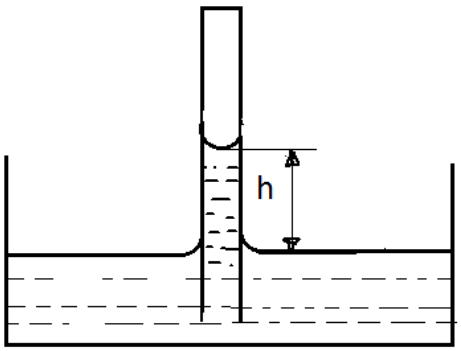
Model Answer **Subject Code: 17522**

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.

Q. No.	Sub Q. N.	Answer	Marking Scheme
1	(a)	**Attempt any Three of the following.**	
	(i)	**Define capillarity and Specific gravity along with their unit.**	
		Answer: (Capillarity- 2 marks ; specific gravity- 2 marks) **Capillarity:** Capillarity is defined as a phenomenon of rise or fall of a liquid surface in a small tube relative to the adjacent general level of liquid when the tube is held vertically in the liquid. The rise of liquid surface is known as capillary rise while the fall of liquid surface is known as capillary depression.  **Figure- Capillary Rise** h= capillary Rise **Unit: mm or cm of liquid.** **Specific gravity:** It is defined as the ratio of the weight density (density) of a fluid to the weight density (density) of a standard fluid. For liquids, the standard of fluid	**02** **02**

		is taken as water and for gases, the standard fluid is taken as air. Specific gravity is also called as relative density. It is denoted by S. **Mathematically, S (for liquid) = Weight density(density) of liquid / Weight density (density) of water** **Mathematically, S (for gases) = Weight density(density) of gas / Weight density (density) of air** **Unit: No unit.**	
	(ii)	**State any two practical applications of seals and gaskets used in hydraulic systems**	
		Answer: (Any Two – 2 Marks for each) **(Due consideration shall be given for similar and other practical applications)** **Application of Seals and gaskets:** *(Any two)* **Static Seals:** These seals are used in reservoirs, gear boxes, body and casing / cover assembling of storage tanks etc. **Dynamic seals: These seals are used in applications where mating parts are having relative motion. Hence the applications like piston and cylinder, rotating shaft and body, oscillating or limited rotary hydraulic motors.** **Cup seals are used where seals have to withstand higher operating pressure up to 700 bar.** **v- packing and u packing seals are used as ID rod or OD piston seal.** **O ring is used as static as well as dynamic seal.** General Applications where these all seals for different purposes are: Hydraulic pump, hydraulic motors, hydraulic actuators, valves, filter, reservoir	**04**
	(iii)	**Give classification of pneumatic actuators.**	
		Answer: (4 marks) **Classification of pneumatic actuators** **Pneumatic actuators** **Linear Actuators (Air cylinders)** | **Rotary Actuators (Air Motors)**	**04**

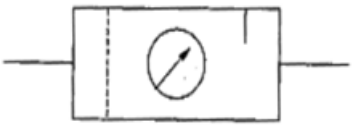
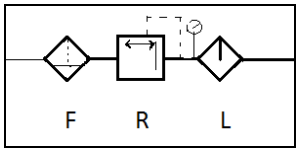
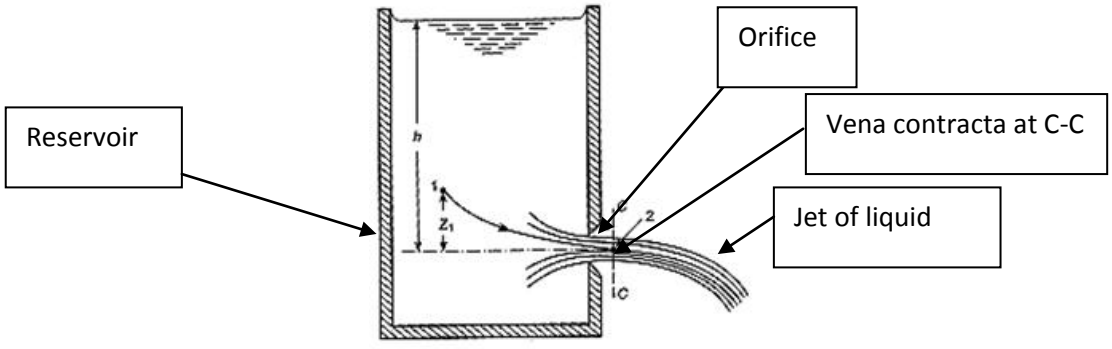
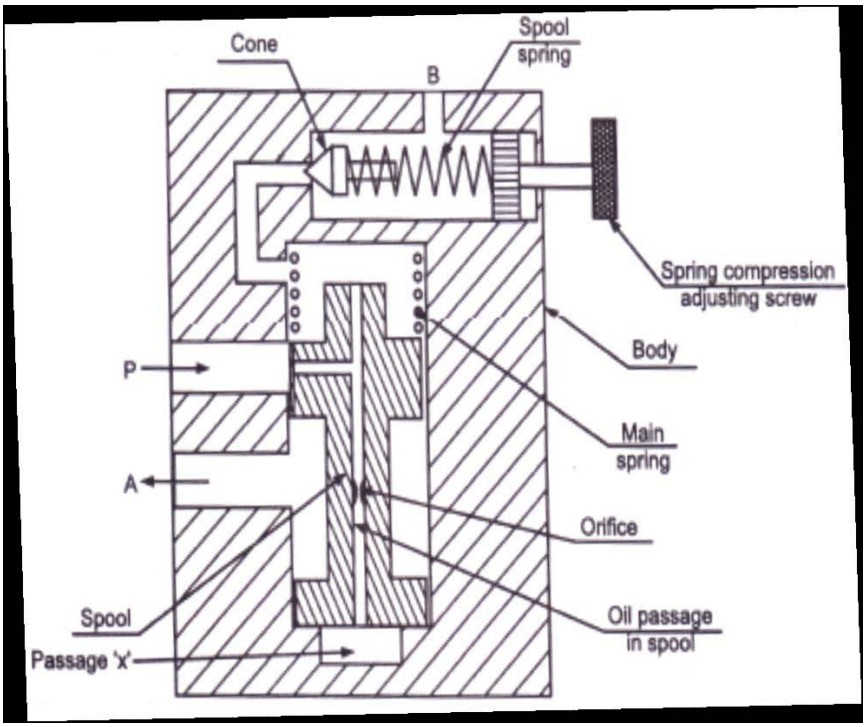
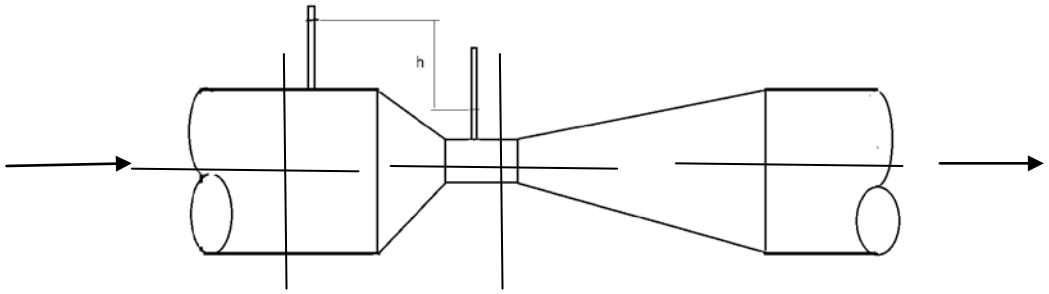
		1) Single acting cylinder	1. Vane motors	
		2) Diaphragm cylinder	2. Gerotor motor	
		3) Rolling diaphragm cylinder	3. Turbine motors	
		4) Double acting cylinder	4. Piston type motors	
		5) Turn cylinder		
		6) Tandem cylinder		
	(iv)	**Write the function of 'FRL' unit with it's composite and combined symbols.**		
		Answer: (Functions 2 mark, symbol- 2 mark) **Function of FRL Unit:-** 1) Filter: a. To prevent entrance of solid contaminants to the system. b. To condensate and remove the water vapour that is present in the air. c. To arrest submicron particles that may pose a problem in the system components. 2) **Regulator**: To regulate the incoming pressure to the system so that the desired air pressure is capable of flowing at a steady condition. 3) **Lubricator:** To provide lubrication for mating components of valves, cylinders etc. by forming a mist of oil and air. Composite Symbol  Combined Symbol 	**02** **02**
1	b)	**Attempt any One of the following**		
	i)	**Explain the term vena-contracta with neat sketch**		
		Answer: (figure -3 marks , explanation- 3 marks) **Vena Contracta:**  **Fig. Reservoir with sharp edge orifice** ***(Note: Equivalent credit shall be given to any other diagram and suitable explanation)***	

