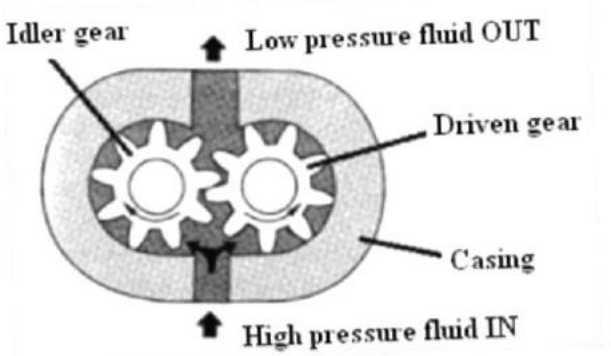
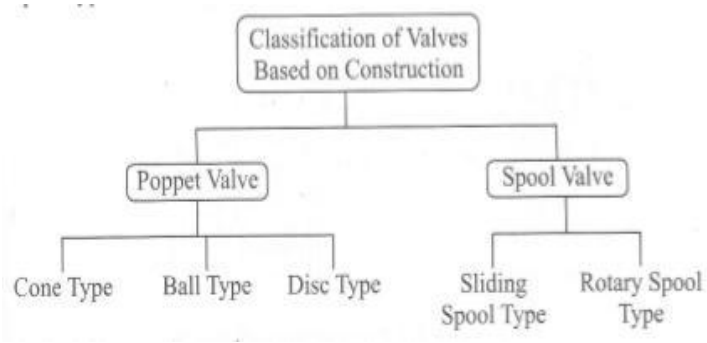
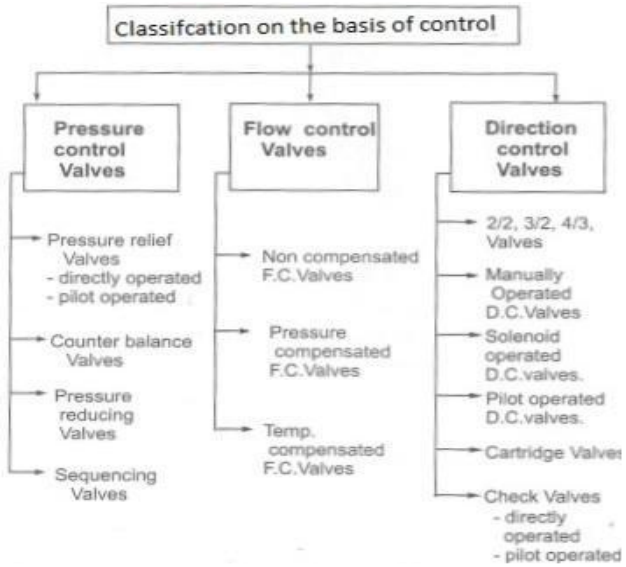
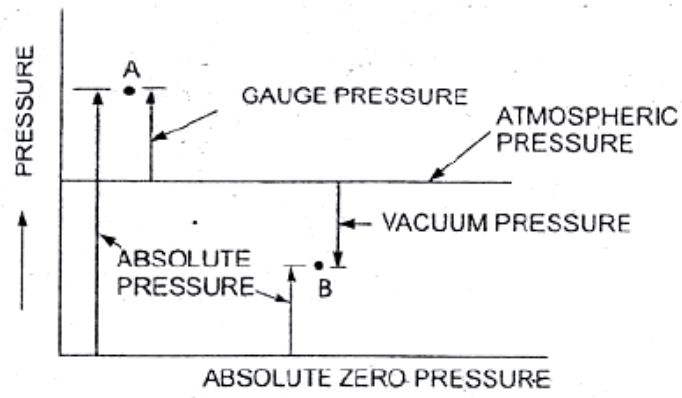
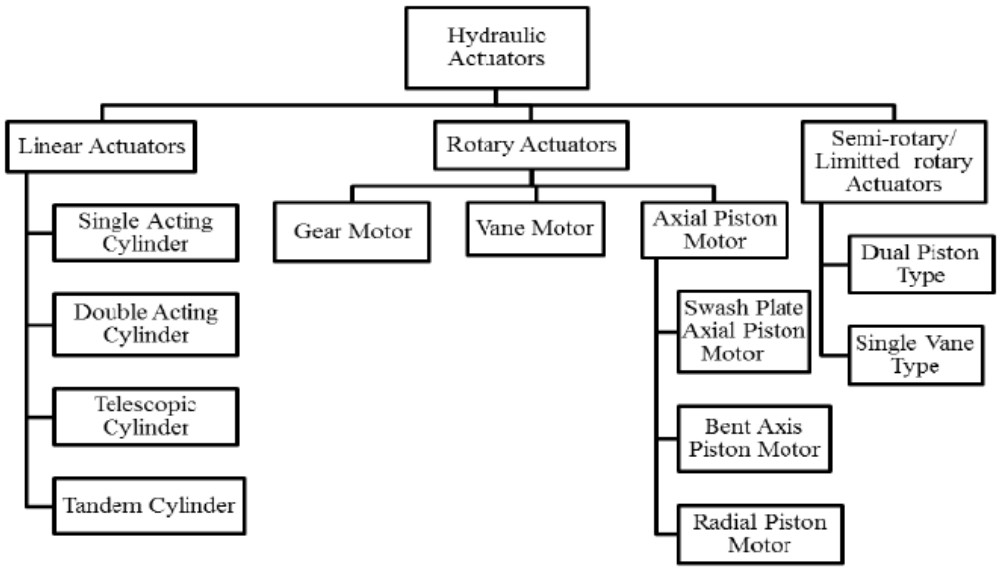
Important Instructions to examiners:

