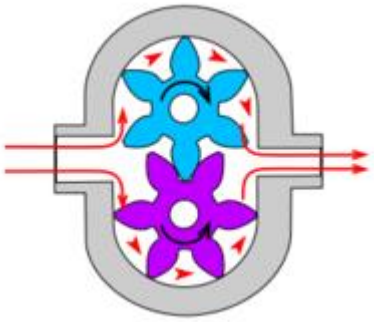
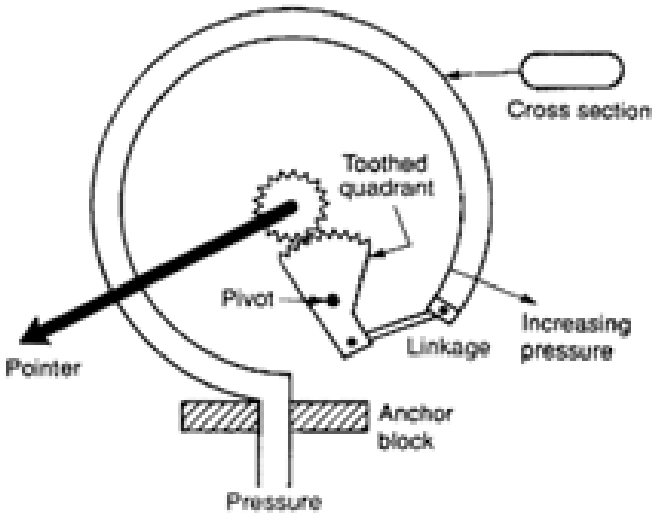
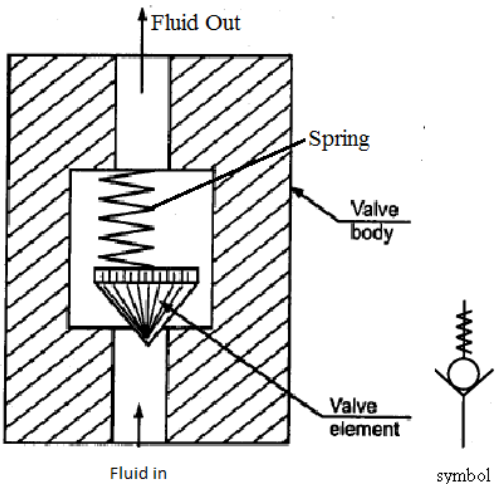
Important Instructions to examiners:

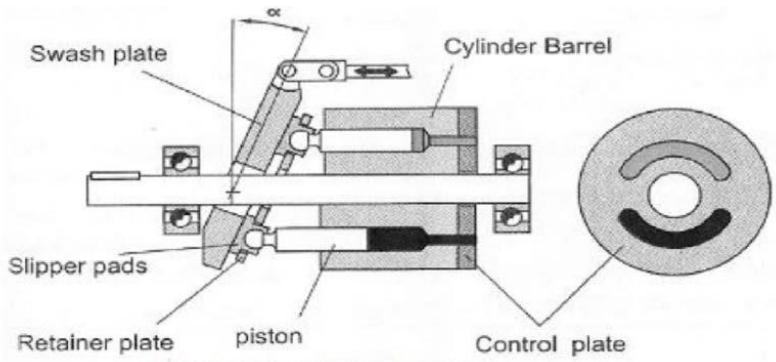
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling 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	(a)	**Attempt any Three of the following.**	12
	(i)	**Define Viscosity and Surface Tension with their S I unit.**	04
		Answer: (Viscosity- 2 marks; Surface Tension- 2 marks) • **Viscosity:** It is the property of fluid which offers resistance to the movement of one layer of fluid over another adjacent layer. **S. I. unit is N-s/m^2 OR Poise** • **Surface Tension:** The tensile force acting on the surface of liquid such that the contact surfaces behave like membrane under tension. **S. I. unit is N/m**	02 02
	ii)	**Give the Classification of valves used in hydraulic system**	04
		1. Classification of valves based on construction a)Poppet Valve-Cone type , Ball type and Disc type b)Spool valve- Sliding spool type , Rotary spool type 2. Classification of valves based on control a) Pressure control valve Pressure relief valve, Counterbalanced valve ,pressure reduce valve, sequence valve b) Flow control valves Pressure compensated valve , Pressure non compensated valve , Temperature compensated valve c) Direction control Valves 2/2,3/2,4/3 valves, Solenoid operated D C valve, check valve, cartridge valve	01 01 01 01

	iii)	**Explain hydraulic motors with neat sketch.**	04
		Ans:(working- 2marks; sketch-2 marks) Hydraulic motors are rotary actuators that convert hydraulic or fluid energy into mechanical power. They work in tandem with a hydraulic pump, which converts mechanical power into fluid, or hydraulic power. Hydraulic motors provide the force and supply the motion to move an external load. Three common types of hydraulic motors are used most often today—gear, vane and piston motors. **Gear Motor:** A gear motor (external gear) consists of two gears, the driven gear (attached to the output shaft by way of a key, etc.) and the idler gear as shown in fig.. High pressure oil is ported into one side of the gears, where it flows around the periphery of the gears, between the gear tips and the wall housings in which it resides, to the outlet port. The gears then mesh, not allowing the oil from the outlet side to flow back to the inlet side.  Fig . Gear motor ***(Note: Equivalent credit shall be given to other correct diagram and suitable explanation)***	**02** **02**
	iv)	**State the function of seals and gasket with their materials.**	04
		Answer: 1. **Seals :** A **mechanical seal** is a device that helps join systems or mechanisms together by preventing leakage. 2. **Gasket:** A **gasket** is a mechanical **seal** which fills the space between two or more mating surfaces, generally to prevent leakage from or into the joined objects while under compression. **Material of Seal :** 1. Two materials of seals used in hydraulic systems. i) Metallic seal like Aluminum alloy. ii) Non metallic seal like Synthetic	**01** **01** **01**