		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)	**Write construction and working of sequence valve with neat sketch**	
		Answer: (Sketch- 3 marks, Working-3 marks) **Sequence Valve**  **Figure- Sequence Valve** **Working :** Sequence valve is nothing but pilot operated relief valve. It has a special spool	**03** **03**

		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)***	
2.		**Attempt any FOUR of the following**	
	(a)	**How would you apply Bernoulli's theorem in venturi–meter to know the discharge?**	
		Answer: **Venturi-meter**: is a device used for measuring the rate of flow of a fluid flowing through a pipe. It consists of three parts: 1) A short converging part 2) Throat 3) Diverging part **Bernoulli's theorem-** This theorem states that 'whenever there is a continuous flow of liquid, the total energy at every section remains the same provided that there is no loss of addition of the energy. OR It states that ' in a steady, ideal flow of an incompressible fluid the total head at any point is constant. The total head consist of pressure head, velocity head and datum head. Expression for measurement of discharge through orifice meter  Section 1-1 section 2-2 **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	1

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

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

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

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

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) 1

Now, applying continuity equation at section 1 and 2

$a_1v_1 = a_2v_2$ or $v_1=\frac{a2v2}{a1}$

Substituting this value of v1 in equation 1,

$$h=\frac{v_2^2}{2g}-\frac{\frac{(a_2^2v_2^2)}{a1}}{2g}$$

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

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

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.

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

where,

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

Above equation gives expression for discharge through venture- meter.

(b) State any two faults of centrifugal pump. Write two causes and two remedies of each.

Answer: 2

Fault no. 1. Fails to start Pumping: (Any two- 2marks)

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	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

Fault no. 2. Low efficiency: *(Any 2- 2 marks)*

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.

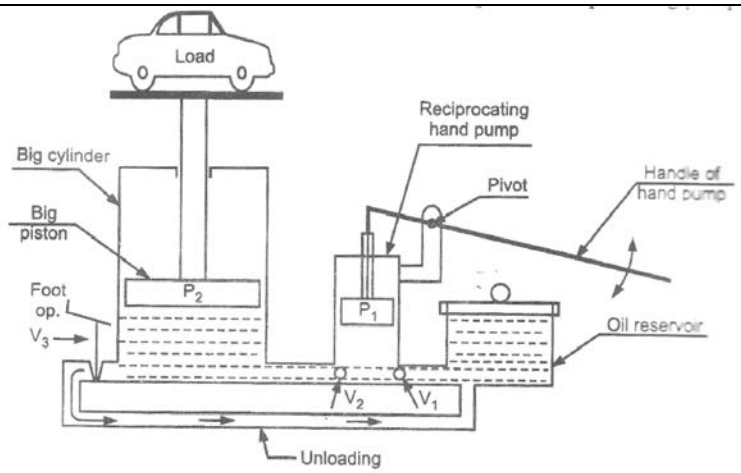
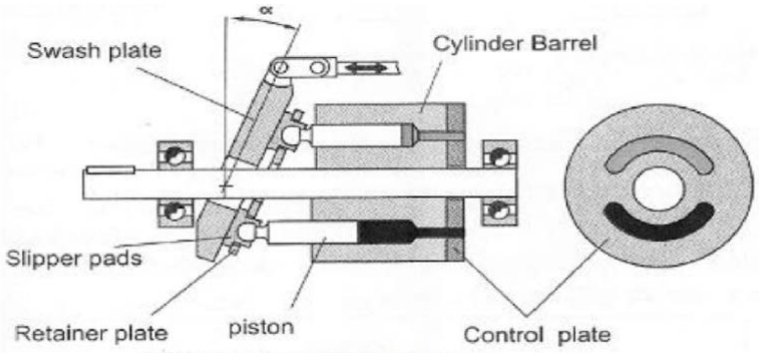
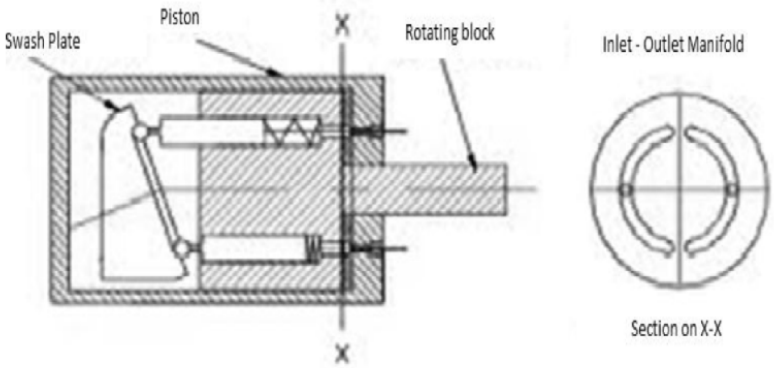
2