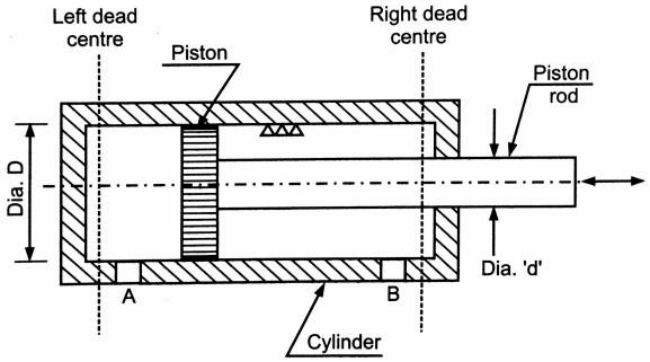
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling 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.**	
	(a)	Define Specific weight and viscosity. Also State their SI unit.	
		Answer: **(i) Specific weight:** Specific Weight of a fluid is the ratio between the weight of a fluid to its volume. Or weight per unit volume of a fluid is called specific weight. It is denoted by **'w'**. **S. I. unit is N/m^3** **(ii) 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 $N\text{-}s/m^2$ OR Poise**	**1** **1** **1** **1**
	(b)	Describe working of gear type hydraulic motor with neat sketch.	
		Answer: **Working of gear type hydraulic motor:** Gear type motor is a rotary actuator used to rotate the shaft. It consists of two gears in mesh with each other. One gear is connected to output shaft and other is idler. Both the gears are mounted in closed casing. Pressurized fluid enters from the bottom, and pressurizes the chamber. This pressure exerts a force on teethes These forces results in rotation of both gears. This rotary motion is further used in rotation of output shaft. Gear motors suffer from leakage, which is quiet high at low speeds. Hence gear motors are used where medium speed	**02**

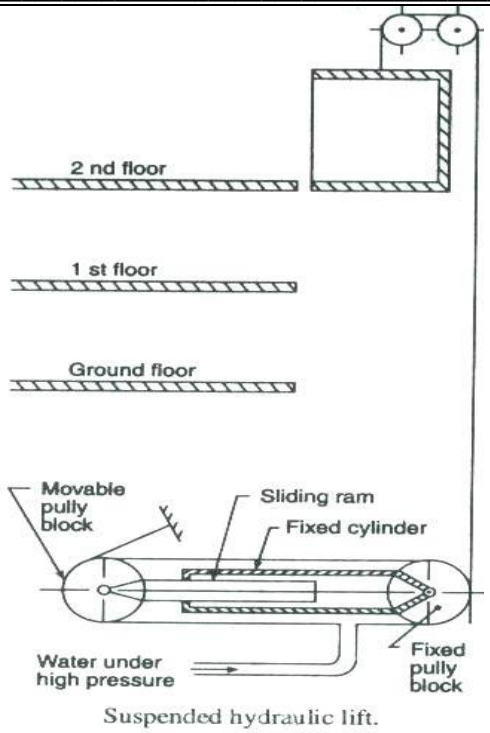
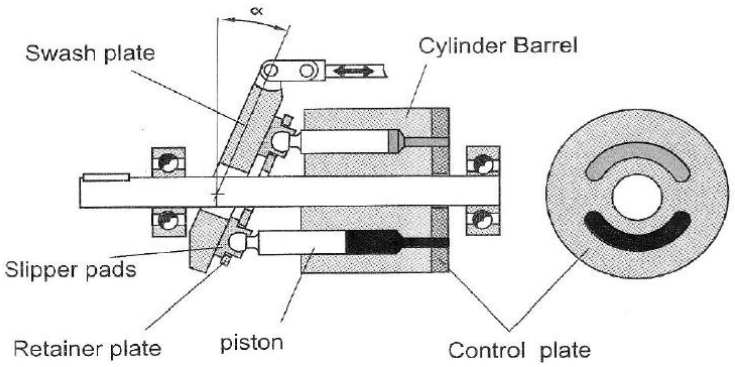
		and low torque are required.  Fig. Gear type hydraulic motor	02
	(c)	Write classification of control valves.	
		Answer: **Classification of control valves**   	02 02
	(e)	Describe the construction of hydraulic hose and state its materials.	

