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.

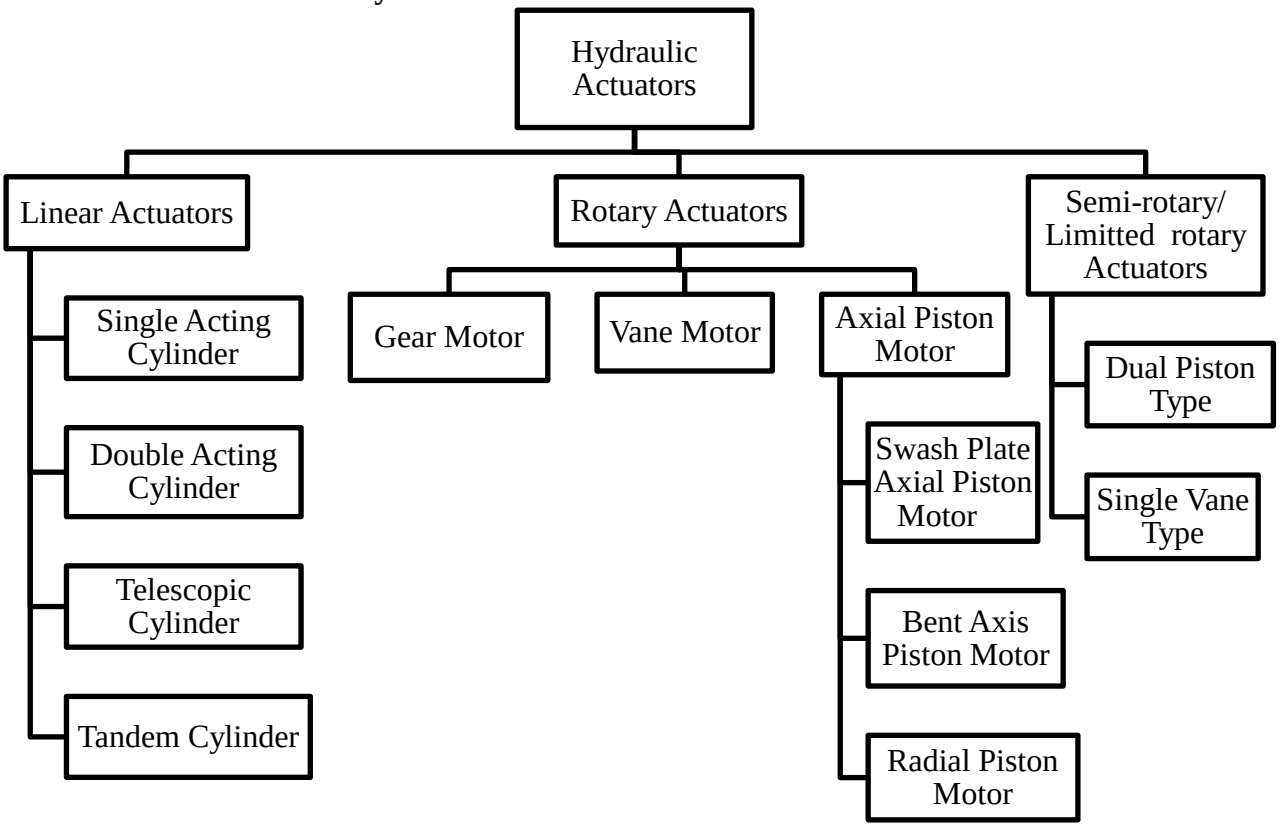
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.

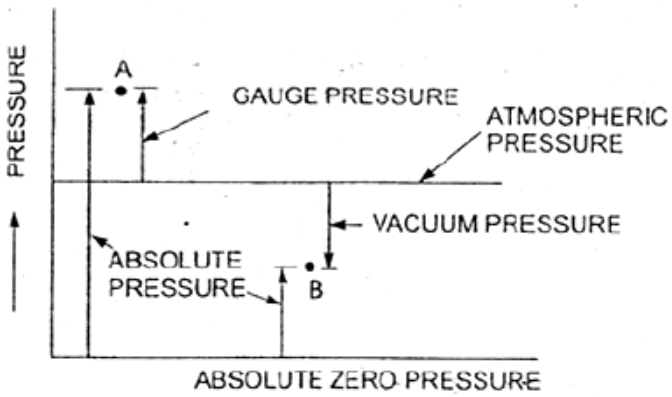
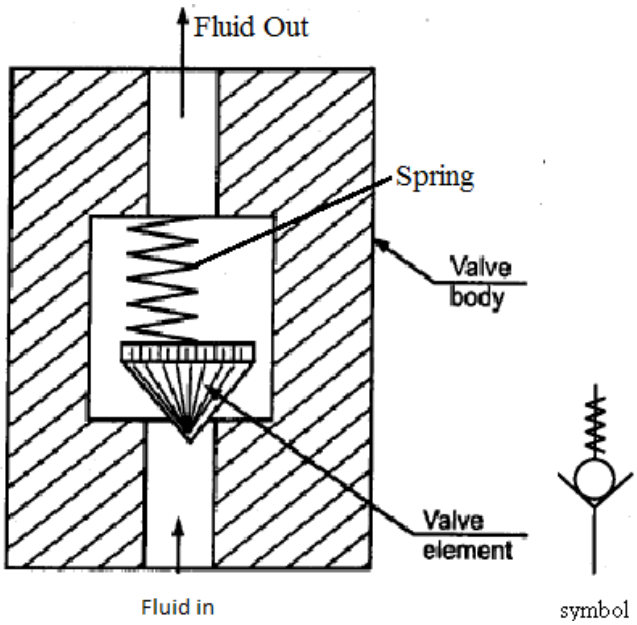
6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidate's understanding.

7) For programming language papers, credit may be given to any other program based on equivalent concept.

……

	Marks
1. a) Attempt any three of the following:	**12**
a) Define viscosity and specific gravity along with their unit.	4
Answer: Definition: *(Definition- 1 mark & its unit- 1mark)* 1. **Viscosity:** It is the property of fluid which offers resistance to the movement of one layer of fluid over another adjacent layer. **Unit**: N-s/m^2 (In SI System), dyne-sec/cm^2 (CGS), kgf-sec/m^2 (MKS) **2. Specific gravity:** It isdefined as the ratio of the weight density (density) of a fluid to the weight density (density) of a standard fluid. It is denoted by S. **Unit:** Being a ratio of two quantities with same units, Specific gravity is a pure number independent of the system of units used.	2 2
b) State two locations each, where seals and gaskets are used in hydraulic system.	4
Answer: Locations where seals and gaskets are used in hydraulic system: *(Any two locations of each - 2 marks)* **1. Seals:** i) Non- positive seal: Piston ring ii) Positive seal – Oil seal in gear pump, motors, hydraulic and pneumatic actuators. **2. Gaskets:** Cylinder head gasket, gasket in pumps, air compressor, oil pan gasket. *(Any other applications shall be considered)*	 2 2

c) Give classification of hydraulic actuator.	4
Answer: Classification of hydraulic actuator:  	4
d) Write the function of flexible hose, filters, lubricators and gaskets.	4
Answer: Function of – **1. Flexible hose:** *(any one*) 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 anywhere in complicated region very easily where rigid tubes, pipes are not possible to fit. 6) To sustain internal high pressure of hydraulic oil. **2. Function of Filters:** To remove the impurities and other foreign matters from the oil/air. **3. Function of Lubricators:** To form a mist of oil and air for the sole purpose of providing lubrication to the mating components of valves, cylinders, etc. **4. Function of Gaskets:***(any one*) 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.	1 1 1 1