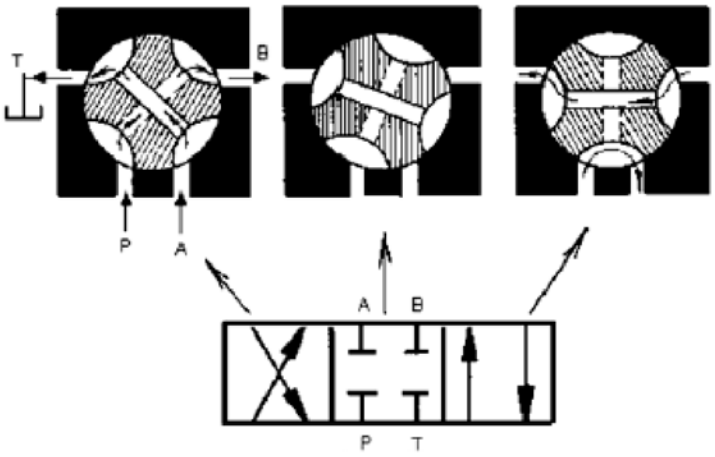
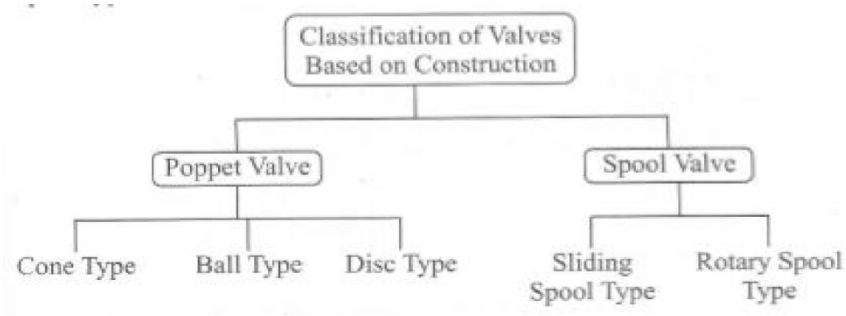
(c) What is NPSH ? how it is useful in pump selection.

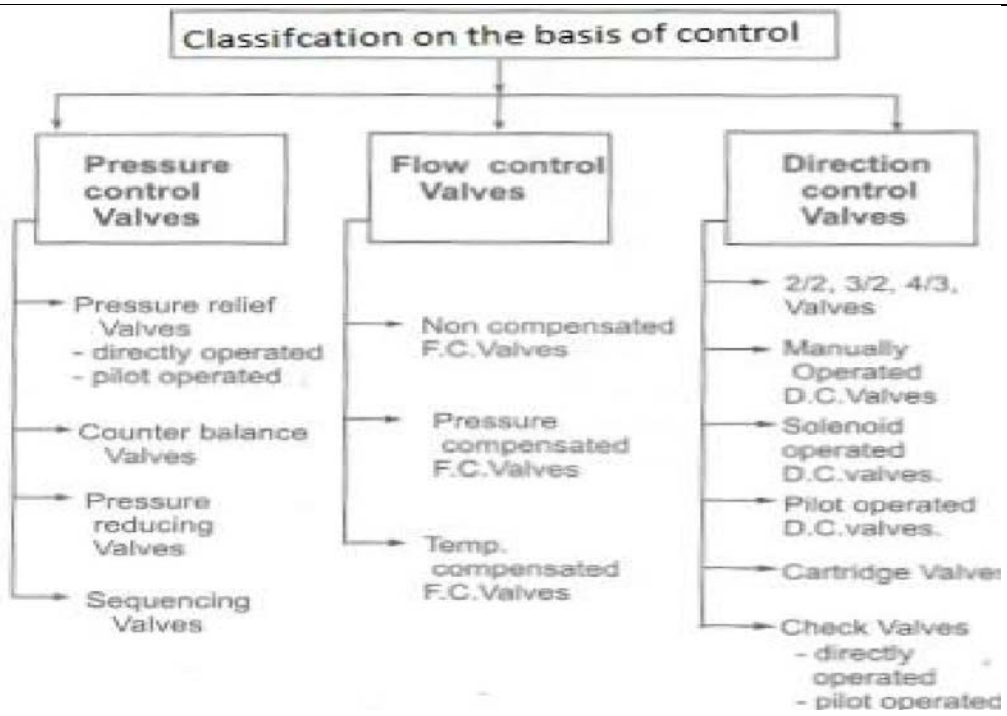
Answer: (NPSH 2 marks, pump selection -2 marks) **02**

1. NPSH: The net positive suction head (NPSH) is defined as the absolute pressure head at the inlet to the pump, minus the vapour pressure head (in absolute units) plus

		the velocity head. NPSH = Absolute pressure head at the inlet of the pump – vapour pressure head (absolute units) + velocity head. NPSH= [$(H_a-h_s-h_{fs})-H_v$] Where, *Ha* = Absolute pressure head; h_s= suction head; H_v = vapour pressure head (absolute units) **2. Selection of pump :** For any installation/ selection of pump, a distinction is made between the "Required NPSH" and the "available NPSH". The value of "required NPSH" is given by manufacturer. This varies with pump design, speed of pump and capacity of pump. The value of "required NPSH" can be determined experimentally. For determining this value the pump is tested and minimum value of h_s is obtained at which the pump gives maximum efficiency without objectionable noise (i.e. cavitation free). The available NPSH can be calculated from the above equation. In order to have cavitation free operation of centrifugal pump, the "available NPSH" should be greater than the "required NPSH".	**02**
	(d)	**Describe with neat sketch the working of hydraulic jack.**	
		Answer:(working- 2marks; sketch-2 marks) **Working of Hydraulic jack:** **Working:** 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 (V_1) due to vacuum created in cylinder During downward stroke of piston (P_1) valve (V_1) will close and valve (V_2) will open and pressurized oil will enter into big cylinder via valve (V_2).The pressurized oil will lift the piston (P_2) upward and load will be lifted up.	**02**

