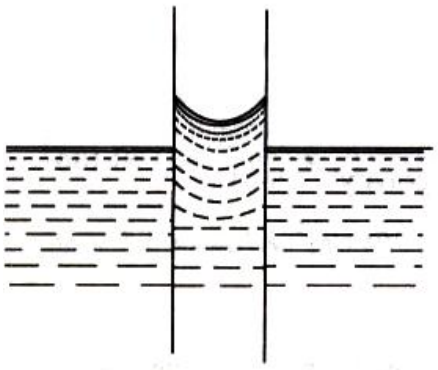
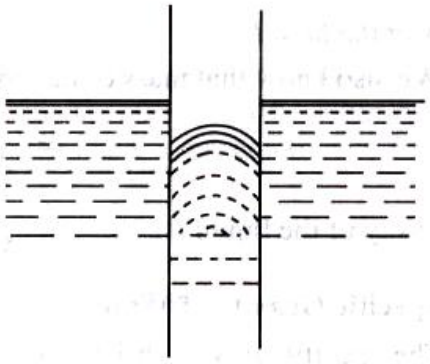
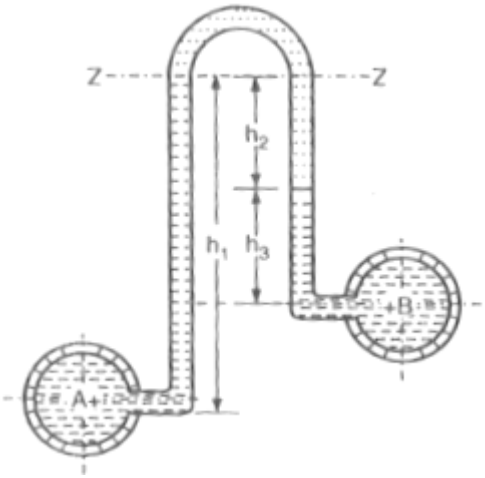
Important Instructions to examiners:

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.

Q1 A) a) Explain the following fluid properties (i) surface tension and (ii) capillarity	
i) Surface tension- It is the force required to maintain unit called length of the film in equilibrium condition. Unit:-N/m Let us consider the two molecules of liquid at points A and B. Molecule at point A is equally attracted from all sides since it has molecules from all sides and therefore the forces acting at this point are in equilibrium condition. However. at point B, there is no liquid molecule at above side and consequently there is a net downward force on the surface of liquid is normal to the liquid surface, due to this a special layer seems to form on a liquid at the surface, which is in tension and small loads can be supported over it e.g. a small needle placed gently upon the water will not sink but will be supported by the tension at the water surface.	02
ii) Capillarity:- I) when the liquid molecules possess relatively greater affinity for solid molecules or, in other words, liquid has adhesion greater than cohesion then it will wet the solid surface in contact and will tend to rise at the point of contact. This results concave upwards and the angle of contact θ which is less than $90^{0.}$ This is also known as Capillary Rise. II) If the liquid has less attraction for solid molecules or, in other words, Cohesion predominates, then liquid will not have tendency to wet the solid surface in contact and this will result in depression of liquid at that point in the concave downward shape and at the angle θ more than 90^{0} e.g. glass tube is inserted inside the mercury. This phenomenon of rise or fall of liquid surface relative to the adjacent general level of liquid is known as Capillarity.  *(a)* in water  *(b)* in mercury	02
b) State Pascal's law and formula for it. Also list any two application of it.	
It states that " The intensity of pressure at any point in a fluid at rest is same in all directions". In other words when a certain pressure is applied at any point in fluid at rest the pressure is equally transmitted in all directions and to every other point in the fluid.	02

$$p_x = p_y = p_z$$ where, p_x = intensity of pressure in x direction; p_y = intensity of pressure in y direction; p_z= intensity of pressure in z direction; Applications:- Hydraulic press, Hydraulic brakes, Hydraulic jack, hydraulic lift,	01 01
c) Explain construction and working of invented U tube differential manometer	
 An inverted differential manometer is used for measuring difference of low pressure, where accuracy is the prime consideration. It consists of an inverted U tube, containing light liquid. One end is connected to A and other is connected to B. Let us assume that the pressure at point A is more than that at point B. Let us take Z-Z as the datum line in this case h_1=Height of liquid in the left limb below Z-Z h_2=Reading of the manometer h_3= Height of liquid in the right limb in cm S_1 S_2 and S_3=Specific gravities of liquids in the left limb light limb and liquid in the right limb respectively. h_A= pressure in pipe A h_B=pressure in pipe B with reference to the Fig $h_A - S_1h_1 = h_B - S_2h_2 - s_3h_3$ $h_A - h_B = S_1h_1 - S_2h_2 - S_3h_3$ m of water	02 sketch 02
d) Define the Bernoulli's theorem. List its applications. Explain any one application in detail	
This theorem states that 'whenever there is a continuous flow if liquid, the total energy at every section remains the same provided that there is no loss of addition of the energy.	01

Mathematically,

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

Where, Z= potential energy

$v^2/2g$= kinetic energy

P/w= pressure energy 01

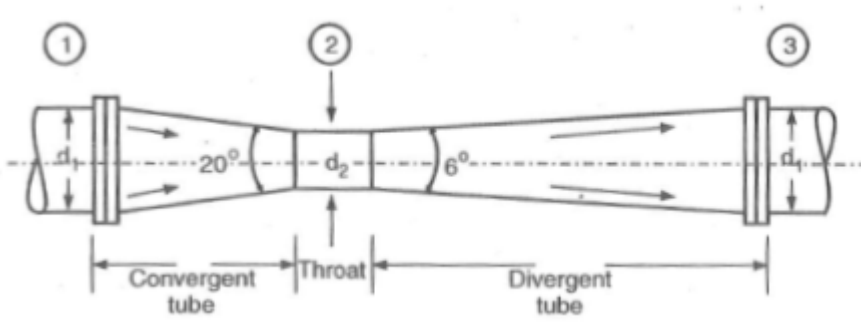
List of applications:- 1) Venturi meter

2) Orifice meter

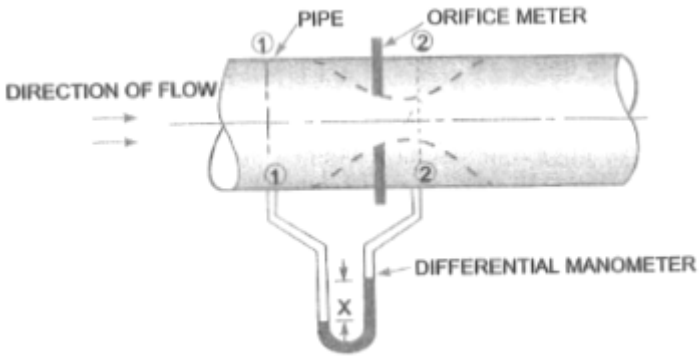
3) Pitot tube

Venturimeter :- A Venturimeter consists of a converging cone, a throat section and diverging cone, all combined in one unit. As the flow takes place in the converging cone, velocity increases, and there is a fall in the pressure according to the Bernoulli's equation. 02 for any one application