		rubber. 2. Material of Gasket: Gaskets are normally made from a flat material, a sheet such as paper, rubber, silicone, metal, cork, felt, neoprene, nitrile rubber, fiberglass, polytetrafluoroethylene or a plastic polymer (such as polychlorotrifluoro- ethylene).	**01**
1	b)	**Attempt any ONE of the following**	**06**
	i)	**Describe with neat sketch Bourdon tube pressure gauge.**	**06**
		Answer: :(Construction and working- 3 Marks; Sketch-3Marks) Bourdon tube pressure gauge Bourdon tube pressure gauge is a device which is used for the measurement of high pressure as well as pressure above or below the Atmospheric Pressure. **Construction and Working**: The device consist of metallic tube, generally this cross section is elliptical. One end of the tube is closed and another is fitted to the pipe where pressure is to be measured. The dial and the pointer fitted over the mechanism. As flowing fluid under pressure enters the tube, the tube tends to be straightening. This causes the free end of the tube to move which is connected to pinion and sector arrangement. The pointer deflect on the calibrated scale, which directly indicates pressure in the term of N/m^2. **Sketch:**  **Fig. Bourdon Tube Pressure Gauge**	**03** **03**
	ii)	**Write construction and working of non return valve with neat sketch.**	06

		Answer- Non-Return Valve: **:(Construction and working- 3 Marks; sketch-3 Marks)** **Construction:** This valve consists of valve body with inlet and outlet ports having valve element like cone, ball or spherical poppet. The valve element is incorporate with specially designed spring. **Working:** When pressurized oil comes in through port A it will lift up the cone by overcoming spring force and flow will start from port A to port B .When flow from A stops spring will expand and cone will block the flow hence only one direction of flow is possible.  **Fig. Non return valve**	**01** **02** **03**
2		**Attempt any FOUR of the following**	16
	a)	**State Bernoulli's theorm and give its applications.**	04
		Answer: (theorem 02 marks, Applications – 02 marks) **Bernoulli's theorem-** This theorem states that 'whenever there is a continuous flow of liquid, the total energy at every section remains the same provided that there is no loss of addition of the energy. OR It states that ' in a steady, ideal flow of an incompressible fluid the total head at any point is constant. The total head consist of pressure head, velocity head and datum head. **Applications of Bernoulli's Theorem :** (Any two) Venturimeter, Orifice meter, Nozzle meter or Flow nozzle, Rotameter, Pitot Tube	**02** **02**
	b)	**What is priming and why it is necessary in centrifugal pump?**	**04**
		Answer: **Priming of Centrifugal pump:** It is the operation in which the suction pipe, casing of	

		the pump and the portion of delivery pipe up to delivery valve is completely filled with the liquid which is to be raised by pump. This operation is carried out only once before starting the pump thus air within these parts is removed. **Necessity:** The pressure developed by the impeller of the centrifugal pump is proportional to the density of fluid in the impeller. It is thus obvious that if the impeller is running in air, it will produce only negligible pressure which may not suck liquid from its source through the suction pipe. To avoid this priming is necessary. Priming reduces the risk of pump damage during start-up as it prevents the dry run. Pump runs smooth and delivers continuous discharge of flow. Priming reduces noise, vibrations in pump.	**02** **02**
	c)	**Give any four reasons for caviations.**	**4**
		Answer: (Any four reasons 4 marks) **Reasons of cavitation:** Cavitation in pumps is usually due to insufficient NPSH (Net Positive Suction Head) energy on the suction side of the pump. This can be caused by: • Having the pump at too high of a distance above the fluid source • Having too small of a diameter of suction pipe • Having too long of a distance of suction pipe • Having too many fittings on the suction pipe • Handling a liquid with a low vapour pressure • Running the pump too fast	**04 (any four points)**
	d)	**Draw a labeled diagram of swash plate type pump.**	**04**
		Answer:(neat sketch- 02 marks, Labelling-02 marks)  Figure: Swashplate Pump OR	**04**

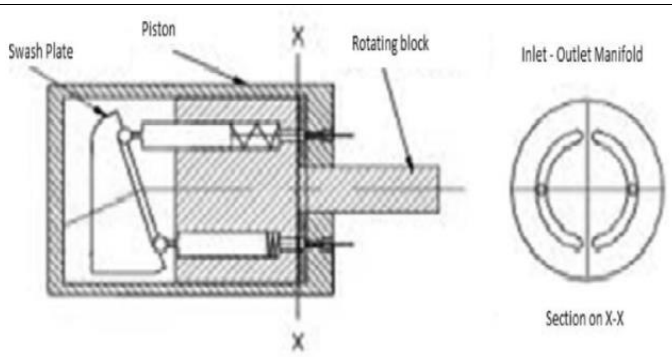


Figure: Swashplate Pump

	e)	**Describe with neat sketch working of hydraulic jack.**	**04**
		Answer:(working- 2 Marks; Sketch-2 Marks) **Working of Hydraulic jack:** The hydraulic jack works on Pascal's principle. Reciprocating pump is operated by moving handle up and down. During upward movement of piston (P1) oil from reservoir will be sucked in via valve (V1) due to vacuum created in cylinder During downward stroke of piston (P1) valve (V1) will close and valve (V2) will open and pressurized oil will enter into big cylinder via valve (V2).The pressurized oil will lift the piston (P2) upward and load will be lifted up.	**02**