		Answer: **construction of hydraulic hose:** Hydraulic Hoses are manufactured in layers of elastomers & braided cloth or wire. Hoses are in 3 layers. **Layer A** This is inner tube through which oil or fluid flow. This layer comes in contact with pressurized hydraulic fluid directly. This layer is called Hose Material layer. **Layer B** This layer is called Hose reinforcement. This increases strength of inner layer. It provides structural strength to entire hose to withstand against hydraulic pressure of oil which is very high in hydraulic system. **Layer C** This is outer layer called as protective layer. It protect middle layer from corrosion, abrasion & other damages which can occur accidents. **Materials for hoses;** **Layer A :-** Plastic, Nylon, braided nylon, PVC, Teflon, synthetic elastomers, natural rubber. **Layer B:-** cotton, nylon, wires, synthetic yarn, Rayon. **Layer C:-** Neoprene, synthetic GRS rubber, cotton /synthetic yarn.	**02** **02**
1.	**(B)**	**Attempt any One of the following**	
	(a)	Represent schematically and explain Atmospheric Gauge, Vacuum and Absolute Pressure.	
		Answer:  Fig. Relation of pressure 1. **Atmospheric Pressure**: At the earth surface, the pressure due to the weight of air above the earth surface is called as atmospheric pressure. 2. **Gauge Pressure:** If the pressure is measured above the atmospheric pressure, it is called as gauge pressure. 3. **Vacuum Pressure:** If the pressure is measured below the atmospheric pressure, it is called as Vacuum pressure.	**02** **01** **01** **01**

		4. **Absolute pressure =** Atmospheric Pressure + Gauge Pressure **Absolute pressure =** Atmospheric Pressure – Vacuum Pressure	**01**
	(b)	Classify Hydraulic Actuators. Describe construction and working of double acting cylinder with neat sketch.	
		Answer: **Classification of Hydraulic actuators:**  **Construction and Working of Double acting Cylinder:** A double acting cylinder means the working fluid is fed on both the sides of the cylinder. Initially on one side and after completion of movement the working fluid is fed on the other side of the piston. It has cylindrical body with two inlet ports; the piston is having close tolerance with a cylinder bore and has piston seals in order to prevent the leakage of the fluid.When the working fluid enters through the port on the cover end it pushes the piston in the forward or extended position. When the working fluid enters through the port on the rod end side it pushes the piston in the reversed or retracted position. It is used when the force is to be applied in both the directions	02 02

		 Figure Double Acting Cylinder	02
2.		**Attempt any four of the following :**	
	a)	**Define all hydraulic coefficients.**	
		Answer: There are four hydraulic coefficients- **1. Coefficient of contraction (Cc):** It is the ratio of area of jet at vena contracta to the area of Orifice is known as Coefficient of contraction. **2. Coefficient of velocity(Cv):** It is the ratio of actual velocity of jet at vena contracta to the theoretical velocity of jet is known as Coefficient of velocity **3. Coefficient of discharge (Cd):** It is the ratio of actual discharge through an orifice to the theoretical discharge is known as Coefficient of discharge. **4. Coefficient of Resistance (Cr):** It is the ratio of loss of head in the orifice to the head of water available at the exit of orifice is known as Coefficient of resistance.	**01** **01** **01** **01**
	(b)	What is priming? Why it is necessary in centrifugal pump?	
		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)	What factors will you considered while selecting a centrifugal pump?	

		Answer: **Factors to be considered while selecting a centrifugal pump:** *(Any four)* **1. Speed of Pump:** When the specific speed is low and it is possible to increase the pump speed it is better to use multi stage pump. The number of stages is decided on the basis of the head and the type of the pump to be used. **2. Flow of pressurized Fluid:** From the values of discharge (Q), head (H) and speed (N), values of specific speed of the pump is calculated and subsequently the type of the pump can be decided. **3. Availability and Cost of Pump:** There is different variety of pumps available in market according to application we can choose it by economical aspect cost of the pump and its spare should be less. **4. Compatibility with working medium:** The meaning of compatibility is nothing but acceptance or familiar. Due to lack of proper working medium, pump will not give a good performance. **5. The type of impeller** : i) Impeller shrouded type - for pumping fresh clean water ii) Impeller un-shrouded or propeller type for pumping solid - liquid mixture or near plastic material iii) Mixed flow impellers with diffuser vanes used for deep well or submersible pumps. **6. Head available.**	04 Any Four 1 mark each
	(d)	Describe the working of suspended type hydraulic lift with neat sketch.	
		Answer: **Working of suspended hydraulic lift:** Hydraulic lift is a device which is used for carrying goods as well as persons from one floor to another in a multi-storied building. It consists of a cage which is suspended from a wire rope. The hydraulic lift obtains its motion from the jigger. The jigger consists of a fixed cylinder, having pulley block and containing a sliding ram. One end of ram is in contact with the water and the other carries a pulley block. A wire rope with one of its end fixed is taken around all the pulleys of the two blocks and finally over the guide pulleys. The cage is suspended from the other end of the rope. The load to be lifted is placed in a cage. The water under pressure is admitted into the cylinder of the jigger. This water forces the sliding ram to move towards the left. This outward movement of the sliding ram makes the pulley block to move outward. Due to increased distance between the two pulley blocks, the wire rope is pulled and the cage is lifted up.	**02**

		 Suspended hydraulic lift. Fig. Hydraulic Lift	02
	(e)	**Draw a labelled sketch of swash plate type pump.**	
		Answer: **Swash plate type pump:**  **OR**	**04**