Consider the arrangement shown in the figure where the fluid passes from point 1 (inlet) to point 2 (throat) and the manometer is fixed between them. Appling Bernoulli's equation to points 1 and 2 with datum at this axis, considering horizontal venturimeter, $Z_1=Z_2$



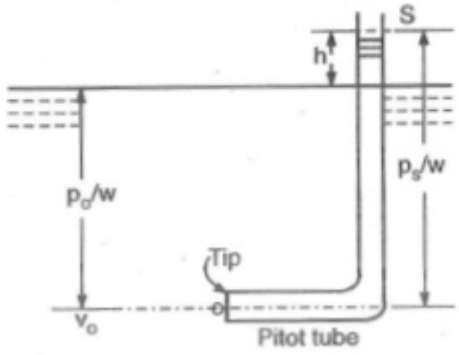
Orifice meter:- it is used to measure the discharge in pipe. It consist of a plate having a sharp edge circular hole known as an orifice. The plate is fixed inside a pipe as shown in figure. As the fluid flows through the orifice meter it accelerates thereby increasing velocity and decreasing pressure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



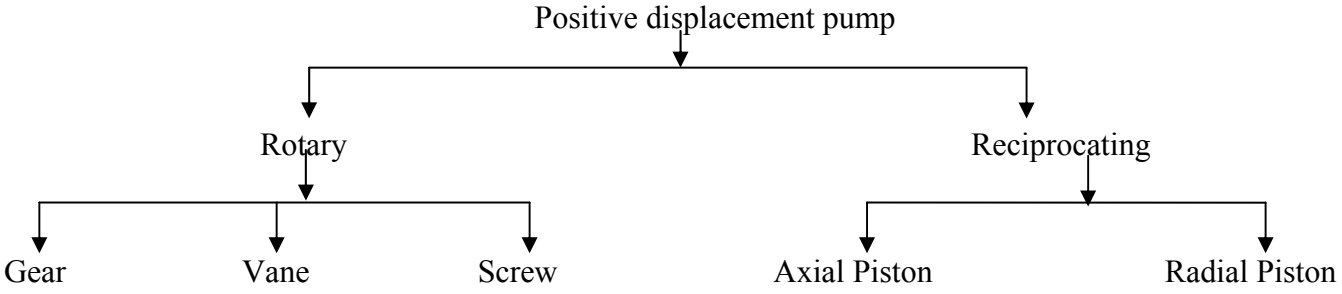
Pitot Tube :- This is an instrument used to determine the velocity of flow at a desired section in a pipe or stream. shows as pilot tube which in its simplest from consists of a 90^0 bent glass tube. The tube is placed in flow such as leg is vertical and the other leg is horizontal. The horizontal leg has the open end facing upstream. The tube is used for measuring the local velocity. At the tip of the tube, the velocity is zero. This

point is called the stagnation point. The pressure at the tip of the tube is called the stagnation pressure.

Fig shows a pilot tube in an open channel. Let p_0 donate the static pressure at point 1 which is at some distance upstream from the tip of the tube and where the velocity v_0 is uniform. p_s be the stagnation pressure at the tip.



B) a) Classify positive displacement pumps and explain any one of them in detail.



02

External gear pump

Constructional details: the pump consists of two intermeshing gears machined to close tolerance with the casing The gear have 12 teeth which reduces the variation of output flow rate and noise level respectively.

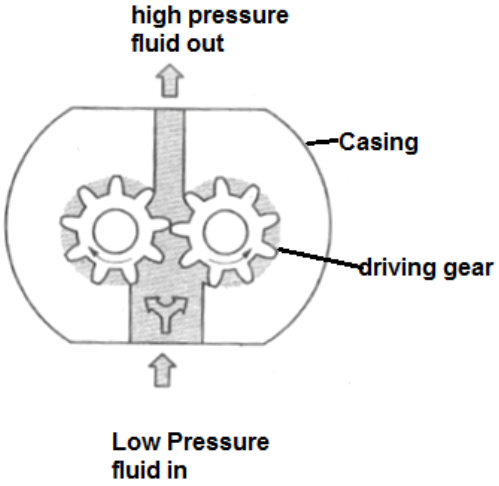
Operation: when the pump started working liquid is trapped in the gaps between the gear teeth, and is propelled along three inside of the pump.

From the suction port to the pressure port. The partial vacuum needed to produce suction in the suction chamber is generated when the teeth take away liquid along with them from suction chamber, thus, reduction in the volume of suction chamber creates suction.

The suction and delivery sides are constantly scaled due to continuous meshing of two gears.

In pressure chamber, the teeth deliver the liquid they were carrying along and thus force the liquid into delivery line. As discussed earlier the pressure developed by the pump, depends upon the load on the system.

02 sketch and 02 for explanation of any one



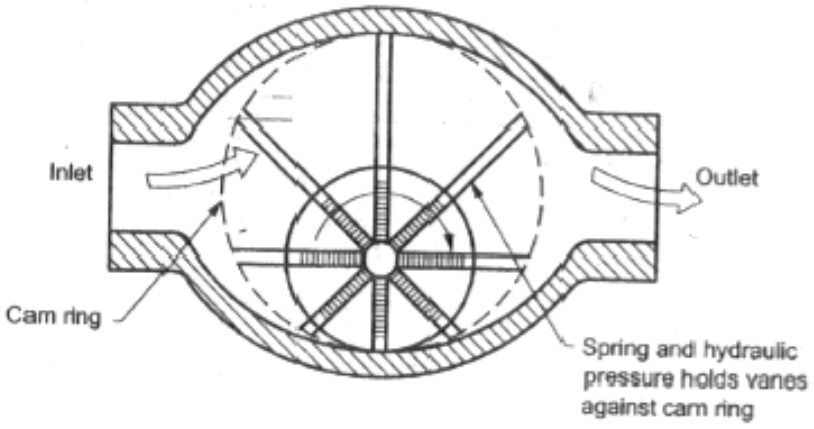
Vane pump:-

As shown in fig its simplest version, it consists of a rotor in which vanes are held in a series of slots around the rotor.

Operation:-

As the rotor rotates in clockwise direction, the area between vanes is sealed as the vane uncover suction port this creates partial vacuum in suction chamber.

Further, the fluid confined between two vanes is carried away to the outlet chamber. forcing the fluid into the delivery port.



Screw type pump:-

Constructional Details:-

The figure below illustrates the construction details of a screw type pump. The screws are hardened and precision ground, which are enclosed in a closely machined casting.

Each of the two screws have half part right hand threading and other half part left hand threading.