B). Attempt any one of the following :	6
a) Describe meaning and relation between atmospheric gauge and vacuum pressure.	6
Answer: Relationship between atmospheric, gauge and vacuum pressure:  Figure:Relationship between atmospheric, gauge and vacuum pressures. 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.	3 3
b)Write construction and working non-return valve with neat sketch.	6
Answer- Non-Return Valve:  Figure: Non-Return Valve	3

Construction: This valve consists of valve body with inlet and outlet ports having valve element like cone, ball or spherical poppet. The valve element is incorporate with specially designed spring.	1
Working: When pressurized oil comes in through port A it will lift up the cone by overcoming spring force and flow will start from port A to port B .When flow from A stops spring will expand and cone will block the flow hence only one direction of flow is possible.	2
2. Attempt any four of the following :	16
a)Define Bernoulli's theorem and give its applications.	4
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. Mathematically, $\frac{P}{w}+\frac{V^2}{2g}+Z=\text{Constant}$ Where, $\frac{P}{w}$ = Pressure energy, $\frac{V^2}{2g}$ = Kinetic energy, Z= Potential energy	2
Applications: *(Any two)* Venturimeter, Orifice meter, Nozzle meter or Flow nozzle, Rotameter, Elbow meter (or Pipe-bend Meter), Pitot Tube	2
b) The two faults in centrifugal pumps are; fails to start pumping and lowefficiency; write two causes and two remedies of each.	4
Answer : **Causes and Remedies for faults in centrifugal pump:** **1. Fails to start Pumping:** *(Any two- 2marks)*	2

Sr	Causes	Remedies
1	Pump may not be properly primed	Fill the suction valve, suction pipe, impeller and delivery pipe up to delivery valve with liquid to be pumped
2	Total head against which the pump is working may be more than the designed head	Reduce the head or change pump with pump having higher total head.
3	Impeller, strainer or suction line may be clogged	clean the pump parts
4	Suction lift may be excessive	Reduce the suction lift
5	Speed of impeller may be too low	Check and compare it with design speed, if found low, 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 by changing electric connections, if required

2. Low efficiency: *(Any two- 2marks)* — 2

Sr	Causes	Remedies
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.

c) How priming in centrifugal pump is done? Why it is done? — 4

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 field 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. — 2

Necessity:

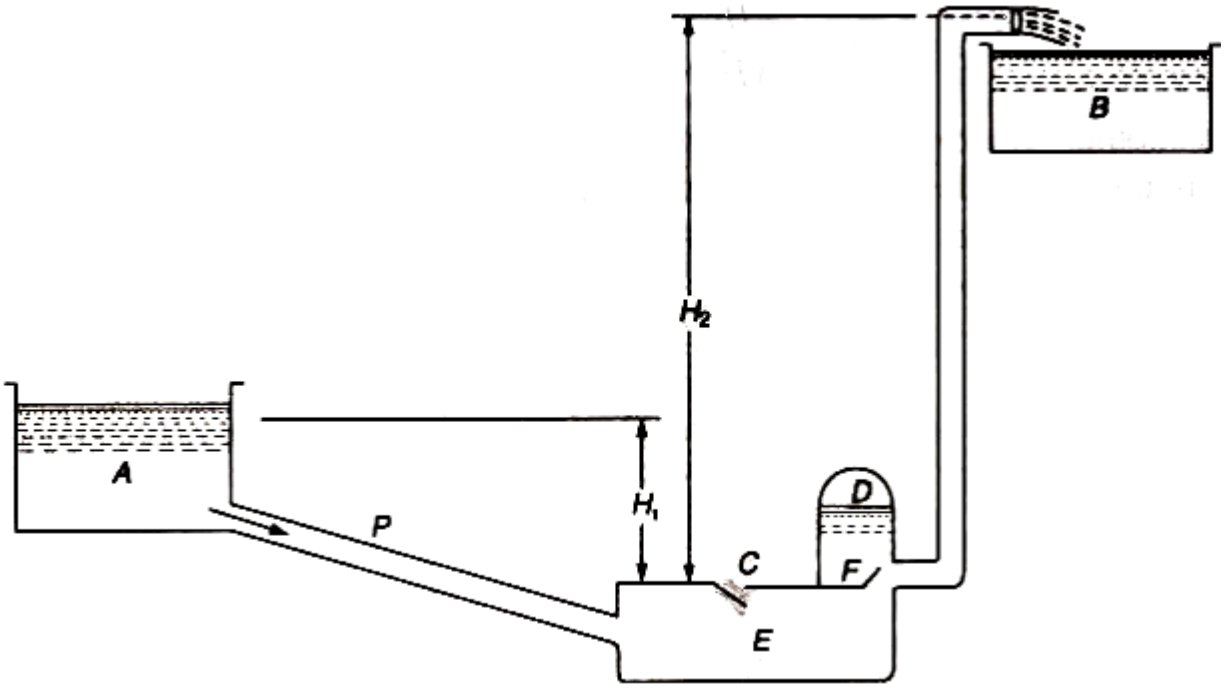
The pressure developed by the impeller of the centrifugal pump is proportional to the density of fluid in the impeller. It is thus obvious that if the impeller is running in a air, it will produce only negligible pressure which may not suck liquid from its source through the suction pipe. To avoid this, the pump is first primed. — 2

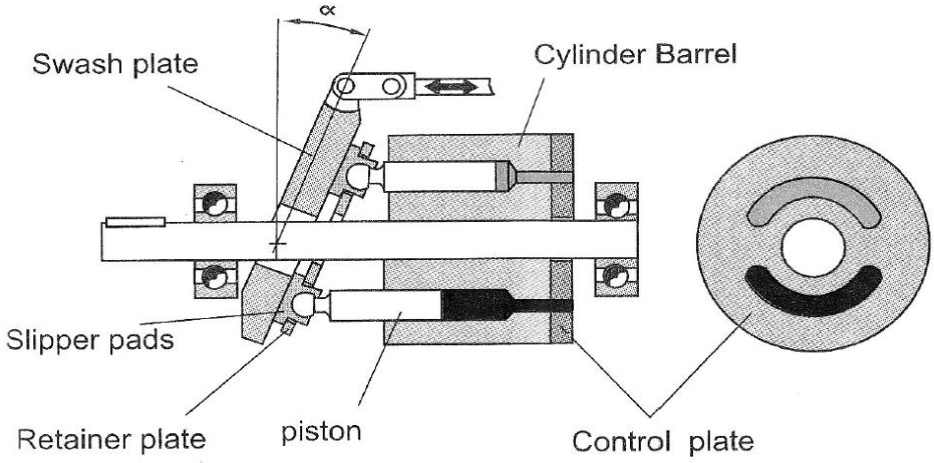
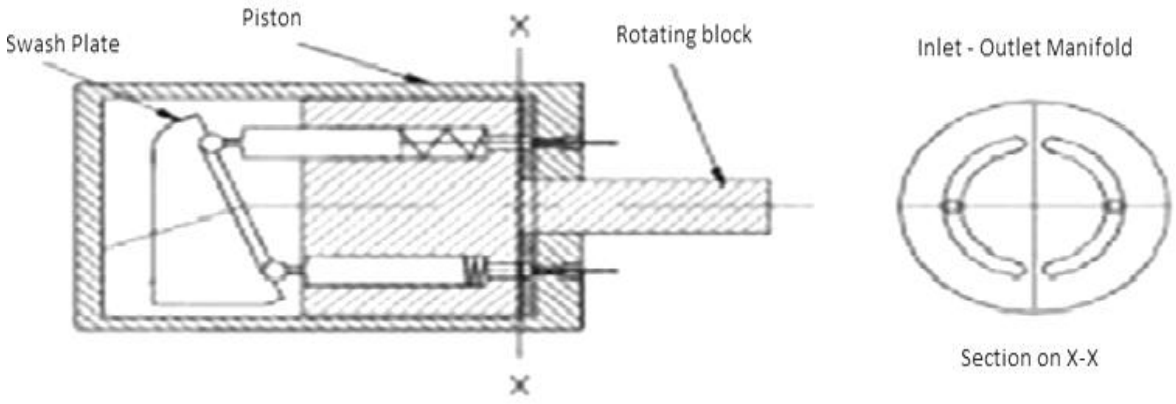
d) Compare the characteristics of vane and swash plate type pump and give one application for each pump. — 4

