



WINTER- 14 EXAMINATION
Model Answer

Subject Code: 17522

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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 judgment 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.

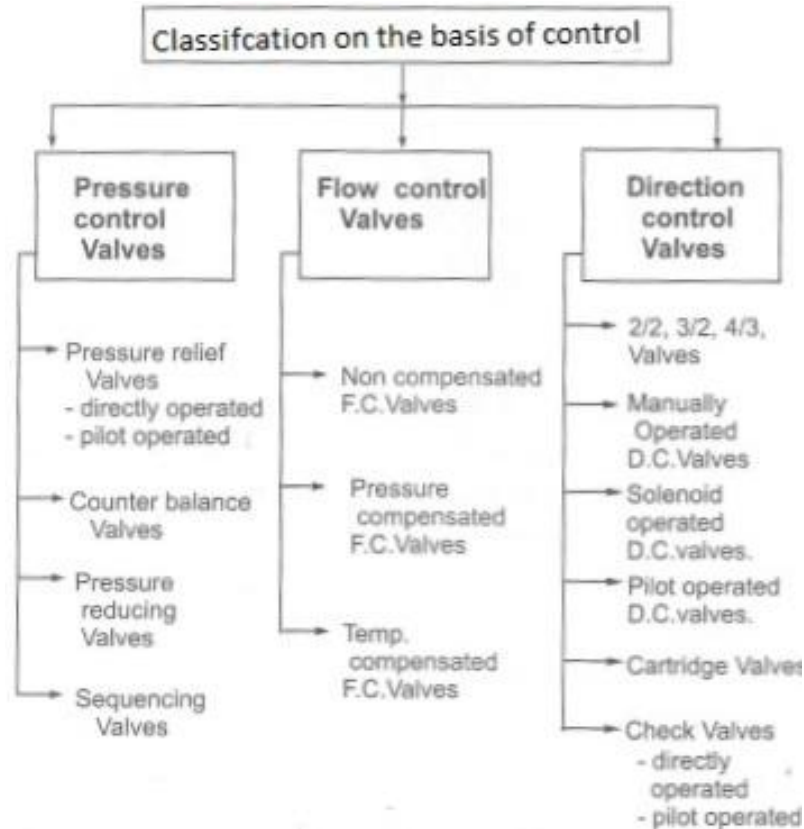
1. A) Attempt any three of the following	12
a) Define the following terms and state their S. I unit. i) Specific weight ii) viscosity	04
Answer: i) Specific weight: Specific Weight of a fluid is the ratio between the weight of a fluid to its volume. Or weight per unit volume of a fluid is called specific weight. It is denoted by 'w'. S. I. unit is N/m ³	02
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-s/m ²	02
b) Write classification of control valves.	04
Answer: Classification of control valves <pre>graph TD A[Classification of Valves Based on Construction] --> B[Poppet Valve] A --> C[Spool Valve] B --> D[Cone Type] B --> E[Ball Type] B --> F[Disc Type] C --> G[Sliding Spool Type] C --> H[Rotary Spool Type]</pre>	02

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02

c) Explain construction and working of sliding spool type 4/3 direction control valve.

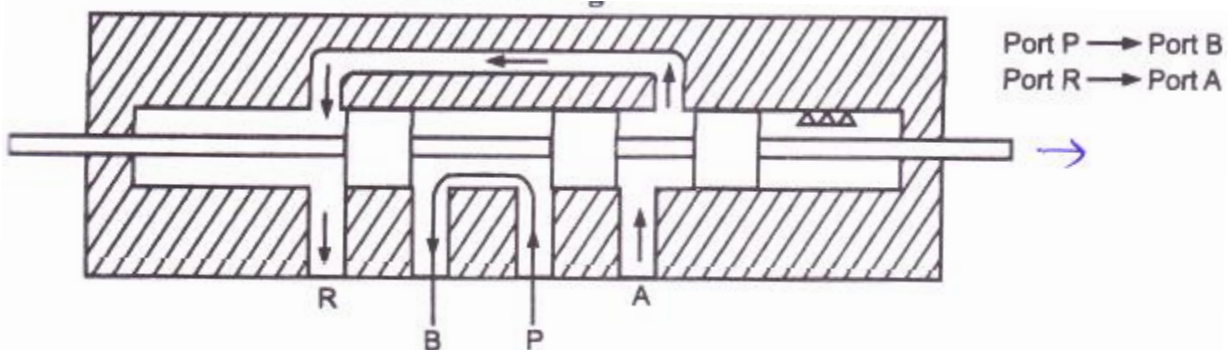
04

Answer: **Construction and working of sliding spool type 4/3 direction control valve:**

(Note: any one figure should be considered)

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.

01



01

Figure: Sliding spool type 4/3 direction control valve

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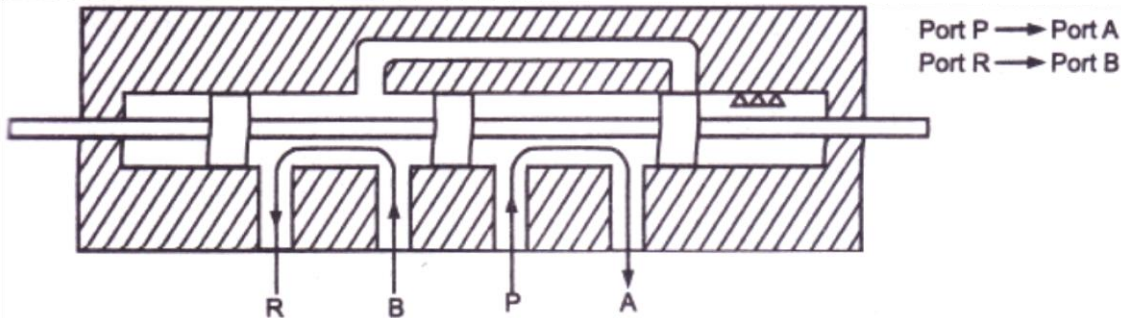


Figure: Sliding spool type 4/3 direction control valve

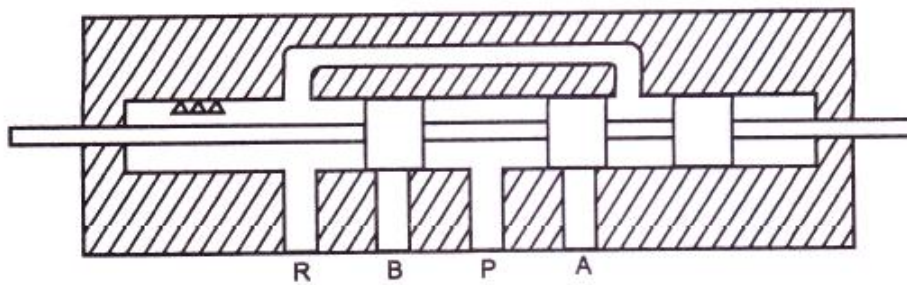


Figure: Sliding spool type 4/3 direction control valve

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 take 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) State the function of flexible hose and gaskets.

04

Answer: **Function of flexible hose:** (any 02)

- 1) To transfer energy generating liquid.
- 2) It can allow torque, flexibility and elasticity in tool arm movement.
- 3) They should flow machine geometry as much as possible
- 4) To reduce a rigidity
- 5) It can place any were in complicated region very easily where for rigid tubes, pipes are not possible.
- 6) To sustain internal high pressure of hydraulic oil.