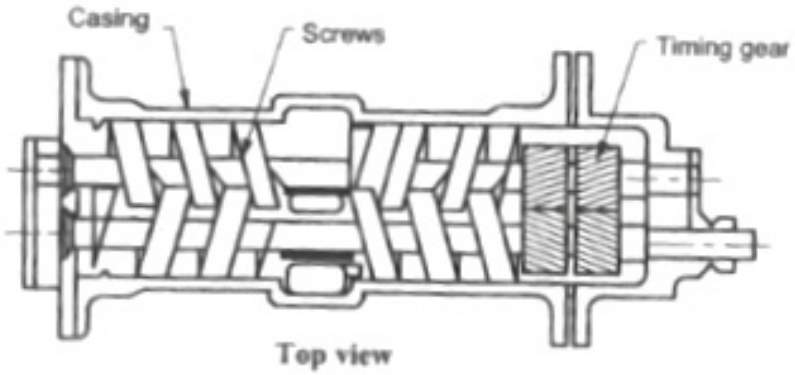
These screw mesh to form a fluid tight seal between the screw and the screw and casting. Out of two screw, one is connected to power source and another is driven through gears.

Operations:-

As the screw rotates it draws oil from the suction chamber, enfold it into; the helical grooves.

As the screw further rotates the fluid gets transferred along the screw and finally forced into delivery chamber.

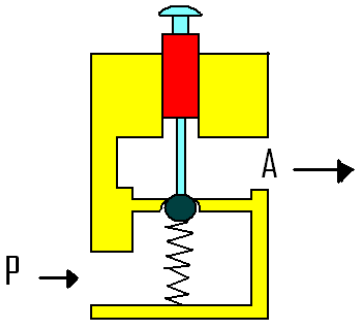
Thus oil is sucked continuously from four points and finally discharged into delivery chamber.



b) Which are the various valves used in Direction Controlling the air in pneumatic circuit? Explain construction and working of any one valve.

The valves used in directional control of air in pneumatic circuits are poppet valve and spool valve- sliding and rotary spool.

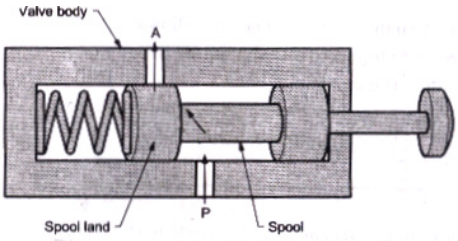
Poppet valve:- It consists of simple disc, cones or balls are used in conjunction with simple valve seats to control flow. When a push button is depressed, it lifts ball to its seat and allow fluid to flow from port 'P' to port 'A'. When button is released, spring & fluid pressure forces the ball up again closing the valve. A poppet valve quickly opens relatively larger orifice in a shorter travel to permit full flow of air thus it is fast response time. These valves are simple, cheap and insensitive to dirt.



POPPET VALVE

Spool Valve:

1. sliding spool: it consist of a spool which moves axially within the valve body to control the direction of flow. The body has inlet & outlet port. The inlet port is connected to pump & outlet to actuators. The spool is moved by actuating mechanism or push button. Normally valve is in closed condition. When push button is pressed the spool moves to left side & land on the port P. so that the valve is in open position. When the push button is released spring forces spool to return to closed condition.



Valve in the normal position

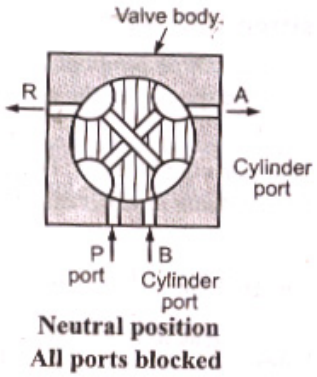
Sliding spool type Direction control valves are the following types- 2/2, 3/2 and 4/2.

01Types

02 Sketch and

03 explanation for any one

2. Rotary Valve: It consist of a rotating spool which aligns with a hole in the valve casing to give required operation. Openings in casing are connected to compressor, and two sides of cylinder i.e. port A and port B. When rotary spool is rotated the compressor port is connected to cylinder port A causing pressurized air to move the piston at the same time port B is open to atmosphere. When spool returns to original position pressure port and cylinder port is blocked and valve is in neutral position. Rotary valves are compact, simple & have low operating forces. They are low pressure devices & hence used for hand operation in pneumatic systems. Leakage control is rather difficult as rotary valves require close contact between port plate and spool. Leakage is important in high pressure. Hence they are better suited for low pressure applications.



Q2 a) State and explain law of continuity. State any two applications.

Law of Continuity:- Continuity equation is also based upon "principle of conversation of mass" For a fluid flowing through the pipe at all the cross-section, the quantity of fluid flowing per second is constant.

Let,

V_1= Average velocity of fluid at sect. a-a'

P_1= Density of fluid at section at section a-a'

A_1= Area of pipe at section a-a'

And $v_2.p_2,a_2$ are corresponding valve at section bb'

Then rate of flow at section a-a' (mass of liquid flowing per unit time)

$$=p_1A_1V_1$$

Similarly, rate of flow of section b-b'

$$=p_2A_2V_2$$

According to the principle of conservation of mass i.e. mass can't be created not be destroyed. The total quantity of fluid passing through section aa' and bb' is same.

$$P_1A_1V_1=p_2A_2V_2$$

Above equation is applicable for both compressible and incompressible fluid. If considering liquids,

$$P_1=p_2$$

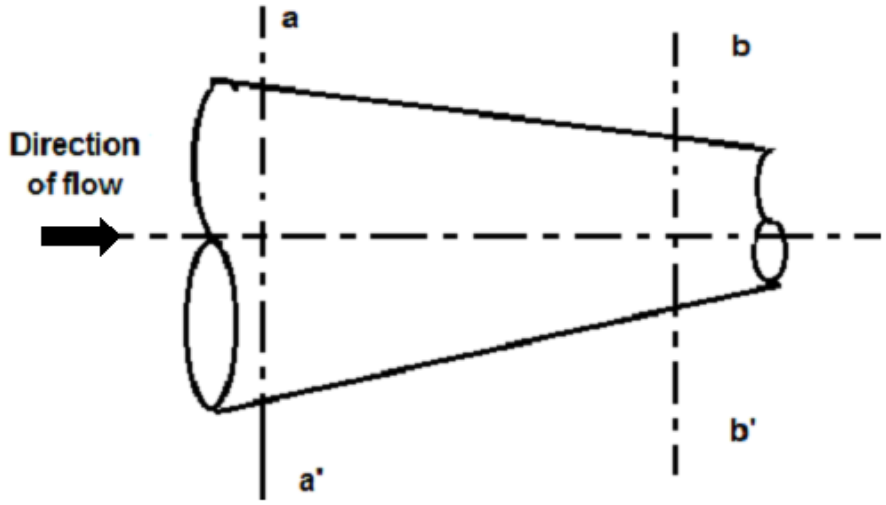
$$A_1V_1=A_2V_2$$

Further $AV=Q$

Where Q is volume of liquid flowing through any section per unit time or volume rate of flow of liquid which is known as discharge. It is expressed in terms of m^3/sec. or lit/sec.

01 law

02 explanation



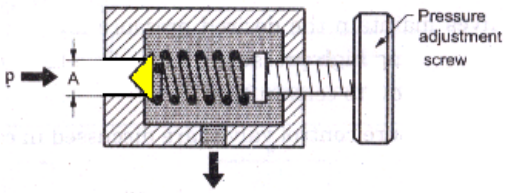
Applications:-

1. steady and unsteady flow
2. uniform and non uniform flow
3. compressible and incompressible flow

01 application

b) Explain the function of relief valve in hydraulic circuit and sketch the same one.