		 Figure: Hydraulic Jack	02
3		**Attempt any FOUR of the following**	
	A	**Draw the labeled Sketch of Swash plate pump.**	
		Answer:- **(02 marks for sketch & 02 marks for labeling)**  Figure: Swashplate Pump **OR**  Figure: Swashplate Pump	04

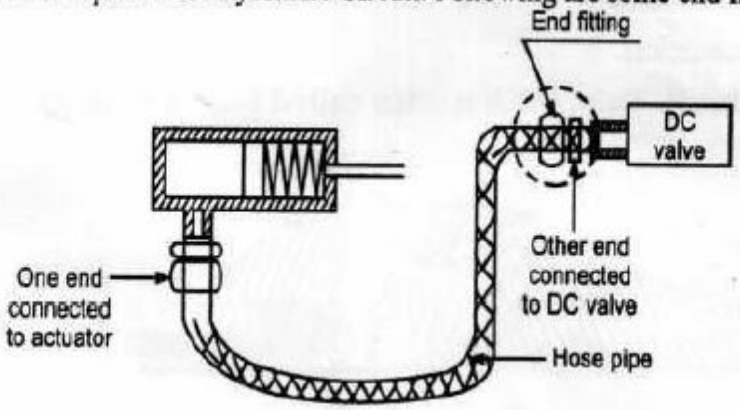
	B	**Explain Construction and Working of Rotary Spool 4/3 valve with neat sketch.**	
		Construction: 2 Marks and working: 2 marks Answer: - The rotary spool directional control valve has a round core with one or more passages or recesses in it. The core is mounted within a stationary sleeve. As the core is rotated within the stationary sleeve, the passages or recesses connect or block the ports in the sleeve. The ports in the sleeve are connected to the appropriate lines of the fluid system. Figure shows three different position of the core when the handle is rotated. Left most envelope of DCV connects P to B and A to T. Middle envelope of DCV blocks all ports. Right most envelope of DCV connects P to A and T to B.  	**04**
	C	**Classify valves on the basis of construction, function and application.**	
		Answer:  	**02**

			02
	d)	**Give the type of End-connectors used in hydraulic system and sketch any one of them with specifying its function.**	

Answer:-

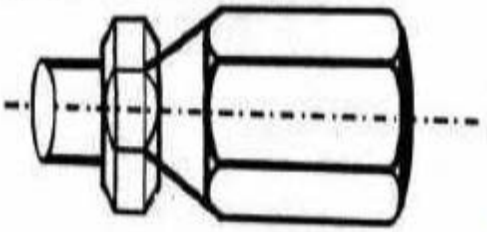
The types of end couplings are :
(a) Male fixed coupling
(b) Compression fittings
(c) Quick coupling

The end fitting or coupling end is that part attached to hose and other end is connected to the component of Hydraulic Circuit. Following are some end fittings :



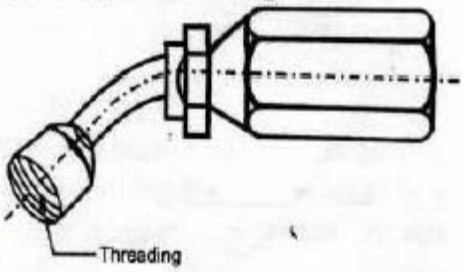
Sketch any one out of three.

(a) Male Fixed Coupling

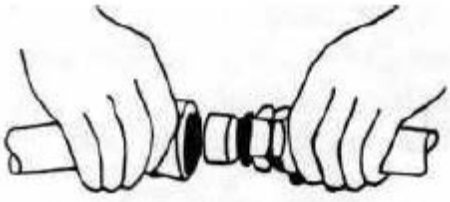


OR

(b) Compression fitting :

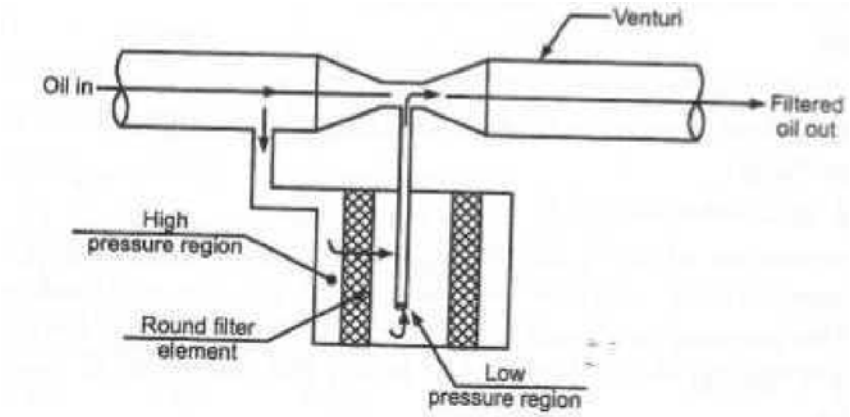
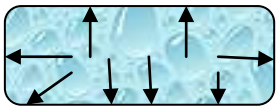


