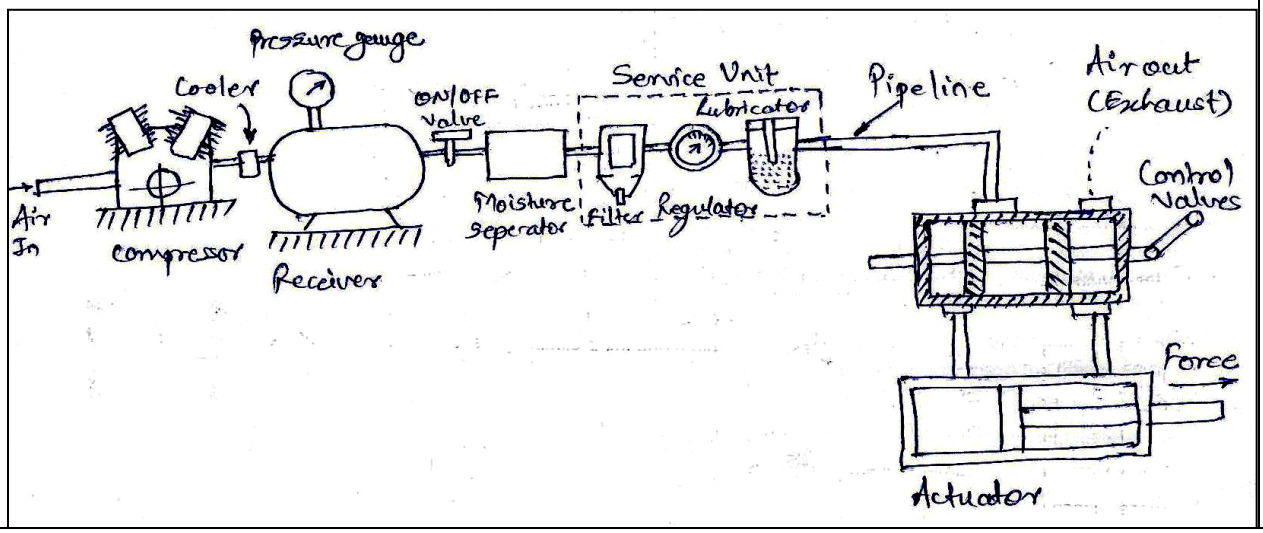
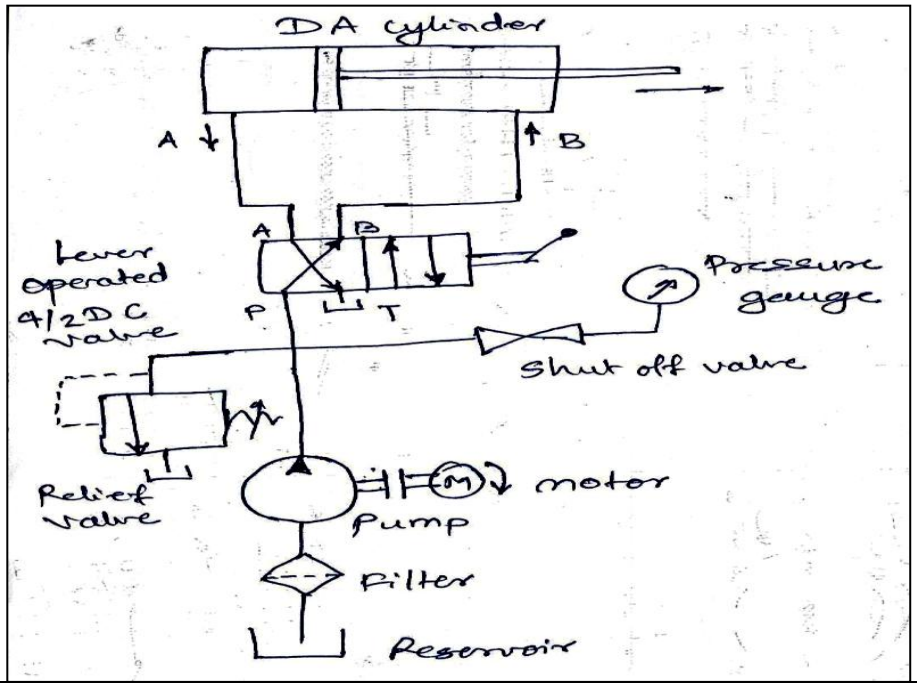
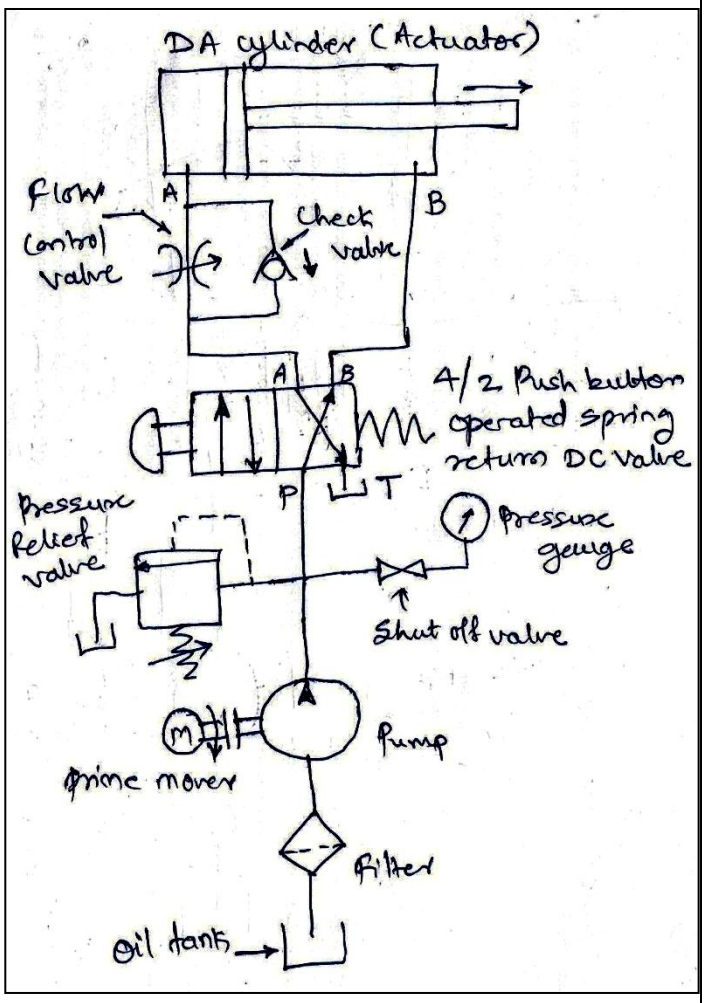
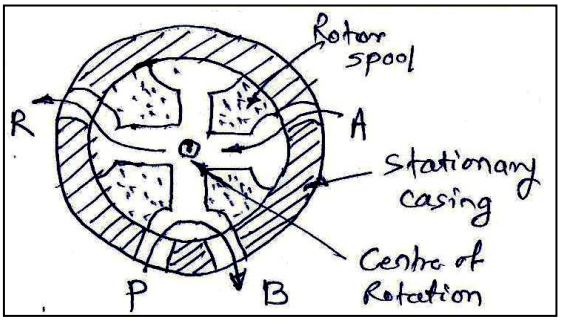
Important Instructions to examiners:

