MODEL ANSWER

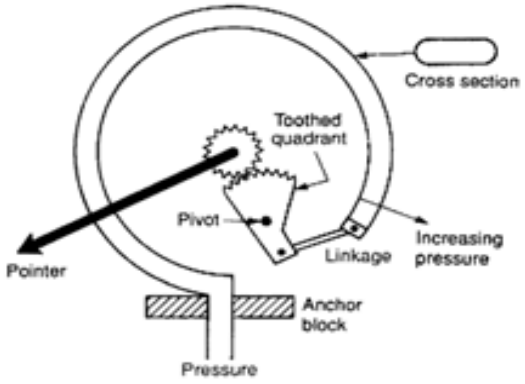
Summer-18 EXAMINATION

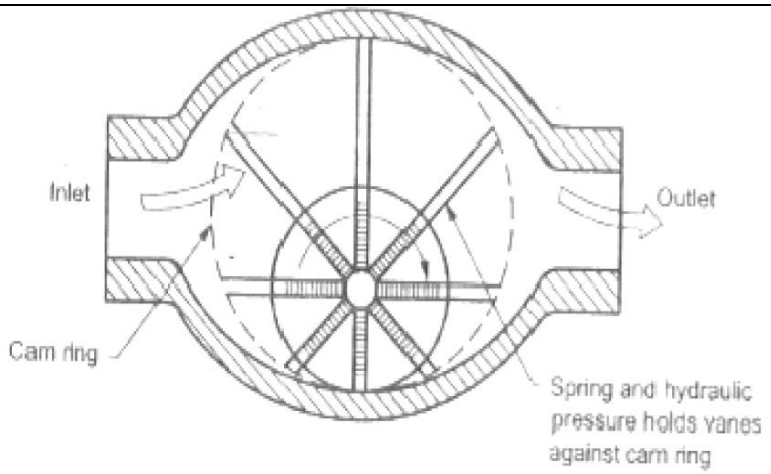
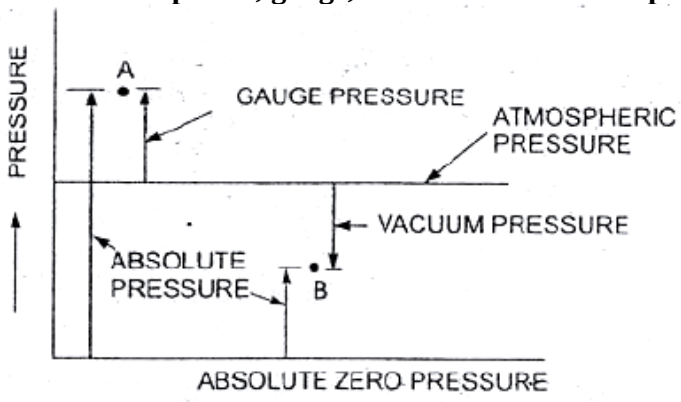
Subject Title: Hydraulic and Pneumatics **Subject Code:** 17522

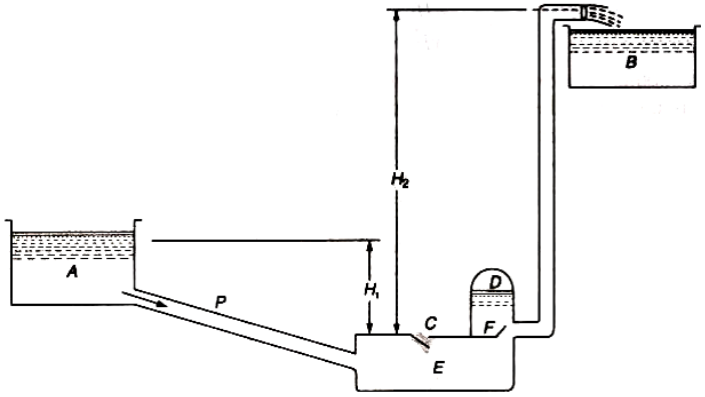
Important Instructions to examiners:

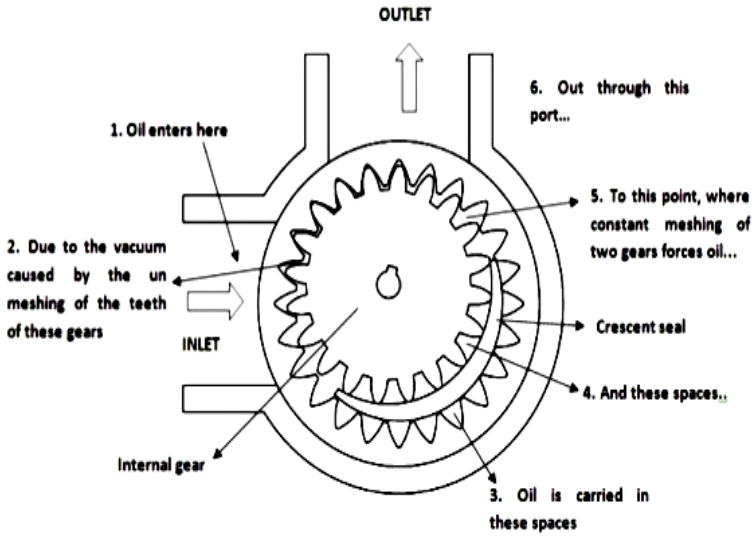
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