Answer: Comparison of the characteristics of vane and swash plate type pump: — 3

(Any three points - 1 mark each)

Sr. No	Characteristic	Vane pump	Swash plate type pump
1	Pressure	Limited pressure up to 275 bar.	High pressure capabilities up to 690 bar for certain specialized units.
2	Input speed	Moderate	High
3	Power density	Low	High
4	Conversion efficiency	Low	High
5	Inlet vacuum	Vane type pumps can handle inlet vacuum up to 152.4 mm-Hg	Swash plate type pumps can handle inlet vacuum up to 101.6 mm -Hg
6	Noise and vibration	Low	High
7	Fluid compatibility	Low range of fluid compatibility.	Great range of fluid compatibility.
8	Repair ability	Easy to repair	Requires well equipped maintenance shop to repair and test pump.

Applications of Vane pump *(Any one,1/2 mark)* 1. Aviation Service - Fuel Transfer, Deicing 2. Auto Industry - Fuels, Lubes, Refrigeration Coolants 3. Bulk Transfer of LPG and NH_3 4. LPG Cylinder Filling 5. Refrigeration - Freons, Ammonia 6. Aqueous solutions. **Applications of swash plate type pump:***(Any one, ½ mark)* 1. Used to power the hydraulic systems of jet aircraft. 2. They are also used in some pressure washers. 3. Used as hydraulic motors. 4. Used as air conditioner compressor in vehicles.	½ ½
e) Explain construction and working of Hydraulic Ram.	4
Answer : **Hydraulic Ram:***(Construction and working-2marks, Sketch-2marks)*  Figure: Hydraulic Ram **Construction:** 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. It consists of large reservoir A at smaller height, chamber E consists of waste valve C and delivery valve F. **Working:** The working of hydraulic ram is based on the principle of water hammer or inertia pressure developed in a supply pipe. 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	2 2

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.	
3. Attempt any four of the following :	16
a) Draw the labelled sketch of swash plate pump.	4
Answer: **Sketch of Swash Plate Pump:**  OR  Figure: Swashplate Pump	4
b) Explain construction and working of 4/2 DC valve which is used in hydraulic systems.	4
Answer: **Construction of 4/2 DC valve:** It consists of a shaft sliding in a bore which has large groove around the circumference. The spool is sealed along the clearance between moving spool and valve body. The grooves guide the fluid flow by interconnecting or blocking the ports. Spring is fitted in bore to bring the spool back to original position. A four-way has four ports labeled P, T, A and B. P is the pressure inlet port. T is the tank; A and B are outlet ports to the system.	1

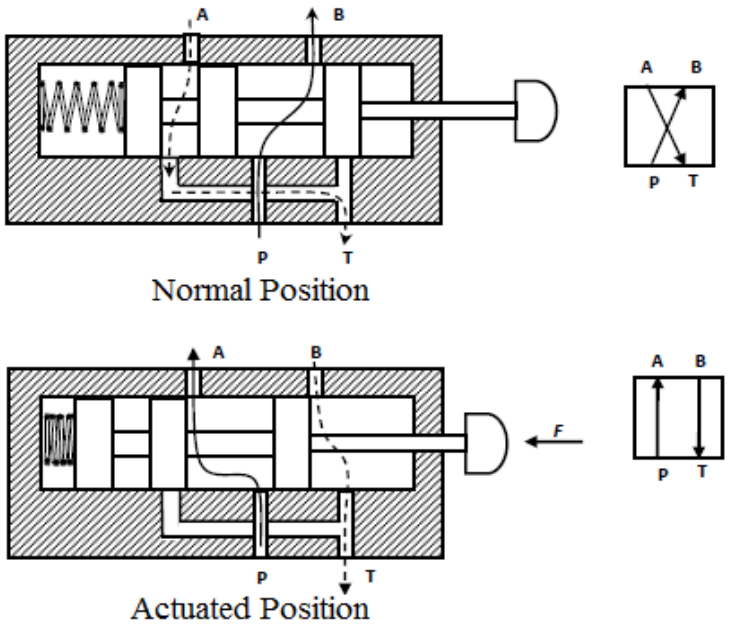


Figure: 4/2 DC valve

Working of 4/2 DC valve:

It has two switching positions.
In the normal position, pump flow is sent to outlet B. Outlet A is connected to the tank.
In the actuated position, the pump flow is sent to port A. Port B connected to tank T.
As soon as actuating force is released from spool, compression force of spring brings the spool back to original position.

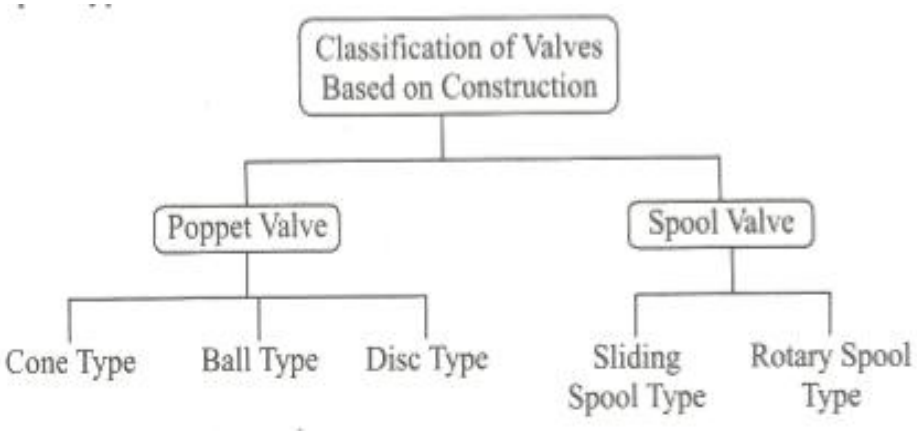
(Note: Credit shall be given to any equivalent sketch and relevant description of 4/2 DC Valve)

