Subject Code: **12170**

Model Answer Page No: 1/23

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.

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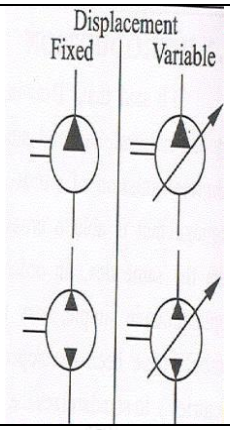
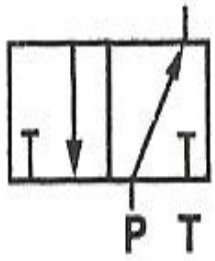
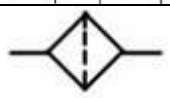
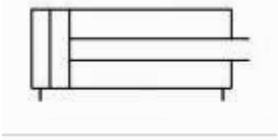
1.A) Attempt **any three** of the following :	**12**
1) Define following terms and state theirs S.I. units	4
Answer: a) **Dynamic Viscosity:** It is defined as the property of fluid which offer resistance to the moment of one layer of the fluid over another adjacent layer of the fluid is known as dynamic viscosity. . S.I Unit: N-S\m^2 b) **Surface tension:** It is the property of fluid which is defined as the tensile force acting on the surface of the liquid in contact with a gas or on the surface between two immiscible liquid such that the contact surface behaves like membrance under tension is known as surface tension. S.I Unit :N\m	01 01 01 01
2) State Bernoulli's theorem and list any two assumptions made while deriving it	04
Answer: 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, $P/w+v^2/2g+ Z$ = constant Where, P/w= pressure energy $V^2/2g$= kinetic energy Z= potential energy **Assumption:** 1) The fluid is ideal. 2) The flow is steady. 3) The flow is incompressible. 4) The flow is irrotational.	02 02 (Any Two)
3) Explain how Pascal's law is utilized in Hydraulic ram.	04
Answer: Pascal law is applied for construction of hydraulic machines such as hydraulic press, hydraulic jack, hydraulic lift, etc. in which by application of relatively smaller forces, larger forces are developed. **Pascal law states that the intensity of pressure at any point in a fluid which is at rest is same in all direction.** Hydraulic system such as ram, lifts and jacks are based on this principle and are useful for lifting and moving purposes. The hydraulic ram: The hydraulic ram is an example of a closed system in which the pressure is applied by the piston is transmitted throughout the hydraulic fluid. The hydraulic ram is a pump which raises water without any external power for its operation. When large quantity of water is	04

available at a small height, a small quantity of water can be raised to a greater height with the help of hydraulic ram.	
4) Draw the symbols for following	04
Answer: symbols a)Hydraulic pump (Any one)  b) $\frac{3}{2}$ DC valve  c) Filter  d)Double acting cylinder 	(01 Marks Each)
B) Attempt any one of the following :	6
1) Define atmospheric pressure, gauge pressure, vacuum pressure and absolute pressure. Represent these pressure in schematic diagram	6
Answer: • **Atmospheric Pressure**: At the earth surface, the pressure due to the weight of air above the earth surface is called as atmospheric pressure. • **Gauge Pressure:** If the pressure is measured above the atmospheric pressure it is called as gauge pressure. • **Vacuum Pressure:** If the pressure is measured below the atmospheric pressure it is called as Vacuum pressure. • **Absolute Pressure:** Absolute Pressure is defined as the pressure which is measure with reference to Absolute vacuum pressure.	04 (01 Mark each definition)

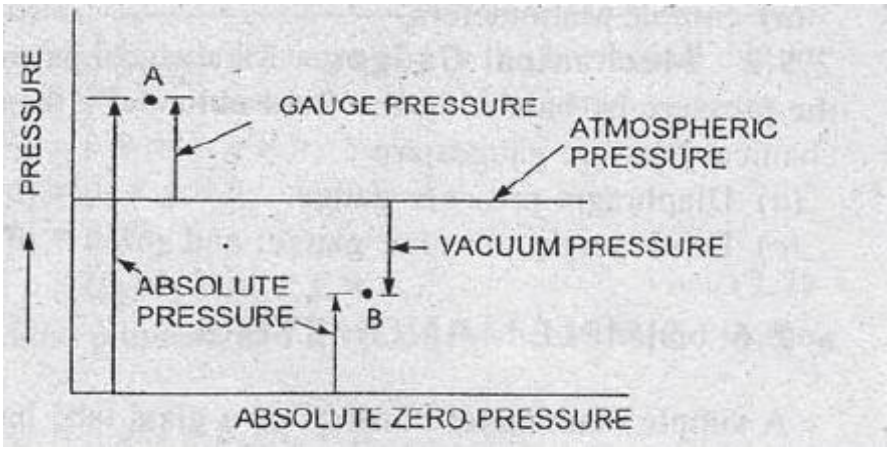


Fig:Relationship between pressures. — 02

2) Draw a neat sketch of Venturimeter. Explain why divergent section has more length than convergent section. — 06

