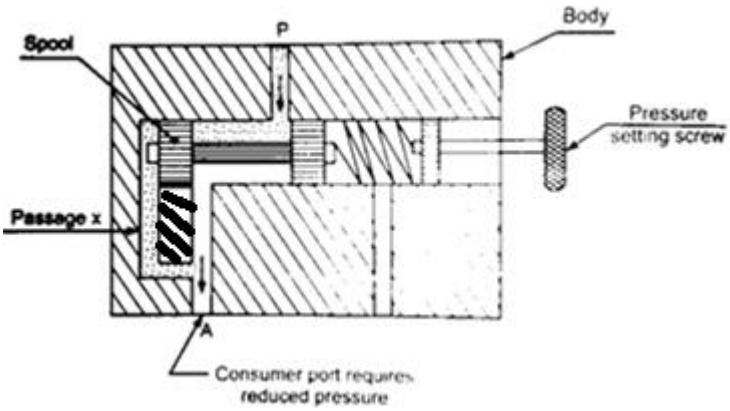
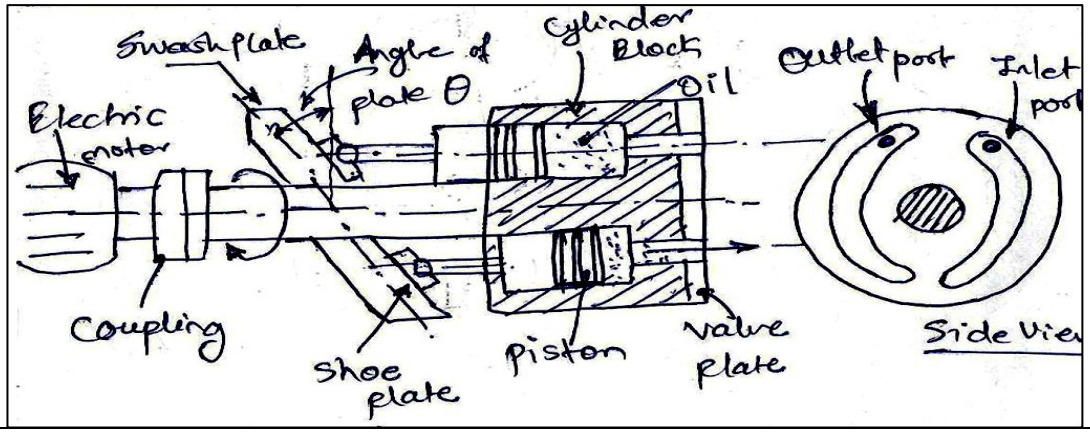
Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in themodel answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may tryto assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given moreImportance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in thefigure. The figures drawn by candidate and model answer may vary. The examiner may give credit for anyequivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constantvalues 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) (a)	**Solve any THREE of the following:** **What is function of** (i) Oil Reservoir – To store the Hydraulic oil for the circuit (ii) Pressure Relief Valve- To release the extra pressure whenever not required by system (iii) Direction Control Valve- To give the direction to the actuator (iv) Filters- To filter the foreign particle from the oil and to separates sub-micron level contamination	4 Marks
	(b)	**Draw and explain working of pressure reducing valve.** The main function of pressure reducing valve is to reduce the pressure in particular branch of the circuit to different level as demanded by consumer in that branch. **Construction:** It consists of spool and spring housed in the bore of valve body. Spring compression can be adjusted by pressure setting screw. Port P is pressure port connected to pump. Port A is consumer port requiring reduced pressure.  **Working:** As shown in normal position, port P is supplying oil to consumer port A. If the main supply is below the set pressure, there will be continuous flow from P to A. Hence normally this valve is open. When outlet pressure rises to valve setting then oil will flow through 'passage x' and will act on	Explanation 2 Marks Figure 2 Marks