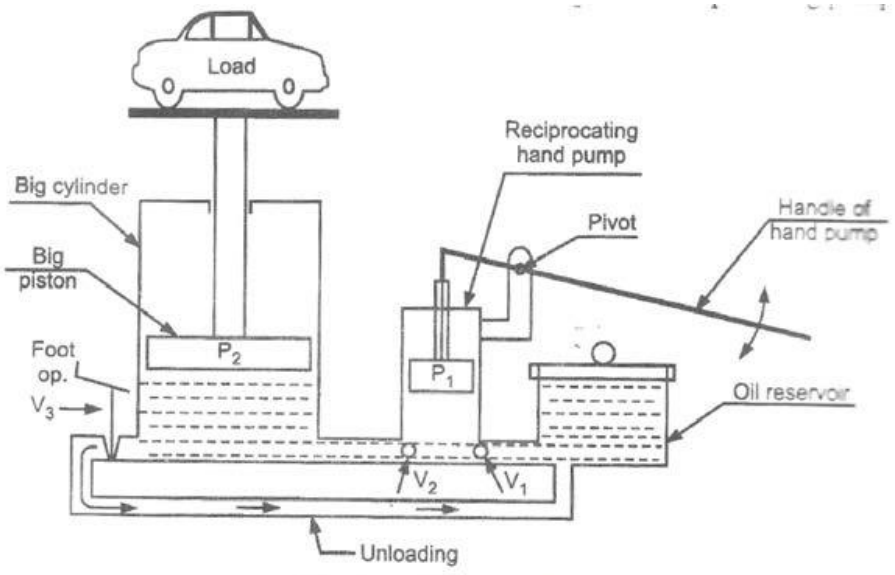


Figure: Hydraulic Jack

02

3		**Attempt any FOUR of the following:**	**16**
3.	**a)**	**Compare between Gear Pump and Vane pump on the basis of**	**04**
		Answer: Comparison between Gear Pump and Vane pump	**04** (One mark for each point)

Sr. No	On the basis of	Gear Pump	Vane Pump
1	Function	A gear pump carries fluid between the teeth of two meshing gears. one gear is driven by the drive shaft and turns an idler gear	A Vane Pump is a type of positive displacement pump. It uses the back and forth motion of the rectangular shaped Vanes inside slots to move fluids.
2	Construction	More robust type- internal external type, positive displacement type	Less robust type- balance/unbalance, fixed/variable displacement
3	Pressure	125 to 175 bar	Above 200 bar
4	Delivery of oil	Capacity and pressure ratings of a gear pumps are generally higher, but More leakage	Capacity and pressure ratings of a vane pump are generally lower than gear pumps, but reduced leakage gives an improved volu-metric efficiency of around 95%.

	b)	**Describe working of single acting hydraulic cylinder with neat sketch.**	**04**
	Ans.	**Answer: (Working- 2 Marks; Sketch-2 Marks)**	02

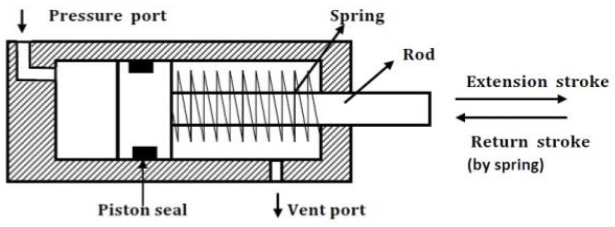
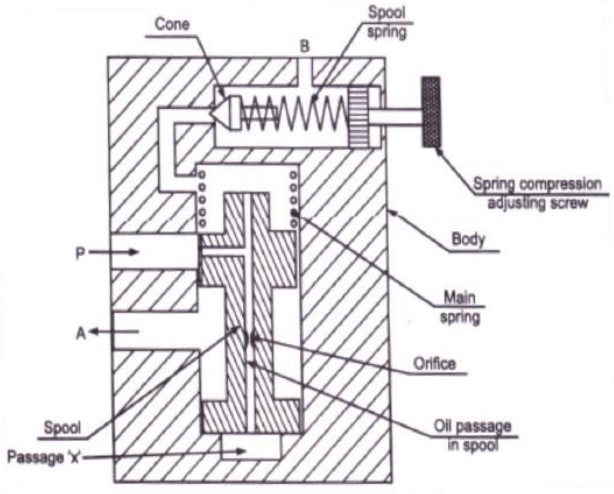
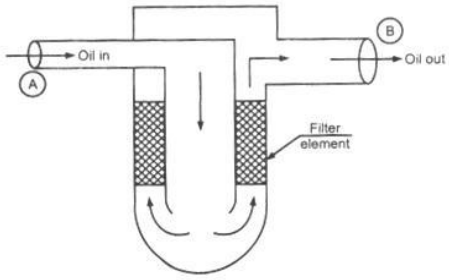
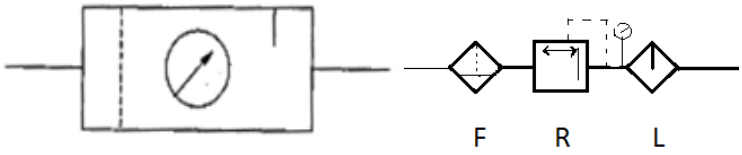
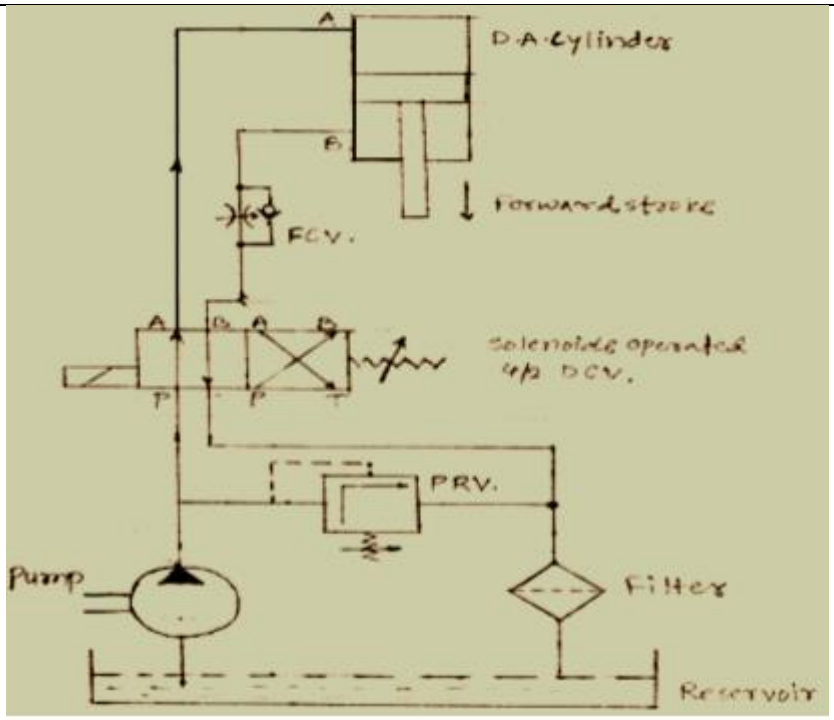
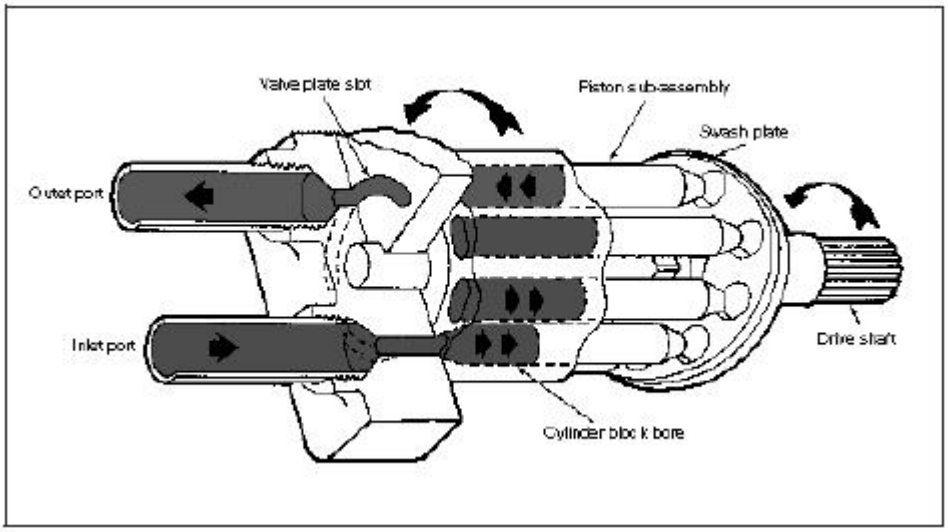