Answer:

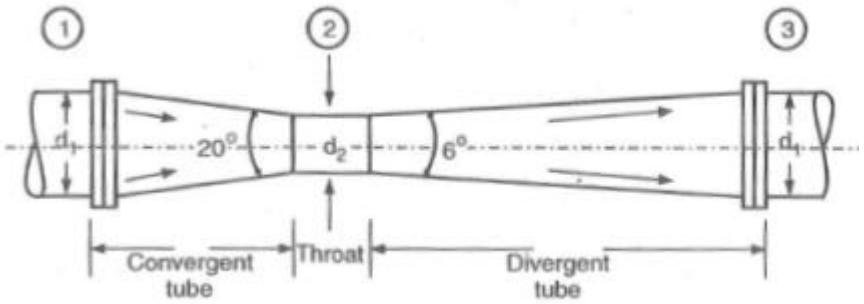


Fig:Venturimeter — 03

In convergent cone because of gradual decrease in diameter there is increase in velocity i.e. kinetic energy there should be decrease in pressure energy. In convergent cone velocity of fluid is increased. This acceleration of flowing fluid may allow to take place rapidly in a relatively small length, without resulting in appreciable loss of energy.
In divergent cone due to increase in diameter there is increase in pressure. However if decrease in velocity of flow in divergent section is allowed to take place rapidly in small length, then the flowing fluid will not remain in contact with the boundary of diverging flow passage, flow will separate from walls and eddies are formed.
Therefore length of divergent section has more than convergent section and it is kept 2 to 3 times that of convergent section. — 03

2. Attempt **any four** of the following :	**16**
1) Give the different types of manometers used for pressure measurement. State the limitations of Piezometer tube.	04
Answer: **Types of manometers:** a) Simple manometers: 1.Piezometer 2.U-Tube manometer 3. Single column manometer. b)Differential manometers: 1.U-tube differential manometer 2.Inverted U-tube differential manometer **Limitations of Piezometer tube:** 1. Piezometers can measure gauge pressures only. It is not suitable for measuring negative pressures. 2. Piezometers cannot be employed when large pressures in the lighter liquids are to be measured since this Would require very long tubes, which cannot be handled conveniently.	02 02
2) List out different types of fluid flows. Define steady and unsteady flow	04
Answer: **Types of Flows are:** 1. Steady and Unsteady flow. 2. Uniform and Non Uniform flow. 3. Laminar and Turbulent flow. 4. Rotational and irrotational flow. 5. Compressible and incompressible flows. 6. One, Two, Three dimensional flows. 1) **Steady flow**: The flow is said to be steady when the flow characteristics, such as velocity, density, pressure and temperature do not change with respect to time. 2) **Unsteady flow**: The flow is said to be unsteady when the flow characteristics, such as velocity, density, pressure and temperature change with respect to time.	02 02

3) Differentiate between centrifugal pump and reciprocating pump. — 04

Answer:

Sr. No.	Centrifugal Pump	Reciprocating Pump
1	The discharge is continuous and smooth.	The discharge is fluctuating and pulsating.
2	It can handle large quantity of liquid.	It can handle small quantity of liquid only.
3	It can be used for lifting highly viscous liquids.	It can be used for lifting pure water or less viscous liquids.
4	It is used for large discharge through smaller head	It is used for small discharge and high heads.
5	Cost is less.	Cost is more.
6	Runs at high speed	Runs at Low speed.
7	Operation is smooth and without much noise.	Operation is complicated and with much noise.
8	Efficiency is high	Efficiency is low.

(Any 4 Point)

4) Explain with neat sketch vane type air motor. — 04

Answer:

A typical vane type air motor is shown in fig. These motors are simple in construction, extremely compact. The rotating element is a slotted rotor which is mounted on a drive shaft. Each slot of the rotor is fitted with a freely sliding rectangular vane. The rotor and vanes are enclosed in the housing, the inner surface of which is offset from the drive shaft axis. The compressed air is made to pass through inlet ports and this air flows over the vanes and is exhausted through the outlet, causing the shaft to rotate. The speed of air motor can be varied by varying the air flow to the motor. — 02