		spool and spool will shift to right thereby partly closing the port A. Now only enough flow will pass through port 'A' so that consumer connected to A will receive reduced pressure.	
	(c)	**Explain Piston pump with neat sketch**. (Radial/ axial piston pump can be considered**)** **Swash Plate –** It's an inclined plate in axial piston pump on which all pistons are connected through piston rod. This swash plate is usually inclined. **Use –** It is helps to reciprocate the piston of axial piston pump while the cylinder block is rotating **Working:** Motor drives the shaft, which in turn rotates the entire cylinder block. The pistons are connected to inclined swash plate through piston rod. 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. **If we change the angle of swash plate i.e. θ if** a) θ = 0 then no flow of oil, because pistons are at same level. When θ = 0 swash plate is vertical. No reciprocation of piston, hence no flow. b) θ = max or + ve, then x will be stroke length which is maximum and there will be maximum forward flow. c) θ = - ve, then 'x' i.e. stroke length will be maximum in reverse direction and hence there will be reverse flow. By changing the swash plate angle we can vary the stroke length of the piston. and also output flow can be changed.  	Figure 2 Marks Working 2 Marks
	(d)	**What is am accumulator? Why accumulator is necessary for huge Hydraulic Presses?** **Accumulator:** It is a device which stores the pump delivery when it is not required by the system and makes available to the system whenever required. **Necessity of accumulator for every huge hydraulic press:** Oil requirement of the system is not continuous but intermittent. A hydraulic press needs the oil only during the lifting operation. While, during the lowering of load, holding the load or during idle period, it doesn't not require any supply of oil. During such period, the hydraulic pump has to stop or delivered oil must be drained back to the sump. But frequent starting and stopping of pump is not desirable as it reduces the pump life. Also, draining the pressurized oil is wastage of power which reduces the system efficiency. The remedy to above problem is to use accumulator in the system.	Definition 2 Marks Necessity 2 Marks

B) Solve any ONE of the following:

(a) Write causes and remedies for the following:

Causes	Remedies
(i) Excessive heat in oil	1. Check up system pressure and correct it to designed value 2. Check up oil viscosity and replace oil is needed. 3. Inspect the cooling system and set right if found faulty 4. Use proper pipe layout 5. Arrange proper protection from ambient atmosphere
(ii) Noisy pump	1. clean filter in inlet line or replace defective filter 2. adjust drive motor to correct rpm if pimp speed is to high 3. check the fluid temperature if oil is too cold, warm-up 4. Pump shaft seal may be damaged. To be replaced. 5. Oil level in reservoir may be down-too up to the specified level.
(iii) Low pressure in system	1. Identify the source of leakage and stop leakage 2. May be PRV stuck open pipeline inlet and return line damaged. 3. Set the valves correctly 4. Sources of contamination to be detected and stopped. 5. Defective or damaged accumulator needs to be replaced.

2 Marks for each causes and remedies

(b) What is pressure compensated flow control valve? Explain with neat sketch.

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.

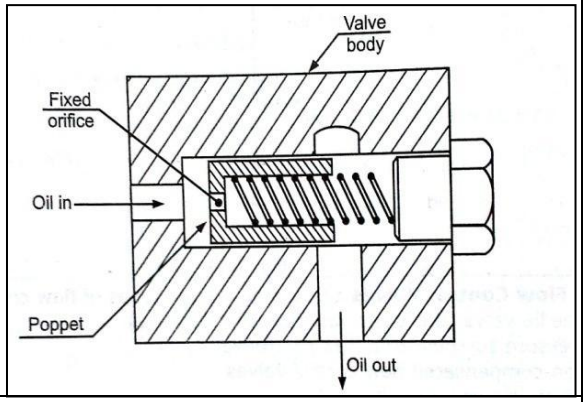


Figure 3 Marks

Explanation 3 Marks

2. Solve any TWO of the following:

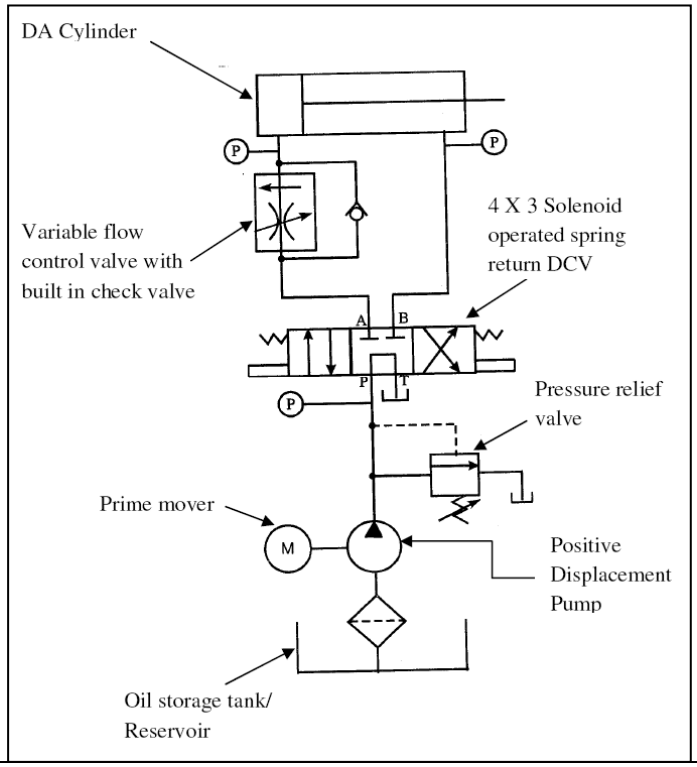
(a) Compare meter-in-circuit with meter-out-circuit, draw neat sketch of meter-in-circuit.