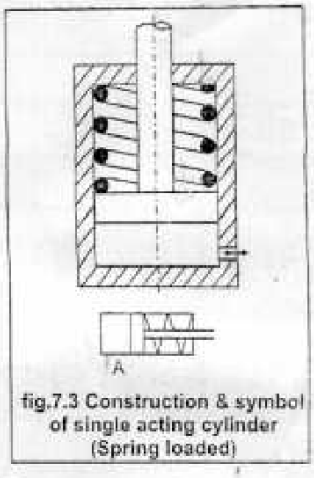
Connected

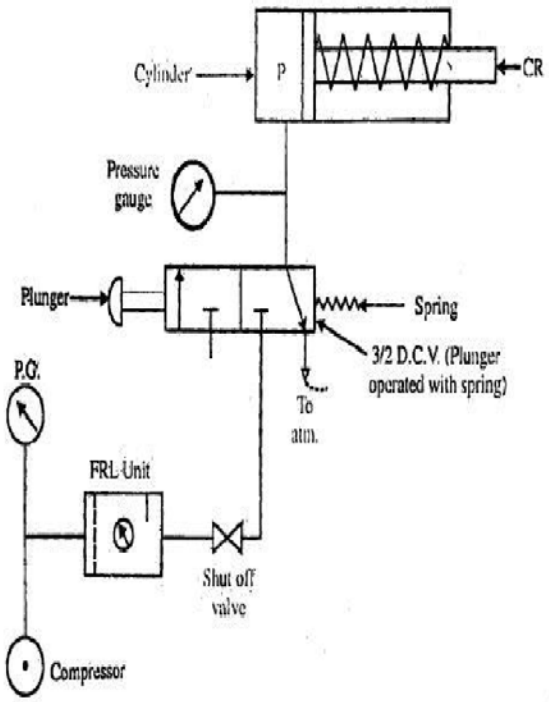


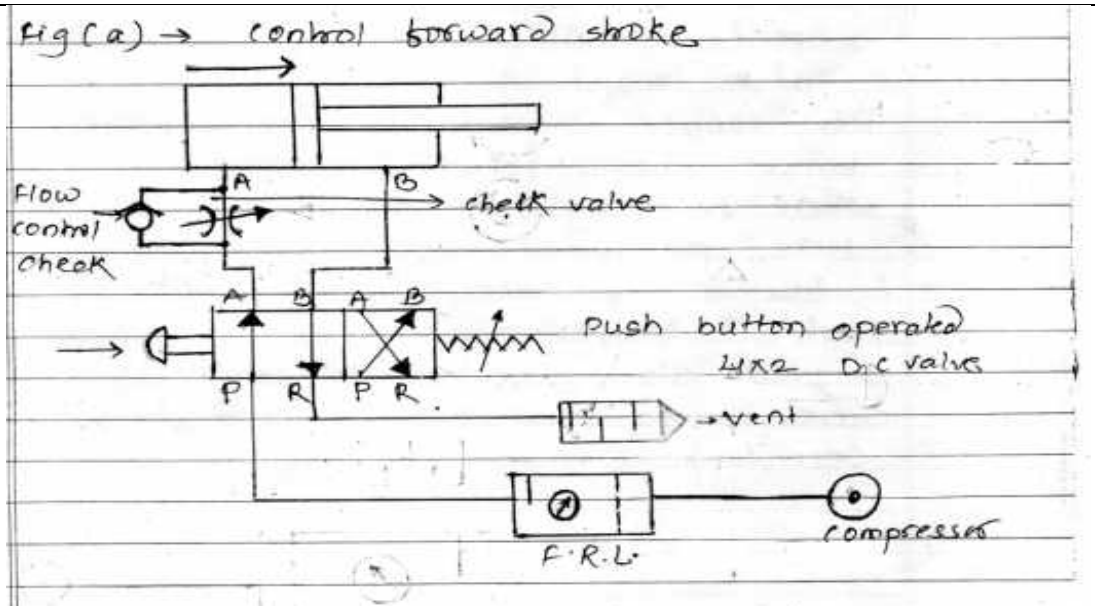
Disconnected

	e)	**Explain with neat sketch proportional flow type filter.**	
		Answer: (sketch : 2 marks and explanation : 2 marks) **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 propionate quantity passes through filter element. In this filter the pressure drop is very low hence is having wide application.  **Proportional Flow Filter**	
4		**Attempt any THREE of following.**	
	i)	**What is Pascal's law? State its application**	
		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. $p_x = p_y = p_z$ Fig.  where, px = intensity of pressure in x direction; py = intensity of pressure in y direction; pz= intensity of pressure in z direction. **Applications**:- Hydraulic press, Hydraulic brakes, Hydraulic jack, hydraulic lift.	02 02

	ii)	**Explain working of single acting pneumatic cylinder with neat sketch**	
		Answer: (sketch : 2 marks and explanation : 2 marks) Single acting cylinder with single piston rod. This type of cylinder is used for comparatively lower loads than Plunger (or) ram type hyd. Cylinder. This cylinder may be gravity return (or) spring return. Its applications mostly in Production tooling for clamping, Pushing, etc. also in automation Plant where number of cylinders perform individual operations in a predetermined sequence.  fig.7.3 Construction & symbol of single acting cylinder (Spring loaded)	04
	iii)	**Specify types of seals used in hydraulic system.** **(Any 4 types – 4 marks)**	
		According to nature of application: a. 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 make leak proof joint because of pressure applied in tightening the bolts. Under pressure the seal material flows and fills the 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. **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.	04

		Types of dynamic seals 1)O-ring 2)Lipped seals 3)Piston cup packing 4)Piston rings 5)Wiper rings **According to sealing type:** 1. **Positive seal:** when sealing is required for 100% leak proof and no oil is allowed to leak. 2. **Non positive seal:** when sealing is allowed minute amount of oil leakage for lubrication of spools and moving parts of valves.	
	iv)	**Draw general layout of pneumatic system and label the components.** **(Layout – 2marks and labeling – 2marks)**	
		 ***(Note :-Credit shall be given to suitable sketch)***	04
4	b)	**Attempt any <u>ONE</u> of the following**	
	i)	**Draw and explain pneumatic meter-in circuit.**	
		Answer: (Fig 3 marks and Explanation – 3marks)	

		 Speed control of double acting cylinder consists of 4 X 2 DC valve, compressor, flow control valve with check valve fig (a) shows forward movement of piston where incoming air is checked. Here pressurized air is taken from compressor and further is taken into cylinder by connecting port P to port A.	04 02
	ii)	**1)identify the following circuit in fig.no.1** **2) Label it and state its application.** **3) Explain its working.**	
		Answer: (Identification and labeling 2 marks, application 2marks , working 2 marks) i) The figure shows a **bleed off circuit**.	