02

Function of gaskets: (any 02)

1. To create and retain static seal between two relatively stationary parts
2. To protect the working condition or environment from contamination
3. It fills irregularities in the matching surface.
4. To resist extrusion and creep under operating condition.
5. To avoid the leakage

02



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B) Attempt any one of the following	6
a) Define all hydraulic coefficients. Derive relation between the hydraulic coefficients.	06
Answer: There are four hydraulic coefficients- <ol style="list-style-type: none">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.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 velocityCoefficient of discharge (Cd): It is the ratio of actual discharge through an orifice to the theoretical discharge is known as Coefficient of discharge.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. Relation among Cd, Cc and Cv: We know, $C_d = \frac{\text{Actual Discharge}}{\text{Theoretical Discharge}}$ But by continuity equation, Discharge , Q = Area × Velocity Hence, $C_d = \frac{\text{Actual Area} \times \text{Actual Velocity}}{\text{Theoretical Area} \times \text{Theoretical Velocity}}$ Therefore, $C_d = C_c \times C_v$	04
b) State the types of hydraulic actuators. Describe construction and working of single acting cylinder with neat sketch.	06
Answer: Types of hydraulic actuators/cylinders: <ol style="list-style-type: none">Single-acting cylinders.Double-acting cylinders.Telescopic cylinders.Tandem cylinders. Construction and working of single acting cylinder: A single-acting cylinder is simplest in design and is shown schematically in figure. It consists of a piston inside a cylindrical housing called barrel. On one end of the piston there is a rod, which can reciprocate. At the opposite end, there is a port for the entrance and exit of oil. Single-acting cylinders produce force in one direction by hydraulic pressure acting on the piston. (Single-acting cylinders can exert a force in the extending direction only.) The return of the piston is not done hydraulically. In single-acting cylinders, retraction is done either by gravity or by a spring.	02

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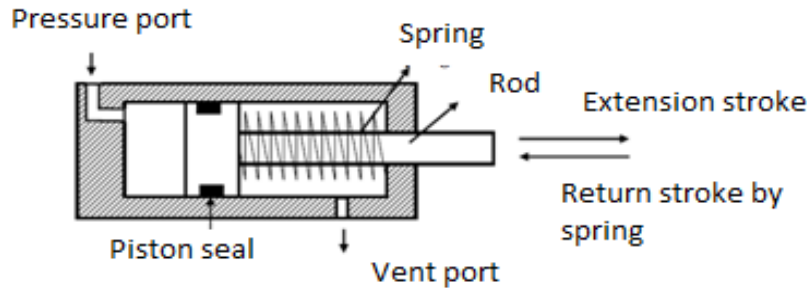


Figure: Single acting cylinder

02

2. Attempt any four of the following

16

a) Define laminar and turbulent fluid flow. State one example of each.

04

Answer:

Laminar flow:

The flow in which each liquid particle has definite path and the path of individual particles do not cross each other is called as stream line flow.

1

Example: (Any one) Flow of river having large banks, flow of tap water, flow of water through channel, flow of thick oil through tube.

1

Turbulent flow:

Flow in which each liquid particle does not have a definite path, and the paths of individual particles also cross each other is called turbulent flow.

1

Example: (Any one) Flow of river during flood, flow of water after opening valve.

1

(Note: Any suitable examples may be considered.)

b) What factors will you consider while selecting a centrifugal pump?

04

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.

04

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.

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b) State the possible causes and remedies for following faults in centrifugal pumps.

- i) Failure to deliver water
- ii) Produces noise

04

Answer:

i) Failure to deliver water (any 02)

Sr. No.	Possible causes	Remedies
1.	Loose connections of casings, impellers	Make proper connections
2.	Cavitations	Check suction pressure
3.	Excessive wearing of bearings.	Check the condition of bearing if necessary replace it.

02

ii) Produces noise (any 02)

Sr. No.	Possible causes	Remedies
1	No water in casing, suction pipe.	Priming may be done.
2	High delivery head than capacity of pump.	Lower the delivery head
3	Pump may be running at lower speed	Check the motor speed and adjust it
4	Foot valve, strainer may be clogged	Check foot valve and strainer remove clogging
5	Impeller may be running in a wrong direction.	Check the direction of rotation of impeller and make it proper.

02

d) Draw a labeled diagram of swash plate pump.

04

Answer: (02 marks for sketch & 02 marks for labeling)

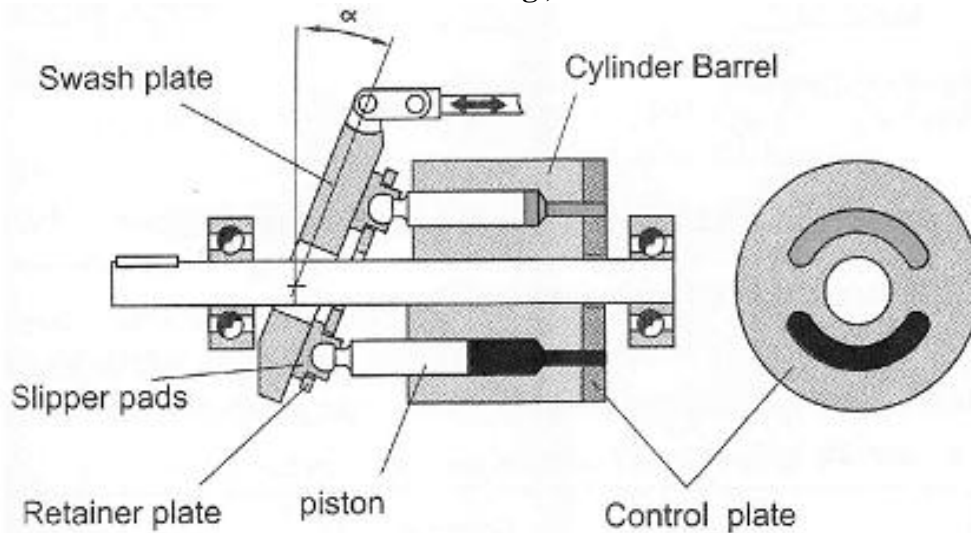


Figure: Swashplate Pump

04

OR

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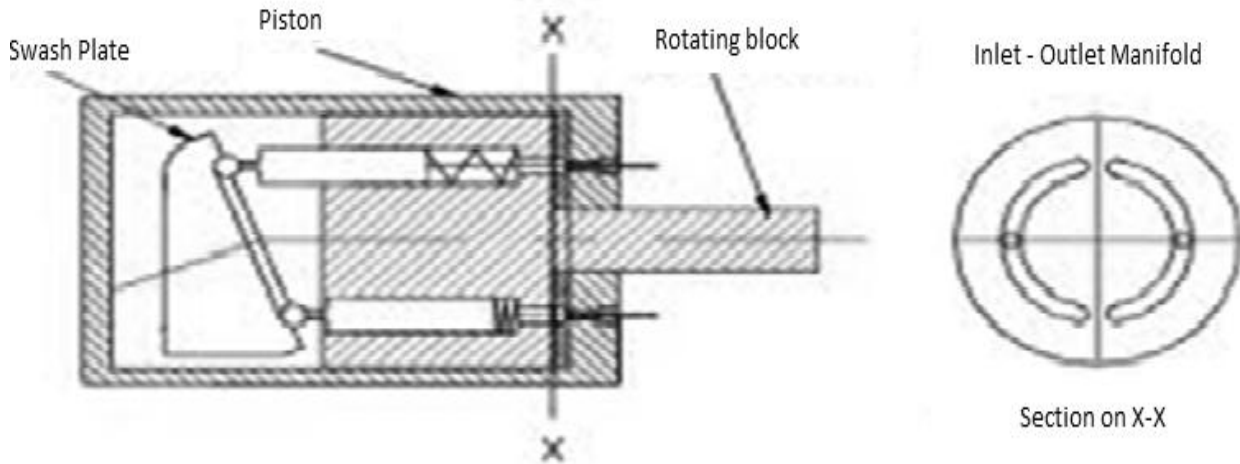


Figure: Swashplate Pump

04

e) Describe with neat sketch working of hydraulic ram.