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) (i)	**Attempt any THREE of the following:** **Write any four applications of oil hydraulic systems** 1. Earth Moving equipments 2. Broaching machine 3. CNC/VMC/HMC Machines. 4. Hydraulic thread rolling machine 5. Hydraulic press brake. 6. Material handling equipments 7. Hydraulic thread rolling machine 8. Hydraulic cranes	4 Marks
	(ii)	**What are the effects of contaminants in the oil?** Following are the effects of contaminants in the oil 1) Contaminants in oil make fluid improper or even hazardous for reuse. 2) Excessive heat gets generated during operation of the hydraulic circuit. 3) Electromagnetic radiation contaminated hydraulic system often generates noise thereby polluting the environment. 4) The system operates at lesser efficiency than the desired.	4 Marks
	(iii)	**Draw a general layout of pneumatic system and state the function of components** 	Figure 2 Marks Function 2 Marks

		1) Air inlet filter – Free air from the atmosphere enters the compressor through an air-inlet filter which will essentially keep out the dust and dirt from entering the system. 2) Compressor: It is used to compress the air from atmosphere pressure to the desired higher pressure level. It can be single stage or multistage in operation. 3) Cooler: Removes the heat generated during the process of operation. 4) Pressure switch and control unit: Maintains the pressure in the receiver in the predetermined range by starting and stopping the prime mover. 5) Moisture separator: Cooling air in the cooler results in condensation of vapor in the air. The condensate in the form of water droplets are separated from air. 6) Service unit: **Filter –** Separates sub-micron level contamination. **Regulator –** Bring the pressure of air from receiver pressure to the device pressure. **Lubricator –** Adds lubricants to air. 7) Pipe Line: They carry the compressed air from one location to another. 8) Control Valves: They are required to control the air direction, pressure and flow rate. They are responsible for the smooth and precise control of the pneumatic actuator, and also for the safe operation of the system. 9) Actuator: They will convert the high pressure energy of the compressed air into mechanical force or do useful work. Actuators can either be pneumatic cylinders to provide linear motion or pneumatic motors to provide rotary motion.	
	(iv)	**Draw the hydraulic circuit showing control of DA cylinder using 4 X 2 DC Valve. Explain the working in brief.** **Fig** shows the circuit used to control DA cylinder using 4 X 2 DC Valve. The operation is described as follows: 1) When the 4/2 way DC valve is in its open center position pump oil flows from port P to port A to the blank end of the cylinder, extending the piston rod against a load. The oil in the rod-end of the cylinder is free to flow back to the tank via port B and T. 2) When DC valve is activated then it engaged in cross connection of the ports. The cylinder retracts as the oil flows from ports P and B to the rod end. Oil in the blank end is returned to the tank via ports A and T.	Circuit 2 Marks Explanation 2 Marks