2

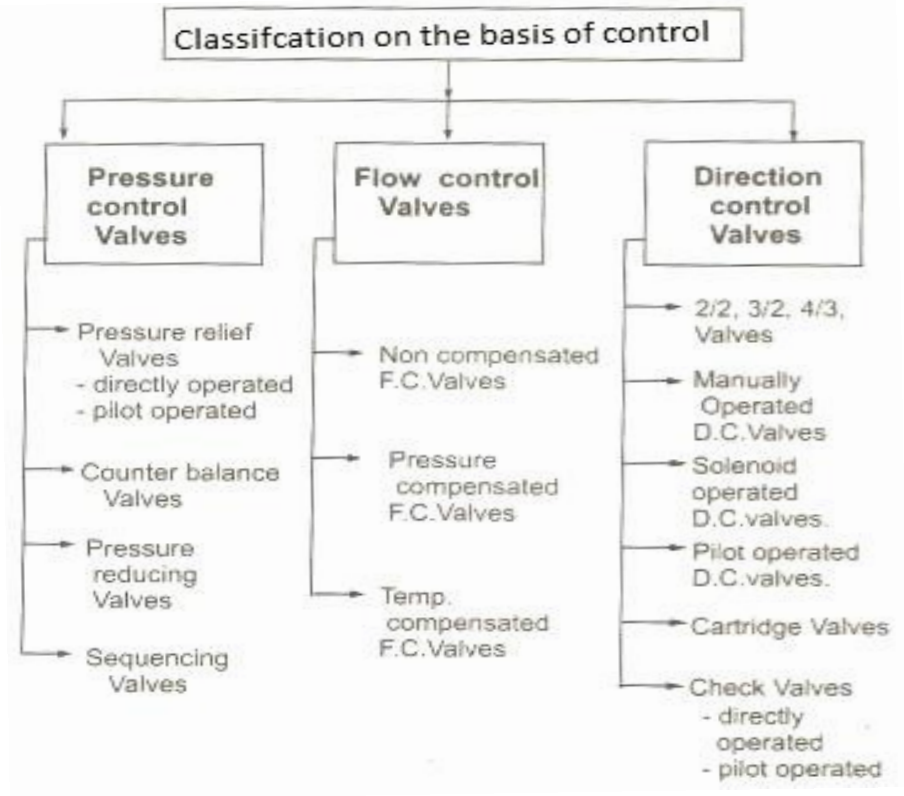
1

c) Give the classification of valves. 4

Answer: Classification of valves:



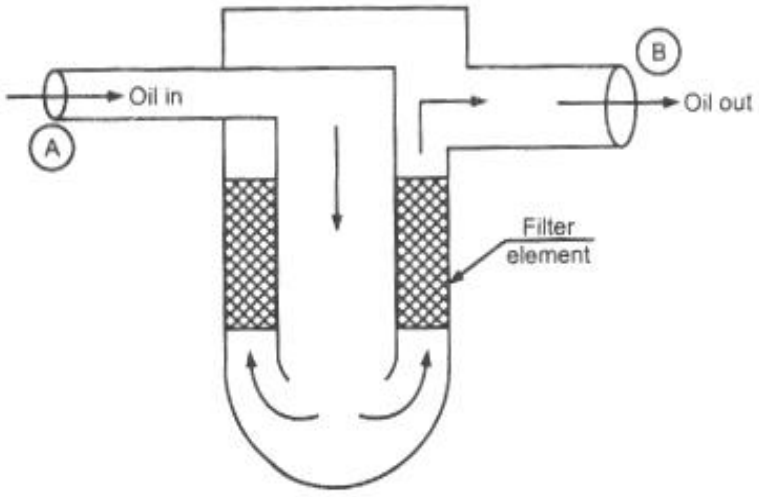
4



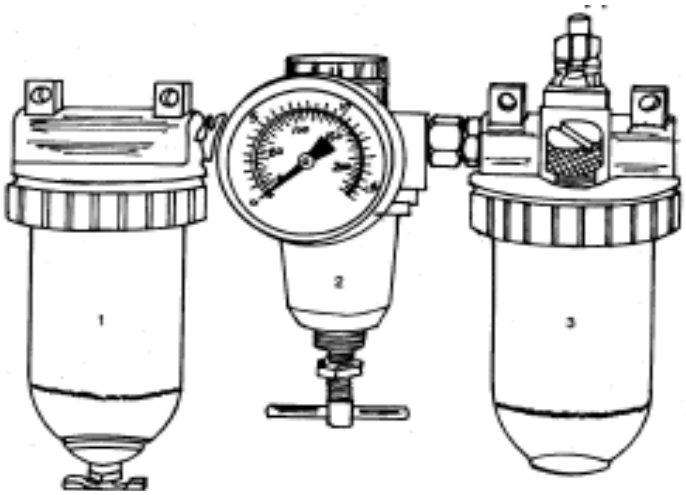
d) Explain full flow hydraulic filter with neat sketch. 4

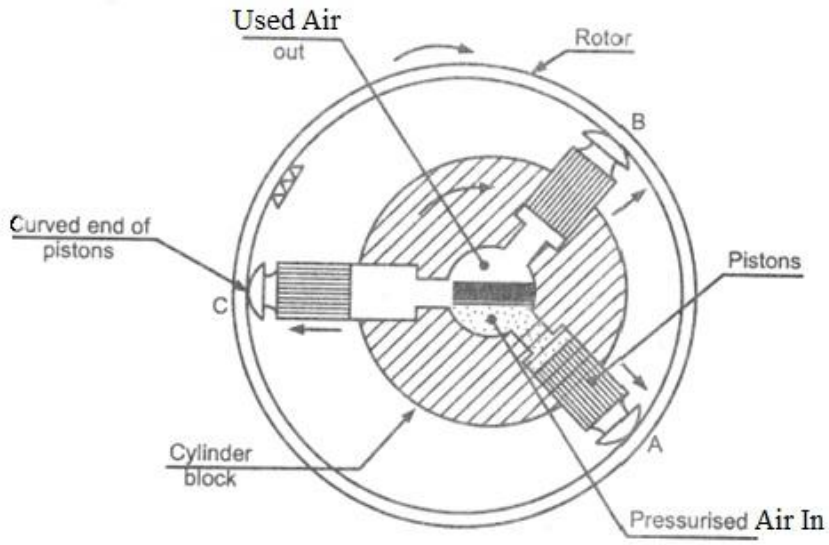
Answer: Full flow hydraulic filter:

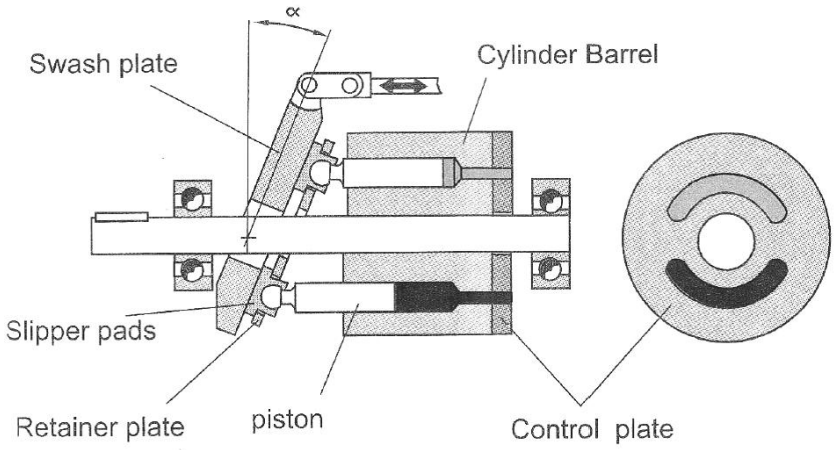
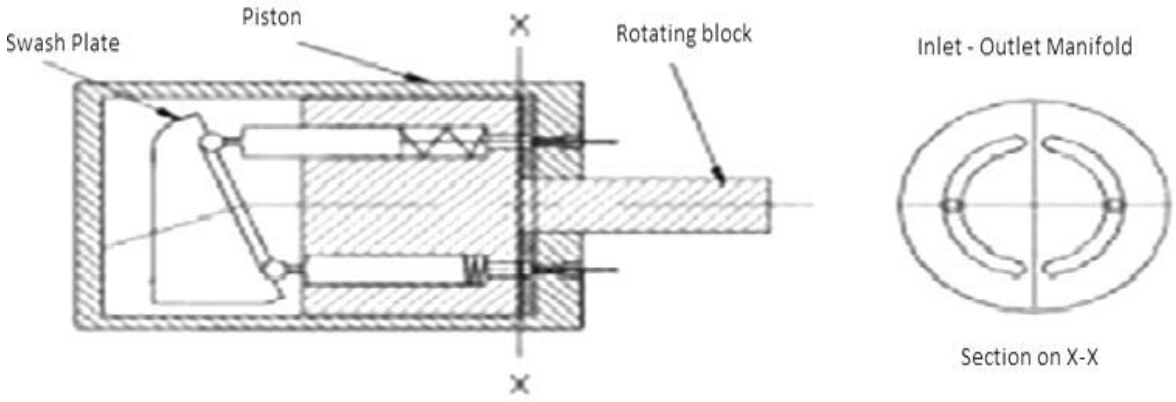
As shown in figure, in full flow filter oil comes in through port A, passes through filter element and goes out through port B. In this filter all flow passes through filter, hence it is called as a full flow filter. This is very efficient filter but only drawback of this filter is that there is large pressure drop. It increases due to clogging of filtering element. 2