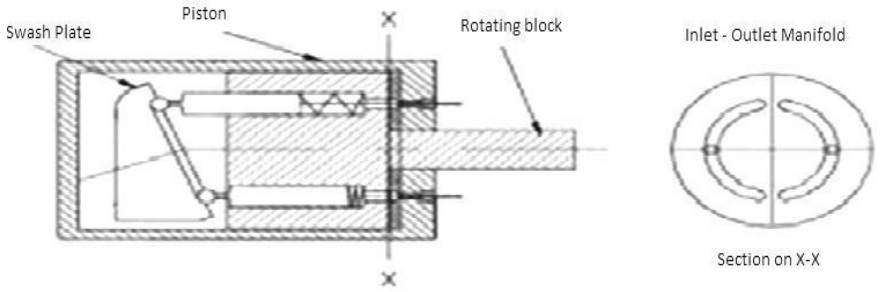


Fig. Swash plate type pump

3 **Attempt any FOUR of the following**

a) Compare Vane and gear pump on the basis of

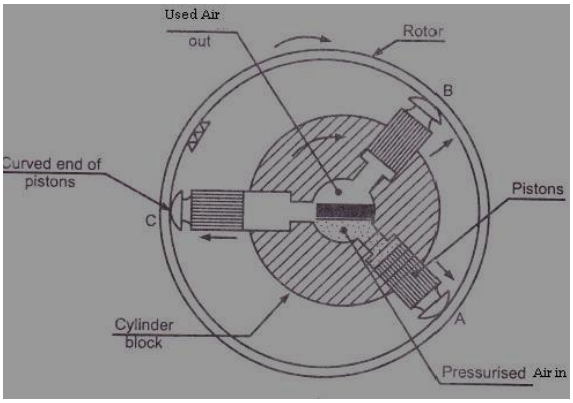
i)Construction ii) Pressure iii)speed iv)Application

Answer:

Sr. No.	On the basis of	Vane pump	Gear pump
1	Construction	Less robust type- balance/unbalance, fixed/variable displacement	More robust type- internal external type, positive displacement type
2	pressure	Above 200 bar	125 to 175 bar
3	Speed	Upto 25000 r.p.m.	200 – 300 r.p.m.
4	applications	In light air craft to drive gyroscopic flight instruments, Vacuum pump, as automatic transmission pumps in power steering, during the installation of air conditioner.	Oil pump, hydraulic pack, earthmover

04
One mark for each point

b) Draw a labeled sketch of radial piston type pneumatic motor. Describe its working

		Answer: **sketch of redial piston type pneumatic motor**  **Fig. Redial piston type pneumatic motor** **Working**: Here three pistons fitted in cylinder block. The curve ends of Pistons can rest on smooth surface of rotor. Cylinder block and rotor are rotating member of motor. If compressed air is introduced in cylinder under pressure, piston will pushed outward this principle is used in this motor, suppose compressed air is under pressure is admitted to cylinder No A piston will move outward in its cylinders. Now curved end of piston will slide inside the rotor with force and rotor will turn in clockwise direction Then the cylinder B will occupy the position of A since cylinder block also starts rotating and same cycle will starts which results in rotational motion of rotor.	02 02
	c)	Describe construction and working of sliding spool type 4/3 direction control valve.	
		Answer: **Construction:**- 4/3 D.C. valve is shown in the figure. There are four ports, A and B are consumer ports (ports going to actuator). P is pressure port through which pressurized oil goes in. R is return port through which used oil is return to oil reservoir. Valve is push button operated (manually) valve regains by spring expansion. There are total three positions which are represented by three square blocks. Out of which central one is closed position and other two are actuated positions.**(Note: any one figure should be considered)**	01