04

Answer: **Working of hydraulic ram:**

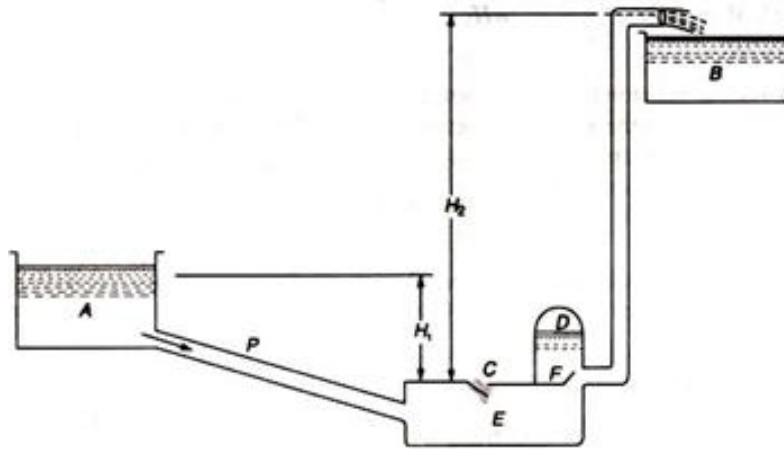


Figure: Hydraulic Ram

02

Working: It is a type of pump which can lift a small quantity of water to a greater height when large quantity of water is available at smaller height. The working of hydraulic ram is based on the principle of water Hammer or inertia pressure developed in a supply pipe. It consists of large reservoir A at smaller height, chamber E consists of waste valve C and delivery valve F.

02

When water starts flowing from tank A to chamber E through supply pipe P, it starts flowing through waste valve C as it is open. As the speed of water increases, the pressure on the valve lid increases thereby closing the waste valve. This sudden closing of waste valve brings the water in supply pipe to rest, causing further increase of pressure in valve chamber due to development of inertia pressure.

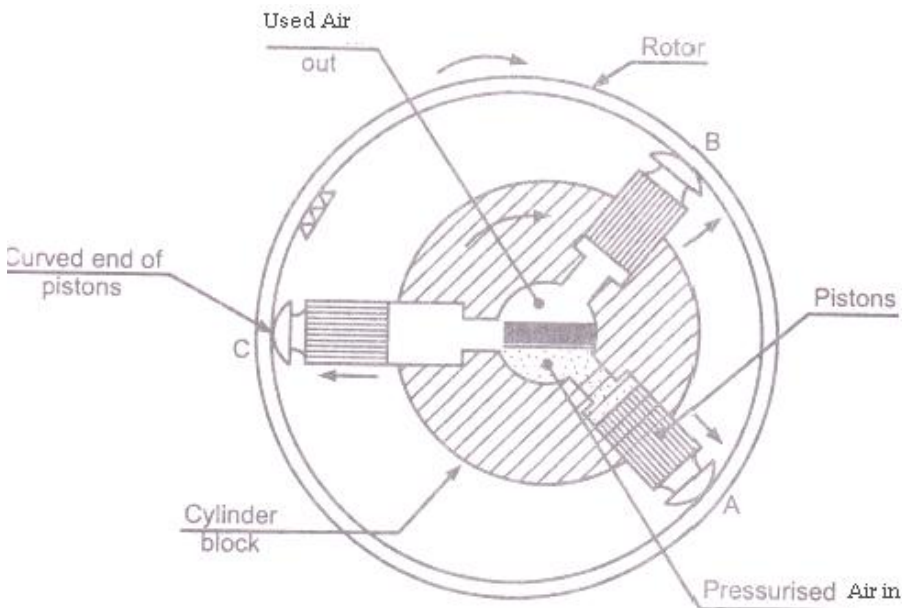
Due to this increase of pressure in the valve chamber the delivery valve is forced to open. The water starts flowing in air vessel and delivery pipe which supply to delivery tank. When the momentum of water in the chamber is destroyed, the waste valve is opened again causing flow of water from tank A to recommence.