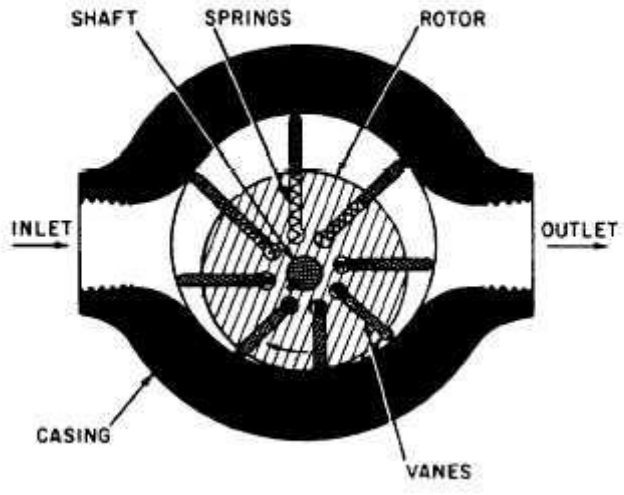
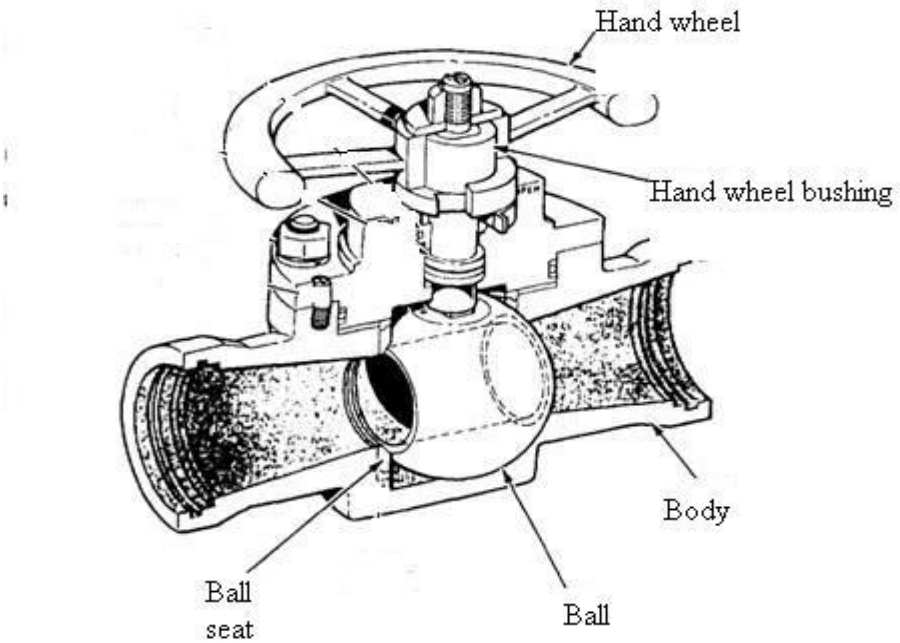
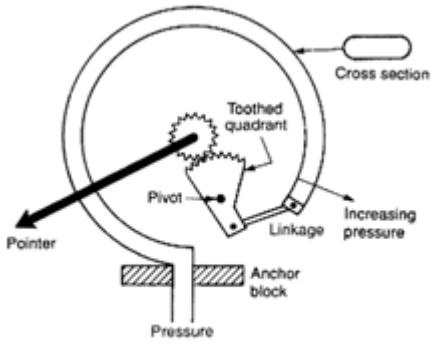
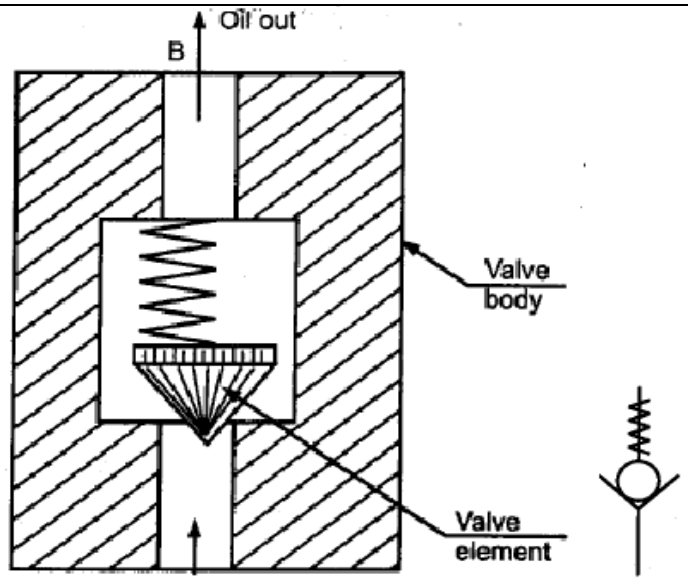


Fig: Vane type Air motor. — 02

5) Give the different function of hydraulic seals.	04
Answer: Different function of hydraulic seals are: 1. Prevent escape of fluid. 2. Prevent contamination. 3. To enhance working life of system. 4. Prevent environmental damage.	(1 marks each)
6) Explain constructions of ball valve with neat sketch	04
Answer:– **Construction:** Ball valves control Flow & Pressure of the fluid inside the Hydraulic systems which regulates & controlled linear & rotational movements of the applications. Rotary ball valve are very similar to rotary spool valves but with more limited porting configurations. Although these are sliding element valve their good sealing is obtained by the use of seals which is shown in fig .They may be categorized as full or reduced passage depending on size of the hole through the ball relative to the valve ports. Ball valves are available in Steel, Stainless Steel, and Brass Materials. Ball valves can be made in Cast body / Forged body & also in Solid bar stock body.	02
 Ball Valve	02