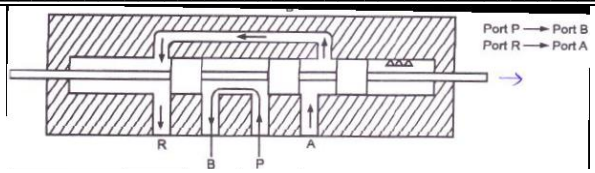


Figure: Sliding spool type 4/3 direction control valve

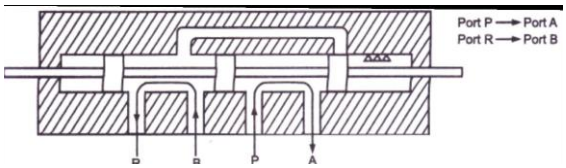


Figure: Sliding spool type 4/3 direction control valve

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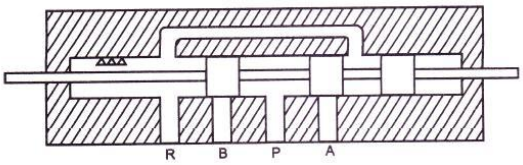
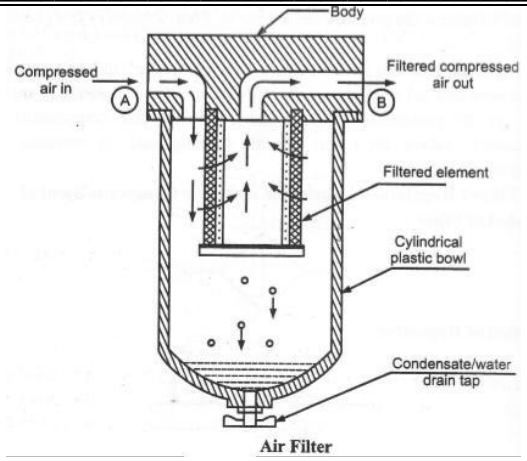
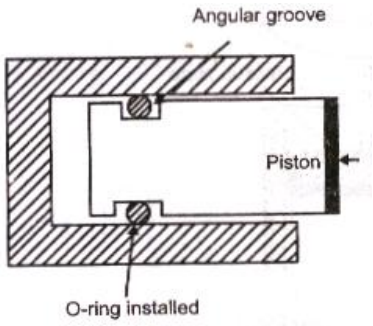


Figure: Sliding spool type 4/3 direction control valve

Working: When we have shifted the spool manually in such a manner that all ports are close to each other. No flow from port P to A or B and no flow from port A and B to R. When D.C. valve attains this position, pressurized oil returns to reservoir via pressure relief valve. While closed centre position is in active mode then flow will not takes place. When sliding spool moves towards right side then pressure port P connected to consumer port B and consumer port A connected to return port R. Similarly when sliding spool moves in a left hand side manually then pressure port P connected to consumer port A and consumer port B connected to return port R.

02

	d)	Describe mechanical type pneumatic filter with neat sketch	
		Answer: The compressed air which is unfiltered enters through the port A and comes into bowl. It has no alternative than to enter into the filtering element. The special zigzag passages created in filtering element, arrest the micron and sub micron particles and clean air go out through port B.	02

		 Figure Pneumatic filter	02
	e)	State different types of seals used in hydraulic circuit and explain 'O' ring with neat sketch.	
		Answer: The types of seals used in hydraulic circuits are 1) Static seals 2) Dynamic seals  Fig O ring **O-ring:-** It is moulded synthetic rubber seal that has round cross section in free state. It can be used for static as well as dynamic conditions. It gives effective sealing strength through a wide range of pressures, temperatures and movements. It provides sealing pressure in both directions as well low running friction on moving parts. It is installed in an annular groove formed into one of the mating parts. When the pressure is applied, the O-ring is forced against the third surface to create a positive seal. Hence it is capable of sealing against high pressures.	02 02
4	A)	Attempt any THREE of the following :	
	a)	Describe the working of hydraulic jack with neat sketch.state its application.	
		Answer: (Sketch 02Marks, working 01 Mark and applications 01 mark)	

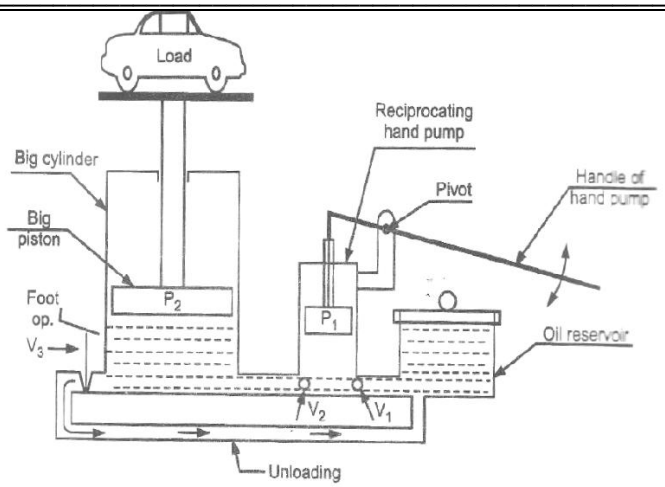


Figure Hydraulic Jack

02

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.

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Application:- 1)for lifting the vehicles for removing tyres

2)Hydraulic pallet for material handling

3) Stationary material lifting platform.

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b) Draw a labeled sketch of sequence valve and describe its working

Answer:

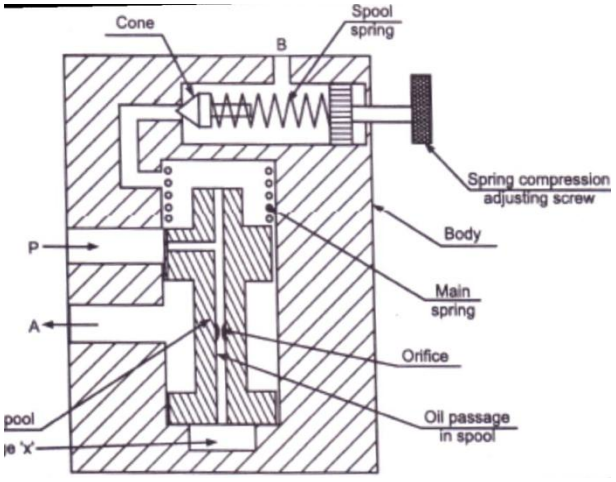


Figure sequence valve

02

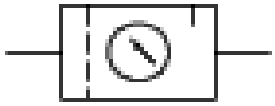
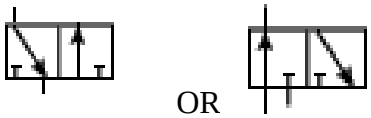
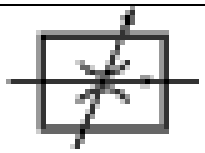
		Working:- Sequence valve is nothing but pilot operated relief valve. It has a special spool having specially drilled oil passage with internal orifice drain is directed to main drain. In normal position sequence valve is closed when the operation of consumer 1 is completed pressure starts building and 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'.	02
	c)	Differentiate between filters and strainers	
		Answer: Difference between filters and strainers. (Any 4 points-1 mark each)	04