Sr. No.	Meter-IN	Meter-OUT
01	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.

02	Flow control valve 'F' is placed in pressure line	Flow control valve 'F' is placed in return line	
03	Give best result when used in higher pressure systems	The actuator movement is very stable	
04	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.	
05	Suitable for very low piton rod speeds	Provides positive speed control of the cylinder	
06	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.	
07	The circuit is used where finer speed control is required.	This circuit is used where very stable movements of actuators are needed.	
08	Used in - Surface grinders, Welders, Milling Machines	Used in - Drilling, boring, reaming and tapping operations	

Comparison any four points-

4 Marks



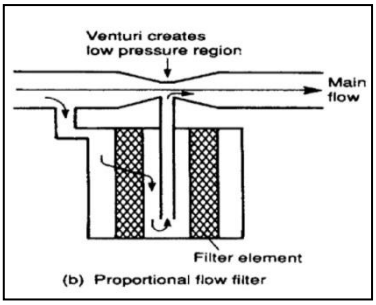
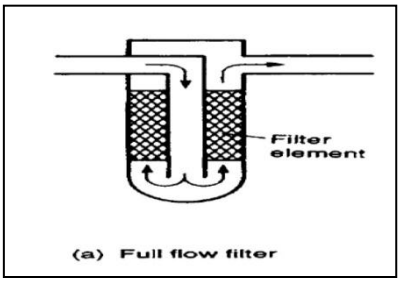
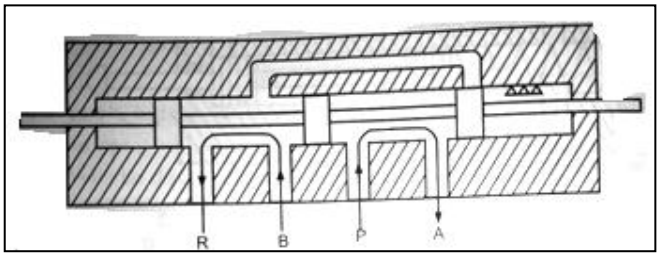
Circuit Diagram

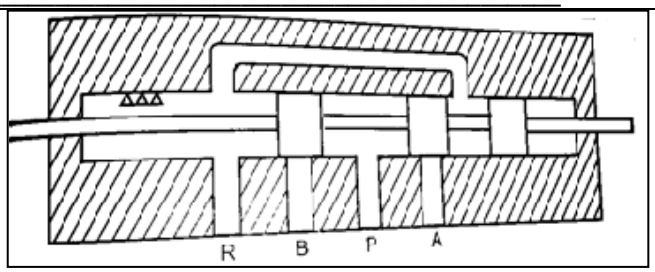
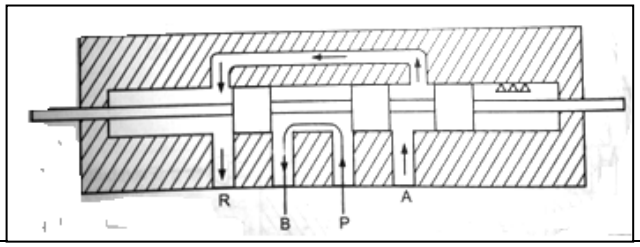
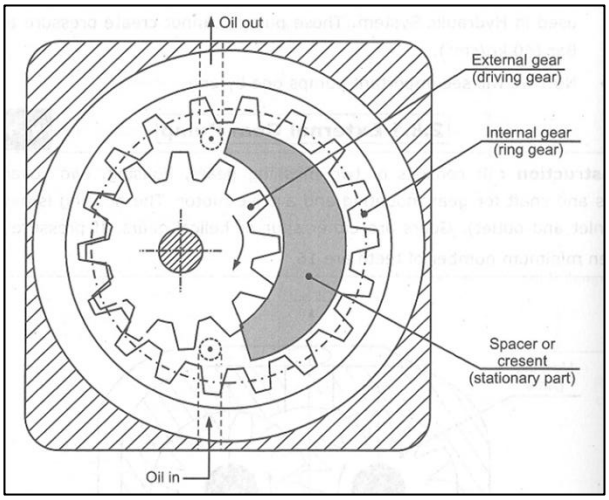
4 Marks