3. Attempt **any four** of the following	**16**
1) Explain Bourdon tube pressure gauge with labeled diagram.	04
Answer: It is a device which is used for the measurement of high pressure as well as pressure above or below the Atmospheric Pressure. **Construction:** 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. **Working:** 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  Bourdan Tube Gauge	02 02
2) Define various hydraulic coefficients and give the relation between them if any.	04
Answer: 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. **Relation among Cd, Cc and Cv:** We know, $C_d = \frac{\text{Actual Discharge}}{\text{Theoretical Discharge}}$	02 (1/2 each for definition)

But by continuity equation Q = Area × Velocity Hence $C_d = \frac{\text{Actual Area} \times \text{Actual velocity}}{\text{Theoretical Area} \times \text{theoretical velocity}}$ $C_d = Cc \times Cv$	02
3) What is priming and why it is necessary in centrifugal pump?	04
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. **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.	02 02
4) Draw a neat sketch of non return valve and explain it.	04
Answer: Non return valve is also called as Check valve or one way 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 in corporate 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

 Non return valve	02
5) Explain with neat sketch bleed off circuit.	04
Answer: Bleed off circuit does not control the flow going to actuator or flow returning from the actuator. It controls diverted part of the fluid to control the flow. In this circuit Flow control valve are placed in the bypass line. In this circuit neither incoming nor outgoing flow is metered. In this method pressurized fluid coming out of pump is diverted and bypassed to oil reservoir. This circuit is used for controlling linear speed of piston in double acting cylinder. Here speed of piston is depends on difference between pump delivery flow and flow being by passed to tank through flow control valve.	02 02

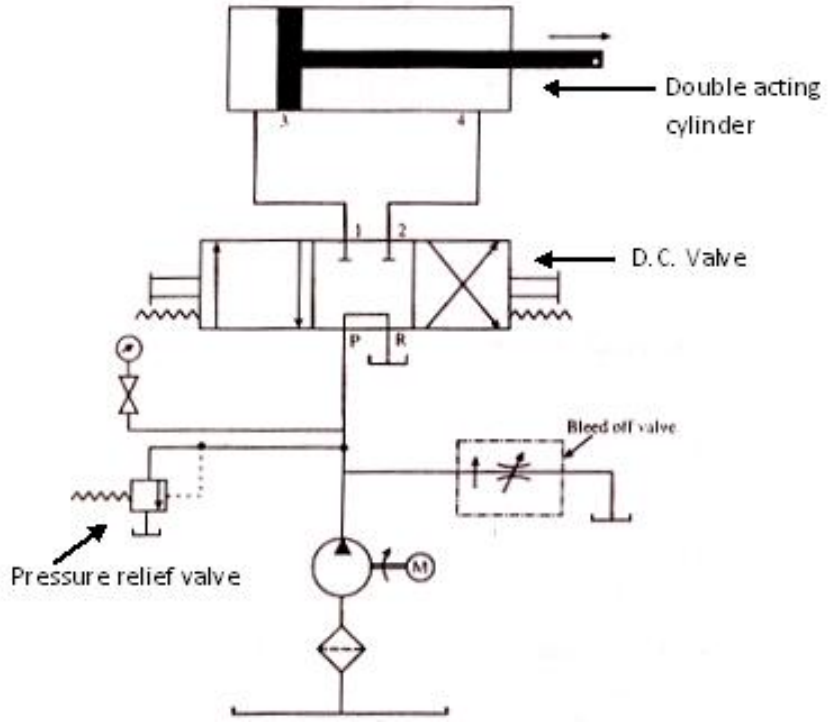
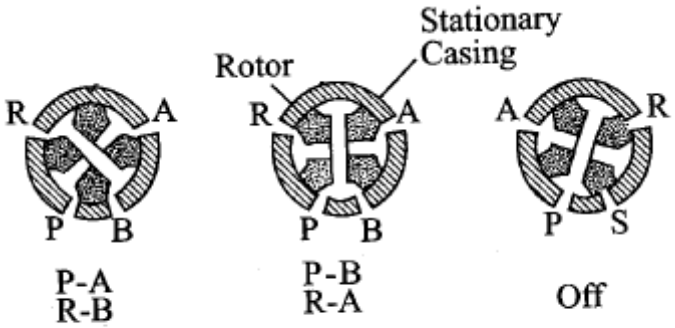
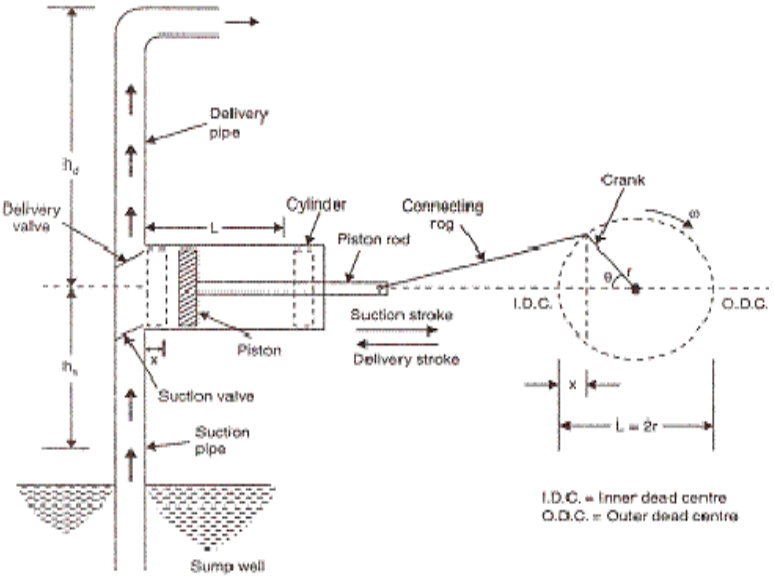