Sr.N.	**Filters**	**Strainers**
1	Filters remove particulates that are smaller than 40 microns	Strainers remove particulates that are larger than40 microns.
2	If the particulate is too small to see with the naked eye the term "filter" is used.	Word "strainer" is typically used if the particulate being removed is visible to the naked eye
3	Filters have a screen that can be used once until it is clogged.	Strainer incorporates various screens which are reused.
4	If the screen is clogged, it must be changed. Filter screens are not re-used.	If the screen is clogged, it can be cleaned out and used again.
5	Filters are much more flow restrictive	Strainers are much less flow restrictive.
6	Filters are much better applied where positive pressure exists and where constant flow exists i.e. in return line	In most cases, strainers are connected in suction lines into a pump

	d)	Draw symbols of: i) Hydraulic pump ii)FRL unit	

iii) 3/2 directional control valve. iv)Variable flow control valve

Answer:

i)	Hydraulic pump	
ii)	FRL unit	
iii)	3/2 directional control valve.	 OR
iv)	Variable flow control valve	

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B) Attempt any ONE of the following:

a) Compare hydraulic and pneumatic circuit on the basis of

Operating pressure ,Ease of operation, noise ,speed, cost and application

Sr. no	On the basis of	Hydraulic circuit	pneumatic circuit
1	Operating pressure	Used for circuits up to 700 bar pressure	Operative below 10 bar pressure.
2	Ease of operation	Difficult to operate	Easy to operate
3	Noise	Low noise	Noisy operation
4	Speed	Speed is always limited.	very high speed is possible.
5	cost	Moderate operating cost. High maintenance	Low operating and maintenance cost.

One mark for each point

06

				cost. Overall cost is moderate to high.	Overall cost is low.	
		6	Application	Hydraulic circuits are used in tackling heavy loads, hence used in earthmoving equipment, 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 industry.	
	b)	Differentiate between meter In and meter Out hydraulic system				
		Answer: Difference between meter In and meter Out hydraulic system				One mark for each point 06

Sr. No.	Meter in circuit	Meter out circuit
1	Flow is metered before entering into cylinder.	Flow is metered after leaving the cylinder.
2	Flow control valve and check valve are placed in primary or pressure line.	Flow control valve and check valve are placed in return line.
3	Heated oil is taken into cylinder after throttling.	Heated oil is taken into reservoir after throttling.
4	Pump does not work against pressure.	Pump work against maximum pressure.
5	Piston is not stable.	Piston is stable.
6	Application- in Grinding ,Milling m/c.	Application- in Drilling and Reaming, Boring m/c.

5		**Attempt any TWO of the following**	
	A)	**State Bernoulli's theorem. Derive an expression for measurement of discharge through orifice meter.**	

Answer:

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. 01

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.

Expression for measurement of discharge through orifice meter

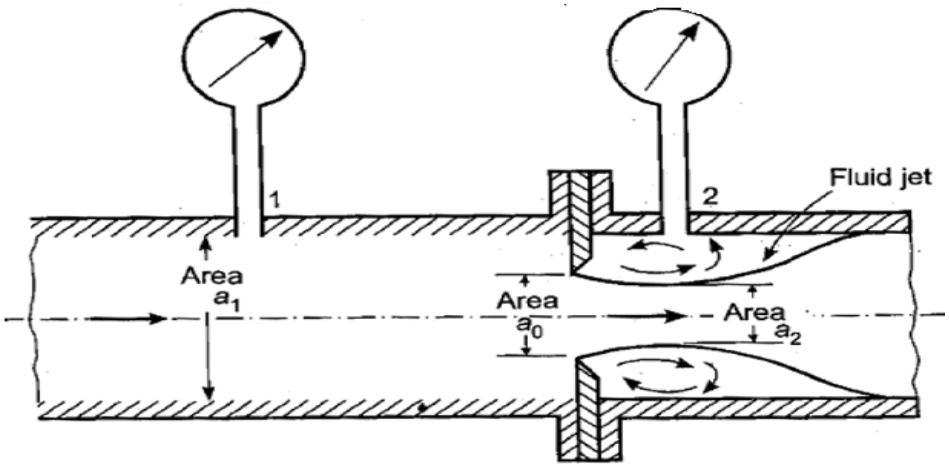

Figure. Orifice meter

Let,
P1 = Pressure at section 1
V1= Velocity at section 1
a1 = area of pipe at section 1
P_2, V_2, a_2 are corresponding values at section 2 01
Applying Bernoulli's equation at section 1 and 2

$$\frac{P_1}{\rho g}+\frac{V_1^2}{2g}+z_1=\frac{P_2}{\rho g}+\frac{V_2^2}{2g}+Z_2$$