	b)	**Attempt any ONE of the following:**	
	(i)	**Draw actual hydraulic system and explain its working.** Oil hydraulics system uses pressurized oil which is circulated through various components of the hydraulic system to perform the given task. The various components of hydraulic system have to perform its intended function and they are arranged to form a layout of the system as per sequence of operation of hydraulic system. This arrangement of various hydraulic system components as per the nature of equipment/machine is known as actual layout of the system. The oil from reservoir is cleaned by the filter and sucked by the pump when driven by the motor. The pump increases the pressure of oil and high pressure oil is then passed through relief valve to drain excess pressure. Now oil is circulated to the direction to control to the actuator. The oil moves the piston and piston rod to give output force/motion. This motion/force is then utilized for performing the work/task. The oil from the relief valve and outlet of the actuator transferred to the reservoir through drain line and recirculated in the hydraulic system.  	Circuit 3 Marks Explanation 3 Marks
	(ii)	**Explain with neat sketch the working of rotary spool type DC Valve** A rotary spool valve consists of a rotating spool which aligns with ports in stationary valve casing, so that fluid is directed to required port. A/B/P/R are the ports in casing. The port 'P' is a pressure port though which pressurized oil is coming in the valve. 'R' port is the port through which used oil is returning to oil tank. From fig port p is connected to port B and port A is connected to port R  	Figure 3 Marks Explanation 3 Marks
2.	**a)**	**Attempt any TWO of the following:** **What is swash plate? What is its use? What will happen if we change the angle of swash plate? Explain with sketch.** **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. 2 Marks

Use –

It is helps to reciprocate the piston of axial piston pump while the cylinder block is rotating 2 Marks

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 infront 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. 2 Marks

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.

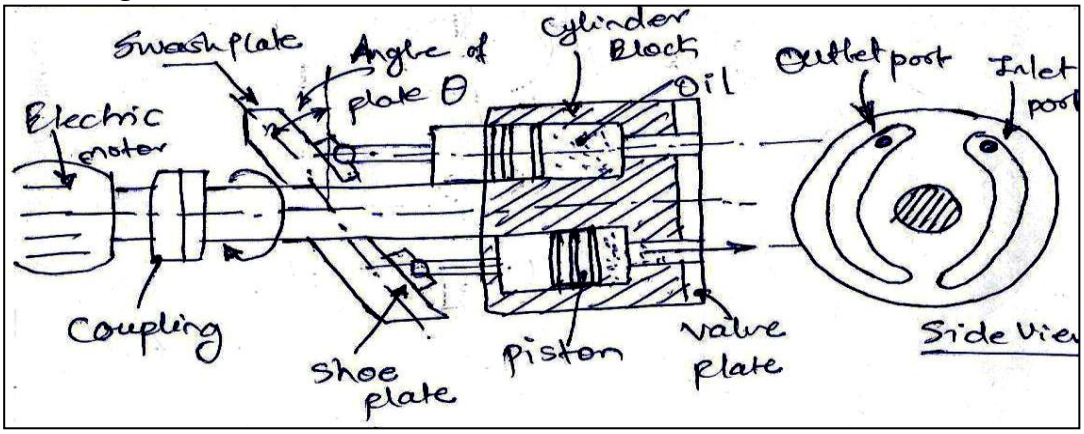
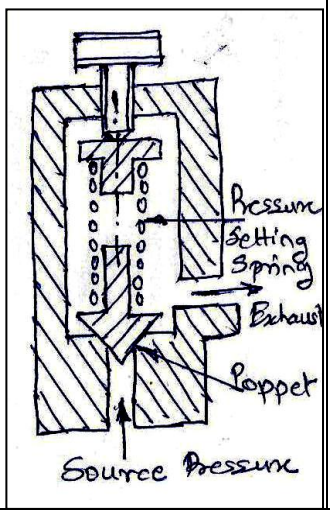


Figure 2 Marks

b) Why pressure relief valve is used in hydraulic circuit? Explain in details with neat sketches.



2 Marks

Pressure Relief Valve used because;

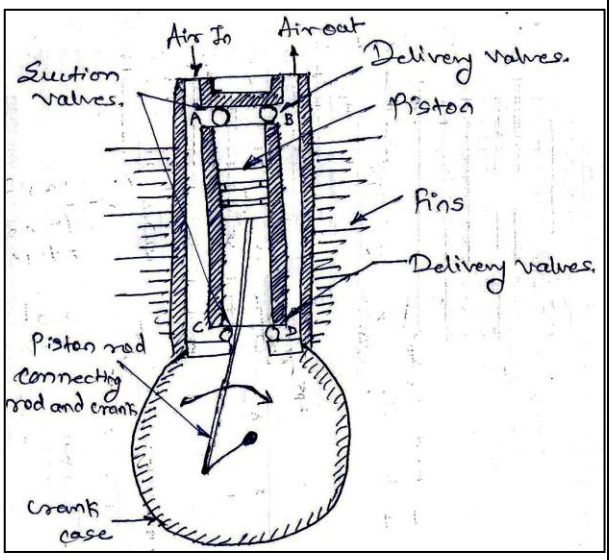
1. To Maintain desired pressure levels in the circuit.
2. To set maximum pressure in hydraulic system.
3. Protect the pump and other system components from overloading.
4. It acts as a relief and safety device

Explanation-

Simple pressure relief valve is also a Direct operated pressure relief valve. It consists of Poppet, spring, pressure setting knob and valve body.