It's function is to limit the pressure in the system & thus protect the individual component and lines from high pressure and danger of bursting. If the pressure in the system increased above a pre-set level, these valve open to release the fluid out of the system, so that the system pressure comes to normal.



Directly operated pressure relief valve

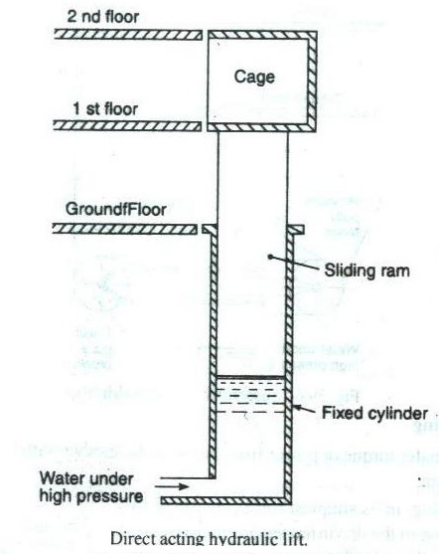
02 function

02 sketch

c) Explain the construction and working principle of 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.



Direct acting hydraulic lift.

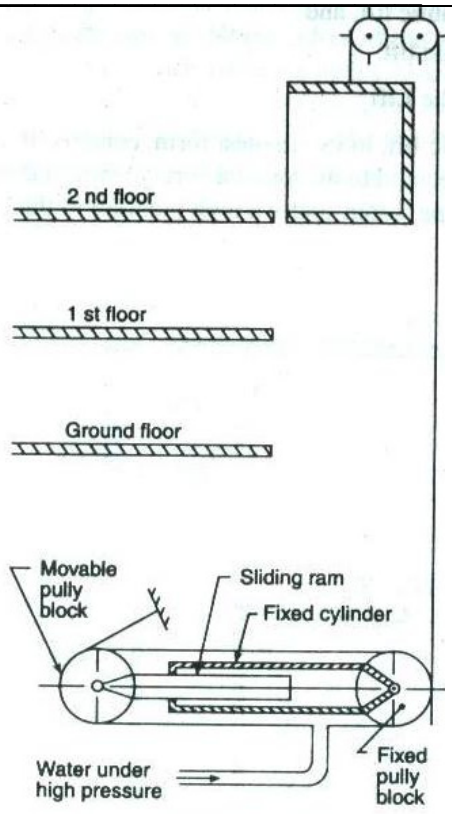
02 sketch

02 explanation

Any one

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 consist 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.



Suspended hydraulic lift.

d) What is the function of oil filter? List types of filters.

Function of filters is to remove the impurities and other foreign matters from the oil. The filters used to clean the oil for the hydraulic system are termed as hydraulic filters. — 02 Function

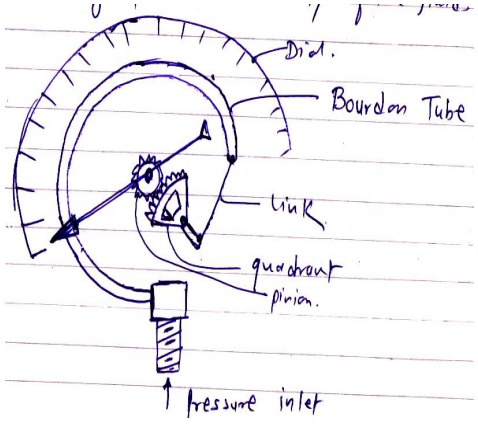
Types of Hydraulic Filters — 02 types

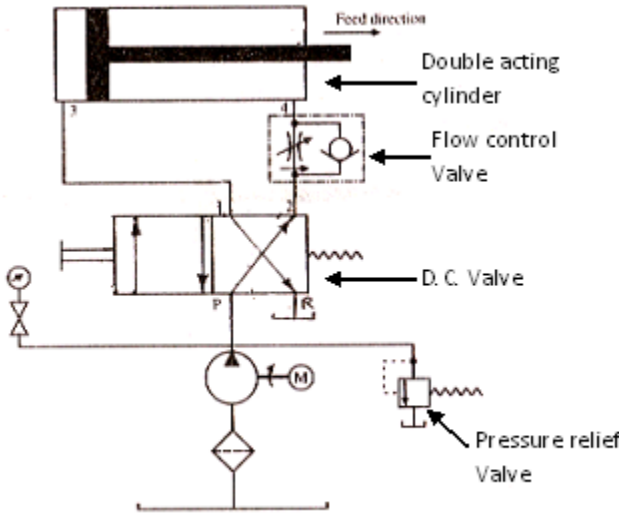
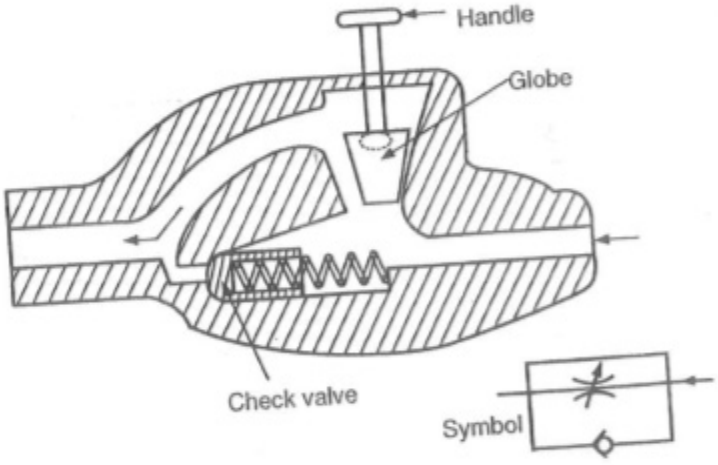
- Mechanical
- Absorbent
- Adsorbent
- Magnetic
- Full flow filters
- Proportional type filters

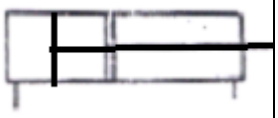
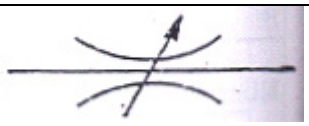
e) Draw a neat diagram of Bourdon tube pressure gauge and explain its working.