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3. Attempt any four of the following :	16																				
iii) Compare gear pump and vane pump on the basis of: i) Construction ii) pressure iii) speed iv) applications	04																				
Answer: Comparison of gear pump and vane pump:	04																				
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%;">Sr. No.</th> <th style="width: 20%;">On the basis of</th> <th style="width: 35%;">Gear pump</th> <th style="width: 35%;">Vane pump</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">1</td> <td>Construction</td> <td>More robust type- internal external type, positive displacement type</td> <td>Less robust type- balance/unbalance, fixed/variable displacement</td> </tr> <tr> <td style="text-align: center;">2</td> <td>pressure</td> <td>125 to 175 bar</td> <td>Above 200 bar</td> </tr> <tr> <td style="text-align: center;">3</td> <td>speed</td> <td>200 – 300 r.p.m.</td> <td>Upto 25000 r.p.m.</td> </tr> <tr> <td style="text-align: center;">4</td> <td>applications</td> <td>Oil pump, hydraulic pack, earthmover</td> <td>In light air craft to drive gyroscopic flight instruments, Vacuum pump, as automatic transmission pumps in power steering, during the installation of air conditioner.</td> </tr> </tbody> </table>	Sr. No.	On the basis of	Gear pump	Vane pump	1	Construction	More robust type- internal external type, positive displacement type	Less robust type- balance/unbalance, fixed/variable displacement	2	pressure	125 to 175 bar	Above 200 bar	3	speed	200 – 300 r.p.m.	Upto 25000 r.p.m.	4	applications	Oil pump, hydraulic pack, earthmover	In light air craft to drive gyroscopic flight instruments, Vacuum pump, as automatic transmission pumps in power steering, during the installation of air conditioner.	04
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b) Write the construction and working of piston type air motor with neat sketch.	04																				
Answer: Piston type air motor 1) Radial Piston Motor Construction and 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																				
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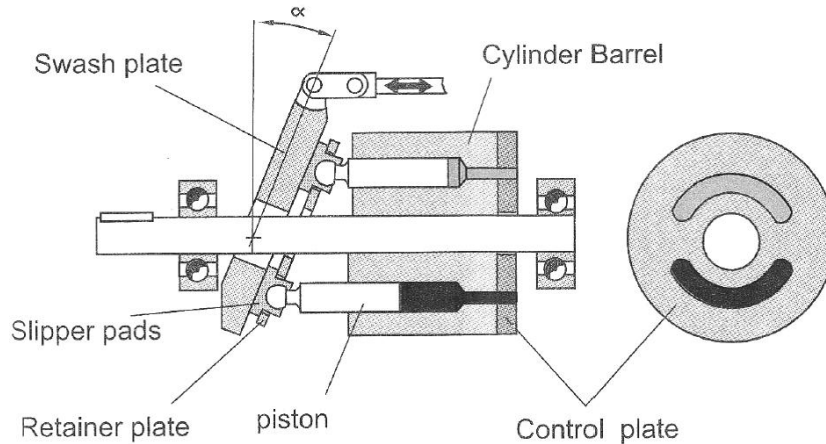
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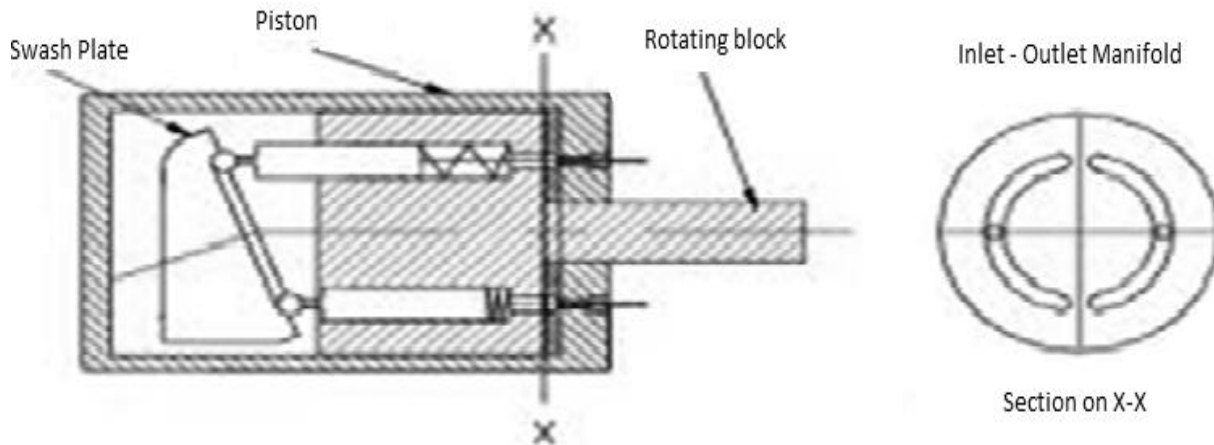
(OR)

2) Axial Piston motor :



02

OR



02

Figure: Swashplate Pump

Construction and Working:

In axial piston motors, the piston reciprocates parallel to the axis of the cylinder block. These motors are available with both fixed-and variable-displacement feature types. They generate torque by pressure acting on the ends of pistons reciprocating inside a cylinder block. Above figure illustrates the inline design in which the motor, drive shaft and cylinder block are centered on the same axis.

Pressure acting on the ends of the piston generates a force against an angled swash plate. This causes the cylinder block to rotate with a torque that is proportional to the area of the pistons. The torque is also a function of the swash-plate angle. The inline piston motor is designed either as a fixed- or a variable-displacement unit. The swash plate determines the volumetric displacement.

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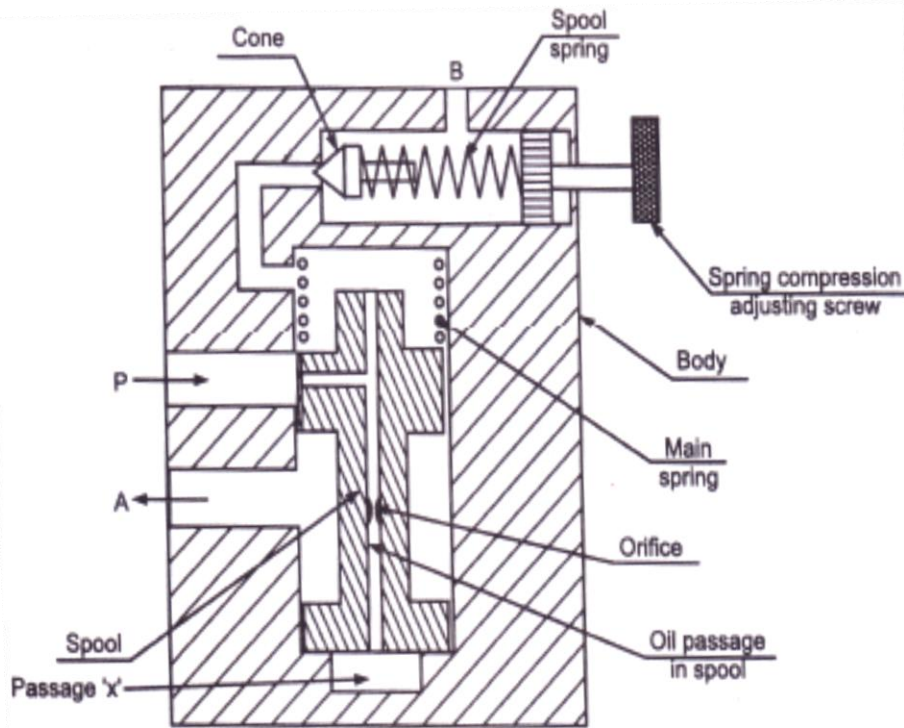
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c) Draw a labeled sketch of sequence valve and describe its working.

04

Answer: 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

d) State two applications and two materials of seals used in hydraulic systems.

04

Answer:

Application of seals:

- 1) Non positive seal - Piston ring
- 2) Positive seal - Oil seal in gear pump, motors, hydraulic and pneumatic actuators.

02

Two materials of seals used in hydraulic systems.

- 1) Metallic seal like Aluminum alloy.
- 2) Non metallic seal like Synthetic rubber.

02

e) Why FRL unit is used in pneumatic system? State the functions of each component of FRL unit.

04

Answer:

FRL unit used in pneumatic system:

We know that FRL unit nothing but service unit which is normally installed between air compressor and direction control valve for the preparation of air, in which filtration, pressure regulation and lubrication takes place. By using FRL unit it increases efficiency and life of pneumatic system.

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Functions of components of F.R.L Unit:-

- 1) **Filter:** It is a important element through which initially air gets filters which separators (or) arrest very small dust particles these particles are arrested in filter and air gets cleaned This filtered compressed air then enter into Regulator .
- 2) **Regulator:** It is nothing but pressure reducing valve it is used to regulate pressure of air required by pneumatic system suppose pressure of compressed air is say 8 bar and pneumatic system required 3 bar working pressure then regulator is used to reduce the pressure from 8 bar to 3 bar.
- 3) **Lubricator:** For lubrication purpose in pneumatic system it is used because after filtration of air this air become dry which harmful for mechanicals parts like a actuators valves etc. so for smooth operation as well as increase the life of components it played very important role here during working condition fine oil droplets are mixed with air.

03

4. A) Attempt **any Three** of the following :

12

a) Describe the working of hydraulic lift with neat sketch.