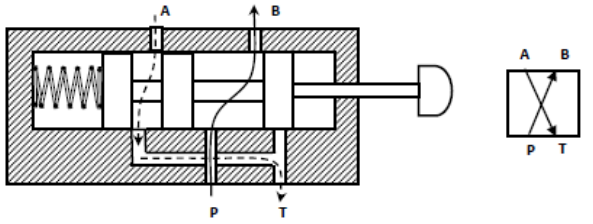
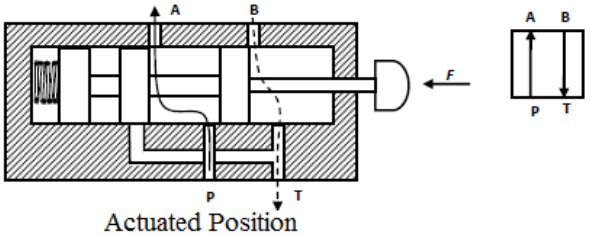
Q. No.	Sub Q. N.	Answer	Marking Scheme
1	a)	**Attempt any THREE of the following.**	12
	(i)	**Define surface tension and viscosity with their unit**	04
	Ans	**Surface Tension:** It is a tensile force acting on the surface of liquid in contact with air (or gas), such that this surface behaves like elastic membrane under tension **S. I. unit is N/m** **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/m2**	01 01 01 01
	(ii)	**Explain working of Bourdon tube pressure gauge with neat sketch**	04
	Ans	**Working:** It is a device which is used for the measurement of high pressure as well as pressure above or below the Atmospheric Pressure. 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	02

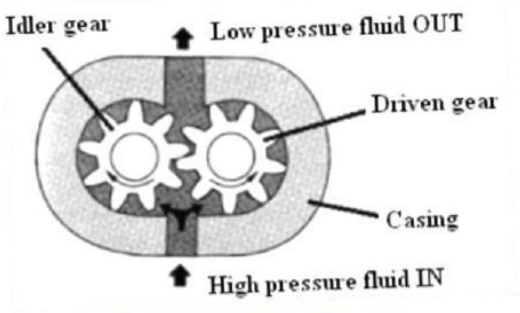
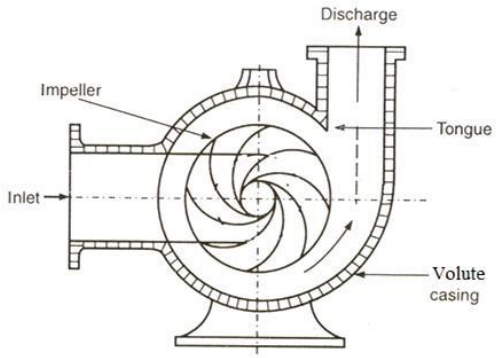
		 **Figure: Bourdon tube pressure gauage**	02
	(iii)	**What is priming? State need of priming.**	04
	Ans	**Priming of Centrifugal pump:** It is the operation in which the suction pipe, casing of the pump and the portion of delivery pipe up to delivery valve is completely filled with the liquid which is to be raised by pump. This operation is carried out only once before starting the pump thus air within these parts is removed. **Need of priming:** The pressure developed by the impeller of the centrifugal pump is proportional to the density of fluid in the impeller. It is thus obvious that if the impeller is running in air, it will produce only negligible pressure which may not suck liquid from its source through the suction pipe. To avoid this priming is necessary. Priming reduces the risk of pump damage during start-up as it prevents the dry run. Pump runs smooth and delivers continuous discharge of flow. Priming reduces noise, vibrations in pump.	02 02
	(iv)	**Explain working of vane pump with neat sketch**	04
	Ans	**Working of vane type pump:** Vane pump consists of a rotor in which vanes are held in a series of slots around the rotor. 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.	02

		 **Fig. Vane type pump**	02
	b)	**Attempt any ONE of the following.**	6
	(i)	**Describe the concept of atmospheric pressure, gauge pressure, Vacuum pressure, absolute pressure and relation between them with neat sketch**	6
	Ans	**Relationship between atmospheric, gauge, vacuum and absolute pressure:**  Figure: Relationship between atmospheric, gauge, vacuum and absolute pressure. 1. **Atmospheric Pressure**: At the earth surface, the pressure due to the weight of air above the earth surface is called as atmospheric pressure. 2. **Gauge Pressure:** If the pressure is measured above the atmospheric pressure, it is called as gauge pressure. 3. **Vacuum Pressure:** If the pressure is measured below the atmospheric pressure, it is called as Vacuum pressure. 4. **Absolute pressure =** Atmospheric Pressure + Gauge Pressure **Absolute pressure =** Atmospheric Pressure – Vacuum Pressure	02 01 01 01 01