It consists of tube of steel or bronze having elliptical cross-section and is curved into a circular arc. The tube is closed at its outer end & this end is free to move. The other end through which fluid will flow is fixed to the frame. — 02 sketch

When the gauge is connected to the point where pressure is to be measured, the fluid under pressure enters the tube. Due to increase in pressure elliptic cross-section of tube tends to become circular, thus causing the tube to straighten out slightly. The small outward movement of the free end of the tube is transmitted, through a link, quadrant and pinion to a pointer which moves on graduated dial indicating pressure intensity of the fluid. — 02 explanation



Q3) a) Draw a neat lable sketch of meter-out hydraulic circuit.	
 **Meter-out speed control hydraulic circuit**	03 sketch 01lab el
b) Explain the construction and working of non-compensated flow control valve.	
The non-compensated flow control valves create an orifice in a pipe to restrict the flow. The control element of the valve may be needle, globe type as in figure. The non-pressure compensated type is used where the system pressure are relatively constant and motoring speeds are not too critical. It works on the principle that the flow through an orifice will be constant if the pressure drop remains constant. Without compensation, flow through these simple valves can very at a fixed setting with changes in pressure or temperature. Fig. shows a non-pressure compensated flow control valve with its symbol. It consists of a check valve, which permits free flow in the direction opposite to the flow control direction. If the load on the actuator changes, then the system pressure will change appreciably and also the flow rate through a non-pressure compensated valve will change for the same flow rate setting. 	02 sketch 02 expla nation
c) Draw pneumatic symbols of following i) 4x3 DC valve ii) Tandem cylinder iii) Variable flow control valve iv)Bi-directional air motor.	

i) 4x3 D.C. Valve		ii) Tandem cylinder		01 each
iii) variable Flow control valve		iv) Bi- directional air motor		

d) Explain construction and working of hydraulic power steering.

Rotary valve type power steering

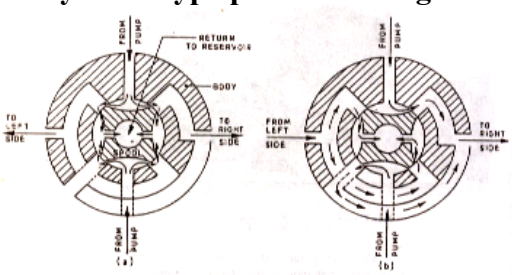
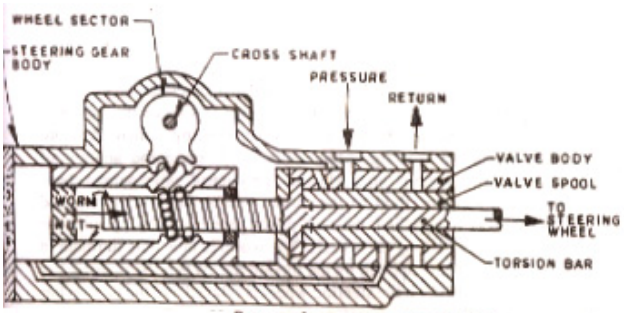


Diagram showing action of a rotary valve (*a*) steering in neutral (*b*) steering in action to turn right.



Rotary valve type power steering gear.

02 sketch

02 explanation

For any one

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.

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.

OR

Reaction piston type hydraulic steering system

It consist of piston connected to chassis, a moving cylinder, ball joint connected to drop arm and sliding spool valve The spool valve is operated by ball joint.

When the steering wheel is moved to right, the ball joint connected to the drop arm moves the spool valve to right against spring pressure. This allows hydraulic pressure to pass to the rear of the piston.

As piston is stationary the pressurized fluid react against the piston and push the cylinder to the right. The fluid from front of piston is returned to the reservoir.

Thus it helps in reducing the effort applied by driver.

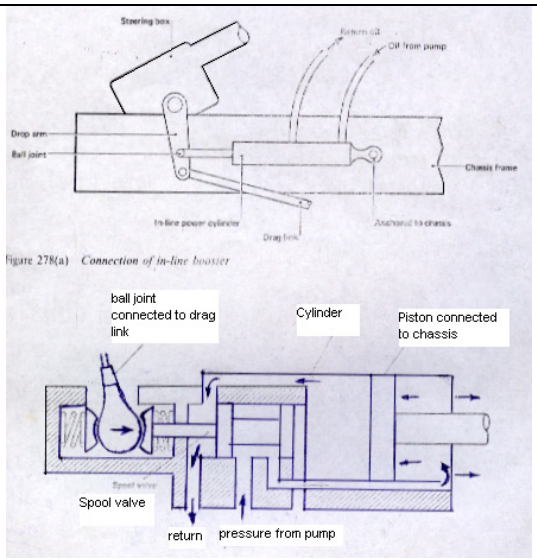
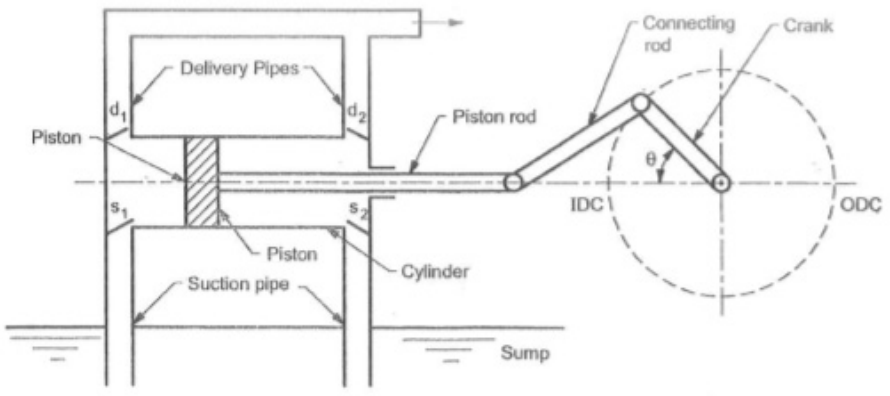


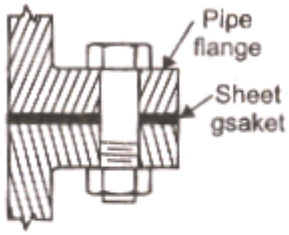
Figure 278(a) *Connection of in-line booster*

e) What is the function of pipe used in hydraulic circuit? Explain standard pipe and double extra strong pipe.

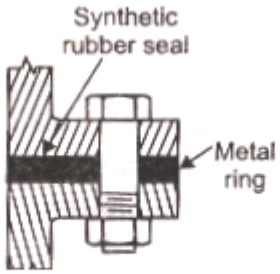
Function of pipe is to interlink the various components of hydraulic system to perform the working of system. 02

It is used to transmit the pressurized fluid from one component of hydraulic system to another. Standard pipe is made to different wall thickness and to standardized dimensions. The actual outside diameter in this various wall thicknesses does not change. The increased thickness of the wall decreases the internal diameter. Except for the larger sizes, the size of the pipe is specified in terms of the nominal inside diameter. The double extra strong is also having same outside diameter, but its thickness is more than the standard pipe and extra strong pipe. The standard pipe is a class- A pipe, and the double extra strong is class- C pipe.	functi on 02 expla nation
Q4 A) a) What is vapour pressure? How these vapour pressure effects on pressure pumping systems?	
When the liquid temperature increases vaporization takes place, this causes the molecules to escapes from the free surface of the liquid. This vapour molecules get accumulated in the space between the free liquid surface and top of vessel. This accumulated vapours exerts a pressure on the liquid surface. This pressure is known as vapour pressure of the liquid. Effects :- if the system pressure drops below the vapour pressure cavitation occurs which leads to 1. Sudden drop in efficiency and head, 2. Continuity of flow may not occur, 3. Noise and vibration will produce, 4. Pitting action on the surface will produced.	02 02
b) Explain the construction and working of double acting reciprocating pump.	
It consists of two suction pipes with suction valve and two delivery pipe with delivery valve. Here liquid is in contact with both sides of the piston. In double acting pump suction and delivery strokes occurs simultaneously. When the crank rotates in clockwise direction, piston moves from inner dead center to right causing vacuum to develop on the left side of the piston and the liquid is sucked through suction valve S_1. At the same time the liquid on right side of the piston is compressed to high pressure causing delivery valve D_2 to open and liquid flows through delivery pipe 2. This process continues till the crank reaches to ODC. As the crank rotates to move the piston from ODC to IDC, the liquid is sucked from suction valve S_2 and delivered through delivery valve D_1. When the graph of discharge Vs crank angle is plotted, it is observed that during both suction and delivery stroke, discharge is obtained.  	02 expla nation 02 sketch
c) What are the different types of seals used in hydraulic circuits explain any one?	
The types of seals used in hydraulic circuits are static seals and dynamic seals **Static seals:-** The seals used between the mating parts that do not move relative to each other are termed as static seals. These seals are compressed between two rigidly connected parts. These seals makes leak proof joint because of pressure applied in tightening the bolts. Under pressure the seal material flows and fills the	01 types