$$\left(\frac{P_1}{\rho g}+z_1\right)-\left(\frac{P_2}{\rho g}+z_2\right)=\frac{V_2^2}{2g}-\frac{V_1^2}{2g}$$

$$\text{But } \left(\frac{P_1}{\rho g}+Z_1\right)-\left(\frac{P_2}{\rho g}+z_2\right)=h=\textit{differential head}$$

$$h=\frac{V_2^2}{2g}-\frac{V_1^2}{2g}=\frac{V_2^2-V_1^2}{2g}$$

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

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

$$V_2 = \sqrt{2gh + V_1^2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

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

01

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

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

Discharge at section 1 & 2 is

$$Q = a_1 v_1 = a_2 v_2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

The area of jet 2 a i.e. at vena contracta may be related to the area of orifice 0 a by following

Expression

Cc = 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)

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

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

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

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

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

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

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

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

01

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

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

01

Now $Q = a_2 v_2$

$Q = c_c.a_0 v_2$

Put vale of a_2

And $C_c.C_v = C_d$

C_d = coefficient of discharge through orifice

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

$$Q = c_d . a_0 \sqrt{\frac{2gh}{1 - c_d^2 \frac{a_0^2}{a_1^2}}}$$ 01

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

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

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

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

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

$$Q = \frac{c . a_0 . \sqrt{2gh}}{\sqrt{\frac{a_1^2 - a_0^2}{a_1^2}}}$$ 01

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

c = coefficient of discharge for and orifice meter.

Above equation gives expression for discharge through an orifice meter.

b) Compare reciprocating pump and centrifugal pump on the basis of :

Discharge, pressure, speed, weight of pump, floor area used, maintenance, cost, and applications.

Answer:

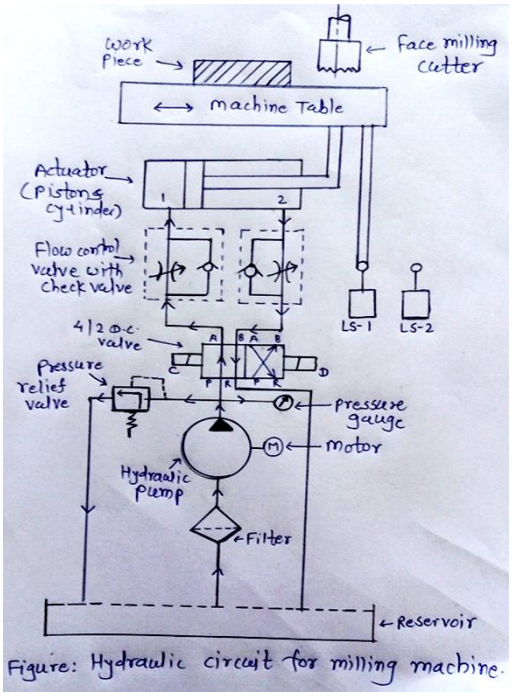
Comparison between reciprocating pump and centrifugal pump on the basis of

Sr. No.	Factor	Reciprocating pump	Centrifugal pump
1	Discharge	The discharge is fluctuating and pulsating.	The discharge is continuous and smooth.
2	Pressure	Applicable for high pressure	Applicable for low pressure
3	Speed	Low speed	High speed
4	Weight of pump	More than centrifugal pump	Less than reciprocating pump
5	Floor area used	More floor area required for installation	Less floor area required for installation
6	Maintenance	More	Less
7	Cost	More	Less
8	Applications	In service stations for washing vehicles	In sugar factories, oil, chemical factories milk dairies and domestics applications.

08

One Mark Each point

c) Construct the hydraulic circuit for milling machine and describe its working.

		Answer: (Figure 04 marks and Working 04 marks) **Working:** Figure shows the hydraulic circuit for operation of milling machine. When the spool of 4/2 D.C. valve is in left envelope mode, the oil from pump port 'P' enters the blank or head end of cylinder via line P-A-1 and acts on the piston so that machine table moves to the right. The oil from other side of piston is discharged into the reservoir via line 2-B-R. Limit switch 2 (LS-2) energizes the solenoid 'D' so that the spool of 4/2 D. C. valve shift in it's right envelope mode. The oil from pump port 'P' enters piston rod side of cylinder via line P-B-2 causing the table to to move towards the left. At the same time oil from blank or head end of cylinder is discharged into the reservoir via line 1-A-R. At the end of stroke limit switch 1 (LS-1) energizes the solenoid 'C' so that spool of D. C. valve get shifted in left envelope mode to perform forward stroke again and cycle is repeated**:**  Figure: Hydraulic circuit for milling machine.	04 04
6		**Attempt any TWO of the following**	
	a)	A horizontal venturimeter 150 mm X 75 mm is used to measure flow rate of water. Determine the deflection of mercury in water mercury gauge if the flow rate is 35 litres per second. Take $C_d = 0.96$	