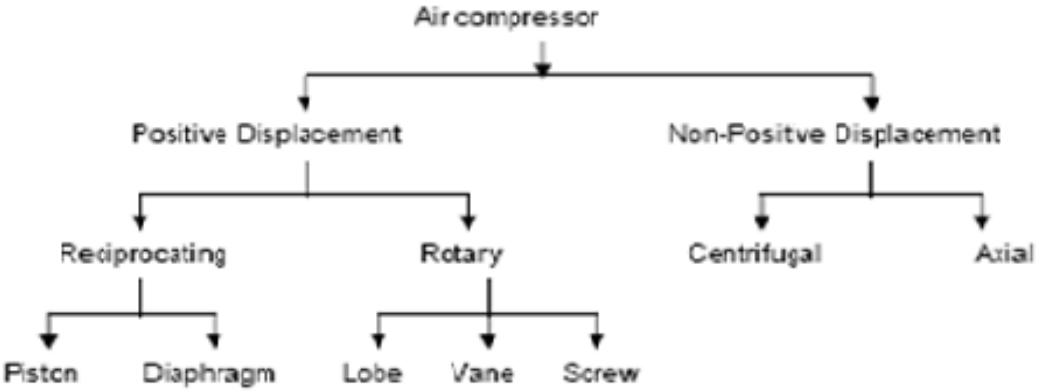
Figure: Bleed-off circuit

4.A)Attempt **any three** of the following	**12**
1) State the law of continuity. Water flows through a pipe of diameter 1.6m with a velocity of 3m/s Find the rate discharge though pipe.	04
Answer: **Law of continuity:** 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. Given data : Diameter of pipe (d) = 1.6 m Velocity of flow (v) = 3 m/s Area of pipe A = $\prod /4 \times d^2$ = $\prod/4 \times (1.6)^2$ = 2.0106 m^2 By continuity question, $Q = A \times v$ = 2.0106 × 3 = 6.03 m^3/s	02 02

2) Define : a) Mechanical efficiency b) Hydraulic efficiency of a centrifugal pump.	04
Answer: a) Mechanical efficiency of a centrifugal pump: It is the ratio of power available at impeller to the power at shaft of pump. Mathematically, $\text{Mechanical efficiency} = \frac{\text{Power available at impeller}}{\text{Power at shaft of pump}}$ b) Hydraulic efficiency of a centrifugal pump: It is the ratio of gross work done to the energy supplied to the impeller $\text{Hydraulic efficiency} = \frac{\text{Gross work done}}{\text{Energy supplied to the impeller}}$	02 02
3) State the function and advantages of air vessel in reciprocating pump.	04
Answer: Function of air vessel: 1. To get more uniform discharge and continuous supply through delivery pipe of reciprocating pump. 2. To save a considerable amount of work in overcoming the frictional resistance in suction and delivery pipe. Advantages of air vessel in reciprocating pump: 1. By using air vessel we can avoid the fluctuation by maintaining constant velocity and discharge. 2. The velocity being constant, there is no acceleration of water and hence no accelerating head is present. This can permit us to install the pump at a higher level or to run the pump at higher speed without separation occurring inside the cylinder.	02 02
4) Explain rotary spool valve with neat sketch.	04
Answer: A rotary spool valve has a rotary spool which has internal oil passages to carry out the direction control element. As shown in the figure the valve body has four passages pressure (P), return(R) and two connections to load (A & B). Figure shows the three positions of the spool and respective port connections. As compared to sliding spool the rotary spool valve is less motion to operate, but it may need more operative force to switch the position.	02