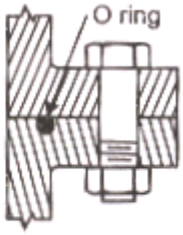
irregularities in the surface making the joint leak-proof. A static seal may often termed as gasket and is usually cut from compressible flat sheet material like paper, cork, rubber or asbestos. The thickness is ranging from 0.25 mm to 3 mm. Figure shows static flange joint and rubber seal moulded in metal ring. O-ring static seal is the simple and most versatile seal used for static applications. The O-ring can be made circular, rectangular or U-ring in cross-section. (any one figure)



Static seal flange joint



Rubber seal moulded in metal ring



O-ring static seal

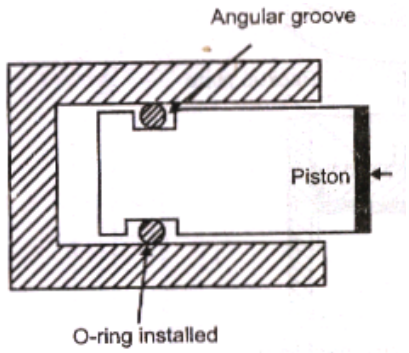
Dynamic seals:- The seal between the mating parts that move relative to each other is called as dynamic seals. These seals are subjected to wear as one of the mating part rubs against the seal. These seals prevents leakage around a moving component. Ex. Piston rings, O- rings on rotating and reciprocating shafts

Types of dynamic seals

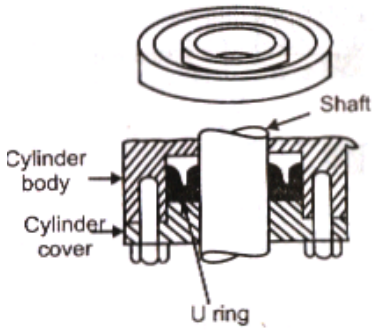
- O-ring
- Lipped seals
- Piston cup packing
- Piston rings
- Wiper rings

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.

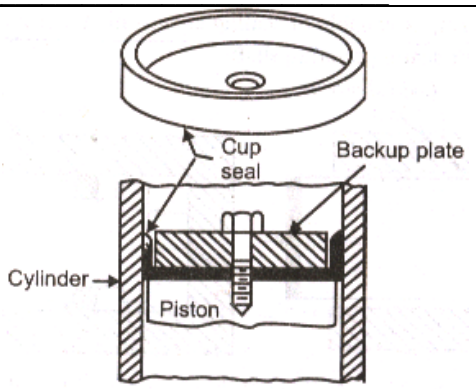


Lipped seals: These are used in all types of reciprocating motion applications. The U-type of seal is pressure driven against the mating moving face and the supporting walls of its recess.



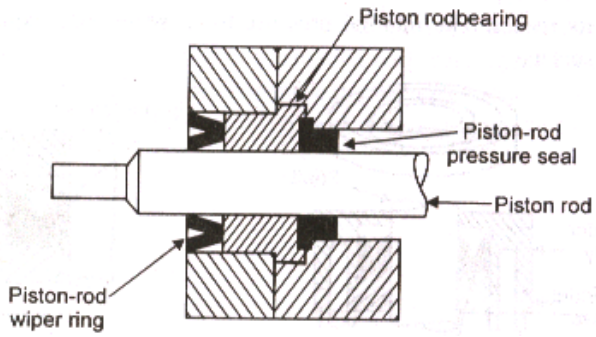
03 explanation with sketch of any one

Piston cup packing: These are designed for pistons in the reciprocating pump and power cylinders. These are simple and installed quickly. In this there is full pressure at lip and decreasing to zero at the base. The wall of cylinder supports the pressure at the cup's top. For lower pressures and shock loads an expander is placed inside the expander packing to force lip against wall.
Ex. Pistons, plungers, rams for sealing reciprocating motion. In wheel cylinder.



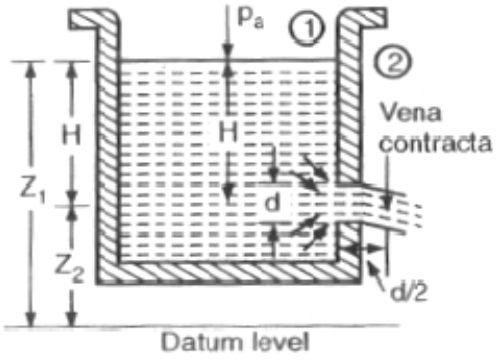
Piston rings:- these are endless, bevel-cut, butt-cut and step-cut. The piston rings are installed in a groove cut in piston to prevent leakage of fluid past the cylinder

Piston rod wiper rings:
These rings are used to prevent foreign abrasive or corrosive material from entering into a cylinder. The wiper ring moulded from a synthetic rubber which is stiff enough to wipe all dust of dirt on the piston rod.



d) Explain Vena-Contracta with neat sketch. State its significance.

Consider a small circular orifice with sharp edges in the side of a tank. Let the centre of the orifice be at a depth below the free surface. Let us assume that the orifice is discharging free into the atmosphere. As the fluid flows through the orifice, it contracts and attains a parallel form at a distance of about d/2 from the plane of orifice. This is due to the fact that the fluid particles cannot change their directions abruptly. The point at which the streamlines first become parallel is termed the 'vena contracta'.