It is normally closed valve connected between pressure line and the oil reservoir when inlet oil pressure is less than the spring force; it means

Explanation 3 Marks

		that it is insufficient to overcome the spring force, the valve remains closed. The pressure of oil is safe for the system. When the oil pressure is greater than spring force, it pushes the poppet against the spring force and unseated the poppet. Now the valve opens and oil flow from inlet port to the reservoir. The valve will remain open until the excessive pressure is diverted to the tank. **Cracking pressure**: the pressure at which the valve first opens is called the cracking pressure. It is essential for every hydraulic system to provide pressure relief valve as a safeguard against the pressure.	Figure 3 Marks
	c)	**Explain the construction and working of double acting reciprocating compressor with neat sketch.** Double acting reciprocating air compressor is similar to double acting reciprocating pump. It is comprised of following parts: 1) Cylinder 2) Piston and piston rod and connecting rod. 3) Crank and crank case 4) Two suction valves and two delivery valves. 5) One inlet port and one outlet port It uses four bar mechanism. There are 4 valves (2 suction valves and 2 delivery valves) shown at A, B, C, D in figure. There are cooling fans similar to single acting compressors. The crank rotates on electric motor/engine/turbine. In this compressor, compression of air takes place on both side of the piston. When crank rotates, the piston starts reciprocating. When piston comes down and attains, 'Bottom dead center piston' the air comes in through port 'A' due to vacuum created due to downward movement. When piston starts moving upward, the air starts compressing. When piston attains, 'Top dead center piston', the stroke is complete and air is fully compressed which goes out through delivery valve 'B' to air receiver.  During this upward movement the vacuum is created on other side (Piston rod side) of piston. Suction valve 'C' opens and air comes in. When piston starting comes down, this air which came through valve 'C', gets compressed and compressed air goes out through delivery valve 'D' to air receiver. In this downward movement air comes in through valve 'A' and entire cycle repeats.	Explanation 4 Marks Figure 4 Marks
3.	**a)**	**Attempt any FOUR of the following:** **Write any four advantages of oil hydraulic system.** 1) We can generate very high pressures in hydraulic system. Due to this nature of hydraulic	4 Marks

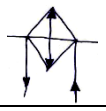
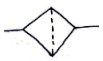
system we can use this power to lift, hold, press very heavy loads

2) Weight to power ratio of a hydraulic system is comparatively less than that of an Electro-Mechanical System. Electric motor weigh appropriately 8.5 Kg/kW whereas, same power hydraulic motor weighs 0.85 kg/kW only.

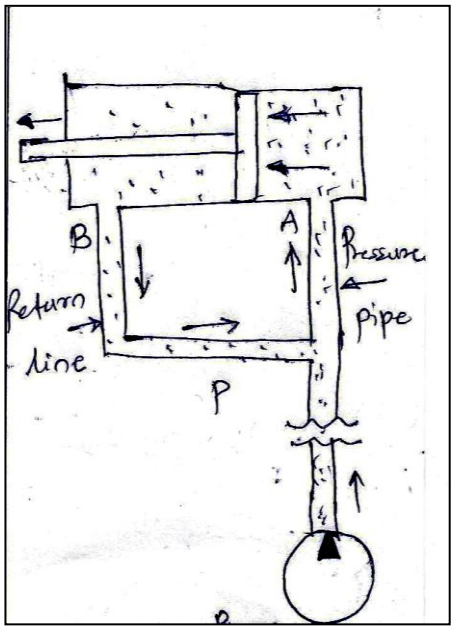
3) The speed control of linear as well as rotary actuators can be achieved with ease. By merely adjusting small flow control valve, wide range of speed and feed can be obtained.

4) The system provides instant and smooth reversible motion

b) Draw symbols of: — 4 Marks

(i) Oil Reservoir		**(iii) Heat Exchanger**	
(ii) Oil Filter		**(iv) Unidirectional fixed displacement pump**	

c) Explain the principle of regenerative circuit. — Sketch 2 Marks, Explanation 2 Marks



Principle of regenerative circuit is recovering the energy available with returning oil by using regeneration technique.

The concept of re-generative circuit is explained from following figure. Consider the double acting cylinder. Pressurized oil from pump is admitting in cylinder cavity through port (A). Due to pressure force piston is moving from right to left. During this movement, the oil present on piston rod side of piston starts coming out through port (B). This oil will return to the oil reservoir via DC valve.

It is clear from figure that, returning oil will enter in pressure pipe through pipe 'P' During exit of oil through port (B), some energy is still there with oil on piston rod side. This energy is otherwise wasted if this oil directly goes to oil reservoir. To avoid wastage of this energy, pipe 'P' is connected so that, the pressurized oil gets more energy and it will create more pressure force while entering through port (A).