 Rotary spool valve	02
B) Attempt **any one** of the following	06
I) A venture meter with 200 mm at inlet and 100 mm throat is laid horizontally and used for measuring the flow of oil of specific gravity of 0.8. U tube differential manometer gives deflection of 180 mm. The discharge through Venturimeter is found to be 60 liters per second. Find out coefficient of discharge for this meter. Take specific gravity of mercury 13.6.	06
Answer: Given Data: Discharge (Q) = 60 lit/sec. = 60 $\times 10^{-3}$ m^3/sec. Diameter at inlet (d_1) = 200 mm =0.2 m Diameter at throat (d_2) = 100 mm =0.1m Specific gravity of oil (S_f) = 0.8 Specific gravity of mercury (S_m) = 13.6 Difference of manometric liquid (x) = 180mm=0.18m Solution: Area at inlet (a_1) = $\frac{\pi}{4}d_1^{\,2} = \frac{\pi}{4}(0.2)^2 = 0.0314\ m^2$ Area at throat (a_2) = $\frac{\pi}{4}d_2^{\,2} = \frac{\pi}{4}(0.1)^2 = 7.85 \times 10^{-3}\ m^2$ $\therefore$ pressure head (h) = $x\ (\frac{Sm}{Sf}$ -1) = $0.18\ (\frac{13.6}{0.8}$ -1) = 2.88 m	02

$\therefore \quad Q = Cd\frac{a_1.a_2\sqrt{2gh}}{\sqrt{a_1^2 - a_2^2}}$ $\therefore \quad 60 \times 10^{-3} = Cd\frac{0.0314 \times 7.85 \times 10^{-3}\sqrt{2\times 9.81\times 2.88}}{\sqrt{(0.0314)^2-(7.85\times 10^{-3})^2}}$ $\therefore \quad 60 \times 10^{-3} = Cd\ \frac{1.85\times 10^{-3}}{0.0304}$ $\therefore \qquad Cd = \frac{60 \times 10^{-3} \times 0.0304}{1.85 \times 10^{-3}}$ Cd = 0.985	02 02
II) Draw neat sketch of arrangement of reciprocating pump. Label all the parts. Explain construction and working of reciprocating pump.	06
Answer:  Fig. Reciprocating pump	02

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.	02
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. 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.	02
5. Attempt any two of the following	16
1).Give the classification of air compressors. Differentiate between reciprocating and rotary compressor.	08
Answer: Classification of Air Compressors:  	04

Difference between Reciprocating and rotary compressor:

Parameters	Reciprocating	Rotary
1.Air discharge	Low at very high pressure 300 m^3/min up to 1k bar	Large at low pressure 3000 m^3/min up to 10k bar
2.Speed	Low	High
3.Receiver required	Yes, as supply is intermittent	No as supply is continuous
4. Size	Large for the same discharge	Small
5.Balancing problem	Yes, due to more no of parts.	No, due to less no of parts
6.Quality of air supplied	Less cleaner	More cleaner.
7.Lurication system	More complicated	Simple
8. Compression process	Isothermal	Isentropic

(Any four points)

04

2) Explain sequencing pneumatic circuits with neat sketch. 08

Answer:

Generally in mass type production industries when two (or) more than two operations / activities are done sequentially then sequencing circuit is used. For getting output we use double acting actuators in a predetermined sequence.

Sequencing is done by two methods namely pressure dependents and position dependent. In position based sequencing the cams attached to the actuators (cylinders) operate the valves censing another actuator to move. This method is commonly used in pneumatics. A simple position dependant sequencing of two double acting cylinders in shown in fig when start button is pushed by the operator the cylinder one is extended when it reaches the desired position a 2/2 D.C. valve is actuated which provides impulse to the 4/2 D.C. valve of second cylinder causing it also to extend. Thus the position based sequencing is achieved.

04

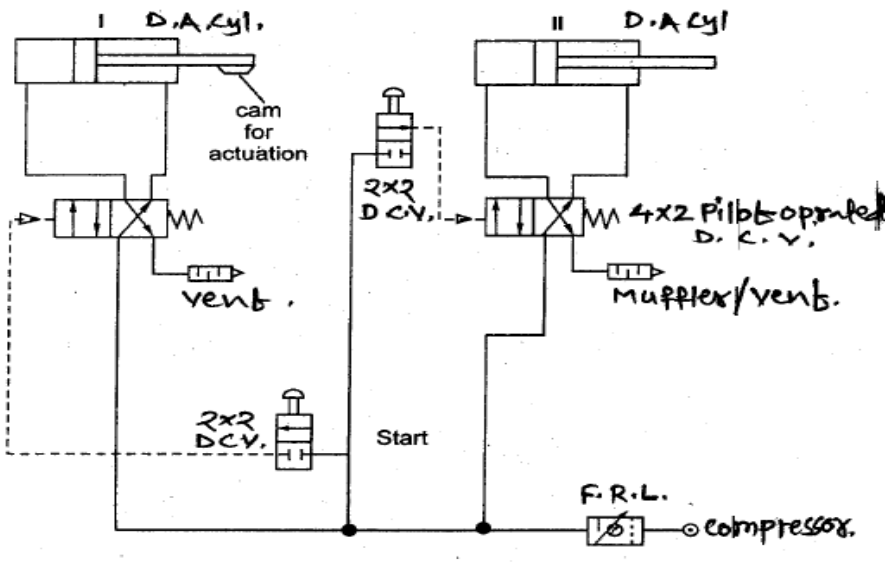


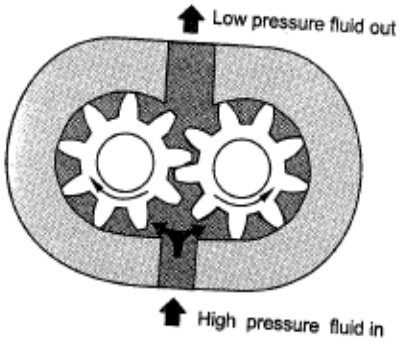
fig. Position based sequencing
(for two double acting cylinders)