	(ii)	**Explain construction and working of Hydraulic ram with neat sketch**	06
	Ans	**Hydraulic Ram:***(Construction-2marks, 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 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.	
2		**Attempt any <u>FOUR</u> of the following.**	16
	a)	**State the law of continuity and write any two application of it**	04
	Ans	**Law of continuity**: For a fluid flowing through the pipe at all cross section, the quantity of fluid per second is constant. **OR** It states that if an incompressible liquid is continuously flowing through a pipe or a channel whose cross sectional area may or may not be constant then quantity of liquid passing through it per second is same at all sections. **Applications** *(Any two-1 mark each)* **:** i) Flow through branching of pipe. ii) Steady and unsteady flow iii) Uniform and non-uniform flow iv) Compressible and incompressible flow	02 02

	b)	**Explain cavitation and reasons for cavitations in pumps.**	04
	Ans	**Cavitation**: It means formation of vapour bubbles of a flowing liquid in a region where the pressure of the liquid falls below its vapour pressure and sudden collapsing of these vapour bubbles in a region of higher pressure. When the vapour bubbles collapse, a very high pressure is created. The metallic surfaces, above which these vapour bubbles collapse is subjected to high pressure which causes pitting action on surfaces. Thus cavities are formed on metallic surface, known as cavitation. Also considerable noise and vibrations are produced. **Causes of cavitation:** *(Any two)* Cavitation in pumps is usually due to insufficient NPSH (Net Positive Suction Head) energy on the suction side of the pump. This can be caused by: 1. Having the pump at too high of a distance above the fluid source 2. Having too small of a diameter of suction pipe 3. Having too long of a distance of suction pipe 4. Having too many fittings on the suction pipe 5. Handling a liquid with a low vapour pressure 6. Running the pump too fast	02 02
	c)	**Explain working of internal gear pump with neat sketch.**	4
	Ans	(Note: Credit shall be given to any equivalent sketch and relevant description)  **Working:** External gear (driving gear) drives the internal gear (ring gear). Portion where teeth start meshing, tight seal is created. Near inlet port the vacuum is created due to quick un meshing and oil enters from oil tank through inlet port. Oil is trapped between the internal and external gear teeth on both sides of spacer (cresent) and then carried from inlet to outlet port. Meshing of gear near outlet port reduces the volume or gap and oil gets pressurized. These pumps can create pressure up to 350 bar and one other specialty of this pump is that it makes very less noise.	02 02

	d)	**Explain construction and working of 4/2 DC valve used in Hydraulic system**	4
	Ans	**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.  Normal Position  Actuated Position **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)	01 02 01
	e)	**Explain hydraulic gear motor with neat sketch**	04
	Ans	Hydraulic gear motor: Gear type motor is a rotary actuator used to rotate the shaft. It consists of two gears in mesh with each other. One gear is connected to output shaft and other is idler. Both the gears are mounted in closed casing. Pressurized fluid enters from the bottom, and pressurizes the chamber. This pressure exerts a force on teethes These forces results in rotation of both gears. This rotary motion is further used in rotation of output shaft. Gear motors suffer from leakage, which is quiet high at low speeds. Hence gear motors are used where medium speed and low torque are required.	02

		 Fig. Gear type hydraulic motor	02
3.		**Attempt any FOUR of the following.**	16
	a)	**Describe working of centrifugal pump with neat sketch**	04
	Ans	**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.  Figure: Centrifugal Pump	02 02
	b)	**Explain hydraulic jack with neat sketch**	04
	Ans	(Sketch 02Marks, working 02 Marks) **Working of hydraulic jack: -** The hydraulic jack works on Pascal's principle. Reciprocating pump is operated by moving handle up and down. During upward movement of piston (P1) oil from reservoir will be sucked in via valve (V1) due to vacuum created in cylinder During downward stroke of piston (P1) valve (V1) will close and valve (V2) will open and pressurized oil will enter into big cylinder via valve (V2).The pressurized oil will lift the piston (P2) upward and load will be lifted up.	

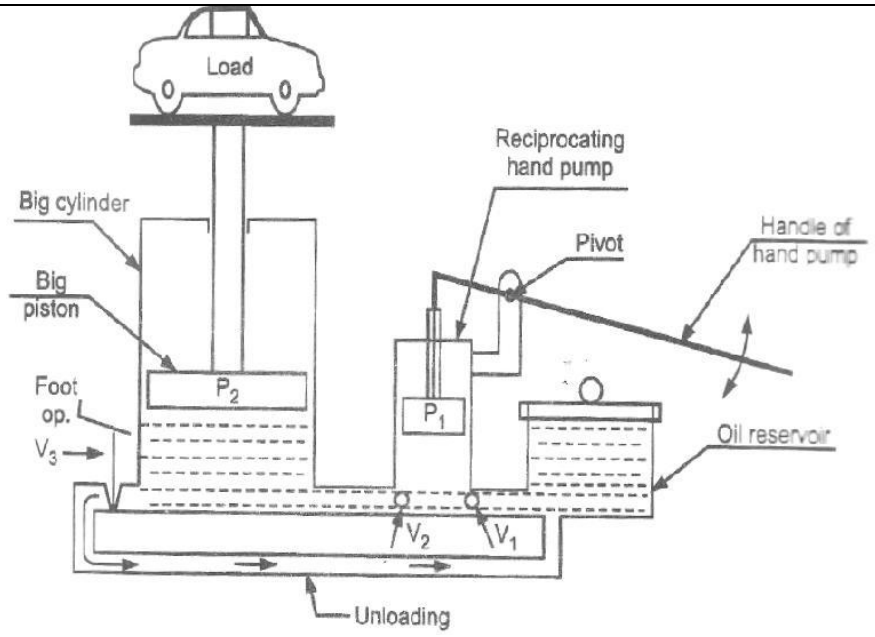


Figure Hydraulic Jack

	c)	**Explain hydraulic telescopic cylinder with neat sketch**	4
	Ans	(Note: Credit shall be given to any equivalent sketch and relevant description) Most telescopic cylinders are single acting. The telescopic cylinder is equipped with a series of nested tubular rod segments called sleeves. These sleeves work together to provide longer working stroke than possible with a standard cylinder. Up to four to five sleeves can be used. The maximum load is exerted when the cylinder is collapsed. In the extended position, the load is in function of the diameter of the smallest sleeve.	02