d) What is FRL unit? Explain its function. — 1 Mark

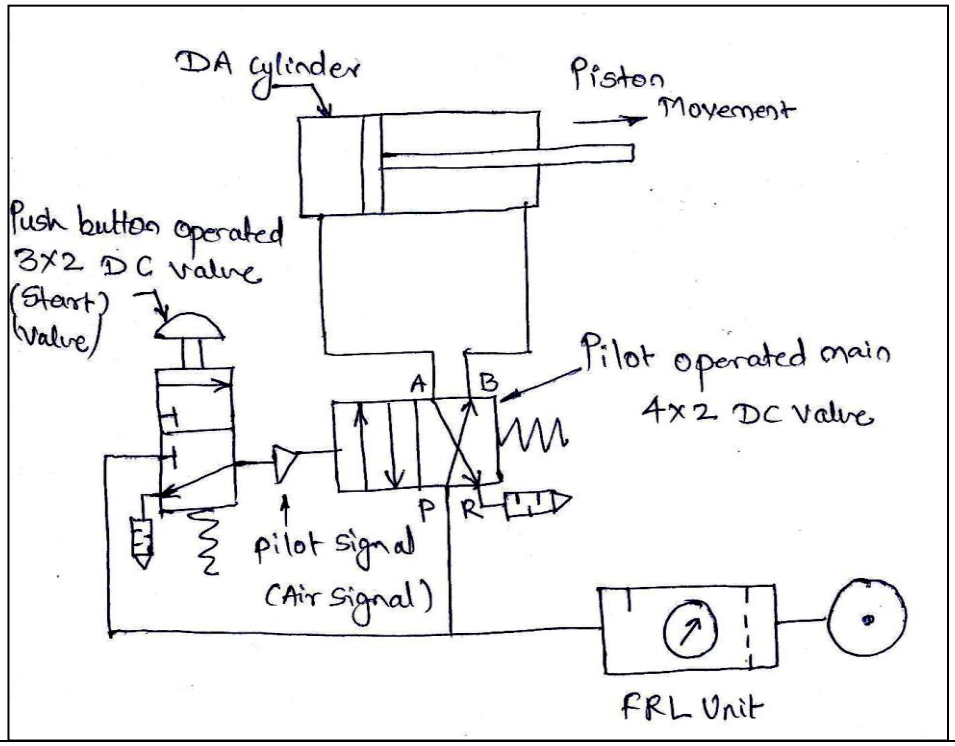
FRL unit means Filter Regulator and Lubricator Unit

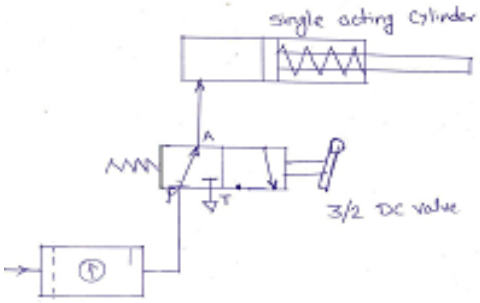
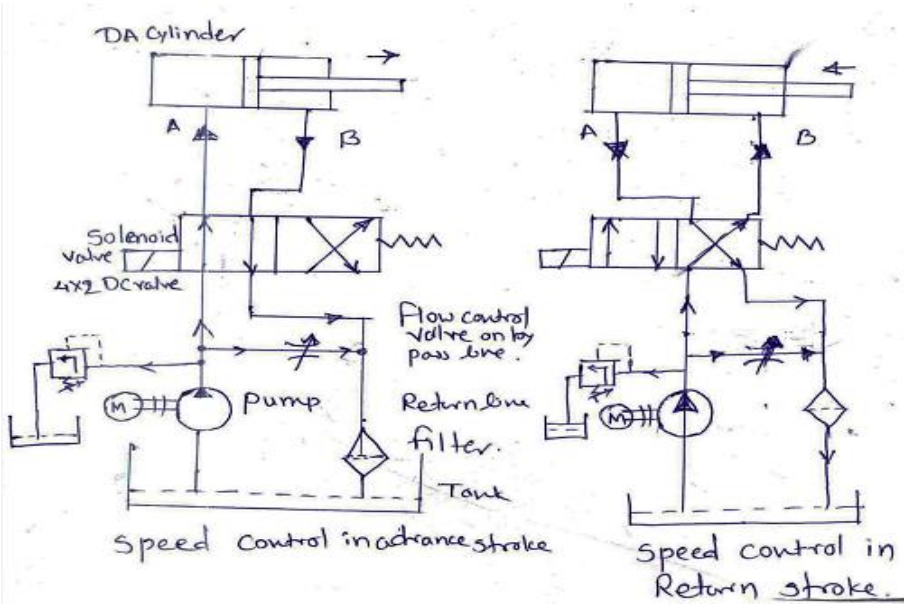
Function of FRL unit

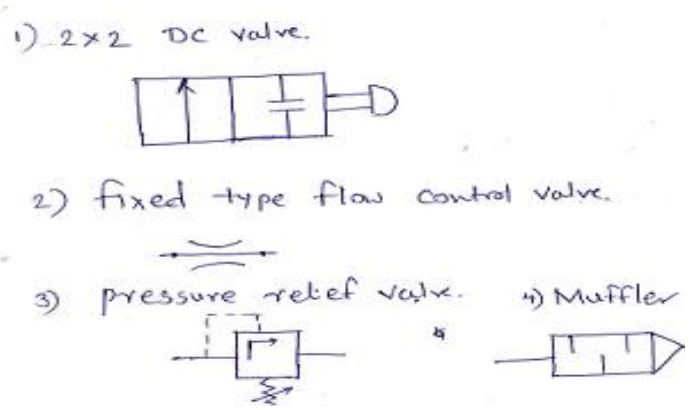
Filter (F) – 1) To remove the micron and sub-micron particles present in the entering air of compressor