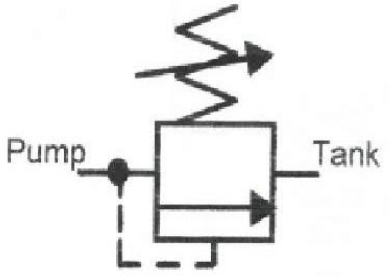
Fig. Single acting Cylinder

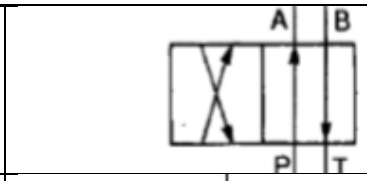
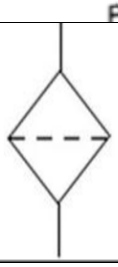
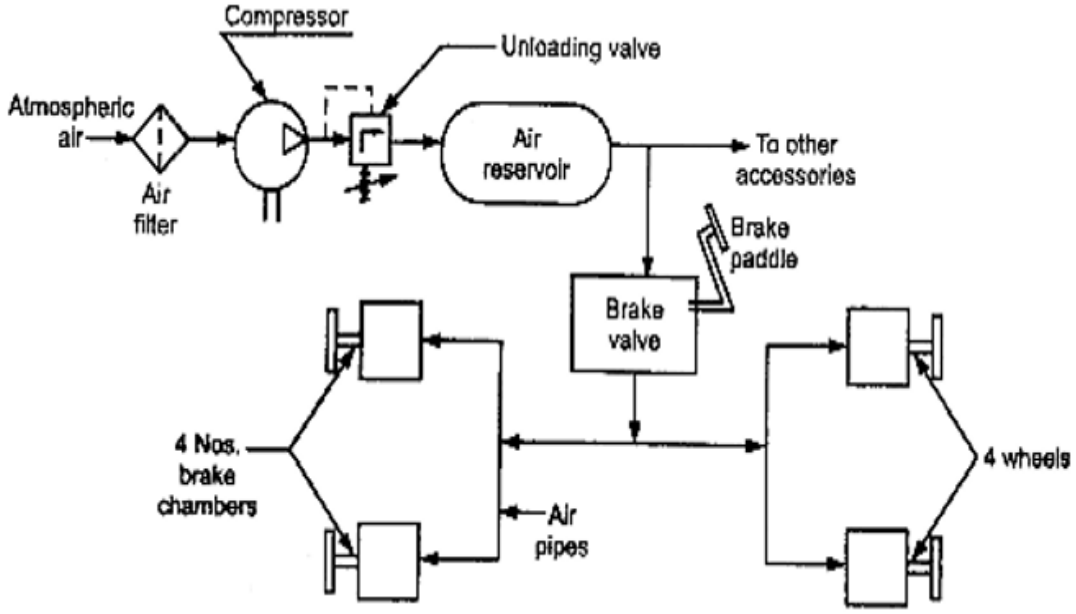
Single acting hydraulic cylinders: Single acting hydraulic cylinders are the simplest form of hydraulic cylinder which is used for pulling, lifting, moving and holding the load. Single acting hydraulic cylinder is displayed here in following figure. It consist of one port i.e. cap end port. Single acting cylinder will be operated hydraulically in one direction only. Single acting hydraulic cylinder will have one piston within a cylindrical 02

		housing. When hydraulic oil will be supplied to its cap end port, hydraulic pressure force will be applied over the piston or plunger and hence piston will be extended and this stroke of cylinder will be termed as forward stroke.	
	c)	**Draw labeled sketch of sequence valve and describe its working.**	**04**
	Ans.	**Answer: (Working- 2 Marks; Sketch-2 Marks)** **Working :** Sequence valve is nothing but pilot operated relief valve. It has a special spool having specially drilled oil passage with internal orifice drain is directed to main drain. In normal position sequence valve is closed when the operation of consumer 1 is completed pressure starts building and when reaches set value of pilot relief valve fluid flows through spool to drain/ tank. As the fluid flows through spool the orifice causes pressure difference between spring side and spool side. This pressure difference results in differential force which lifts the spool causing it to uncover the port' A' thus supplying fluid to another consumer 'A'  **Figure- Sequence Valve** ***(Note: Equivalent credit shall be given to other correct diagram and suitable explanation)***	**02** **02**
	d)	**Explain full flow hydraulic filter with neat sketch.**	**04**
	Ans.	**Answer: (Working- 2 Marks; Sketch-2 Marks)**  **Fig. Full flow hydraulic filter**	**02**