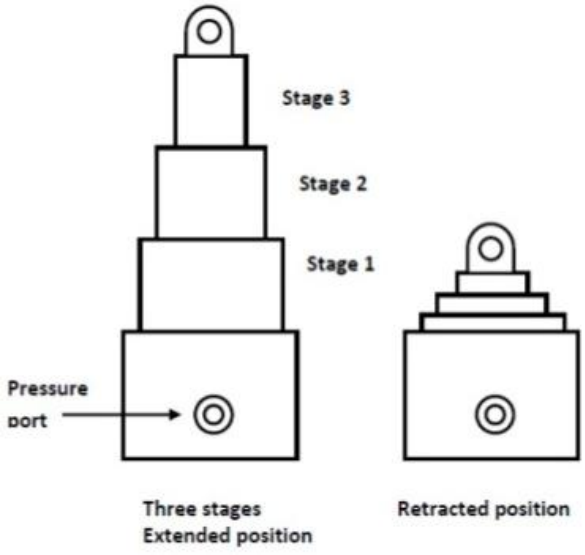
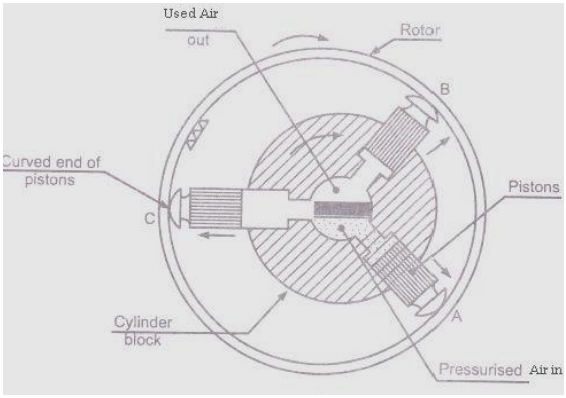
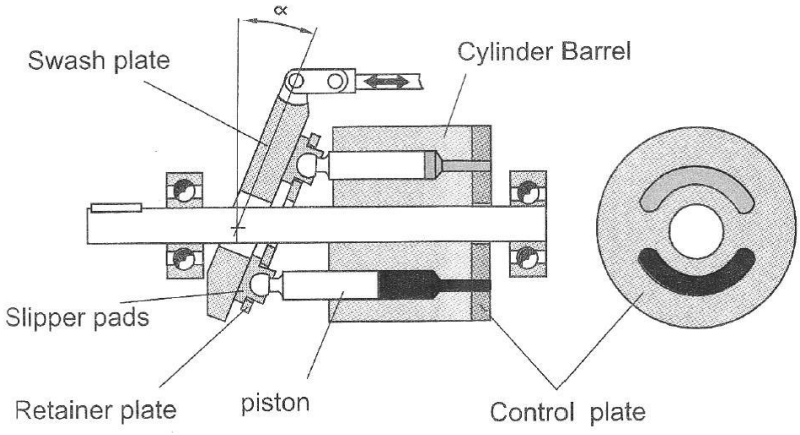
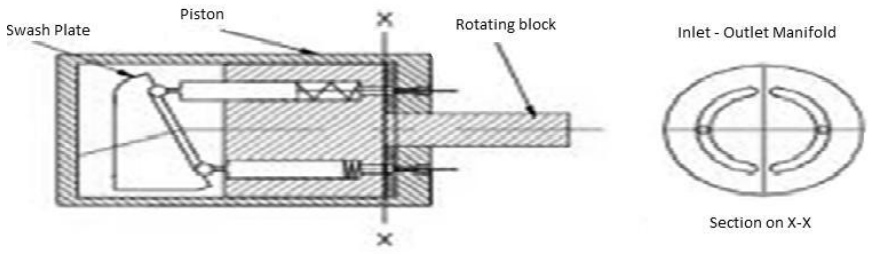
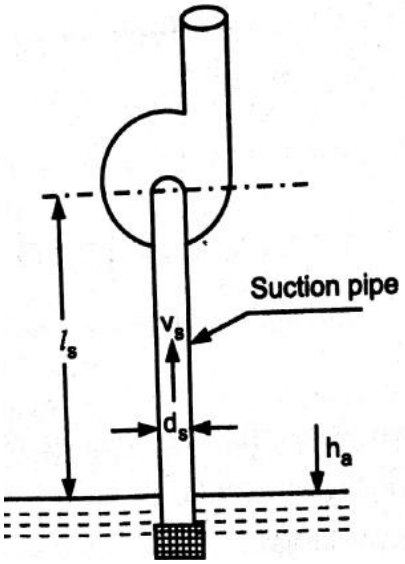