Full Flow Filter 2

e) Explain working of the FRC unit with neat sketch.	4
Answer: Working of the FRC unit: FRC unit means Filter Regulator Combine unit. Most of the pneumatic system uses FRL unit. Main elements of FRL unit are: Filter, Regulator, and Lubricator.  **1. Filter:** Air enters the inlet port of the air filter through angled louvers. The centrifugal action of the rotating air causes the larger pieces of dirt and water particles to be thrown against the inner wall of the filter bowl. These contaminants then flow down into the bottom of the filter bowl. A baffle prevents turbulent air from splashing water on to the filter element. The air then passes through the filter element, where the fine dirt particles are filtered out. The compressed air then exits through the outer port to regulator. **2. Relieving or Venting Type Pressure regulator:** Outlet pressure is sensed by a diaphragm preloaded with an adjustable pressure setting spring. The compressed air, which flows through a controlled cross section at the valve seat, acts on the other side of the diaphragm. The diaphragm has large surface area exposed to secondary (outlet) pressure and is quite sensitive to its fluctuations. The movement of diaphragm regulates the pressure. **3. Lubricator:** As air enters the lubricator, its velocity is increased by a venture ring. The pressure at the venture ring will be lower than the atmospheric pressure and the pressure on the oil is atmospheric. Due to this pressure difference between the upper chamber and lower chamber, oil will be drawn up in a riser tube. Oil droplets mix with the incoming air and form a fine mist. The needle valve is used to adjust the pressure difference across the oil jet and hence the oil flow rate. The air – oil mixture is forced to swirl as it leaves the central cylinder so that large particles of oil goes back to bowl and only the mist goes to outlet.	1 3
4. A) Attempt any three of the following:	12
a) What is the Pascal's law? State its applications.	4
Answer: **Pascal's law**: 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.	2

$p_x = p_y = p_z$ 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 of Pascal's law:** *(Any two)* Hydraulic press, Hydraulic brakes, Hydraulic jack, hydraulic lift.	2
b) Explain construction and working of piston type air motor.	4
Answer: **Construction and Working of Piston type air motor:** *(Description -2 marks, Sketch – 2marks)* **1) Radial Piston Motor:** In this, three pistons are 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 the cylinder under pressure, piston will pushed outward in its cylinder. This principle is used in this motor. Suppose compressed air under pressure is admitted to cylinder A, piston will move outward in its cylinder. 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 start which results in rotational motion of rotor. These motors produce high power and torque.  Figure: Radial Piston Motor **OR** **2) Axial Piston motor :** **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. The figure illustrates the inline design in which the motor, drive shaft and cylinder block are cantered 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	2 2 2

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.  **OR**  Figure: Swashplate Pump	
c) Draw neat sketch of proportional type of filter and write its construction and working with principle.	4
Answer: **Proportional flow filter:** **Working principle**: By reducing cross sectional area of flow passage, a pressure difference is created, due to which proportionate quantity of oil passes through filter element. **Construction and Working:** Main parts of Proportional flow filter are**:** Venturi passage, Filtering element. 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 proportionate quantity passes through filter element. In this filter the pressure drop is very low hence is having wide application	1 2

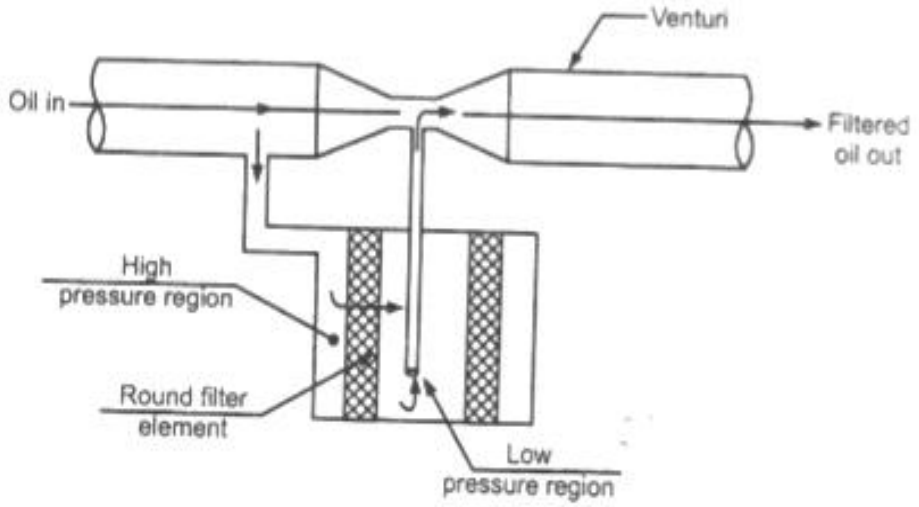


Figure: Proportional Flow Filter

1

d) Draw general layout of pneumatic system and label the components. 4

Answer: General layout of pneumatic system:

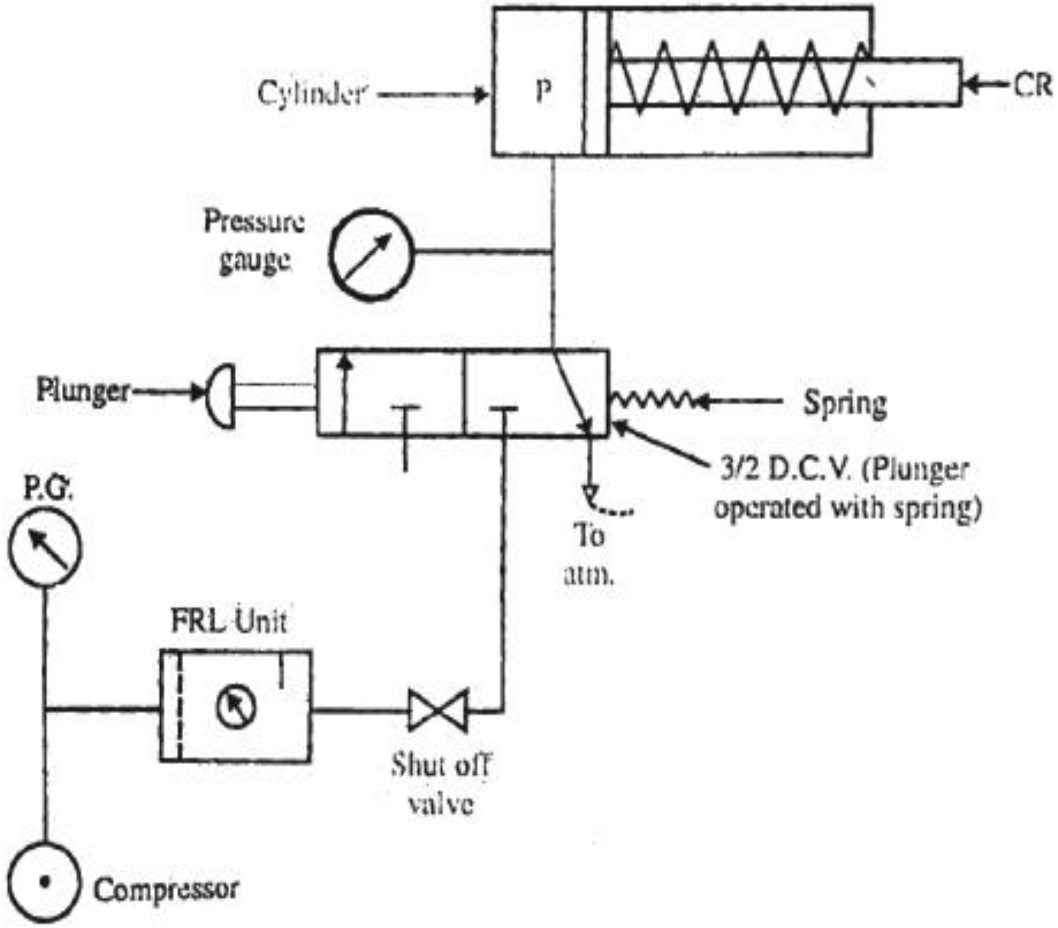


Figure: General layout of pneumatic system

4

4.B) Attempt any one of the following:	6
a) Draw layout of hydraulic steering system. Explain its working.	6