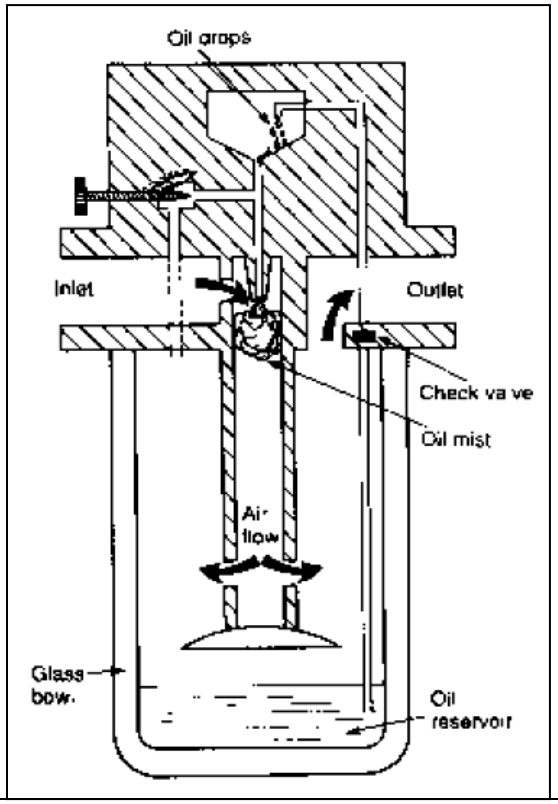
(b) **Name any eight pipe or tube fitting with their application.**

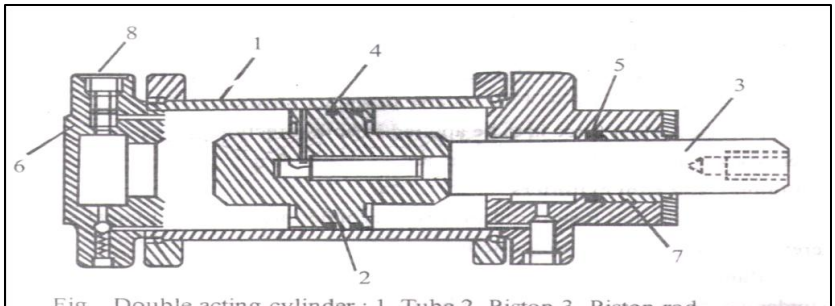
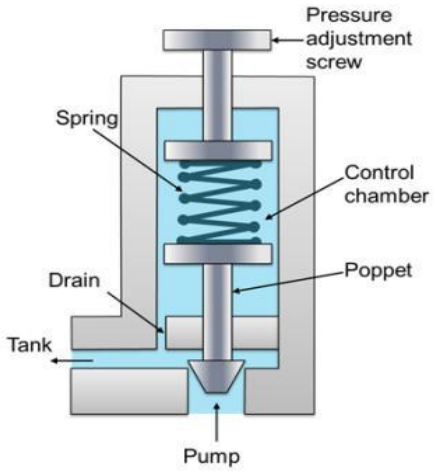
1) Adaptor – To connect two pipes of different diameters.
2) Coupling- To connect two pipes of same diameters.
3) Tee- To connect two pipes with one pipe.
4) Cross- To connect two pipes in crosswise.