Figure: Telescopic cylinder

02

	d)	**Explain piston type air motor with neat sketch**	4
	Ans	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.  (OR) 2) Axial Piston motor :  OR	02 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.	02 02
	e)	**State function of filter and strainer**	4
	Ans	**Function of filter:** To remove the impurities and other foreign matters from the oil/air. **Function of strainer: T**o remove particulate which is visible to naked eye.(larger than 40 micron)	02 02
4.	**a)**	**Attempt any <u>THREE</u> of the following.**	12
	(i)	**Describe net positive suction head with suitable sketch**	4
	Ans	(Note: Credit shall be given to any equivalent sketch and relevant description) To avoid cavitation in centrifugal pumps, the pressure of the fluid at all points within the pump must remain above saturation pressure. The quantity used to determine if the pressure of the liquid being pumped is adequate to avoid cavitation is the net positive suction head (NPSH). The net positive suction head available is the difference between the pressure at the suction of the pump and the saturation pressure for the liquid being pumped. The net positive suction head required is the minimum net positive suction head necessary to avoid cavitation.	02



Now, let h_s = suction head

$\frac{V_s^2}{2g}$ = Velocity head in suction pipe

h_v = vapour pressure head of liquid corresponding to the temperature of liquid

Then,

Net Positive suction head = Suction Head + Velocity Head – Vapour Pressure

$$NPSH = h_s + \frac{V_s^2}{2g} - h_v$$

02

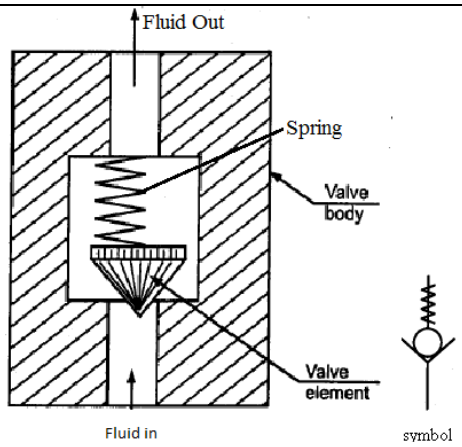
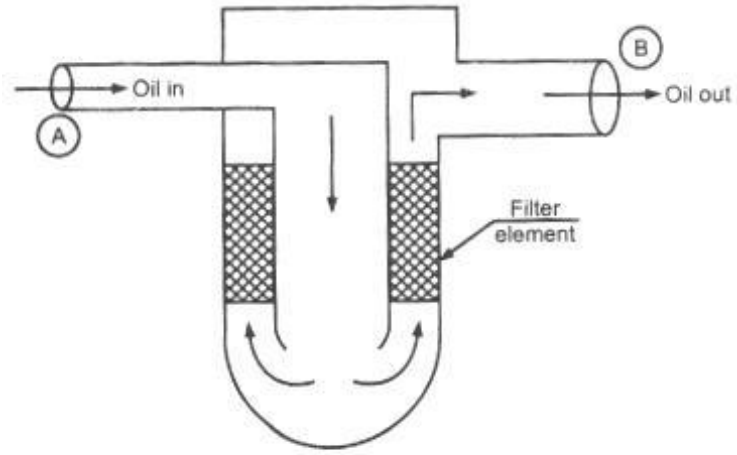
NPSH can also be determined by applying Bernolli's theorem at liquid level in sump and inlet of pump in that case

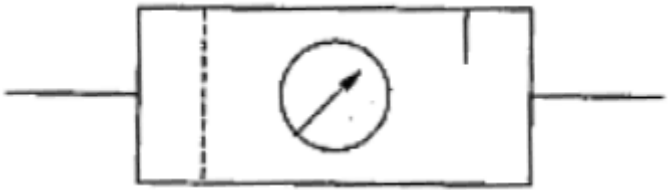
$$\boxed{NPSH = h_a - h_v - h_s - h_{fs}}$$

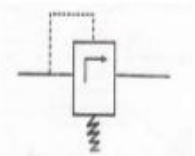
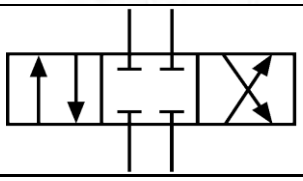
h_a = Atmospheric pressure head at sump

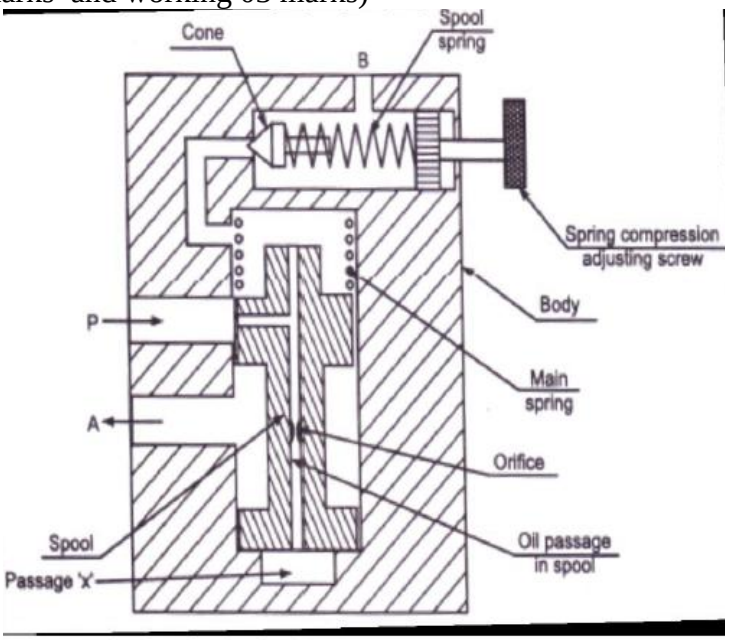
h_{fs} = head lost due to friction in suction pipe