04

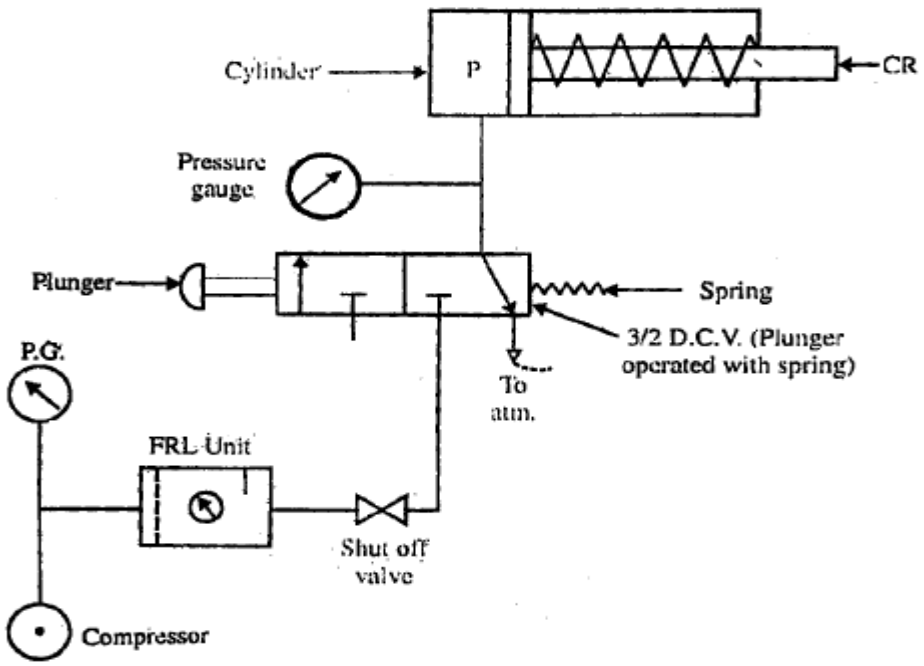
3) a) Explain with neat sketch gear type hydraulic motor. 04

Answer:

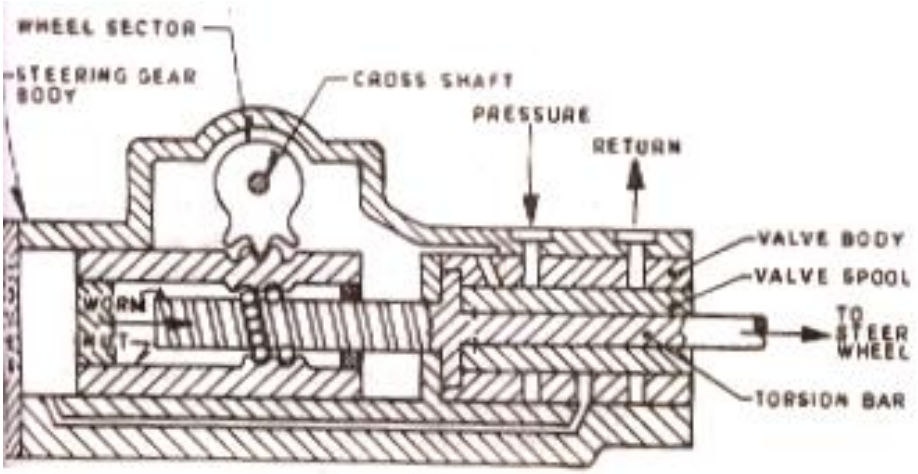
Gear type motor works on the same principle to that of gear pump in fig shows construction of gear motor. Pressurized fluid enters from the bottom, and pressurizes the chamber. This pressure exerts a force on two teeth T1 and T2.These forces cause imbalance of forces on the gears resulting in rotation of both gears. 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



Gear Type hydraulic motor 02

3 (b) Draw general layout of pneumatic circuit and label all the parts.	04
Answer:  Fig. General layout of Pneumatic circuit	04
6. Attempt any two of the following	16
1) Give the application of hydraulics and pneumatics in automobiles. Explain any one of them with neat sketch.	8
Answer: (applications- 2 Marks, Sketch- 3 Marks, Suitable explanation- 3 Marks) Application of hydraulics and pneumatics in automobiles 1. Hydraulic braking system. 2. Hydraulic power steering system 3. Air suspension system. 4. Air braking system. **Note: credit to suitable explanation of any one appropriate application of hydraulics and pneumatics in automobiles.**	02