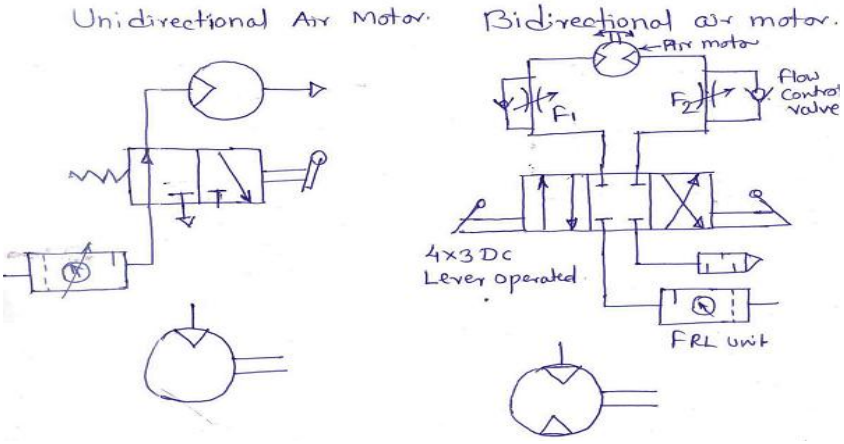
2) Used to separate out contaminants like dust, dirt particles from the compressed air

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 performed 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.	3 Mark
	e)	**Draw pilot operated DA cylinder circuit using 4 X 2 DC valve and 3 X 2 pilot valve.** 	Correct Pilot Operated Circuit 4 Marks
4		**Attempt any TWO**	
	a)	**Use of direction control valve: (Use of DC valve 2 Marks ,Sketch 2 Marks)**	
	i)	1. DC valves are used to release, stop or redirect the fluid that flows through it. 2. DCV is used to control the direction of fluid flow in any hydraulic system and changing the position of internal movable parts. 3. To start, stop, accelerate, decelerate and change the direction of motion of a hydraulic actuator. 4. To permit the free flow from the pump to the reservoir at low pressure when the pump's delivery is not needed into the system. 5. To vent the relief valve by either electrical or mechanical control. 6. To isolate certain branch of a circuit.	4 Marks

	(i)	**The following circuit shows use of 3/2 DC valve.** When the lever is operated, port A is connected to exhaust port ,i.e change in direction of the piston. **(Alternative sketch can be considered)** 	
4 a	**(ii)**	**Bleed off circuit:(Any one circuit diagram with label 4 Marks)** 	4 marks
	(iii)	**Limitations of pneumatic system: (Each point 1Mark 1x4)** 1. Relatively low accuracy: As pneumatic systems are powered by the force provided by compressed air, their operation is subject to the volume of the compressed air. As the volume of air may change when compressed or heated, the supply of air to the system may not be accurate, causing a decrease in the overall accuracy of the system. 2. Low loading: As the cylinders of pneumatic components are not very large, a pneumatic system cannot drive loads that are too heavy. 3. Processing required before use Compressed air must be processed before use to ensure the absence of water vapour or dust. Otherwise, the moving parts of the pneumatic	4

			Marks
		components may wear out quickly due to friction. 4. Uneven moving speed: As air can easily be compressed, the moving speeds of the pistons are relatively uneven. 5. Noise: Noise will be produced when compressed air is released from the pneumatic components. 6. Lubricator: Lubricator is required to add lubricant oil to compressed air to reduce friction.	
4a	**(iv)**	Symbol:  	4Marks
b)		**Attempt any One**	
	(i)	**Unidirectional air motor:(Explanation 2 Marks, sketch 2Mark and symbol 2 Marks)** Operating or moving or allowing movement in one direction only. It runs in one direction only. It does not run in the other direction. Unidirectional motor can be operated by using 3/2 DC valve as shown in fig. **Bidirectional air motor:** Functioning or allowing movement in two usually opposite directions. It can runs in both direction. Bi-directional motor can be operated by using 4/3 DC valve as shown in fig.	6Marks



(ii)

Linear Actuators	Rotary actuators
1.These actuators reciprocates in a cylinder	1. These actuators rotate about center.
2.Linear speed measured in m/sec	2.Rotary speed measured in RPM
3.Example-Single acting cylinders, double acting cylinders, Tandem cylinder	3.Example-Vane motors, gear motors, piston motors, air motors
4.Used for pushing ,pulling types of tasks	4. Used where rotary motions are required. Straight grinders, pistol drills.
5.Provide motion along straight line	5.provide motion along center
6.Manufacturing cost is High	6.Manufacturing cost is low

6Marks

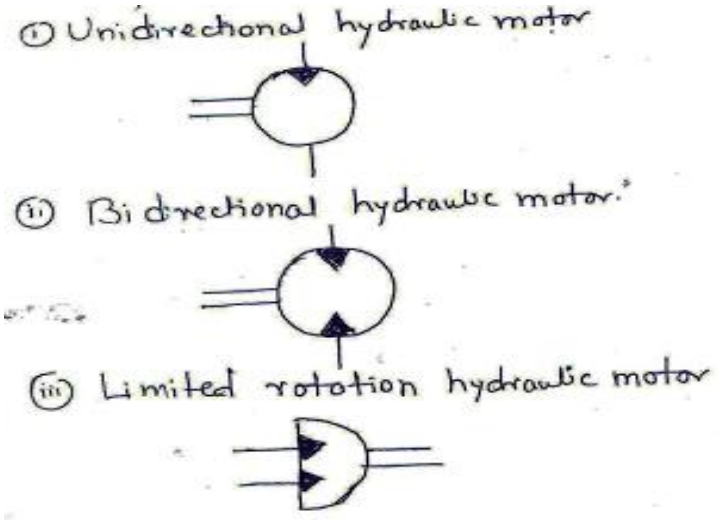
(1 x 6)

