer of power and the speed is very easy to set up 5) Can be stored and Easy utilized **Disadvantages of Pneumatic system (Four points 02 Marks)** 1) Requires installation of air-producing equipment 2) Easy to leak 3) Potential noise 4) Easy condenses 5) Low operating pressure 6) Limited applications.	**04**
	(b)	**Draw symbol of unloading valve and sequence valve**	**04**
		 	
	(c)	**Enlist the hydraulic oil manufacturer's in india**	
		Castrol **Shell** **Indian oil**	04
	(d)	**Enlist application of hydraulic system**	
		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 & D equipment and robotic systems etc. 2 Mobile hydraulics: Tractors, irrigation system, earthmoving equipment, material handling equipment, commercial vehicles, tunnel boring equipment, rail equipment, building and	04

		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: There are equipment and systems used for rudder control, landing gear, breaks, flight control and transmission etc. which are used in airplanes, rockets and spaceships. Any four applications	
	(e)	**Explain pneumatic circuit for speed control of single acting cylinder with neat sketch.**	**04**
		 Pneumatic cylinders can be directly controlled by actuation of final directional control valve as shown in fig. These valves can be controlled manually or electrically. This circuit can be used for small cylinders as well as cylinders which operates at low speeds where the flow rate requirements are less. When the directional control valve is actuated by push button, the valve switches over to the open position, communicating working source to the cylinder volume. This results in the forward motion of the piston. When the push button is released, the reset spring of the valve restores the valve to the initial position [closed]. The cylinder space is connected to exhaust port there by piston retracts either due to spring or supply pressure applied from the other port.	