		Working of Full flow type filter: As shown in figure, in full flow filter oil comes in through port A, passes through filter element and goes out through port B. In this filter all flow passes through filter, hence it is called as a full flow filter. This is very efficient filter but only drawback of this filter is that there is large pressure drop. It increases due to clogging of filtering element.	**02**
	e)	**State functions of FRL unit and draw a symbol of it.**	**04**
	Ans.	**(Functions - 3 Marks; Sketch-1 Marks)** Function of FRL Unit: 1) Filter: a. To prevent entrance of solid contaminants to the system. b. To condensate and remove the water vapour that is present in the air. c. To arrest submicron particles that may pose a problem in the system components. 2) Regulator: To regulate the incoming pressure to the system so that the desired air pressure is capable of flowing at a steady condition. 3) Lubricator: To provide lubrication for mating components of valves, cylinders etc. by forming a mist of oil and air. **Symbol**  	**01** **01** **01** **01**
4	**(a)**	**Attempt any THREE of the following:**	**12**
	I	**Describe the working of hydraulic press with neat sketch.**	**04**
	Ans	**Answer:** (Working- 02 marks and neat sketch -02 marks) In this circuit, double acting cylinder is used. The flow control valve is connected in secondary line directly after load. In this operation, retraction stroke should be rapid one, but for achieving forward stroke it should be controlled. So that flow is metered after coming out from cylinder. For forward stroke port 'P' is connected to 'A' and after completion of stroke 'B' is connected to 'R', but in return line flow control valve with check valve is placed in parallel with throttle valve. So the flow is metered before going to reservoir. In this forward stroke is controlled stroke. for return stroke 'P' is connected to 'B' and flow is taken into cylinder directly opening spool of check valve without restriction of flow control valve ; hence return stroke is uncontrolled stroke.	**02**

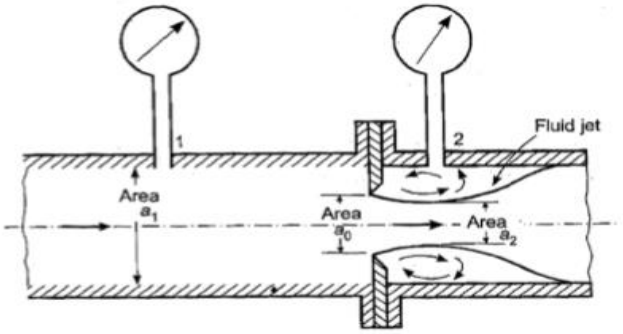
		 **Figure: Hydraulic Circuit for Hydraulic Press**	**02**
	ii	**Explain working of piston type hydraulic motor with neat sketch.**	**04**
	Ans	**Answer: (Working – 02marks, Sketch-02marks)**  **Fig. Piston type Hydraulic Motor** **Working:** Piston-type motors are available in a variety of different styles, including radial-, axial-, and other less common designs. Radial-piston motors feature pistons arranged perpendicularly to the crankshaft's axis. As the crankshaft rotates, the pistons are moved linearly by the fluid pressure. Axial-piston designs feature a number of pistons arranged in a circular pattern inside a housing (cylinder block, rotor, or barrel).	**02** **02**

		This housing rotates about its axis by a shaft that is aligned with the pumping pistons. Two designs of axial piston motors exist—swashplate and bent axis types. Swashplate designs feature the pistons and drive shaft in a parallel arrangement. In the bent axis version, the pistons are arranged at an angle to the main drive shaft. Although some piston type motors are controlled by directional-control valves, they are often used in combination with variable-displacement pumps. This pump-motor combination (hydraulic transmission) is used to provide a transfer of power between a driving element, such as an electric motor, and a driven element.	
	iii	**Explain flexible hose and state its two applications.**	**04**
	Ans	**Working: (Description 02 marks, Applications- 02 marks)** **Flexible hose-** A hose is a flexible hollow tube designed to carry fluids from one location to another. Hoses are also sometimes called pipes (the word pipe usually refers to a rigid tube, whereas a hose is usually a flexible one), or more generally tubing Other hose materials include PTFE (Teflon), stainless steel and other metals. A hose is a flexible hollow tube designed to carry fluids from one location to another. Hoses are also sometimes called pipes (the word pipe usually refers to a rigid tube, whereas a hose is usually a flexible one), or more generally tubing. The shape of a hose is usually cylindrical (having a circular cross section). Hose design is based on a combination of application and performance. Common factors are size, pressure rating, weight, length, straight hose or coilhose, and chemical compatibility. **Applications :(any four)** 1) Earthmoving equipments 2)Machine tools 3) Robotics 4) Material handling equipments 5) CNC/VMC machines 6) Hydraulic automobile brakes SAE 100 R series hoses should be used with petroleum- and water-based hydraulic fluids, within a temperature range from -40° to 100° C.	**02** **02**
	iv	**Draw the symbol for :(any two)** **1.** Pressure relief valve **2.** 4/2 directional control valve **3.** Filter	**04**
	Ans	**Answer: (Any Two symbols 04 marks)** Pressure relief valve — Symbol: 	

		4/2 directional control valve		02 Marks for each
		Filter		
4	(b)	**Attempt any ONE of the following:**		06
	i	**Draw a layout of air brake system and explain its working.**		06
	Ans	**Answer: (Working- 02 marks, Sketch- 02 marks)**  **Figure: Air Brake System** **Working:** Figure shows complete layout of Air Brake System. It consists of Air filter, unloading valve, Air compressor, Air reservoir, Brake valve and 4 numbers brake chamber. The compressor takes atmospheric air through air filter, and compresses the air. This air is stored under pressure in air reservoir. From this reservoir air goes to various accessories of vehicle which operates on compressed air. Part of air goes to brake valve. The control of brake valve is done by driver who controls the intensity of braking according to emergency.	03 03

	ii	**Compare hydraulic and pneumatic circuit.**	**06**
	Ans	Answer: Comparison between Hydraulic and Pneumatic Circuit: (Any six points)	**06**