5 a)

Attempt any Two

(i)

Hydraulic motor :



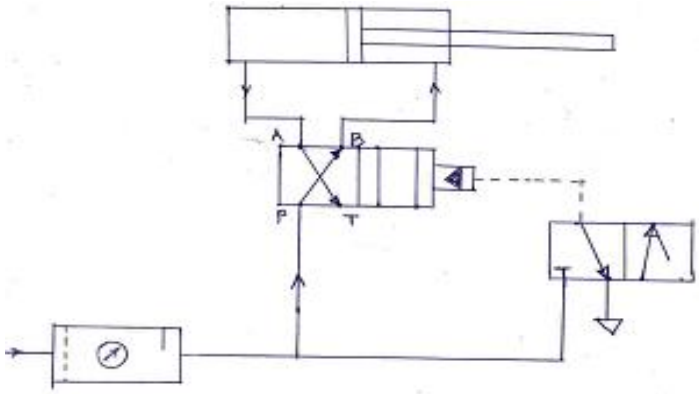
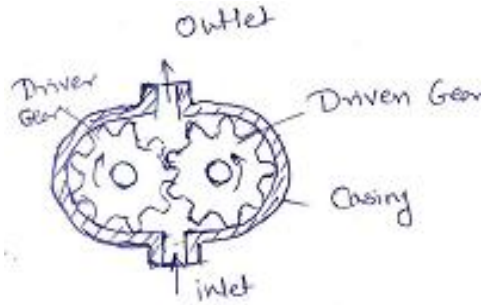
4Marks

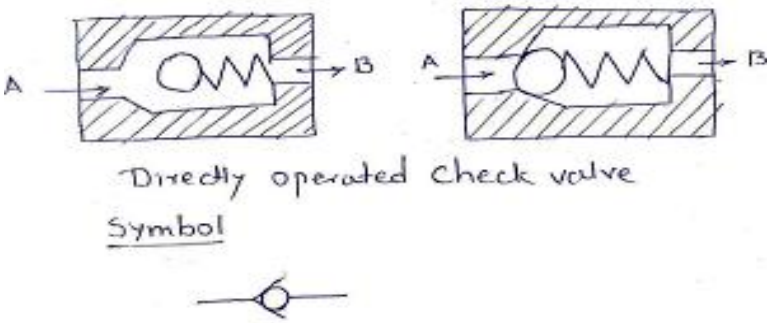
(ii)

(Explanation 2 Marks and Circuit diagram 2Marks Impulse operation means operation of the main valve using the impulse of an impulse valve.

As shown in fig. in circuit has two valves ; main valve and impulse valve. Main valve is a single

4Mar

		pilot operated spring return type 4/2 direction control valve. Impulse valve is palm button operated spring return type 3/2 direction control valve. In normal position of valves, the double acting cylinder is in retracted position. When the palm button of impulsive valve is pressed manually, compressed air flows to the pilot port of main valve. Hence the speed of main valve will be shifted to the second position. Double acting cylinder is extends. 	ks
5	b)	**Gear pump : External Gear pump : (Sketch 4 Marks, Construction 2Marks &working 2Marks)** It consists of a pump housing in which a pair of precisely machined meshing gears runs with minimal radial and axial clearance as shown in fig. One of the gears, called a driver, is driven by a prime mover. The driver drives another gear called a follower. As the teeth of the two gears separate, the fluid from the pump inlet gets trapped between the rotating gear cavities and pump housing. The trapped fluid is then carried around the periphery of the pump casing and delivered to outlet port. The teeth of precisely meshed gears provide almost a perfect seal between the pump inlet and the pump outlet. When the driver is rotated by prime mover and driven will also rotate. Thus partial vacuum is created at the inlet of the pump. Fluid is forced to enter into the pump at atmospheric pressure. Fluid is trapped in the pockets between teeth and the casing and carried towards the outlet port. 	8Marks
5	c)	**Directly operated (Poppet type) check valve : (Sketch 4 Marks and working 4 Marks)** **Working:** When oil under pressure is supplied to port A, the oil exerts pressure on the ball against the spring force, hence the ball will be lifted off from its seat and creates a passage for	8 marks



oil to flow. Hence oil can flow from port A to port B. when under pressure is supplied in opposite direction that is to port B, the oil force the ball to sit firmly in its seat, hence the passage is closed by ball. The oil cannot flow port B to port A.