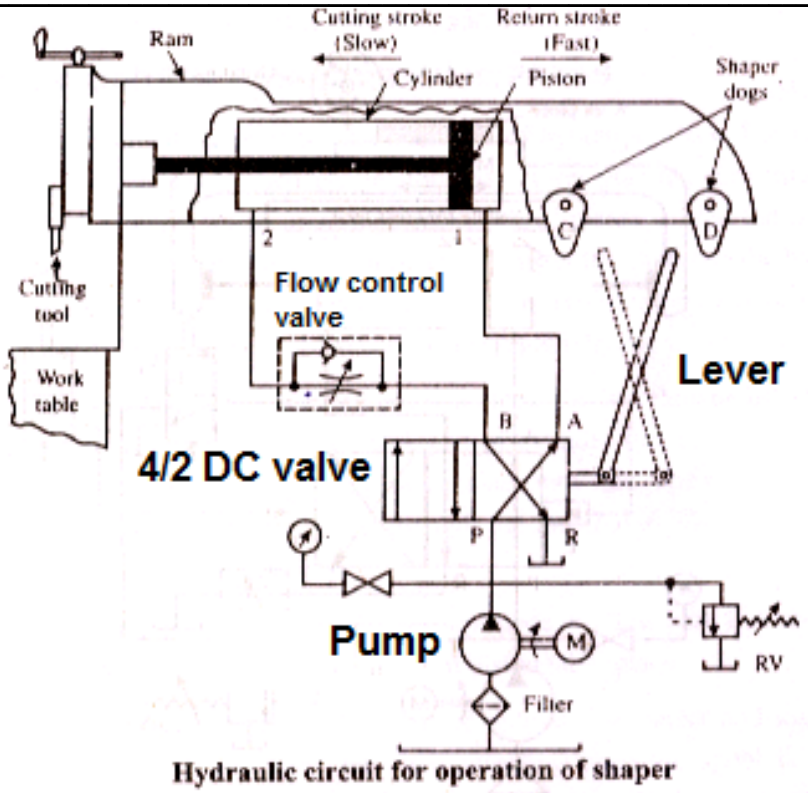
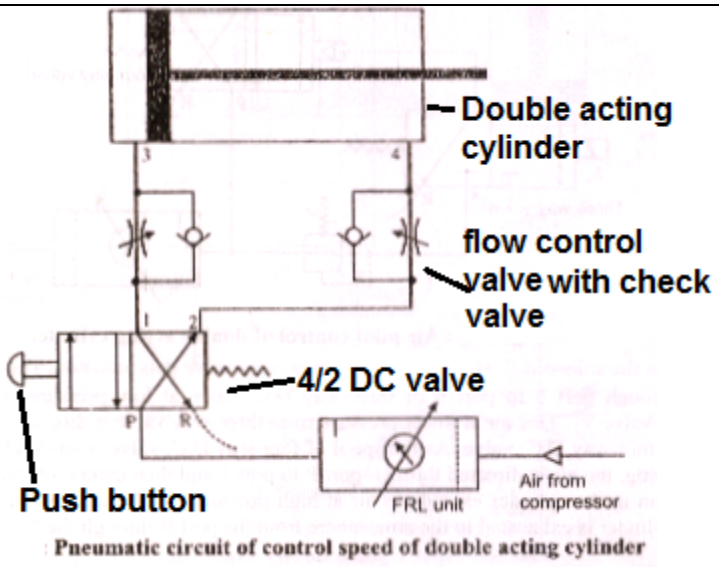


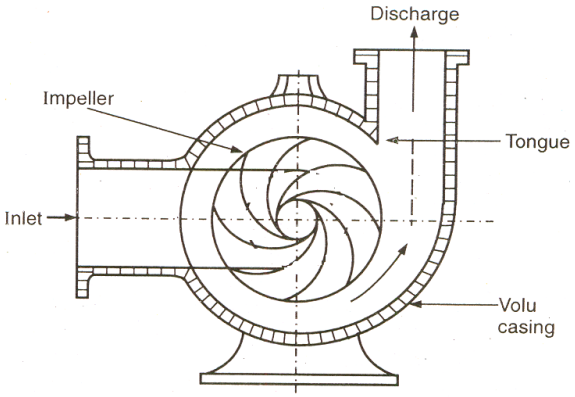
Significance of vena contracta- 1) To measure the flow rate of fluid, 2) To find out Cd, Cc & Cv(hydraulic coefficients)

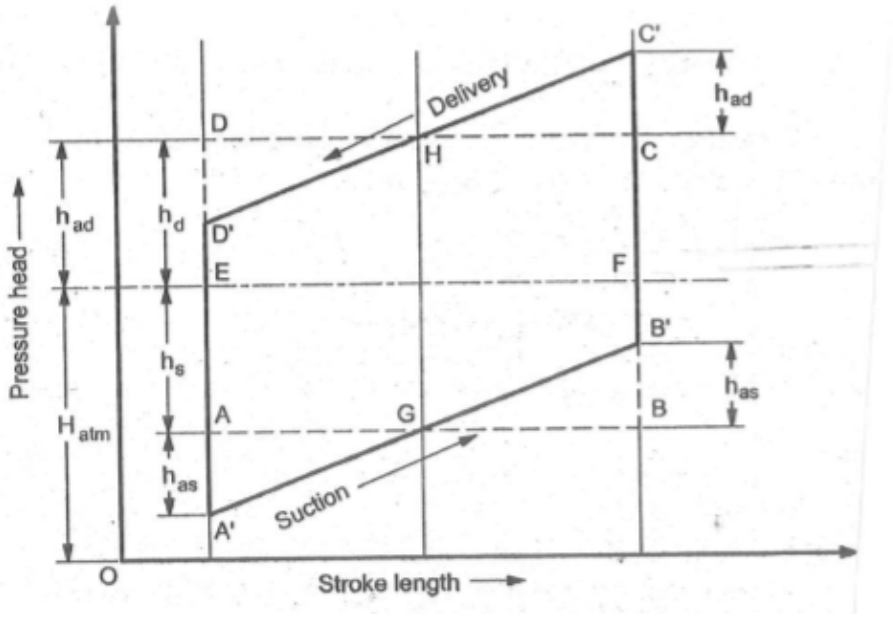
Q4 B) a) Sketch and label a hydraulic circuit for shaper machine.

03 sketch and explanation

01 signaficance

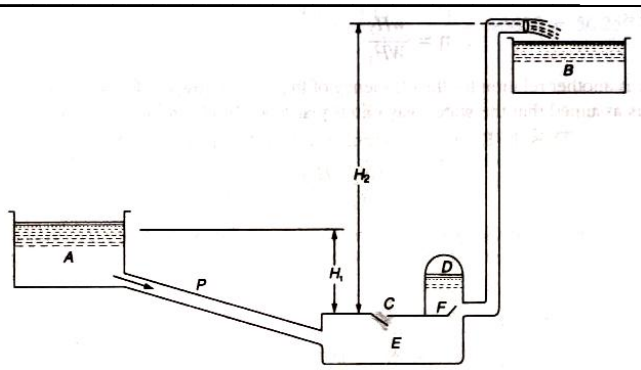
 **Hydraulic circuit for operation of shaper**	04 sketch 02 label
b) Sketch and label pneumatic circuit for speed control of a double acting cylinder.	
 **Pneumatic circuit of control speed of double acting cylinder**	04 sketch 02 label
Q5) a) List different types of fluid flow. Explain any three of them.	
Steady flow; Unsteady flow; Uniform flow; Non uniform flow; Laminar flow; Turbulent flow; Compressible flow; Incompressible flow; Rotational flow; Irrotational flow; Three dimensional flow; Two dimensional flow; One dimensional flow 1)Steady flow ; the flow is said to be steady when the flow characteristics, such as velocity, density pressure and temperature do not change with time. 2) Unsteady flow; the flow is unsteady if the velocity and other hydraulic characteristics change with respect to time.	02 list 02 each for explanation of any