Answer: Working of Hydraulic steering system:

In this system, Pump is driven by engine of vehicle. Pump supplies pressurized oil through specially designed direction control valve. When steering wheel is almost steady and there are very low manual effort at steering wheel the hydraulic oil enters into double acting cylinder through port A and B in equal amount and applies equal and opposite pressure on piston, hence piston is steady.

As soon as the driver applies more efforts than predetermined value, the steering arm actuates the direct control valve. This valve senses the input pressure at steering wheel and directs the pressurized oil to double acting cylinder through port A. Naturally piston will move towards left. The piston rod will move the rack towards left and pinion will rotate to help the driver. Due to additional efforts driver can easily turn the steering wheel. 3

The oil from double acting cylinder will return via port B and direction control valve to oil reservoir. If oil is supplied through port B then piston will move towards right and oil will return to oil tank through port A.

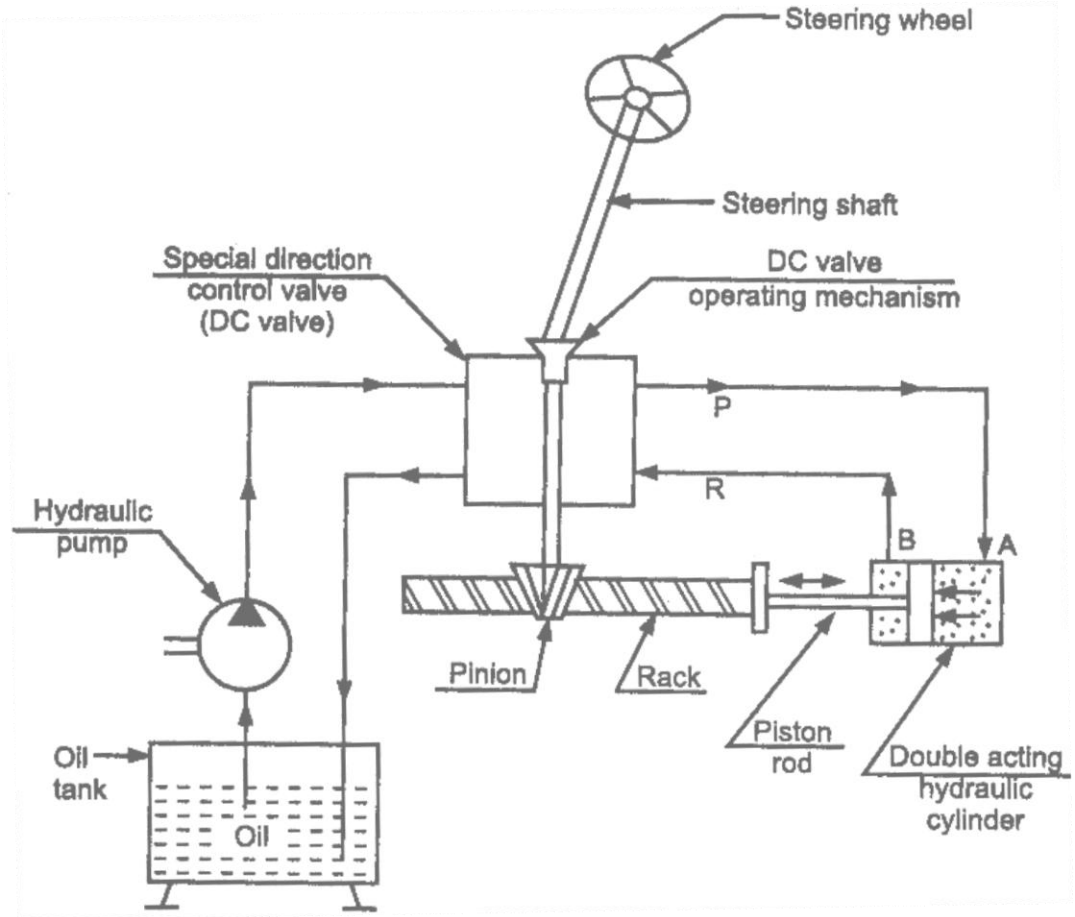


Fig. Layout of hydraulic steering system 3

b) Compare hydraulic and pneumatic circuit on the basis of- fluid used, ease of operation, noise, speed, cost, application. — 6

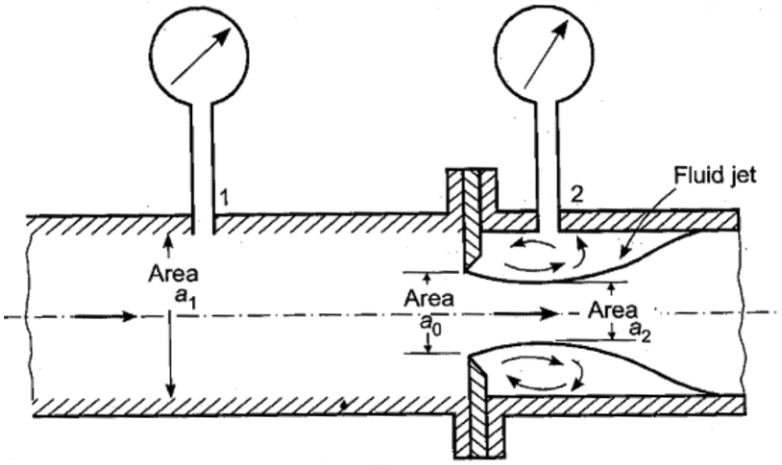
Answer: — 6

Sr. No	Basis	Hydraulic circuit	Pneumatic circuit
1	Fluid used	Hydraulic oil	Air
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 cost. Overall cost is moderate to high.	Low operating and maintenance cost. 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.

5. Attempt any two of the following: — 16

a) Derive an expression of discharge through orifice meter. — 8

Answer: **Expression of discharge through orifice meter:**



2

Fig. Orifice meter.