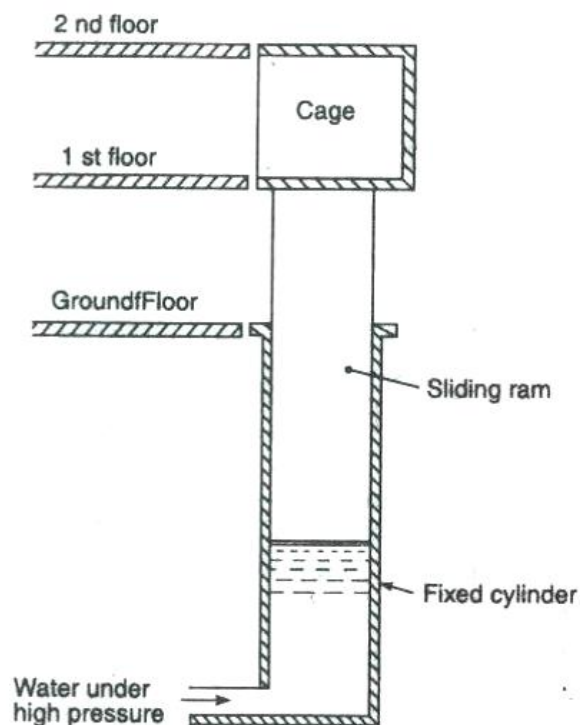
04

Answer:

Working of direct acting 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 ram sliding in a cylinder. At the top of the ram a platform or cage is fitted on which the goods may be placed or the persons may be stand. The liquid under pressure is admitted into the cylinder which pushes the ram vertically upwards thus raising the platform or the cage to the required height. The platform or cage can be made to stay in level with each floor so that goods can be transferred to that floor or persons can walk over to that floor. Again removing the liquid from the cylinder, the ram and hence the platform or cage can be made to move downwards.

02



Direct acting hydraulic lift.

02

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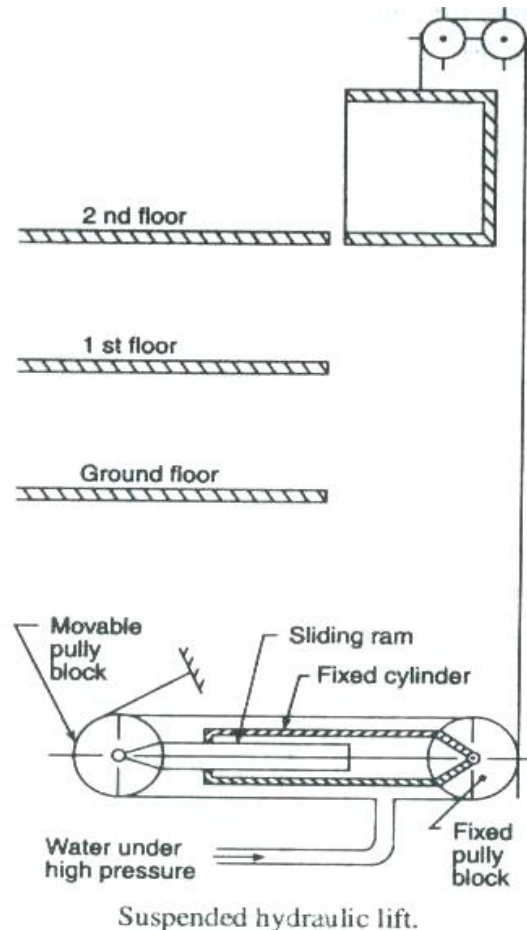
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OR

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

02

iv) Explain working of gear type hydraulic motor with neat sketch.

04

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 teeth. These forces result in rotation of both gears. This rotary motion is further used in rotation of output shaft. Gear motors suffer from leakage, which is quite high at low speeds. Hence gear motors are used where medium speed and low torque are required.

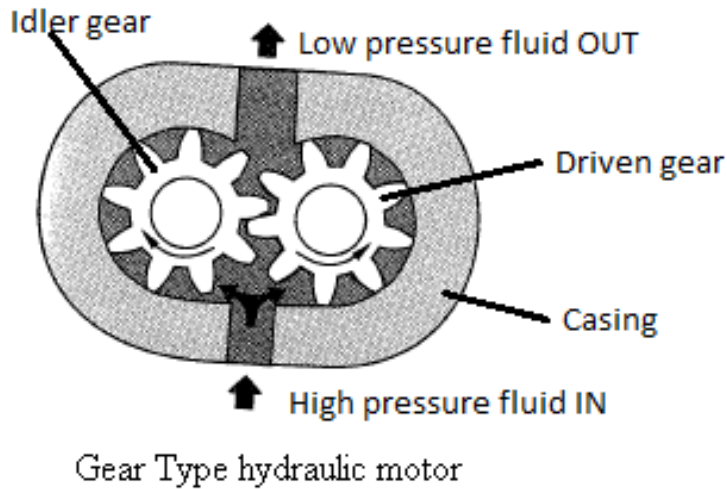
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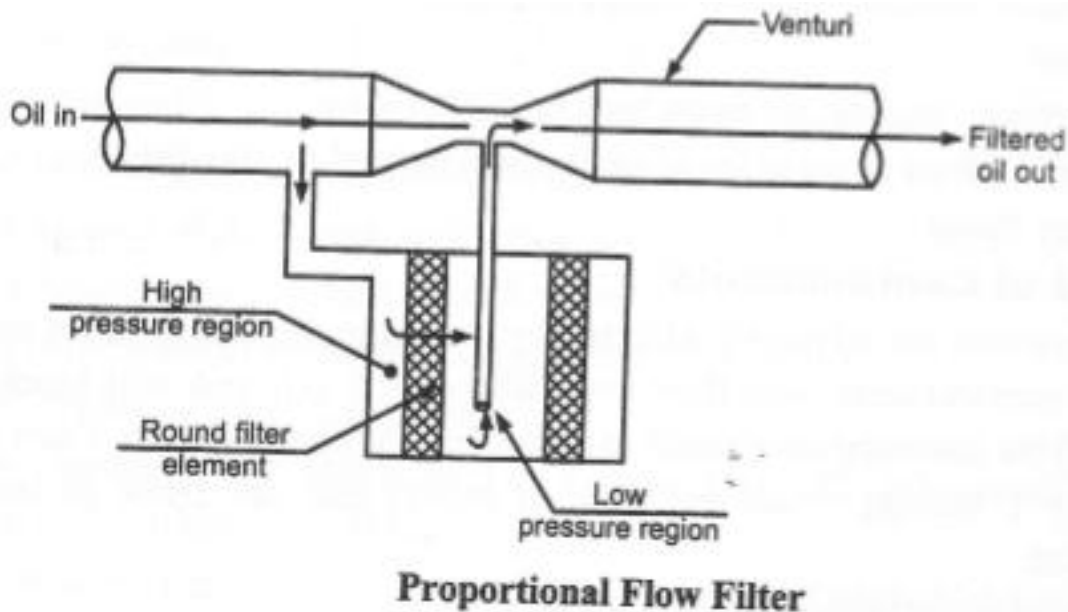
02

c) Draw a neat sketch of proportional flow type filter and describe its working.

04

Answer:

Proportional flow filter:



02

Working:

In this filter main oil flow passes through venturi, which create localize low pressure area inside the filter element. Outside of the filter element there is high pressure oil, due to the pressure difference crated across filter element. The propionate quantity passes through filter element. In this filter the pressure drop is very low hence is having wide application.

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d) Draw a neat sketch of meter in circuit.