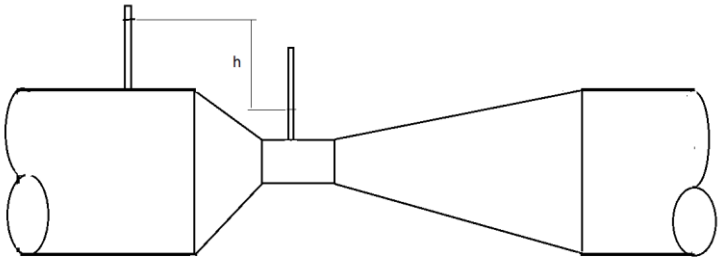
	(ii)	**Explain construction and working of Non-return valve with neat sketch**	4

	Ans	 **Figure: Non-return valve** **Construction:** This valve consists of valve body with inlet and outlet ports having valve element like cone, ball or spherical poppet. The valve element is incorporate with specially designed spring. **Working:** When pressurized oil comes in through port A it will lift up the cone by overcoming spring force and flow will start from port A to port B .When flow from A stops spring will expand and cone will block the flow hence only one direction of flow is possible.	02 01 01
	(iii)	**Explain full flow filter with neat sketch**	04
	Ans	**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.  **Full Flow Filter**	02 02

	(iv)	**Explain FRL unit with its symbol and application**	04
	Ans	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. **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.  **Application**: pneumatic systems like pneumatic hammers, vibrators, horn	02 01 01
	(v)	**Draw the symbols for :** **1) Directly operated pressure relief valve** **2) 4/3 D.C. valve** **3) Spring Loaded Accumulator** **4) Pressure switch.**	4
	Ans		

	Symbol
1) Directly operated pressure relief valve	
2) 4/3 D.C. valve	

		3) Spring Loaded Accumulator 	
		4) **Pressure switch.** 	
	b)	**Attempt any ONE of the following.**	6
	(i)	**Explain construction and working of sequencing valve with neat sketch**	6
	Ans	(Sketch 03 marks and working 03 marks)  **Figure- Sequence Valve** **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'. ***(Note: Equivalent credit shall be given to other correct diagram and suitable explanation)***	
	(ii)	**Describe seals and gasket with their function, types and material used.**	6
		Function of Seals: A mechanical seal is a device that helps join systems or mechanisms together for preventing leakage. **Types of seals:** Static, dynamic, positive, non-positive, O-ring, V-ring, U-packing, T-ring, Cup seal. **Material used for seals:**	01 01

		1) Metallic seal like Aluminum alloy. 2) Non metallic seal like Synthetic rubber. **Types of gaskets:** Rubber gasket, non-asbestos gasket, cork gasket; Flanged gasket, Spiral wound gasket; Man-way gasket, Transformer gasket **Function of Gaskets:** 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. **Material used for gasket:** Paper, rubber, silicone, metal, cork, paper, rubber, silicone, metal etc.	01 01 01 01
5		**Attempt any Two of the following.**	
	(a)	**Derive an expression of discharge through venturimeter.**	8
	Ans	**Answer:** Expression for measurement of discharge through orifice meter  **Figure. Venturi-meter** Let, P1 = Pressure at section 1 V1= Velocity at section 1 a1 = area of pipe at section 1 P_2, V_2, a_2 are corresponding values at section 2 Applying Bernoulli's equation at section 1 and 2 $\frac{P_1}{\rho g}+\frac{V_1^2}{2g}+z_1=\frac{P_2}{\rho g}+\frac{V_2^2}{2g}+Z_2$ $\left(\frac{P_1}{\rho g}+z_1\right)-\left(\frac{P_2}{\rho g}+z_2\right)=\frac{V_2^2}{2g}-\frac{V_1^2}{2g}$ But $\left(\frac{P_1}{\rho g}+Z_1\right)-\left(\frac{P_2}{\rho g}+z_2\right)=h=differnential\ head$ $h=\frac{V_2^2}{2g}-\frac{V_1^2}{2g}=\frac{V_2^2-V_1^2}{2g}$	2

Since the pipe is horizontal, Z1= Z2

Hence, h = $\frac{P_1 - P_2}{\rho g}$

$h = \frac{v_2^2}{2g} - \frac{v_1^2}{2g}$ ----------(1) — 2

Now, applying continuity equation at section 1 and 2

$a_1v_1 = a_2v_2$ or $v_1 = \frac{a_2v_2}{a_1}$

Substituting this value of v1 in equation 1,

$h = \frac{v_2^2}{2g} - \frac{\frac{(a_2^2v_2^2)}{a_1}}{2g}$

$h = \frac{v_2^2}{2g}\left\{\frac{a_1^2 - a_2^2}{a_1^2}\right\}$

$v_2 = \sqrt{2gh\frac{a_1^2}{(a_1^2 - a_2^2)}} = \sqrt{2gh}\ \frac{a_1}{(a_1^2 - a_2^2)}$

Now $Q = a_2v_2$

$Q = \frac{a_1a_2}{(a_1^2 - a_2^2)}\ \sqrt{2gh}$ ----------**(2)** — 2

Equation (2) gives the discharge under ideal conditions and it is called, theoretical discharge. Actual discharge will be less than theoretical discharge.