6 a) Attempt Any FOUR

Oil heaters:

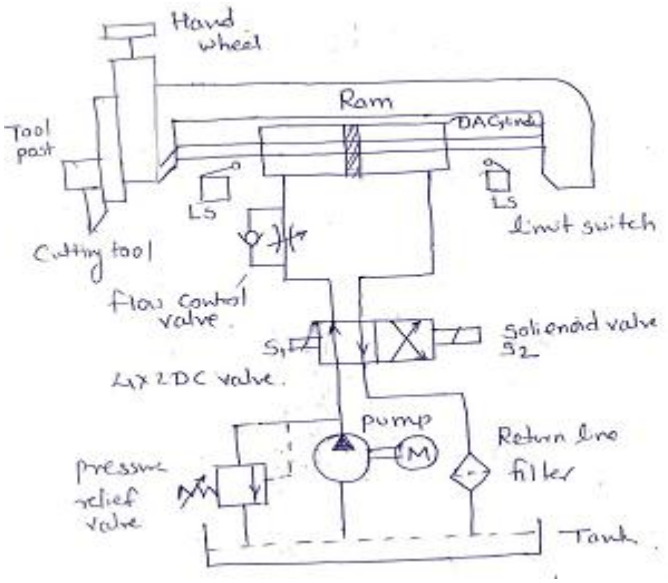
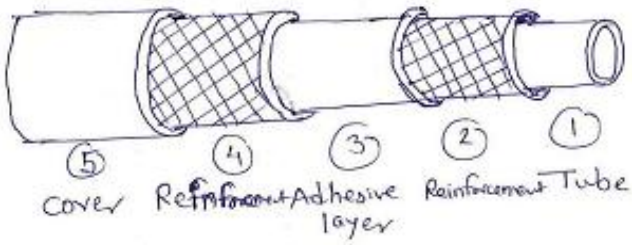
- When hydraulic circuit works in cold climate, then oil is solidifies below 5 ^{o} C temperature.
- To liquefy the oil electrical heater or thermostatic heater are equipped with oil tank.
- This increase the operating and maintenance cost of hydraulic system
- The cost of hydraulic system is higher.
- It heats the oil so that its viscosity increases and it can flow in the system smoothly.
- Thermostatically controlled oil heater commonly used

4Marks

6 b)

Meter in circuit	Meter out circuit
1. Flow control valve is placed in pressure line.	1. Flow control valve is placed in return line.
2.Rate of flow of oil is controlled at inlet of the actuator	2.rate of flow of oil is controlled at outlet of the actuator
3. Used for opposing load only.	3. used for both opposing load as well as running away load.
4. Pressure drop in FCV may reduce force developed.	4. Pressure drop in FCV will not affect force developed.
5.Suitable for very low piston rod speed	5. Suitable where very stable movement of actuators is needs.
6. Used where finer speed control is required.	6. suitable for drilling ,boring or reaming .

4 Marks (Any four points 1 x 4)

		7.less compact	7. More compact	
	c)	**Hydraulic Shaper machine(Circuit diagram 2Marks and working 2 Marks)**  Parts of shaper machine: Fixed DA cylinder, spool type DC valve, spool shaft stroke adjusting lever, pump, pressure relief valve, return line with filter, oil reservoir. Working: Forward stroke: As shown in fig ,the pump is supplying oil to DA cylinder through DC valve and through port B. Hence piston will move from right to left with force and this is a cutting stroke. Backward Stroke: When lever touches the stopper, then spool shifts to right and flow directions in DC valve change. The oil is entering through port A of DA cylinder and piston will move from left to right. During this stroke, the tool post slightly lift with ideal stroke.	4Marks
6	d)	**Construction details of pneumatic hose: (Sketch 2Marks & Explanation 2 Marks)**  Pneumatic hose is made of several layers with metal wire braiding between them.		4Marks (Sketch 2Marks and explanation 2Marks)

S.N	Layer	Function	Material
1	Tube	Conveys the hydraulic compressed air	Polyethylene
2	First reinforcement	Protects and strengthens the tube	Metal wire(steel or copper)

		3	Adhesive layer	Holds the reinforcement layers, protects against vibrations	Rubber
		4	Second reinforcement	Protects the first reinforcement	Woven yarn (cotton, nylon , polyester synthetic fiber)
		5	Outer cover	Protects from abrasions, duct, vibrations, sunrays	Polyethylene

e)

Hose is required in pneumatic circuits:

- They are easy to accommodate and to connect with in the available space.
- Carry compressed air without pressure drop.

Speed control of any actuator (Cylinders or motors) can be controlled using flow control valves. Varying the rate of flow of oil will vary the speed of the actuator.**(Explanation 1Mark)**

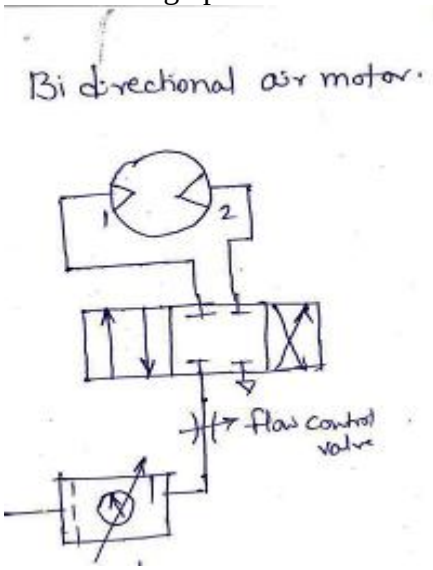
- In meter in circuit, rate of flow of oil is controlled at inlet of the actuator.
- In meter out circuit, rate of flow of oil is controlled at outlet of the actuator.
- In bleed off circuit, rate of flow of oil is controlled in the by-pass line leading towards the tank.

Speed control of bi-directional air motor: (Sketch 1Marks and Explanation 2 Marks)

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.



4 Marks