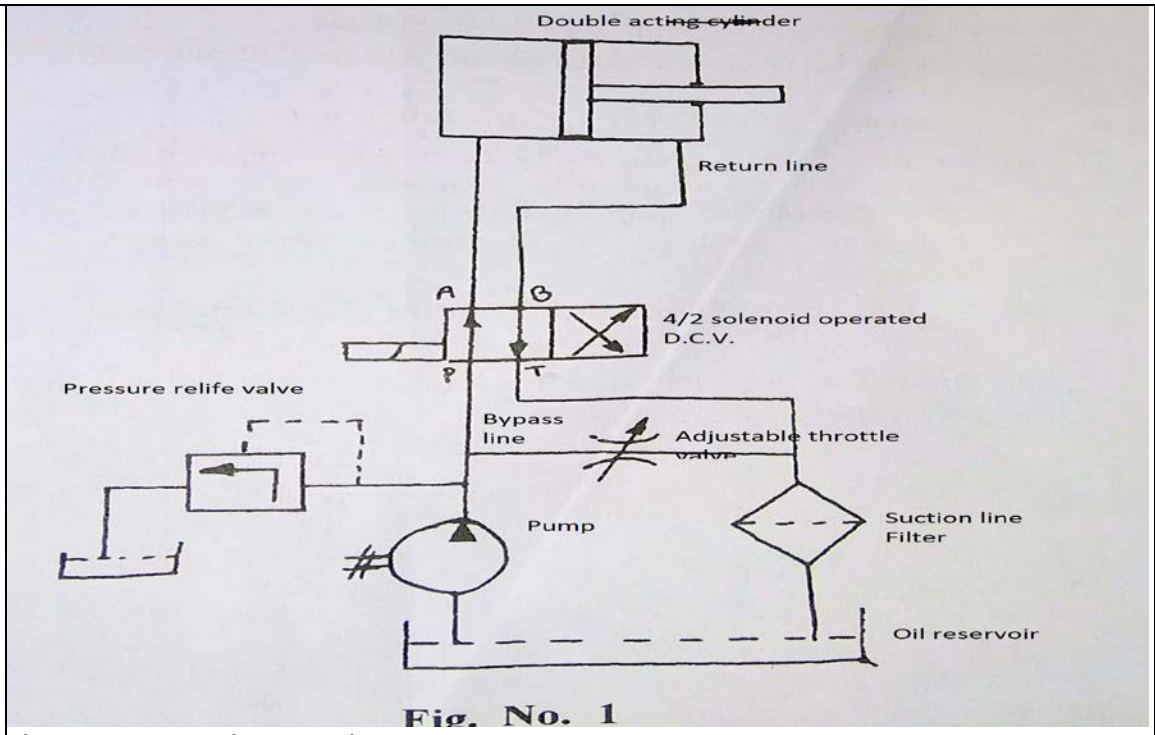


Fig. No. 1

ii) Applications : (Any two)

1) Use in hydraulic shaping machine, planer machine.

2) Used for control of broach in broaching machine.

3) It is suitable in constant pressure.

4) Used where precise speed control is not require.

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

5		**Attempt any <u>TWO</u> of the following**	
	(a) i)	**Explain along with suitable example any four types of fluid flow.**	
		Answer: Explanation – 1/2 Mark and any one example- 1/2 Mark (any four) **Types of fluid flow-** 1. **Steady flow**-The flow in which liquid characteristics like velocity, pressure, and density do not change with time is known as steady flow. **Example**- i)Flow of liquid through pipe at constant rate.	4

		ii) Water flow out of tap which has not just been opened. 2. **Unsteady flow**- The flow in which liquid characteristics like velocity, pressure, and density changes with time is known as unsteady flow. **Example**- i)Flow of liquid through pipe at varied rate. ii) Water flow out of tap which has just been opened. 3. **Uniform flow**- The flow in which velocity at any given time does not change with length of flow is known as uniform flow. **Example**- i)Flow of liquid through a duct of constant c/s. 4. **Non uniform flow**- The flow in which velocity at any given time changes with length of flow is known as non uniform flow. **Example**- i)Flow of liquid through a duct of varying c/s. 5. **Laminar flow**-The flow in which fluid particles moves in well defined path and does not cross each other is known as laminar flow. **Example**- i)Smoke from cigarette before swirling and mixing with atmospheric air. ii) Water or oil flow through thin tube with low speed. 6. **Turbulent flow**- The flow in which fluid particles moves in zig-zag way and crosses each other is known as turbulent flow. **Example**- i)Smoke from cigarette after swirling and mixing with atmospheric air. ii) Water or oil flow through thin tube with high speed. iii) Flow of water from leakage pipe line, during flood conditions. 7. **Compressible flow**- The flow in which density is not constant is known as compressible flow. **Example**- i)Flow of air through varying c/s. 8. **Incompressible flow**- The flow in which density is constant is known as incompressible flow. **Example**- i)Flow of fluid through varying c/s. 9. **Rotational flow**- The flow in which fluid particles rotate about its own axis while flowing is known as rotational flow **Example**- i)Flow of rain fall. 2. Flow of water in wash basin. 10. **Irrotational flow**- The flow in which fluid particles does not rotate about its own axis while flowing is known as irrotational flow **Example**- i)Flow of water in open channel. 11. **One dimensional flow**- The flow which posses streamline along one direction only is known as one dimensional flow. **Example**- i)Flow in a pipe. 12. **Two dimensional flow**- The flow which posses streamlines along any two mutually perpendicular directions is known as two dimensional flow. **Example**- i)Flow over a weir. 13. **Three dimensional flow**- The flow which posses streamlines along any three mutually perpendicular directions is known as two dimensional flow. **Example**- i)Flow over a weir.	
	ii)	**Give the function and working of piezometric tube with its sketch.**	
		Answer: Function - 01 mark ,Figure – 01 mark, Explanation – 02 mark **Function**- To measure pressure at a point in the pipe.	1

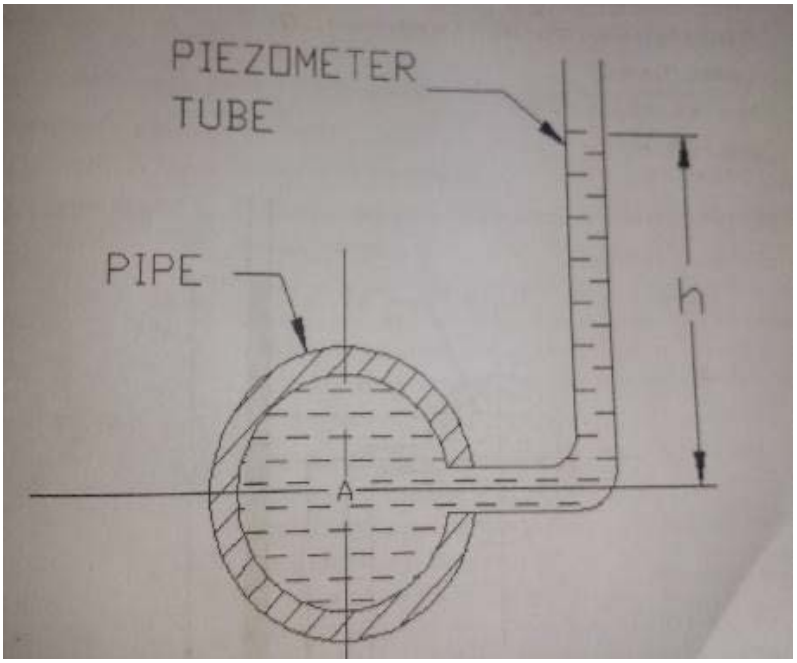


Fig. Piezometer Tube

1

Working- A piezometer tube is the simplest form of instrument, used for measuring moderate pressures. It consists of a tube one end of which is connected to the pipe line in which the pressure is required to be found out. The other end is open to the atmosphere in which the liquid can rise freely without overflow. The height to which the liquid rises up in the tube gives the pressure head directly.