$Q_{act} = C_d \text{ X } \frac{a_1a_2}{(a_1^2 - a_2^2)}\ \sqrt{2gh}$ — 2

where,

C_d= Co-efficient of venture-meter and it's value is less than 1.

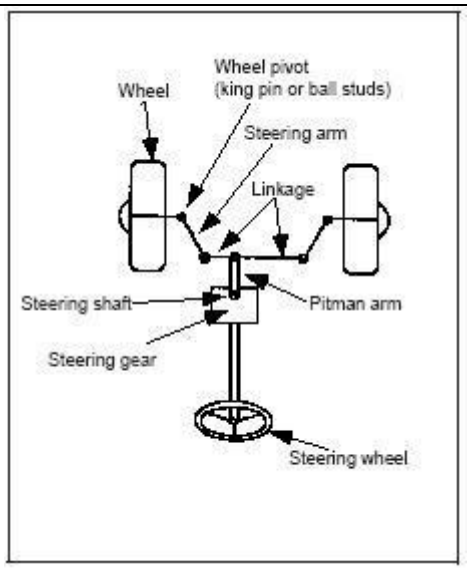
(b) **Compare reciprocating pump and centrifugal pump any eight points.** — 08

Reciprocating Pump	**Centrifugal Pump**
1.discharge is fluctuating and pulsating.	1. discharge is continuous and smooth.
2.Applicable for high pressure	2.Applicable for low pressure
3.Low speed	3.High speed

Any

4.Weight of pump More than centrifugal pump	4.Weight of pump less than reciprocating pump	eight points One mark each
5.More floor area required for installation	5.Less floor area required for installation	
6.Maintenance cost is more	6.Less	
7.Cost of pump is high	7.Less	
8.No need of priming	8.Need of priming	
9.Use of air vessel	9.Not use of air vessel	
10.In service stations for washing vehicles	10.In sugar factories, oil, chemical factories milk dairies and domestics applications.	

	(c)	**Explain construction and working of hydraulic circuit for power steering system.**	08
		(Figure -4 marks , Explanation- 4 marks) (Note: Equivalent credit shall be given to other correct diagram and suitable explanation) Hydraulic power steering incorporates a hydraulic boost into a basic manual-steering system. A basic manual-steering system is an arrangement of gears in a box that multiplies the input torque from the steering wheel to a much greater torque at the steering shaft (as shown in figure) The steering shaft, through the pitman arm (or steering-shaft arm), transmits this increased torque through the steering linkage to the steering arms that turn the wheels. The basic system of manual-steering gears and steering linkage is a steering wheel, steering gear, and linkage to the steered wheel. The hydraulic boost, which is a mechanically operated hydraulic servo, may be applied to the steering linkage (as shown in Figure) or within the steering gear. Steering-wheel movement actuates the steering valve, which directs the fluid under pressure to the steering-valve body that follows the valve spool. Hydraulic boost is applied only when the steering wheel is being moved. An integral power-steering system has the hydraulic-boost subsystem built into the mechanical steering gear. The steering valve is actuated by moving the steering shaft. The valve controls the operation of the power cylinder. Thrust from the power cylinder is transmitted directly to the steering shaft. Road shock transmitted back from the wheels is taken up in the steering gear.	



6		**Attempt any TWO of the following**	16
a)	(i)	**Explain the term venna-contracta with neat sketch**	04
	Ans	(Figure -2 marks , Explanation- 2 marks)	

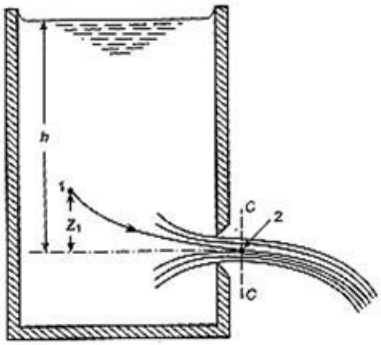


Fig. Resrvior with sharp edge orifice

Figure shows a sharp edged orifice in one side of reservoir containing water. The water will emerge from the orifice as a free jet, that is, a jet discharged in the atmosphere and will therefore be under the influence of gravity only.

The section C-C of the jet, at which the streamlines are straight and parallel to each other and perpendicular to the plane of the orifice, and the jet has the minimum cross sectional area, is known as vena contracta. The pressure at section C-C is uniform and it is equal to the pressure of surrounding the jet. The velocity of flow of water at this section will be maximum by the principle of continuity. Beyond the section C-C the jet may, however, diverge again and it undergoes a downward deflection due to gravity.