Sr.no.	**Hydraulic circuit**	**Pneumatic circuit.**
1	Used for circuits up to 700 bar pressure	Operative below 10 bar pressure.
2	Uses hydraulic oil as a medium	Uses air as a medium
3	03 Pump is used to pressurize the oil	Compressor is used to pressurize the air
4	Since hydraulic oil is reused in the circuit hydraulic oil tank is a must and there are return lines	Air is taken from atmosphere and is vented to atmosphere after use. Hence no return lines. Air reservoir is used to store pressurized air.
5	The rigidity of the system using hydraulic circuit is good.	The rigidity of the system using hydraulic circuit is poor
6	Moderate operating cost.	Operating cost is low
7	Maintenance is critical.	Maintenance is simple.
8	Very suitable for accurate speed/feed movement of cutting tool mechanism.	No accuracy in movement.
9	The system using hydraulic circuit is not clean due to oil leakages.	Pneumatic circuits are very clean.
10	Weight to pressure ratio is small.	Weight to pressure ratio is high.
11	Problem of cavitation is serious in hydraulic circuit.	No problem of cavitation.
12	Oil is changed as per schedule.	No need of change of air as per schedule.
13	Hydraulic circuits are used in tackling heavy loads, hence used in earthmoving equipments, CNC-VMC machines.	Pneumatic circuits are used when loads are much lighter. Hence used in transferring the light weight components, vacuum handling in printing press, food industrys

5		**Attempt any TWO of the following:**	**16**
	A	**Derive an expression of discharge through orifice meter.**	**08**
	Ans	Answer: **Expression for discharge through orifice meter by applying Bernoulli's theorem:**  Figure: Orifice meter. Let, P_1 = Pressure at section 1 V_1= Velocity at section 1 a_1 = area of pipe at section 1 P_2, V_2, a_2 are corresponding values at section 2 Applying Bernoulli's equation at section 1 and 2 $\frac{P_1}{\rho g}+\frac{V_1^2}{2g}+z_1=\frac{P_2}{\rho g}+\frac{V_2^2}{2g}+Z_2$ $\left(\frac{P_1}{\rho g}+z_1\right)-\left(\frac{P_2}{\rho g}+z_2\right)=\frac{V_2^2}{2g}-\frac{V_1^2}{2g}$ But $\left(\frac{P_1}{\rho g}+Z_1\right)-\left(\frac{P_2}{\rho g}+z_2\right)=h=$ *differnential head* $h=\frac{V_2^2}{2g}-\frac{V_1^2}{2g}=\frac{V_2^2-V_1^2}{2g}$	**01** **01**

$2gh = V_2^2 - V_1^2$

$V_2^2 = 2gh + V_1^2$

$V_2 = \sqrt{2gh + V_1^2}$ .....(1) **01**

Since deriving above equation losses are not considered, this expression gives theoretical velocity of flow at section 2

To obtain actual velocity at section 2 of it is multiplied by a factor C_v called coefficient of velocity.

Thus, Actual velocity at section 2 **01**

$V_2 = C_v\sqrt{2gh + V_1^2}$ .....(2)

Discharge at section 1 & 2 is

$Q = a_1 v_1 = a_2 v_2$ .....(3) **01**

The area of jet a_2 i.e. at vena contracta may be related to the area of orifice a_0 by following expression

$a_2 = c_c . a_0$

C_c = Coefficient of contraction

Thus introducing value of a_2 in equation (3)

$a_1 v_1 = a_2 v_2$

$a_1 v_1 = c_c . a_0 v_2$

$v_1 = v_2 . c_c . \frac{a_0}{a_1}$

By substituting value of v_1 in equation (2)

$V_2 = C_v\sqrt{2gh + V_1^2}$ **01**

$V_2 = C_v\sqrt{2gh + \left[v_2 . c_c \frac{a_0}{a_1}\right]^2}$

$$V_2 = C_v\sqrt{2gh + \frac{v_2^2 . c_c^2 . a_0^2}{a_1^2}}$$

$$V_2^2 = C_v^2\left[2gh + v_2^2 . c_c^2 . \frac{a_0^2}{a_1^2}\right]$$

$$V_2^2 = C_v^2\left[2gh + \left(\frac{a_0}{a_1}\right)^2 . c_c^2 . v_2^2\right]$$

$$\frac{V_2^2}{C_v^2} - \left[\left(\frac{a_0}{a_1}\right)^2 . C_c^2 . V_2^2\right] = 2gh$$

$$V_2^2\left[\frac{1}{C_v^2} - \left(\frac{a_0}{a_1}\right)^2 . c_c^2\right] = 2gh$$

$$V_2^2 = \frac{2gh}{\left[\frac{1}{c_v^2} - \left(\frac{a_0}{a_1}\right)^2 . c_c^2\right]}$$

$$v_2^2 = \frac{2gh}{\frac{a_1^2 - a_0^2 . c_v^2 . c_c^2}{c_v^2 . a_1^2}}$$

$$v_2^2 = c_v^2 . \frac{2gh}{1 - c_v^2 . c_c^2\left[\frac{a_0}{a_1}\right]^2}$$

Now $Q = a_2 v_2$

$Q = c_c . a_0 v_2$

Put valve of a_2

And $c_c . c_v = c_d$

c_d = coefficient of discharge through orifice

$$Q = c_c . a_0 c_v \sqrt{\frac{2gh}{1 - c_v^2 . c_c^2 . \frac{a_0^2}{a_1^2}}}$$

$$Q = c_d . a_0 \sqrt{\frac{2gh}{1 - c_d^2 \frac{a_0^2}{a_1^2}}}$$

It is usual to simplify above expression, discharge through orifice meter by using coefficient

$$c = \frac{c_d . \sqrt{1 - \frac{a_0^2}{a_1^2}}}{\sqrt{1 - c_d^2 \left[\frac{a_0^2}{a_1^2}\right]}}$$

$$c_d = \frac{c . \sqrt{1 - c_d^2 . a_0^2 / a_1^2}}{\sqrt{1 - a_0^2 / a_1^2}}$$

$$\therefore Q = \frac{c . a_0 \sqrt{1 - c_d^2 . a_0^2 / a_1^2}}{\sqrt{1 - a_0^2 / a_1^2}} \sqrt{\frac{2gh}{1 - c_d^2 . a_0^2 / a_1^2}}$$