If 'A' is the point at which pressure is to be measured and 'h' is height of liquid in piezometer. Then pressure at A is given by,

$P_A = \rho g h$ in N/m^2

2

b) **Explain with neat sketch construction and working of reciprocating pump using air vessel.**

Answer: Figure – 04 mark, Construction – 02 mark, Working – 02 Mark

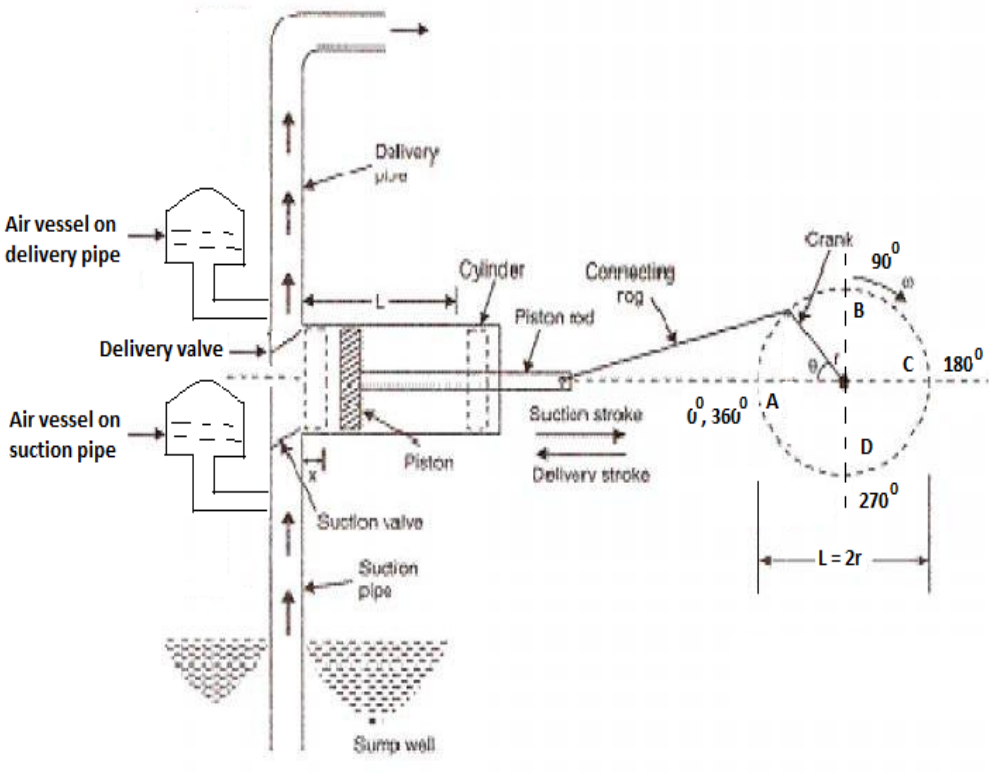


Fig. Reciprocating pump

4

2

Construction:

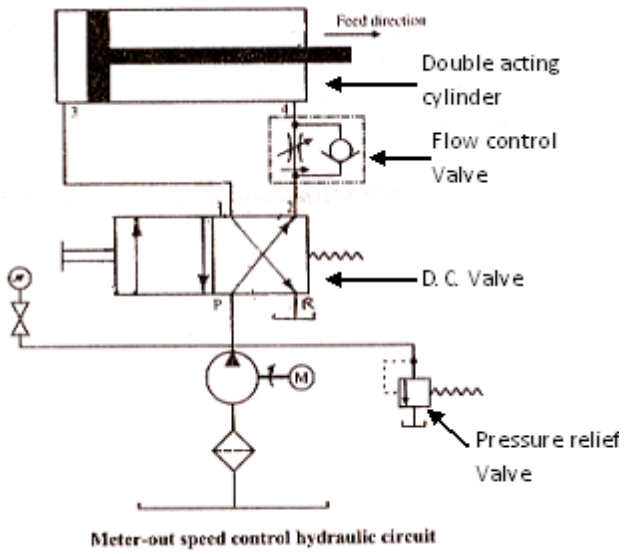
Figure shows a single acting reciprocating pump, which consist of a piston which moves forwards and backwards in a close fitting cylinder. The movement of the piston is obtained by connecting the piston rod to crank by means of connecting rod. The crank is rotated by means of an electric motor. Suction and delivery pipe with suction valve and delivery valve are connected to the cylinder .The suction and delivery valves are one way valves or non return valves, which allow the water flow in one direction only. Suction valve allows water from suction pipe to the cylinder which delivery valve allows water from cylinder to delivery pipe only. Air vessel is also fitted on suction pipe and delivery pipe as shown in figure.