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

$a_2 = C_c . a_0$

C_c=Coefficient of contraction

	(ii)	**Define all Hydraulic co-efficient.**	04
	Ans	There are four hydraulic coefficients- **1. Coefficient of contraction (Cc):** It is the ratio of area of jet at vena contracta to the area of Orifice is known as Coefficient of contraction. **2. Coefficient of velocity(Cv):** It is the ratio of actual velocity of jet at vena contracta to the theoretical velocity of jet is known as Coefficient of velocity **3. Coefficient of discharge (Cd):** It is the ratio of actual discharge through an orifice to the theoretical discharge is known as Coefficient of discharge. **4. Coefficient of Resistance (Cr):** It is the ratio of loss of head in the orifice to the head of water available at the exit of orifice is known as Coefficient of resistance.	01 01 01 01
b)		**Explain construction and working of hydraulic circuit for milling machine.**	
	Ans	**Construction and Working – 05 Mark, Figure – 03 mark** **Construction and Working:** Figure shows the hydraulic circuit for operation of milling machine. When the spool of 4/2 D.C. valve is in left envelope mode, the oil from pump port 'P' enters the blank or head end of cylinder via line P-A-1 and acts on the piston so that machine table moves to the right. The oil from other side of piston is discharged into the reservoir via line 2-B-R. Limit switch 2 (LS-2) energizes the solenoid 'D' so that the spool of 4/2 D. C. valve shift in it's right envelope mode. The oil from pump port 'P' enters piston rod side of cylinder via line P-B-2 causing the table to to move towards the left. At the same time oil from blank or head end of cylinder is discharged into the reservoir via line 1-A-R. At the end of stroke limit switch 1 (LS-1) energizes the solenoid 'C' so that spool of D. C. valve get shifted in left envelope mode to perform forward stroke again and cycle is repeated.	05 03

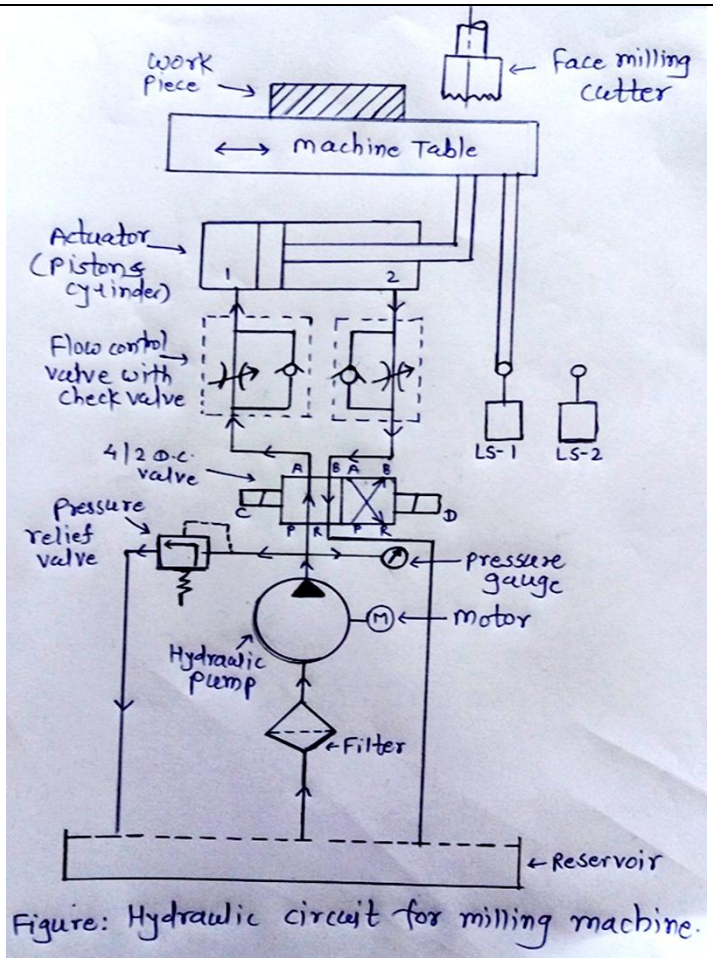


Figure: Hydraulic circuit for milling machine.

c) (i) **Compare hydraulic circuit and pneumatic circuit. Any four points.** 08

Ans

Hydraulic circuit	Pneumatic circuit
1.Energy carrying medium is oil.	1. Energy carrying medium is air.
2.Used upto 700 bar pressure.	2.Used upto 10 bar pressure.
3.Return lines are essential	3.Return lines are not required.
4. High cost	4.Low cost.
5.Hydraulic circuits are used in tackling heavy loads, hence used in earthmoving equipment, CNC-VMC machines	5. Pneumatic circuits are used when loads are much lighter. Hence used in transferring the light weight components, vacuum handling in printing press, food industry
6.Maintenance cost is high	6.Maintenance cost is low
7. Due to leakage of oil ,the overall system and space nearby is not clean.	7. Clean system.

Any FOUR points One mark each.

	(ii)	**Explain principle and application of electro hydraulic system.**	
		Principle of operation: Electro-hydraulic system is a combination of electric and hydraulic control methods. An electric command signal (flow rate set point) is applied to the integrated position controller which drives the pilot stage. The thereby deflected nozzle flapper system produces a pressure difference across the drive areas of the spool and affects its movement. **Applications of electro-hydraulics actuators:** Electro-hydraulic systems can be used in robust robotics systems that have to carry heavier loads efficiently. Electro-hydraulic systems are gaining more attention in applications that need good positioning and force feedback. This system has become progressively popular in various types of engineering equipment and by utilizing it advantageous, different applications such as aircrafts, manufacturing machines, fatigue testing, hydraulic excavator, sheet metal forming process and automotive applications.	02 02