$$= \frac{c . a_0 . \sqrt{2gh}}{\sqrt{1 - (a_0^2 / a_1^2)}}$$

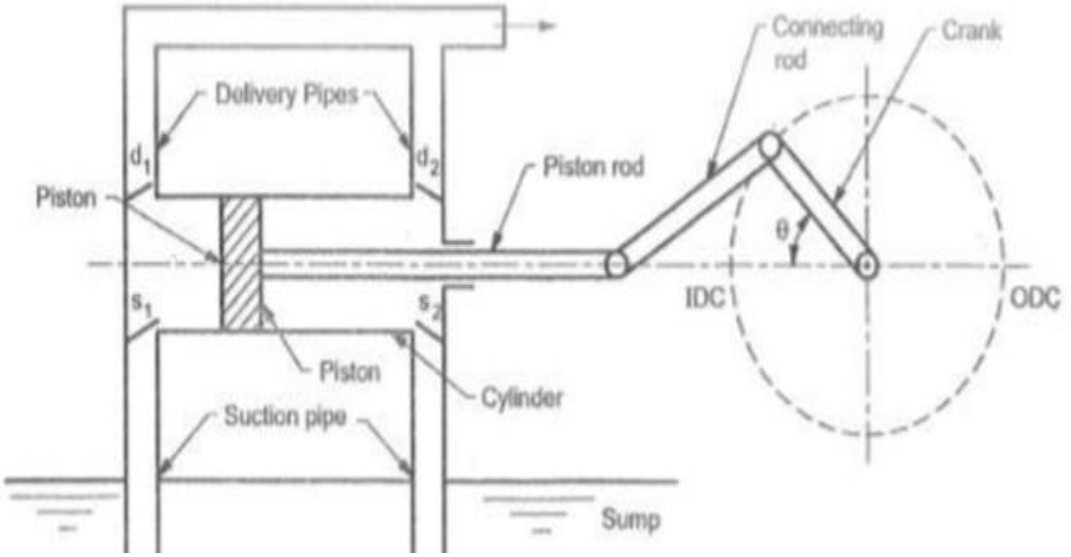
$$Q = \frac{c . a_0 . \sqrt{2gh}}{\sqrt{\frac{a_1^2 - a_0^2}{a_1^2}}}$$

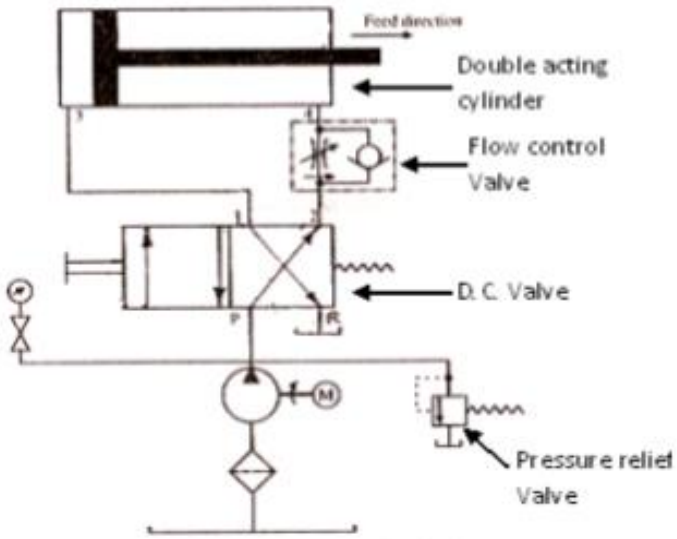
$$Q = \frac{c . a_0 . a_1 \sqrt{2gh}}{\sqrt{a_1^2 - a_0^2}}$$

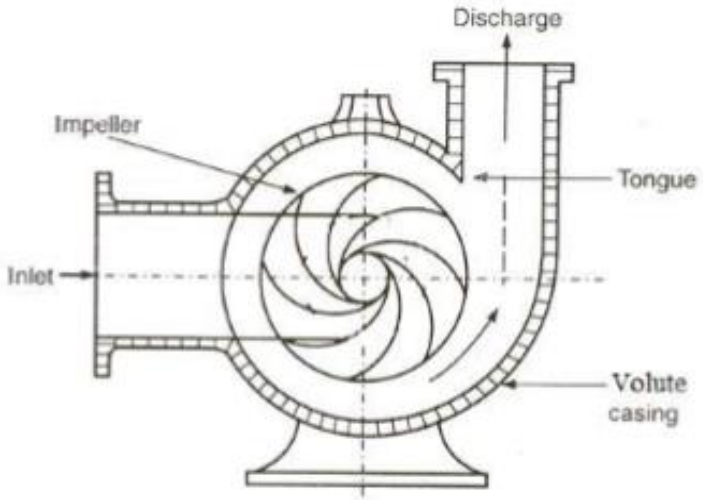
c = coefficient of discharge for and orifice meter