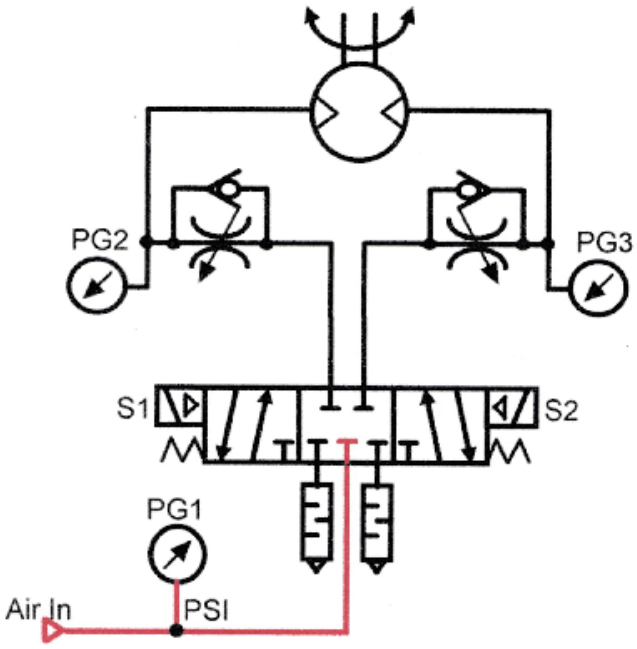
1 Mark

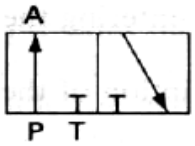
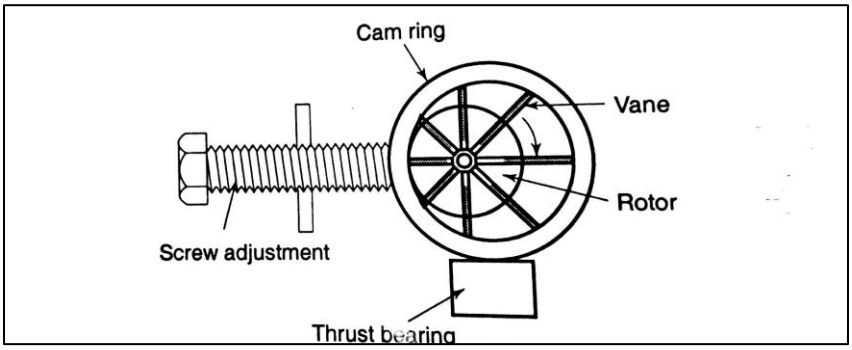
		5) Elbow- To divert the flow between two pipes at right angle. 6) Hex nipple- To connect two pipes internally with the help of hexagonal nut. 7) 45^0 Elbow- To divert the flow between two pipes at 45^0 angle. 8) Reducer- To connect two pipes of different diameters and it will increase or reduce the pressure of flow	for each correct applicatio n
	(c)	What is function of filters? Classify the filters and draw any two types of filters. **Function of filter:** To remove foreign particles from the oil and remove submicron particles dissolved in the oil. **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. ▪ The fluid is drawn from the filter due to the pressure difference. ▪ low pressure drop  	Function 2 Marks Classifica tion 2 Marks Figure 4 Marks
3.	**(a)**	**Solve any FOUR of the following:** **Explain 4-way-3 position direction control valve used in hydraulic system.** 4-way-3 position direction control valve used in hydraulic system is known as 4X3 DC Valve. The valve has four ports and three positions. Following figure shows the Normal and working positions of DCV. Spool of this valve is having three positions. The spool is so selected because we have to obtain third position also called as 'Closed Centre Position' This position is shown in figure. We have shifted the spool in such a manner that all ports are closed to each other. Mo flow from port P to port A or B and no flow from port A and B to R. When DC valve attains this position, pressured oil returns to reservoir via pressure relief valve. The closed center position of DC valve is suitable for immediate closing of movement of actuator. **Position- I** 	Explanati on 2 Marks Figure 2 Marks

		Position- II  **Closed center position**  	
	(b)	**Explain gear pump with neat sketch. (**external gear pump also can be considered) It consists of one external and one internal meshing gear pair. External gear is connected to electric motor and hence is driving gear. Internal gear or ring gear is driven gear which rotates in same direction as that of external gear. Between two gear a spacer called 'crescent' is located which is a stationary pieces connected to housing. Inlet and outlet ports are located in end plates. External gear (driving gear) drives the internal gear (Ring Gear). Portion where teeth start meshing, a tight seal is created near port the vacuum is created due to quick un meshing and oil enters from oil tank through inlet port. Oil is trapped between the internal and external gear teeth on both sides of crescent (spacer) and is then carried from inlet to outlet port. Meshing of gear near outlet port reduces the volume or gap and oil gets pressurized. These pumps make very less noise.  	Working 2 Marks Figure 2 Marks
	(c)	**Explain any four criteria for selection of hydraulic pump in hydraulic system.** **1) Pressure:** It is the basic selection criteria. Pump pressurizes the hydraulic oil to the level required by actuator. When pressures up to 150 bars are required then gear pumps can be selected. For pressure of 150 to 250 vane pump is suitable and for above 500 bar pressure piston pumps are useful. **2) Flow of pressurized oil:** Volumetric output of pump is measures in LPM. The flow of oil decides the speed of actuator. The displacement can also be changed for variable displacement pumps. **3) Speed of pump:** The speed of pump is decided by rated capacity of the manufacturer. If wrong speed is selected for pump then efficiency and working of hydraulic system may get hamper. **4) Efficiency of the pump:**	Correct 4 criteria's 4 Marks