04

Answer:

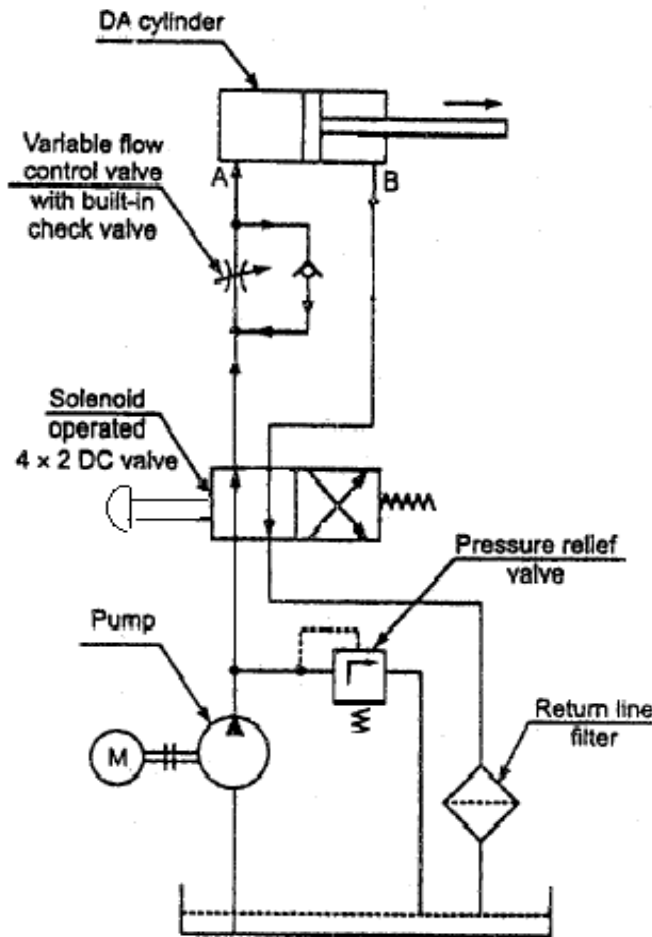


Figure: Meter- in Circuit

04

B) Attempt **any one** of the following :

6

a) Draw and explain pneumatic circuit to control the speed of double acting cylinder.

06

Answer:

Pneumatic circuit to control the speed of double acting cylinder:

03

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.

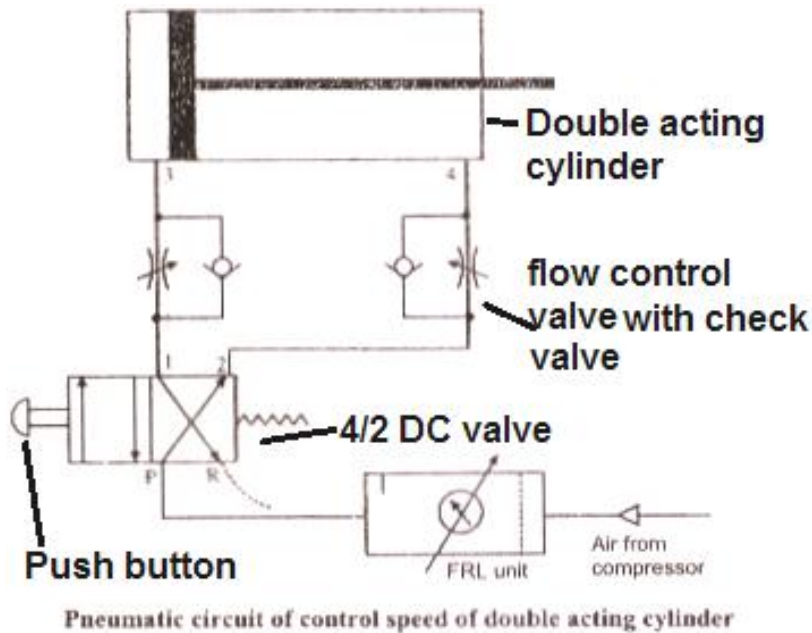
In speed control of a cylinder, a flow control valve along with a check valve is normally used, but this combination provides speed control in one direction. In case of speed control in both direction of double acting cylinder, two sets of combination flow control and check valve are used. Speed in a 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.

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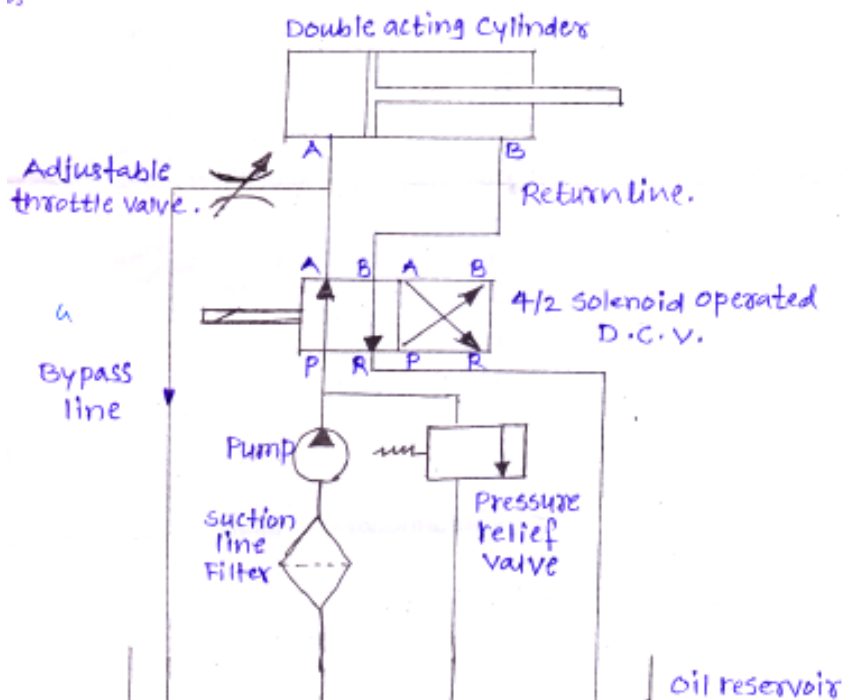
- b) i) Identify the following circuit in figure No. 1
ii) label and explain its working
iii) state its applications

06

Answer:

- i) The figure shows a **bleed off circuit**.

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ii) Working:

Bleed off circuit does not control the flow going to the actuator or flow returning from the actuator. It controls diverted parts of fluid to control the flow in this circuit. An adjustable throttle is placed on the pass line. Bleed of circuit is also used for controlling the linear speed in a double acting cylinder. In this circuit, neither incoming nor outgoing flow is metered. In this method, pressurized flow coming out of the pump is diverted and passed to an oil reservoir. The speed of the piston depends on the difference between pump delivery flow and flow being bypassed to the reservoir through the throttle valve.

02

iii) Applications : (Any two)

- 1) Use in hydraulic shaping machine, planer machine.
- 2) Used for control of broach in broaching machine.
- 3) It is suitable in constant pressure.
- 4) Used where precise speed control is not required.

01

5. Attempt **any two** of the following :

16

a) State Bernoulli's theorem. Explain orifice meter with neat sketch .

08

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 or addition of the energy.'