3)Uniform flow: The flow is said to be uniform when the velocity and other characteristics are constant in a particular reach. 4)Non uniform flow: The flow is non uniform when the flow characteristics change at various points along the path. 5) Laminar flow: The flow in which each liquid particle has define path and the path of individual particles do not cross each other is called as stream line flow. 6) Turbulent flow: Flow in which each liquid particle does not have a definite path, and the paths of individuals particles also cross each other is called turbulent flow. 7) Compressible flow : The flow is said to be Compressible when the volume of the fluid and density of fluid changes during flow. 8) Incompressible flow: The flow is said to be incompressible when the volume of fluid and its density does not changes. 9) Rotational flow: A flow, in which the fluid particles also rotate about their own axis while flowing, is called a rotational flow. 10)Irrotational flow: A flow in which the fluid particles do not rotates about their own axis and retain their original orientations while flowing, is called a rotational flow. 11)Three dimensional flow:- when the various characteristics of flowing fluid such as velocity, pressure, density, temperature etc. are function of space and time. i.e. these may vary with co-ordinate (x,y,z) & time, such fluids are said to be three dimensional flow. 12)Two dimensional flow:- When the various characteristics of flowing fluid are functions of any two of the three co-ordinate directions and time t. i.e. these may vary in any two of the three directions then the flow is said to be two dimensional flow. Or a flow whose streamlines may be represented by a curve is called two dimensional flow. 13)One dimensional flow:- When the various characteristics of flowing fluid are functions of only one of the three co-ordinate directions and time t. i.e. these may not vary only in one direction, then the flow is said to be one dimensional flow. Or a flow in which streamlines of its moving particles may be represented by straight line is called one dimensional flow.	three
b) Explain the construction and working of centrifugal pump with sketch.	
It consists of casing, impeller, suction pipe, delivery pipe, delivery valve and electric motor. 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	03 sketch 01 label 04 explanation

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.	
c) i) What is priming? Why it is necessary? How it can be done?	
Priming is process of removing the air from centrifugal pump. It is necessary due to the fact that the pressure generated in a centrifugal pump impeller is directly proportional to the density of the liquid that is in contact with it. Hence if an impeller is made to rotate in presence of air, only negligible pressure would be produced with the result that no liquid will be lifted up by the pump. Hence it is essential to properly prime a centrifugal pump before it can be started. In this operation the suction pipe, casing and delivery pipe up to delivery valve is filled with the liquid to be lifted so that the air from this portion of the pump is driven out and no air pocket is left.	01 02 01
c) ii) Sketch the effect of Piston acceleration on indicator diagram of reciprocating pump.	
	02 sketch 02 label
Q 6) a) Explain the construction and working of hydraulic ram with sketch.	

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 consist of large reservoir A at smaller height, chamber E consists of waste valve C and delivery valve F.



Hydraulic ram.

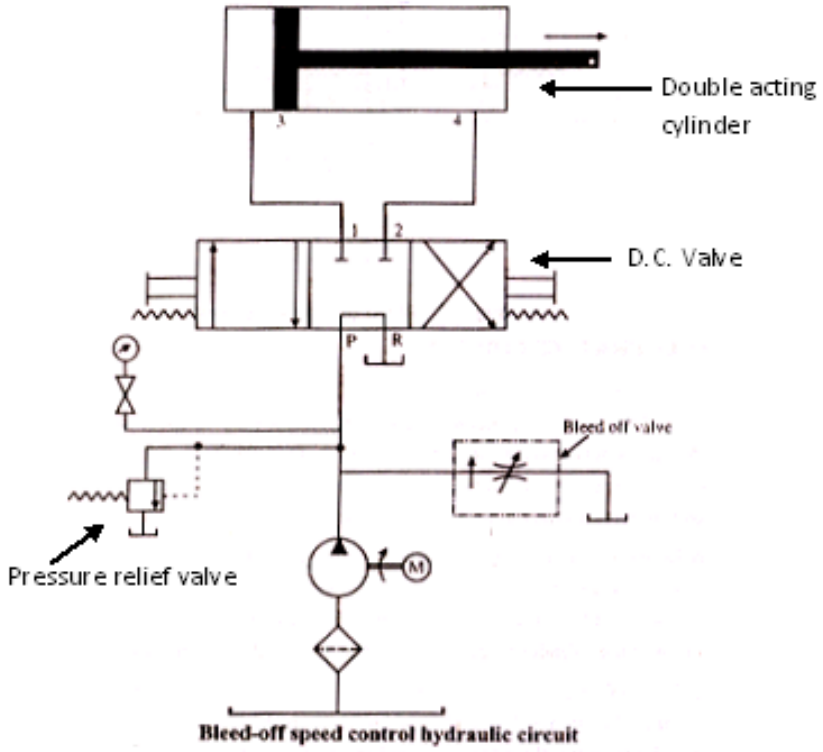
04 sketch

04 explanation

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.

b) Sketch the bleed-off-hydraulic circuit and state any two applications of it.



Bleed-off speed control hydraulic circuit

Applications:

1. broaching machine
2. shaping machine
3. planing machine
4. hydraulic motor brake circuit
5. concrete mixer on truck.

04 sketch

02 label

02 applications

c) What are the different faults that may occur in centrifugal pump and state their remedies.

A) Pump fails to start pumping

	Reason	Remedy

02 each for faults

1	Pump may not be properly primed	Reprime the pump	(4x2) Two reasons for every faults
2	Total head against which the pump is working may be more than the designed head.	Reduce the head or chang the pump	
3	Impeller, strainer or suction line may be clogged.	Clean the pump parts.	
4	Suction lift may be excessive. Check the vacuum gauge fitted on the suction side.	Reduce the suction lift.	
5	Speed may be low. Check the speed with a tachometer and compare it with the design speed.	Increase the speed.	
6	The impeller might be rotating in the wrong direction. Check the direction of the impeller with that marked on the casing.	Change the direction of rotation.	
B) Pump is not working at the required capacity.			
	Reason	Remedy	
1	There may be leakage of air into the pump through the suction line or the stuffing box.	Plug the leakage.	
2	There may be excessive wear and tear. Some of the parts may be damaged.	Replace the damaged parts.	
C) Pump stop working.			
	Reason	Remedy	
1	Air in suction line. This may be due to leakage or improper priming . Sometimes, air enters the suction pipe from the inlet.	Remove the air by priming and plug the air entry.	
2	Suction lift is high.	Reduce the suction lift.	
D) Pump has very low efficiency.			
	Reason	Remedy	
1	Speed may be high.	Reduce the speed.	
2	Head may be low and discharge may be more.	Reduce the discharge or change the pump	
3	Pump may be operating in the wrong direction.	Correct the direction of the impeller.	
4	The impeller may be touching the casing, staffing box may not be working properly, shaft may not be properly aligned or there may be excessive wear.	Repair the affected parts.	