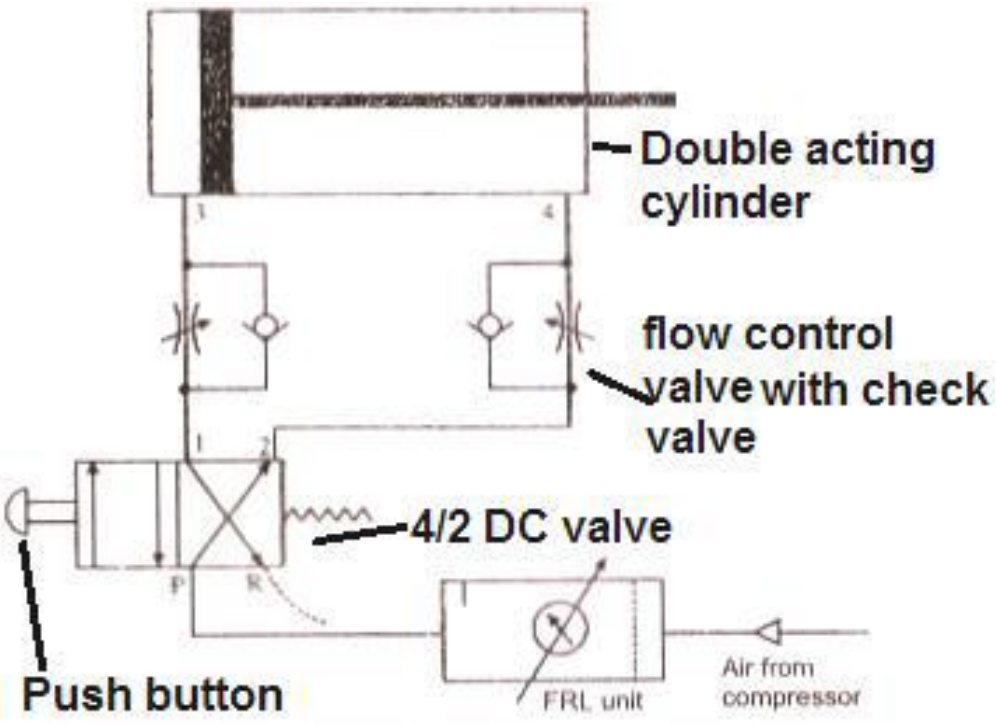
02

	b	**Explain construction and working of double acting reciprocating pump with neat sketch.**	**08**
	Ans	**Answer: (construction 3 marks; sketch 3 mark, working 2 marks)** **Construction:** Figure shows a double acting reciprocating pump, which consist of a piston which moves forwards and backwards in a close fitting cylinder. The movement	

		of the piston is obtained by connecting the piston rod to crank by means of connecting rod. The crank is rotated by means of an electric motor. Suction and delivery pipe with suction valve and delivery valve are connected to the cylinder .The suction and delivery valves are one way valves or non return valves, which allow the water flow in one direction only. Suction valve allows water from suction pipe to the cylinder which delivery valve allows water from cylinder to delivery pipe only.	**03**
			**03**
		Figure: Double acting reciprocating pump **Working:** This type of pump operates in exactly the same way as the single acting with respect to its action. The difference is, that the cylinder has inlet and outlet ports at each end of the cylinder. As the piston moves forward, liquid is being drawn into the cylinder at the back end while, at the front end, liquid is being discharged. When the piston direction is reversed, the sequence is reversed. With a double acting pump, the output pulsation is much less than the single acting.	**02**
	c	**Draw meter out circuit and explain its working.**	**08**
	Ans	**Answer: (Sketch – 04 marks, working – 04 marks)** Working- i) This is speed control circuit. ii) In this circuit speed control is achieved by controlling the flow coming out of cylinder. iii) Flow control valve is placed in between D.C. valve and piston rod end of cylinder**.** iv)Meter out circuit is generally used in Drilling, Boring, Reaming etc.	**04**

		 Meter-out speed control hydraulic circuit	04
6		**Attempt any TWO of the following.**	16
	a	**A 300 mm * 200 mm venturimeter is inserted in vertical pipe carrying water flowing in upward direction. A differential mercury manometer is connected to the inlet and throat of venturimeter gives a reading of 20cm. Find discharge, take Cd = 0.98**	08
	Ans.	Diameter at inlet, d_1 = 300 mm = 0.3 m ∴ area at inlet $a_1 = \frac{\pi}{4} X (d_1)^2 = \frac{\pi}{4} X (0.3)^2 =$ a_1 = 0.07068 m^2 Diameter at throat , d_2 = 200 mm = 0.2 m ∴ area at throat $\frac{\pi}{4} X (0.2)^2 =$ a_2 = 0.0314 m^2 Coefficient of discharge , Cd =0.98 Reading of the differential manometer, y = 20cm =0.20m Rate of flow, Q: Differential head, $h = y X (\frac{S_m}{S_w} - 1)$ $h = 0.2 X (\frac{13.6}{1} - 1)$ ∴ h = 2.52 m of water Discharge through Venturimeter is given by $Q = \frac{a_1 a_2}{\sqrt{(a_1)^2 - (a_2)^2}} X (\sqrt{2 X g X h})$	2 2 2

		$= \frac{0.07068 \text{ X} 0.0314}{\sqrt{(0.07068)^2 - (0.0314)^2}} \text{ X } (\sqrt{2 \, X \, 9.81 \, X \, 2.52})$ Q = 0.266 m^3/s……ANS	**2**
	b	**Explain construction and working of centrifugal pump with neat sketch.**	**08**
	Ans	**Answer: (2 Mark for construction, 3 mark for working 3mark for diagram)** **Construction of centrifugal pump:** Main parts of centrifugal pumps are: 1. Impeller. 2. Casing. 3. Suction pipe with foot valve and strainer. 4. Priming cup and delivery pipe with delivery valve. 5. Prime mover (Electric motor or engine) to drive the pump. **Working of centrifugal pump**: The first step in the operation of a centrifugal pump is priming so that no air pocket is left. After pump is primed, the electric motor is started to rotate the impeller. The rotation of impeller forces the water in radially outward direction in delivery pipe with high velocity. This high velocity water gets converted into high pressure when it passes through spiral casing. At the eye of the impeller due to centrifugal action partial vacuum is created. This causes liquid from the sump to rush through suction pipe to the eye as sump is at atmospheric pressure. This high pressure of liquid leaving the impeller is utilized in lifting the liquid to the required height through the delivery pipe.  **Fig. Centrifugal Pump**	**02** **03** **03**

	c	**Draw and explain pneumatic circuit to control the speed of double acting cylinder.**	**08**
		Answer: (Sketch – 04 marks , Description- 04 marks)  Pneumatic circuit of control speed of double acting cylinder **Pneumatic circuit to control the speed of double acting cylinder:** Speed control circuit is used to control the speed of pneumatic actuator; this is achieved by controlling air supplied to the actuators. The air flow to actuator is controlled either the supply line or drain line. In speed control of a cylinder, a flow control valve along with a check valve is normally used, but this combination provides speed control in one direction. In case of speed control in both direction of double acting cylinder, two sets of combination flow control and check valve are used. Speed in a extension and retraction can be changed independently. It should be noted that position of check valves permits free flow of air to the cylinder chambers and throttled flow of air from the chamber.	**04** **04**