02

Mathematically,

$$Z + \frac{v^2}{2g} + \frac{P}{w} = \text{constant}$$

Where,

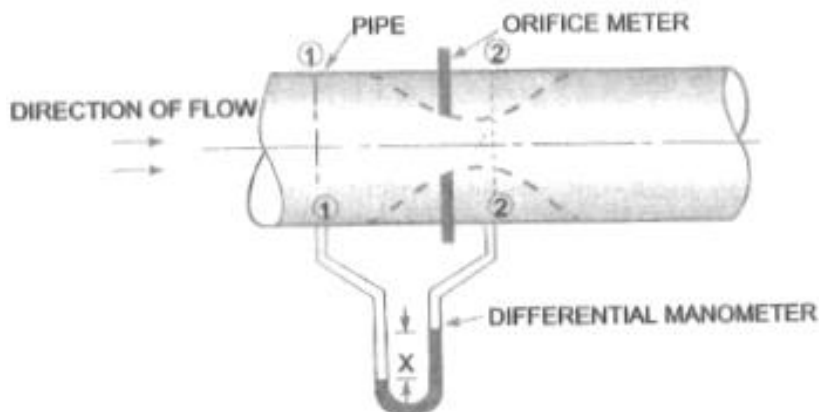
Z = Potential energy

$\frac{v^2}{2g}$ = Kinetic energy

$\frac{P}{w}$ = Pressure energy

Orifice meter:- It is used to measure the discharge in a pipe. It consists of a plate having a sharp edge circular hole known as an orifice. The plate is fixed inside a pipe as shown in the figure. As the fluid flows through the orifice meter, it accelerates, thereby increasing velocity and decreasing pressure since the orifice diameter is less than the pipe diameter. This pressure difference is measured by the manometer. An orifice meter is cheaper for discharge measurement and requires smaller space as compared with a venturi meter.

03



03

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b) Compare reciprocating pump and centrifugal pump on the basis of discharge, pressure, speed, weight of pump, floor area used, maintenance, cost and applications.

08

Answer: (One mark for each point)

Sr. No	Factors	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	Maintenance cost is more.	Maintenance cost is less.
7.	Cost	Less than reciprocating pump	More than centrifugal pump
8.	Applications	In service stations for washing vehicles	In sugar factories, oil, chemical factories milk dairies and domestics applications.

08

c) Explain hydraulic power steering with neat labeled sketch.

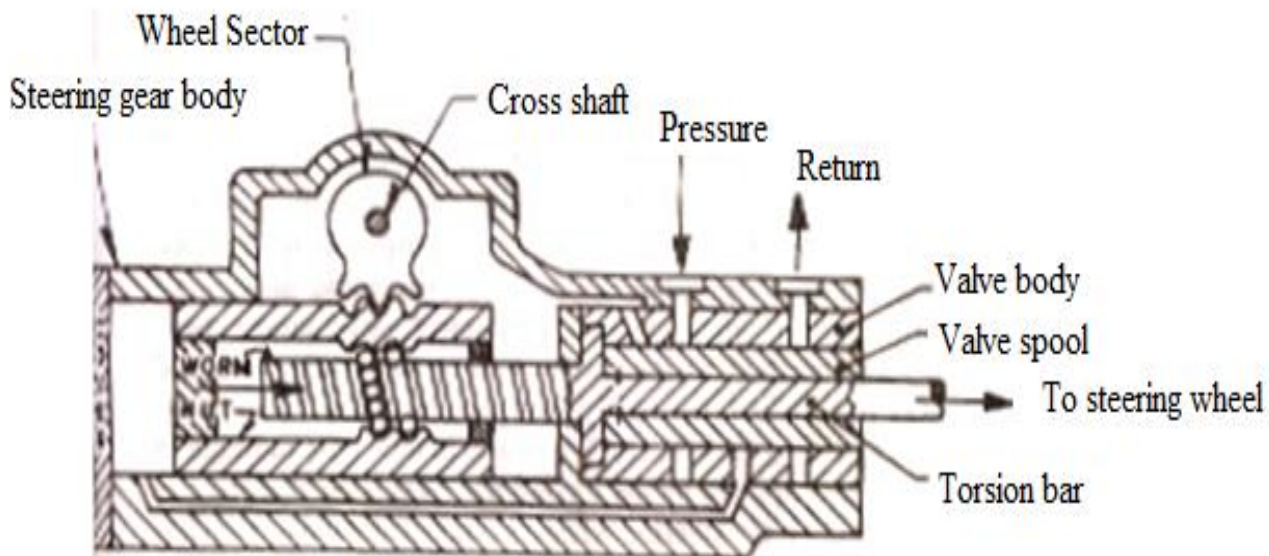
08

Answer: Hydraulic power steering:

This is used to reduce the turning effort required to steer the wheels. It consist of hydraulic pump, gear box, rotary spool type D.C. valve and hoses. The steering wheel is connected to the one end of rotary spool valve while at other end of valve worm is connected. The worm rotates the nut making the sector to turn which turns the road wheels at angle.

04

When driver turns the steering wheel, the spool valve turns directing the pressurised oil from pump to appropriate side of the nut applying the effort on that side. This helps in reducing the effort of driver.



04

Figure: Hydraulic power steering

OR

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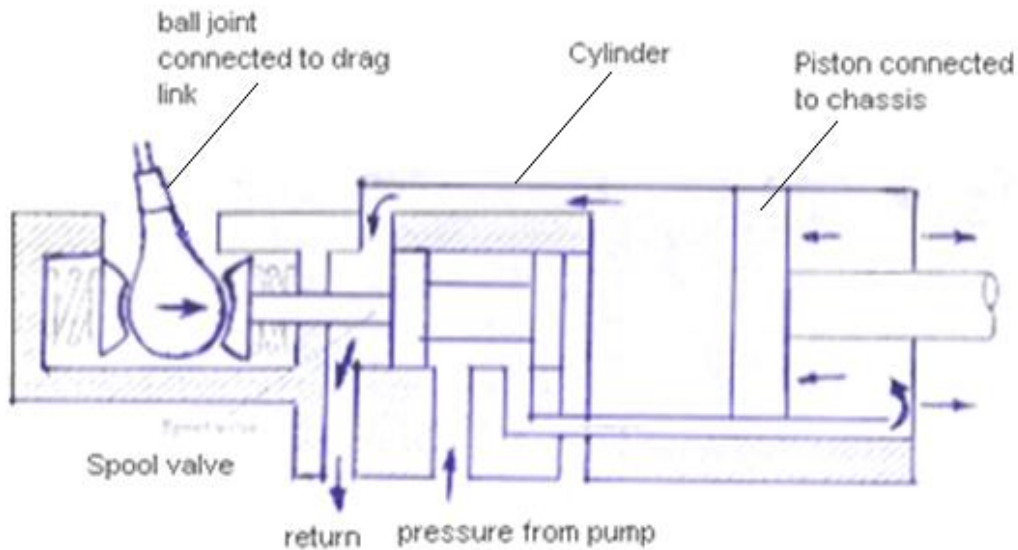
Model Answer

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Reaction piston type hydraulic steering system

It consists of a piston connected to the chassis, a moving cylinder, a ball joint connected to a drop arm and a sliding spool valve. The spool valve is operated by the ball joint. When the steering wheel is moved to the right, the ball joint connected to the drop arm moves the spool valve to the right against spring pressure. This allows hydraulic pressure to pass to the rear of the piston. As the piston is stationary, the pressurized fluid reacts against the piston and pushes the cylinder to the right. The fluid from the front of the piston is returned to the reservoir. Thus, it helps in reducing the effort applied by the driver.