		The selected pump must have good efficiency. We can consider following efficiencies: 1) Volumetric 2) Mechanical 3) Overall **5) Oil compatibility:** The oils used in pump should be compatible with the material of the pump. If wrong oil gets selected then pump will not work to its rated performance.	
	(d)	**Name any four components of pneumatic system. What are the factors considered while selecting them?** **1) Compressor:** a)Pressure Requirement b) Volume of Air c) Compressor configuration **2) Actuators:** a) According to maximum pressure b) According to application – Linear/Rotary c) shape and size of actuator **3) Air Receiver:** a) Storage capacity b) Material of the tank **4) FRL unit:** a) According to working environment b) According to pressure required at hand tools **5) DCV:** a) According to maximum pressure of system. b) According to actuator configuration c) According to application- One hand /Two hand d) According to actuation method suitable for application.	Compone nts 2 Marks Factors 2 Marks
	(e)	**Draw labeled sketch of air lubricator.**  	Labeled Figure 4 Marks

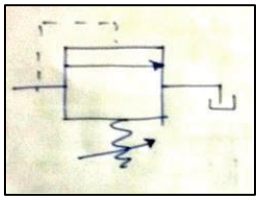
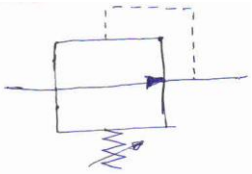
4	A	**Solve any THREE of the following (12 Marks)**	
	a.	**a)Actuator -** Actuators are those components of hydraulic / pneumatic system, which produces mechanical work output. They develop force and displacement, which is required to perform any specific task. An actuator is used to convert the energy of the fluid back into mechanical power.  Fig. Double acting cylinder : 1. Tube 2. Piston 3. Piston rod 4. Double O-ring packing on piston 5. O-ring for piston rod 6. End cover 7. Bush 8. Cushion assembly	**(Sketch 2Marks and Explanation 2 Marks)**
	b	**Pressure relief valve used in pneumatic system**:  The pressure relief valves are used to protect the system components from excessive pressure. Its primary function is to limit the system pressure within a specified range. It is normally a closed type and it opens when the pressure exceeds a specified maximum value by diverting pump flow back to the tank. The simplest type valve contains a poppet held in a seat against the spring force as shown in Figure. This type of valves has two ports; 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. (Pressure switch in Pneumatic or Pressure relief valve in hydraulic system can be considered)	**(Sketch 2Marks and Explanation 2 Marks)**

	c	**c)Speed control of Bidirectional motor** Varying the rate of flow of oil will vary the speed of the actuator. Speed control is possible using meter in circuit, meter out circuit, bleed off circuit or by placing flow control before the DCV. **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 Pilot S1 and S2. *(Lever / Push button / Solenoid may be used)* When Pilot S2 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 Pilot S1 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. 	**(Sketch 2Marks and Explanation 2 Marks)**
	d.	**d) Applications of 3 X 2 DCV:** • To start, stop and change the direction of motion of a Single acting cylinder. (Clamping of Job) □ To actuate Pilot control of 5/2 DCV.	**(Applications**

		□ To isolate certain branch of a circuit. **Symbol:**  	**any two 2 Marks & Symbol - 2Marks)**
B		**Solve any ONE of the following (06 Marks)**	
a.		a) Explain with neat sketch working of variable displacement vane pump. In a hydraulic system the flow rate of the pump needs to be variable this can be easily achieved by varying the rpm of the electric motor. Other method is displacement of a vane inside the pump and therefore its delivery is proportional to the eccentricity between the rotor axis and cam ring. Changing the geometric position of the ring relative to the rotor center will change the delivery volume as per system need. Main components of the vane pumps are: 1. Hardened cam ring 2. Rotor 3. Vanes 4. Screw for position adjustment 5. Thrust bearing 6. Stop  **Working :** The rotor containing the vanes is positioned eccentric or off-center with regard to cam ring by means of the adjusting screw hence when the rotor is rotated, in increasing and decreasing volume can be created inside the cylinder bore. If the screw is adjusted slightly so that the eccentricity of the rotor to the cam ring is not sufficient the flow will be less where as with higher eccentricity the delivery volume will be increased with the screw adjustment back completely out the cam ring naturally centers with a rotor and no pumping will be the eccentricity will be zero.	**(Sketch 3Marks and Explanation 3 Marks)**

5. **b.** b) Compare pressure relief valve and pressure reducing valve.