Let,

P_1 = Pressure at section 1

V_1= Velocity at section 1

a_1 = area of pipe at section 1

P_2, V_2, a_2 are corresponding values at section 2

Applying Bernoulli's equation at section 1 and 2

$$\frac{P_1}{\rho g}+\frac{V_1^2}{2g}+z_1=\frac{P_2}{\rho g}+\frac{V_2^2}{2g}+Z_2$$ — 1

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

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

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

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

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

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

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

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

Thus, Actual velocity at section 2

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

Discharge at section 1 & 2 is

$$Q=a_1v_1=a_2v_2 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3)$$ 1

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

$$a_2=c_c.a_0$$

C_c = Coefficient of contraction

Thus introducing value of a_2 in equation (3)

$$a_1v_1=a_2v_2$$

$$a_1v_1=c_c.a_0v_2$$

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

By substituting value of v_1 in equation (2)

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

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

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

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

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

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

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

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

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

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

Now $Q = a_2 v_2$

$Q = c_c . a_0 v_2$

Put valve of a_2

And $c_c . c_v = c_d$

c_d = coefficient of discharge through orifice

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

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

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

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

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

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

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

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

$Q = \frac{c.a_0.a_1\sqrt{2gh}}{\sqrt{a_1^2 - a_0^2}}$ c = coefficient of discharge for and orifice meter Above equation gives expression for discharge through an orifice meter.	2
b) What is negative slip in reciprocating pump and why air vessel is used in the pump?	8
Answer: Negative slip in reciprocating Pump: Slip of pump means difference between the theoretical discharge and actual discharge of the pump. i.e. Slip = Q_{th} - Q_{act}. If actual discharge is more than the theoretical discharge, in which case C_d will be more than one and the slip of pump will be negative. In that case slip of the reciprocating pump is known as negative slip. Negative slip occurs when delivery pipe is short, suction pipe is too long and pump is running at high speed. This is so because for such pumps the inertia pressure in the suction pipe will be large in comparison to the pressure on the outside of the delivery valve, which may cause delivery valve to open before the suction stroke is completed. Some liquid is thus pushed directly into the delivery pipe even before the delivery stroke is commenced, which results in making the actual discharge more than the theoretical discharge **Purpose of Air vessel used in the pump:** An air vessel is fitted to the suction pipe and to the delivery pipe at a point close to the cylinder of reciprocating pump for the purpose of: 1. To obtain a continuous supply of liquid at uniform rate. 2. To save a considerable amount of work in overcoming the frictional resistance in the suction and delivery pipes. 3. To run the pump at high speed without separation and cavitation. 4. Large amount of power is saved due to low acceleration head	4 4
c) Draw meter-in circuit and explain its working.	8
Answer: Working of Meter-in circuit: Figure shows a meter in circuit in which the flow control valve is placed in the primary line, directly after load. In meter in circuit speed control is achieved by changing the flow adjustment of flow control valve which controls the oil going to the blind end of the cylinder. When spool valve is operated pump is connected to blind end of cylinder thus piston moves forward causing work done. During return stroke the fluid returns back through non return valve. Meter in circuit are generally used when load characteristics are constant and positive, in grinding and milling machine.	4

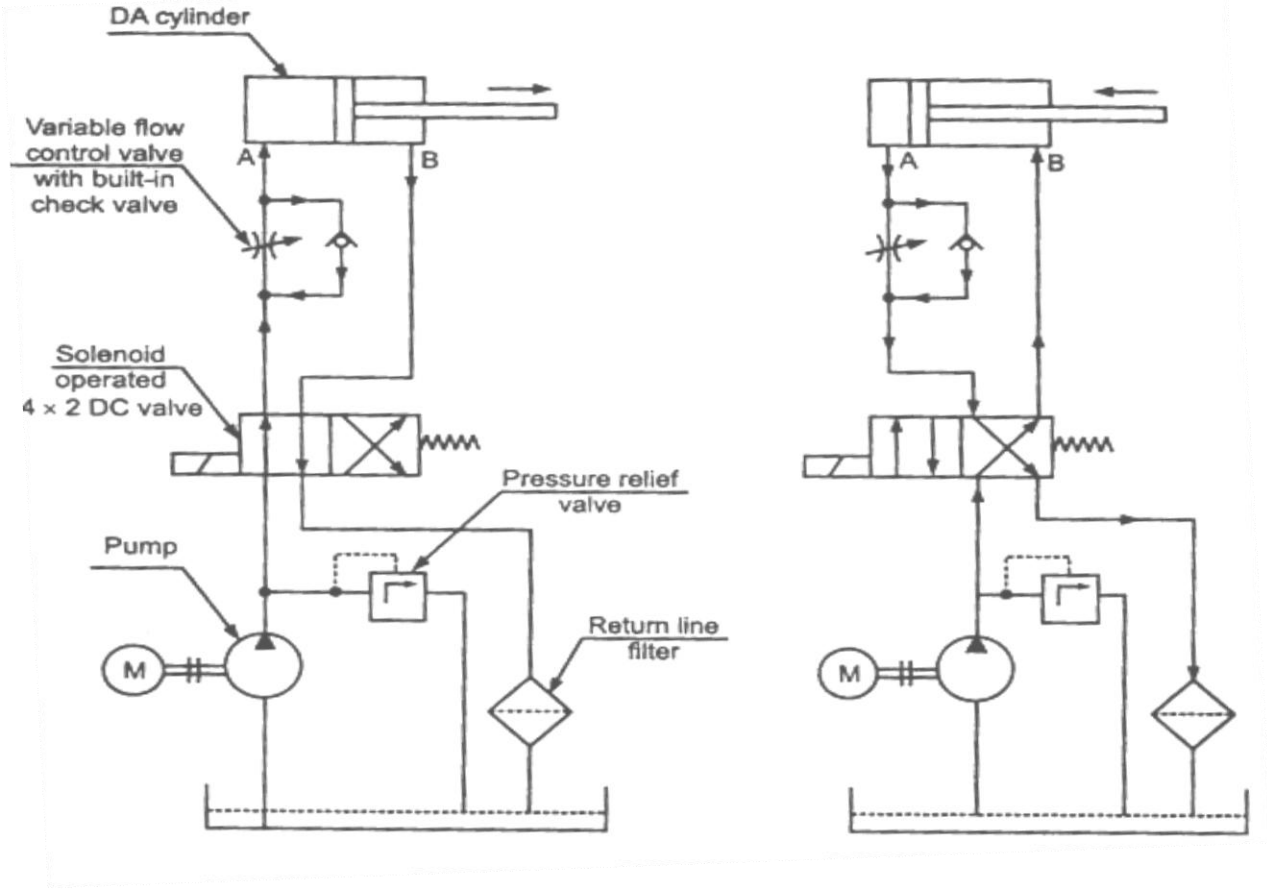


Fig. Meter in Circuit

4

6. Attempt any two of the following:	16
a) A Oil of specific gravity 0.8 is flowing through horizontal venturimeter having inlet diameter 30 cm and throat diameter is 15 cm. The differential manometer shows reading of 30cm of mercury. Calculate discharge of oil through venturimeter if C_d =0.98.	8

Answer: Given,

Specific gravity of oil, $S_o = 0.8$

Specific gravity of mercury, $S_m = 13.6$

Reading of differential manometer $x = 30\,cm$

$C_d = 0.98$

Difference of pressure head

$$h = x\left[\frac{S_m}{S_0} - 1\right]$$

1

$$= 30\left[\frac{13.6}{0.8} - 1\right]$$

$= 30(17-1)$

$h = 480\,cm$ of oil — 1

Diametere at inlet, $d_1 = 30\,cm$

$$a_1 = \frac{\pi}{4} d_1^2$$

$$a_1 = \frac{\pi}{4} \times (30)^2$$

$a_1 = 706.858\,cm^2$ — 1

[Diametere at throat, $d_2 = 15\,cm$]