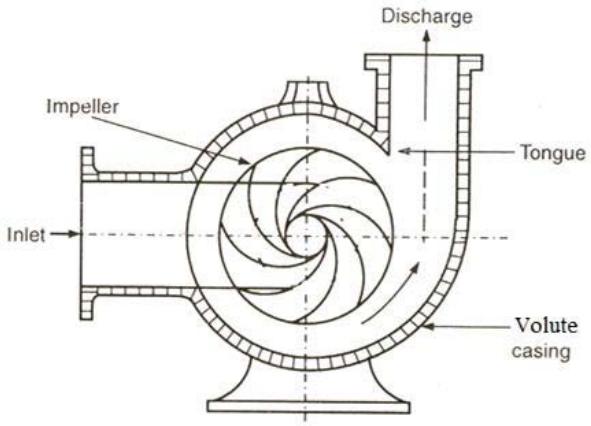
2

Working:

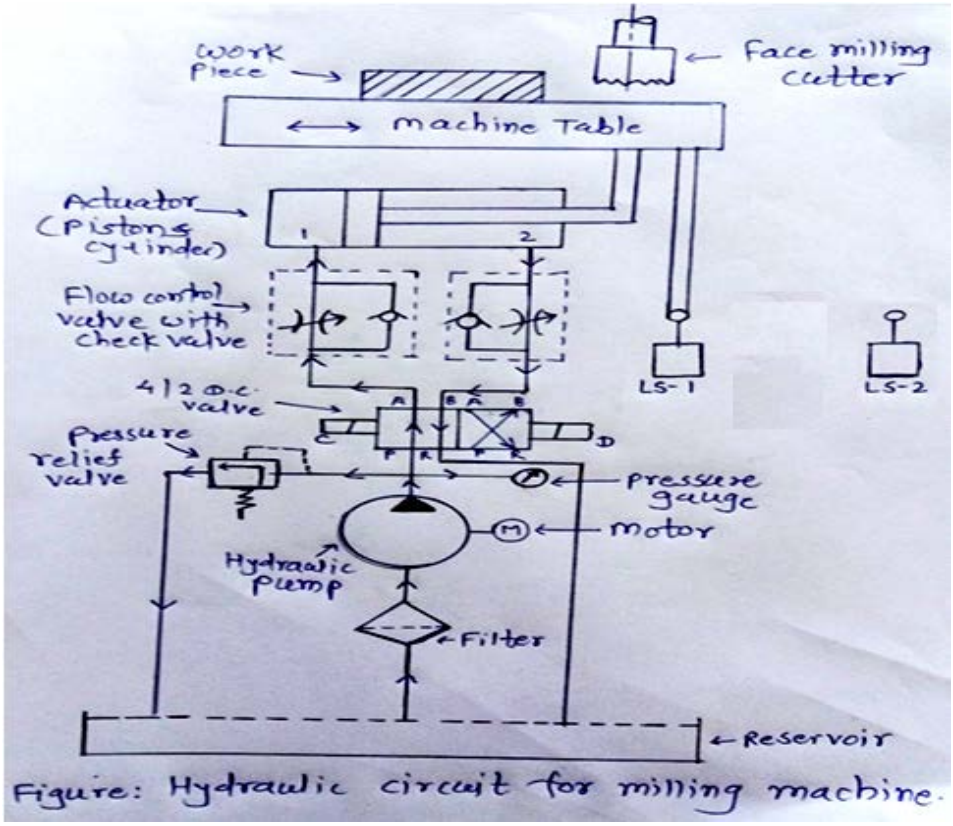
When crank starts rotating, the piston moves to and fro in the cylinder. When crank is at A, the piston is at the extreme left position in the cylinder. As the crank is rotating from A to C, the piston is moving towards right in the cylinder. The movement of the piston towards right creates a partial vacuum in the cylinder. But on the surface of the liquid in the sump atmosphere pressure is acting, which is more than the pressure inside the cylinder. Thus the liquid is forced in the suction pipe from the sump. This liquid opens the suction valve and enters the cylinder. During first half of suction stroke, piston accelerates and extra water is supplied from air vessel. During second half of suction stroke, piston retards and extra amount of water will be stored in air vessel.

When crank is rotating from C to A , the piston from its extreme right position

		starts moving towards left in the cylinder. The movement of piston towards left increases the pressure of the liquid inside the cylinder more than atmosphere pressure. Hence suction valve closes and delivery valve opens. The liquid is forced into the delivery pipe and is raised to required height. During first half of delivery stroke, piston accelerates and extra amount of water is stored in air vessel. During second half of delivery stroke piston retards and extra amount of water will be start flowing into delivery pipe maintaining uniform discharge of water.	
	(c)	**Draw meter-out Hydraulic circuit and explain its working.**	
		Answer: Figure- 04 marks, Working- 04 marks  **Meter-out speed control hydraulic circuit** **Working**- i) This is speed control circuit. ii) In this circuit speed control is achieved by controlling the flow coming out of cylinder. iii) Flow control valve is placed in between D.C. valve and piston rod end of cylinder. iv)Meter out circuit is generally used in Drilling, Boring, Reaming etc.	4 4
6	(a)	A Oil of specific gravity 0.75 is flowing through horizontal venturimeter having inlet diameter 30 cm and throat of 15 cm. The differential manometer shows a reading of 40 cm of Hg. Calculate discharge of oil through venturimeter. Take Cd =0.98.	
		Answer: **Given-** Inlet diameter = d_1= 30 cm =0.3 m Throat diameter = d_2= 15 cm = 0.15 m C_d = 0.98 S_h = 13.6 S_o = 0.75 x = 40 cm = 0.4 m	

		$a_1 = \frac{\pi}{4} d_1^2 = \frac{\pi}{4}(0.3)^2 = 0.07065\ m^2$ $a_2 = \frac{\pi}{4} d_2^2 = \frac{\pi}{4}(0.15)^2 = 0.01766\ m^2$ As h= $\left[\frac{s_h}{s_o} - 1\right] x = \left[\frac{13.6}{0.75} - 1\right]$ x 0.4 **h = 6.853 m** $C_d = \frac{Q_{act}}{Q_{th}}$ $Q_{act} = C_d \times Q_{th}$ $= C_d \times \frac{a_1 a_2}{\sqrt{a_1^2 - a_2^2}} \times \sqrt{2gh}$ $= 0.98 \times \frac{0.07065\ x\ 0.01766}{\sqrt{(0.07065)^2 - (0.01766)^2}} \times \sqrt{2\ x\ 9.81\ x\ 6.853}$ **Q_{act} = 0.207 m^3/s**	1 1 2 1 3
	(b)	**Explain construction and working of centrifugal pump with neat sketch. Also state its its two applications.**	
		Answer: Figure – 02 mark, Construction – 02mark, Working – 02mark, Applications- 02 Mark (similar figure showing components of centrifugal pump along with other points may be considered)  **Construction of centrifugal pump:**	2 02

		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. **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. **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.	02 02
	(c)	**Draw the neat labeled hydraulic circuit of milling machine and explain its working.**	
		Answer: Figure – 04 mark, Working – 04 mark **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.	4

		 Figure: Hydraulic circuit for milling machine.	4