(Any 6 points, 1 Mark each)

Parameter	Pressure Relief Valve	Pressure Reducing Valve
Function	To relive excessive pressure for safety of system	To supply reduced pressure in the certain portion of the circuit
Normal Position	Normally Closed	Normally Open
Operated element	Pilot line from inlet operates the poppet	Pilot line from outlet operates the sliding spool.
Pressure	Inlet pressure is the pilot pressure.	Outlet pressure is the pilot pressure.
Preset value	It opens when inlet pressure becomes more than preset value.	It closes when outlet pressure becomes more than preset value.
Connection	Fitted in by-pass line to reservoir tank.	Fitted in main line to system.
Symbol		

a. **Solve any TWO of the following**

a: List the Factors to be considered for selecting the pipe while designing pneumatic system. Give specification of pipes for the pneumatic system.

(Factors any four – 04 Marks, Pipe size – 04 Marks)

Factors to be considered while selecting the pipe for pneumatic system

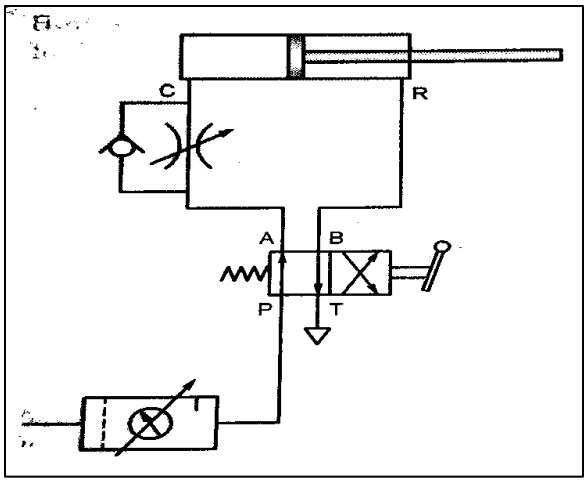
1. Pressure of compressed air in the line.
2. Total flow rate per unit time through the line.
3. Permissible pressure drop in the line.
4. Type of tube material and type of line fittings.
5. Length and diameter of tube or other pipelines.
6. Working environment.

Pipe Size Specifications: Generally pipe size is specified in three ways

1. Nominal Pipe Size (NPS) : This number indicates the base diameter of pipe in inches.

e.g. : ½ inch, ¾ inch, 1 inch, 1 ½ inch etc.

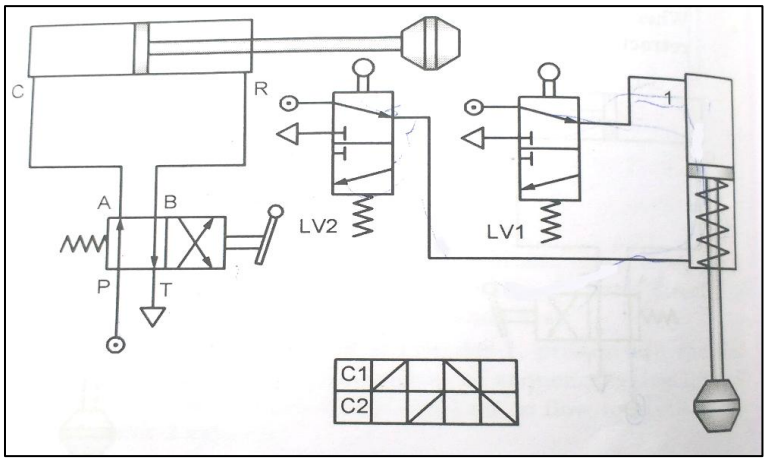
2. Schedule Number (SCH): This number is based on wall thickness, greater the SCH, greater will be the wall thickness of pipe. A schedule number indicates the approximate value of