$$a_2 = \frac{\pi}{4} d_2^2$$

$$= \frac{\pi}{4} \times (15)^2$$

$a_2 = 176.715\,cm^2$ — 1

Discharge of oil through venturimeter,

$$Q = \frac{C_d . a_1 a_2 \sqrt{2gh}}{\sqrt{a_1^2 - a_2^2}}$$ — 1

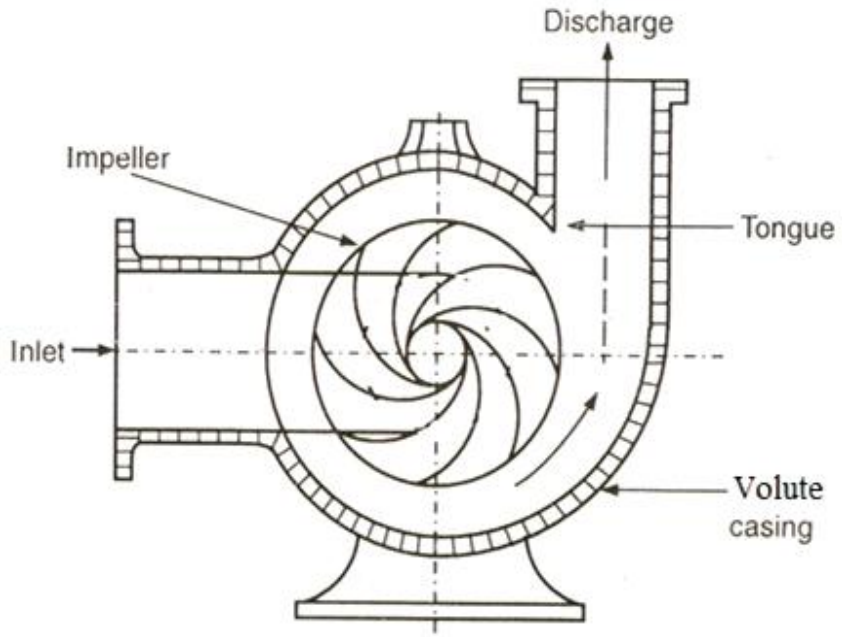
$$Q = \frac{0.98 \times 706.858 \times 176.715 \times \sqrt{2 \times 981 \times 480}}{\sqrt{\left[(706.858)^2 - (176.715)^2\right]}}$$

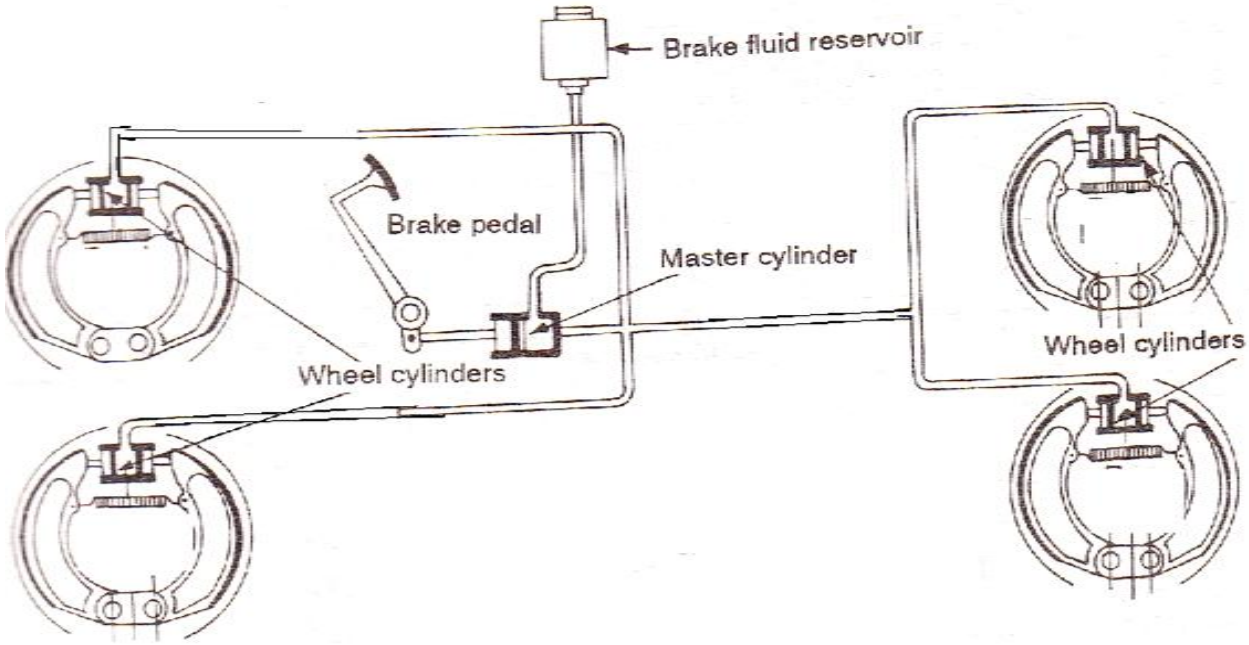
$$Q = \frac{118.796 \times 10^6}{684.412}$$

$Q = 173.574 \times 10^3\ cm^3/s$

$Q = 173.574$ liters/s — 3

Discharge of oil through venturimeter is 173.574 liters /s.

b) Explain construction and working of centrifugal pump with neat sketch. Give its two applications.	8
Answer: Construction of centrifugal pump: Main parts of centrifugal pumps are: 1. Impeller. 2. Casing. 3. Suction pipe with foot valve and strainer. 4. Priming cup and delivery pipe with delivery valve. 5. Prime mover (Electric motor or engine) to drive the pump.	1
Working of centrifugal pump: The first step in the operation of a centrifugal pump is priming so that no air pocket is left. After pump is primed, the electric motor is started to rotate the impeller. The rotation of impeller forces the water in radially outward direction in delivery pipe with high velocity. This high velocity water gets converted into high pressure when it passes through spiral casing. At the eye of the impeller due to centrifugal action partial vacuum is created. This causes liquid from the sump to rush through suction pipe to the eye as sump is at atmospheric pressure. This high pressure of liquid leaving the impeller is utilized in lifting the liquid to the required height through the delivery pipe.	3
 Figure: Centrifugal Pump	2
Applications of centrifugal pump: *(Consider any two)* 1. In domestic purpose for pumping water. 2. For pumping stringy solids and debris-laden liquids. 3. For pumping oil and other viscous liquids. 4. For pumping sewage and waste water. 5. Used for high volume water pumping at low to medium heads. 6. Boiler water feed pumps. 7. Used in handling sugarcane juice in sugar factories 8. Used in milk processing plants. 9. Submerged centrifugal pumps are used to handle acids in chemical plants.	2

c) Draw the neat labeled layout of hydraulic braking system and explain its working.	8
Answer: Layout of Hydraulic Braking System:  Figure: Layout of Hydraulic Braking System **Working:** In hydraulic braking systems, the pressure applied at the brake pedal is transmitted to the brake mechanism by a liquid. Since a liquid cannot be compressed under ordinary pressures, force is transmitted solidly just as if rods were used. Force exerted at any point upon a confined liquid is distributed equally through the liquid in all directions so that all brakes are applied equally. In a hydraulic brake system, the force is applied to a piston in a master cylinder. The brake pedal operates the piston by linkage. Each wheel brake is provided with a cylinder. Inside the cylinder are opposed pistons which are connected to the brake shoes. When the brake pedal is pushed down, linkage moves the piston within the master cylinder, forcing the brake liquid or fluid from the cylinder. From the master cylinder, the fluid travels through tubing and flexible hose into the four wheel cylinders. The brake fluid enters the wheel cylinders between the opposed pistons. The pressure of the brake fluid on the pistons causes them to move out. This forces the brake shoes outward against the brake drum. As pressure on the pedal is increased, more hydraulic pressure is built up in the wheel cylinders and more force is exerted against the ends of the brake shoes. When the pressure on the pedal is released, retracting (return) springs on the brake shoes pull the shoes away from the drum. This forces the wheel cylinder pistons to their release positions and also forces the brake fluid back through the flexible hose and tubing to the master cylinder.	4 4