04



04

Figure: Reaction piston type hydraulic steering system

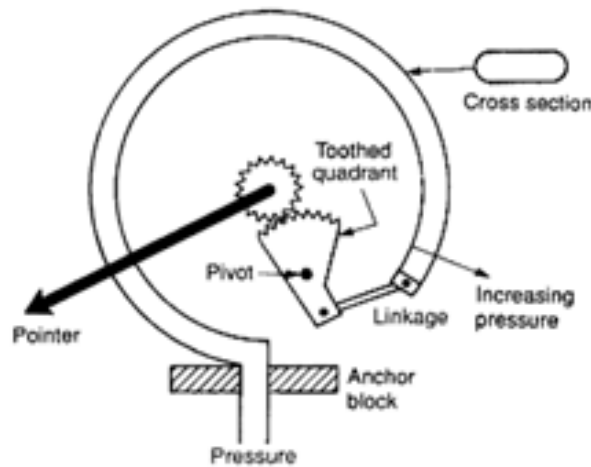
6 Attempt **any two** :

16

a) Explain Bourdon tube pressure gauge with figure and state its applications.

08

Answer: **Bourdon tube pressure gauge:**



03

Figure: Bourdon tube pressure gauge

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Bourdon tube pressure gauge: It 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

Applications:

1. For measuring high pressures e.g. in steam boilers, compressors.
2. For measuring pressures in vehicles tube tyre.

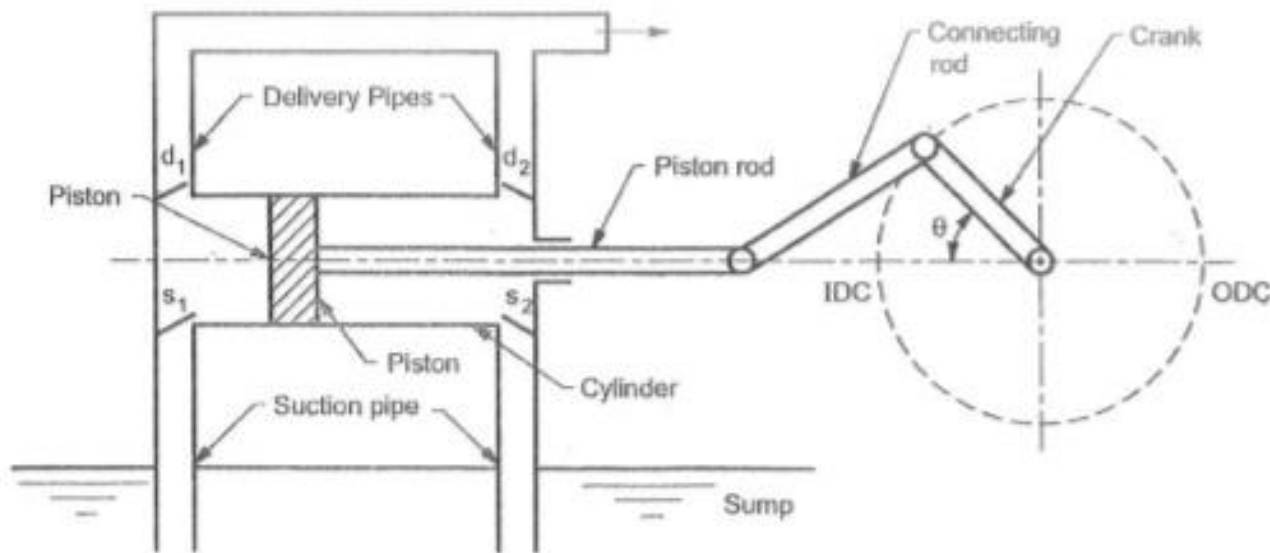
03

02

b) Draw a labeled sketch of double acting reciprocating pump and describe its construction and working.

08

Answer: **Double acting reciprocating pump:**



04

Figure: Double acting reciprocating pump

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.

02

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

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Subject Code: 17522

Model Answer

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c) Construct the pneumatic circuit using sequence valve to control two applications performed in a proper sequence and describe it's working.

08

Answer: **Pressure dependent sequencing circuit :**

The circuit is used for drilling a hole in work piece. The sequence of operation is

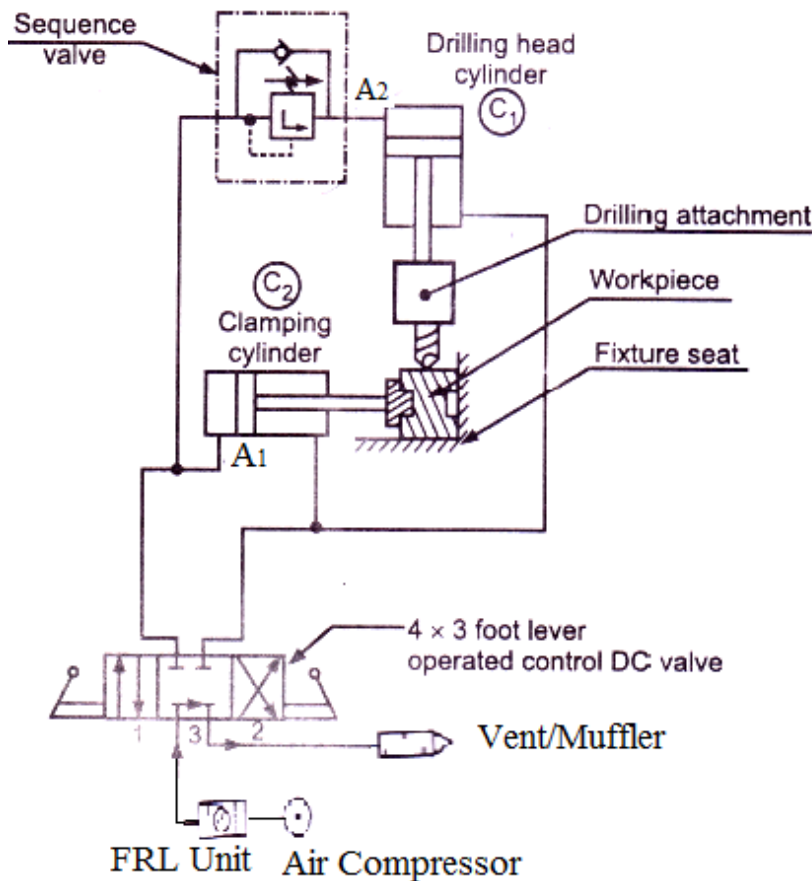
- a) Clamping of work piece
- b) Drilling
- c) Decamping and drill taken out from hole.

The DC valve takes centre position (no 3.) no compressed air supplied to either of cylinder C₁ or C₂. 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 C₁ or C₂.

04

Now compressed air start supplying directly to C₂ and through sequence valve to C₁ When compressed oil enters through port A₂ of cylinder C₂ piston will advance and immediately clamps the work piece.

At the same time compressed air flow towards port A₁ of cylinder C₁ 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 A₁ into cylinder C₁ 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



04

Figure: Pneumatic Circuit Using sequence valve