Answer: Given-

Inlet diameter = d_1= 150 mm =0.150 m

Throat diameter = d_2= 75 mm = 0.075 m

Qact = 35 litres per second =35×10^{-3} = 0.035 m^3/s

$C_d = 0.96$ $S_h = 13.6$ $S_o = 1$ — 01

$a_1 = \frac{\pi}{4}d_1^2 = \frac{\pi}{4}(0.150)^2 = 0.01767\ m^2$

$a_2 = \frac{\pi}{4}d_2^2 = \frac{\pi}{4}(0.075)^2 = 4.417x10^{-3}\ m^2$ — 01

As

$C_d = \frac{Q_{act}}{Q_{th}}$

$Q_{act} = C_d \times Q_{th}$

$Q_{act} = C_d \times \frac{a_1 a_2}{\sqrt{(a_1^2 - a_2^2)}} \times \sqrt{2gh}$ — 02

$0.035 = 0.96 \times \frac{0.01767 \times 4.417x10^{-3}}{\sqrt{(0.01767)^2 - (4.417x10^{-3})^2}} \times \sqrt{2 \times 9.81 \times h}$

$1.86 = \sqrt{h}$ — 02

Squaring both sides,

h = 3.46 m

$h = \left[\frac{s_h}{s_o} - 1\right] x$ — 02

$3.46 = \left[\frac{13.6}{1} - 1\right] x$

x = 0.2746 m

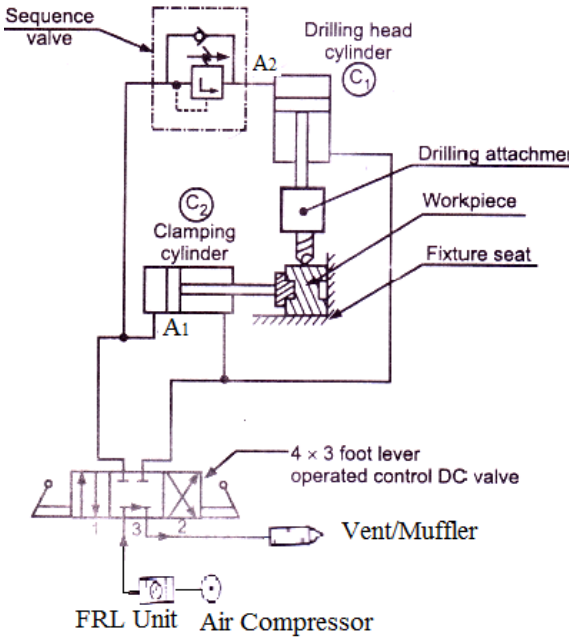
b) i) State the functions of Air vessels.

Answer:

Functions (Any four)

1. To get more uniform discharge and continuous supply through delivery pipe — 04

		of reciprocating pump. 2. To save a considerable amount of work in overcoming the frictional resistance in suction and delivery pipe. 3. To reduce the separation. 4. To run the pump at high speed. 5. As velocity is constant the head loss in friction in the pipe also reduces. 6. Length of suction pipe can be increased. 7. It saves large amount of power which is consumed in supplying accelerating head. 8. It also acts as temporary reservoir of liquid or water.	One Mark Each
		ii) What is cavitation? Give reasons of cavitations in reciprocating pump.	
		Answer: **Cavitation** It means formation of vapour bubbles of a flowing liquid in a region where the pressure of the liquid falls below its vapour pressure and sudden collapsing of these vapour bubbles in a region of higher pressure. When the vapour bubbles collapse, a very high pressure is created. The metallic surfaces, above which these vapour bubbles collapse is subjected to high pressure which causes pitting action on surfaces. Thus cavities are formed on metallic surface, known as cavitation. Also considerable noise and vibrations are produced. **Reasons of cavitation in reciprocating pump: (any Four points)** 1. Having the pump at too high of a distance above the fluid source 2. Having too small of a diameter of suction pipe 3. Having too long of a distance of suction pipe 4. Having too many fittings on the suction pipe 5. Handling a liquid with a low vapour pressure 6. Running the pump too fast	02 02
	c)	Construct the pneumatic circuit using sequence valve to control two operations performed in a proper sequence and describe its working.	
		(Figure- 04 marks, Working- 04 marks Credit should be given to equivalent circuit) **Pressure dependent sequencing circuit:** The circuit is used for drilling a hole in work piece. The sequence of operation is a) Clamping of work piece b) Drilling c) Decamping and drill taken out from hole. The DC valve takes centre position (no 3.) no compressed air supplied to either of cylinder C_1 or C_2. Now undrilled work piece is kept on fixture seat. The compressed air from compressor is going to vent via DC valve so no movement of cylinder C_1 or C_2. Now compressed air start supplying directly to C_2 and through sequence valve to	04

		C_1 When compressed oil enters through port A_2 of cylinder C_2 piston will advance and immediately clamps the work piece. At the same time compressed air flow towards port A_1 of cylinder C_1 but through the sequence valve. Some higher presser is set at pressure relief valve of sequence valve when the pressure of flowing air reaches this set value the sequence valve opens and air enters through port A_1 into cylinder C_1 due to this piston advances comes down so that drilling starts. When operator again operate foot lever of DC valve it takes position 2 and both piston retracts and work piece de-clamps and drill comes out of drilled hole  Figure: Pneumatic Circuit Using sequence valve	04