	b.	SCH = 1000 * P / S where P – service pressure & S – Allowable stress SCH Number 40, 80 and 160 are widely used. **3.** Pipes are also classified as Standard (STD), Extra strong (XS) size, Double Extra strong (XXS) size based on strength.	
		b.Draw and Explain pneumatic meter in circuit to control of speed extension. In meter in pneumatic circuit flow control valve with check valve is fitted between DCV and actuator. For speed control of actuator during extension stroke, FCV with check valve is fitted on piston side of the actuator as shown in figure. With a meter-in circuit, fluid enters into the actuator at a controlled rate. Pneumatic circuit diagram for meter-in flow-control circuit is as shown in figure. In this circuits, the rate of flow of compressed air into the cylinder is controlled by flow control  valve. FCV is placed at inlet of the cylinder. Cap end port "C" is inlet for extension and rod end port "R" is inlet for retraction. **Working:** In first position of 4/2 DCV, compressed air flows from P to A and B to T. this flow is through flow control valve, the flow is controlled and hence piston extends slowly. In second position 4/2 DCV, compressed air flows P to B and A to T. this flow is through check valve. This is free flow. Hence the piston retracts at higher speed, Which is not controlled.	(02 Marks – Explanation, 03 Marks – Circuit diagram & 03 Marks - Working)
	c.	**C:** Explain with neat sketch (position based) working of sequencing circuit for two double acting Air cylinders. Pneumatic double acting cylinders can be operated sequentially using a sequence valve or by using position based method. In pneumatics, use of sequence valve is not popular. Position based sequencing is possible using roller operated DCV or solenoid operated DCV.	(02 Marks – Explanation, 04

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

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

Components are connected as shown in figure.



Working:

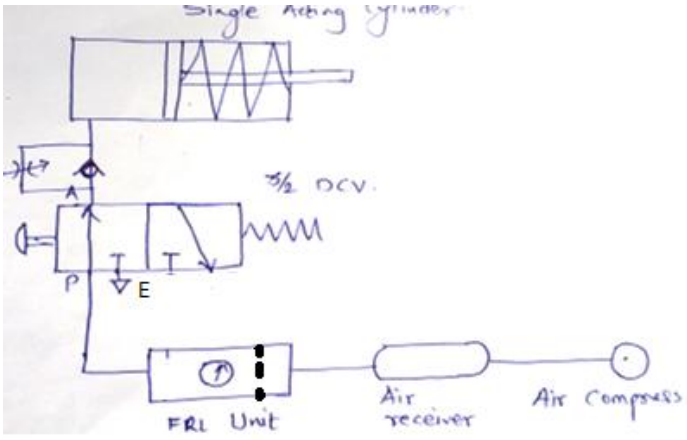
In the first position of lever of 4/2 DCV (5/2 DCV can be used), the DAC extends. By the end of extension of first DAC, the cam presses roller of valve LV1 hence compressed air flows to second DAC, and second DAC extends.

When the lever of 4/2 DCV is shifted to second position, DAC retracts. By the end of retraction of first DAC, the cam presses roller valve LV2, hence compresses air flows to second DAC and second DAC retracts.

Marks – Circuit diagram & 02 Marks - Working)

Solve any FOUR of the following

6 **a.** a) Draw speed control of single acting cylinder pneumatic circuit using 3 / 2 DC valve.



b. b) State any four reasons of failure of pneumatic seals.

Ans – 1. Incompatibility of seal material with operating system

2. Excessive heat

3. Excessive load

4. Excessive clearance

5. Excessive pressure

6. Improper fitting

7. Improper groove geometry

8. Abrasion

9. Wear

4 marks

c. c) What are the advantages of pneumatic systems over hydraulic systems ?

Ans – 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

6. Low component cost & light weight

7. Pneumatic system can run continuously for long period

Any four
4 marks

d. d) Compare positive displacement pump with roto dynamic pump

Positive Displacement Pump	Rotodynamic Pump
1. Delivers fluid in discrete volume per cycle	**1.** Delivery is continuous
2. After finishing on delivery stroke completely , only the next suction stroke can start	**2.** Suction & delivery can keep on going continuously & simultaneously.
3. Discharge is independent of the resisting pressure at delivery	**3.** As resistance increases the discharge reduces.
4. Discharge depends only on speed	**4.** Discharge depends on resisting pressure
5. Work done on the fluid is in the form of pressure energy	**5**. Work done is in the form of kinetic energy
6. There is no limit to the maximum pressure that can be built	**6.** The maximum pressure that can be developed is limited

Any four
4 marks

	e.	e) What are the various types of hoses used in pneumatic system? Hoses are flexible connecting tubes or pipes to connect actuators, control valves. Different layers of hose 1) Inner tube 2) Reinforcement 3) Outer protective cover **Hoses:** are flexible vessels that are constructed of multiple layers of different materials. Fittings for hoses are often not permanent, since the hose itself is often replaced in time due to wear.	4 marks