Hydraulic power steering: Rotary valve type power steering- 03



Rotary valve type power steering gear

This is used to reduce the turning effort required to steer the wheels. It consist of hydraulic pump, gear box, rotary spool type D.C. valve and hoses. The steering wheel is connected to the one end of rotary spool valve while at other end of valve worm is connected. The worm rotates the nut making the sector to turn which turns the road wheels at angle. 03

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

OR

2) Air Braking System:

Fig shows complete layout of Air Brake System. It consists of Air filter, unloading valve, Air compressor, Air reservoir, Brake valve and 4 numbers brake chamber.

Working: The compressor takes atmospheric air through air filter, and compresses the air. This air is stored under pressure in air reservoir. From this reservoir air goes to various accessories of vechile which operates on compressed air. Part of air goes to brake valve. The control of brake valve is done by driver who controls the intensity of braking according to emergency.

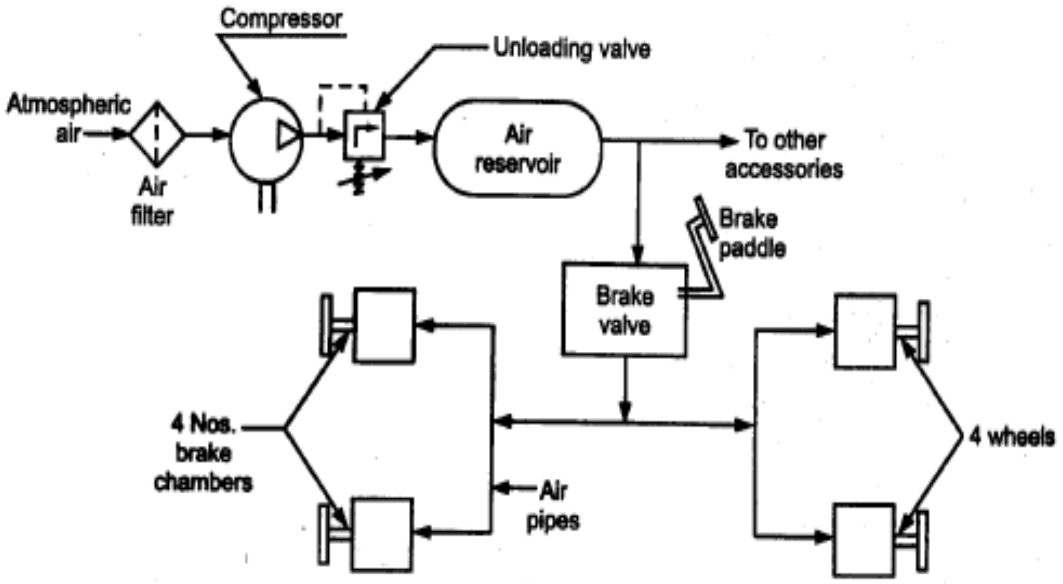


Figure: Air Braking System

2 (a) Explain flexible hose. State material used for it. — 04

Answer:

Hoses are used as flexible connection between moving hydraulic components or for connecting components located in places which are difficult to reach. They also suppress noise & vibration. Hoses are manufactured in layers of elastomers & braided cloth or wire. Hose pipes are in 3 layers.

Layer A

This is inner tube through which oil or fluid flow. This layer comes direct contact with pressurized hydraulic fluid. This layer is called Hose Material layer. Materials are used for this layer are- — 04

Plastic, Nylon, braided nylon, PVC, Teflon, synthetic elastomers, natural rubber.

Layer B

This layer is called Hose reinforcement. This increases strength of inner layer. It provides structural strength to entire hose to withstand against hydraulic pressure of oil which is very high in hydraulic system. This layer is made up of material- **cotton, nylon, wires, synthetic yarn, Rayon.**

Layer C

This is outer layer called as protective layer. It protect middle layer from corrosion, abrasion & other damages which can occur accidents. Materials used for this layer are-

Neoprene, synthetic QRS rubber, cotton /synthetic yarn.

2 (b) What are different types of filters? State its function	04
Answer: **Types of filters** **A) Oil filters** 1) Full flow filter 2) Proportion flow filter **B) According to material used** 1) Surface or screen filter 2) Depth type filter **C) According to location of filter** 1) Suction line filter 2) Pressure line filter 3) Return line filter **D) Pneumatic type or air type filter** **Functions of filters :** 1) To clean oil in hydraulic system. 2) To clean air in Pneumatic system. 3) To arrest unwanted materials. 4) To eliminate the contaminants founds in the oil. 5) To reduce the Chemical reaction products like sludge.	02 02
3) a) identify the following circuits in figure No 1 b) Make correction if any (Redraw) c) Label it and explain its working d) State its applications	08

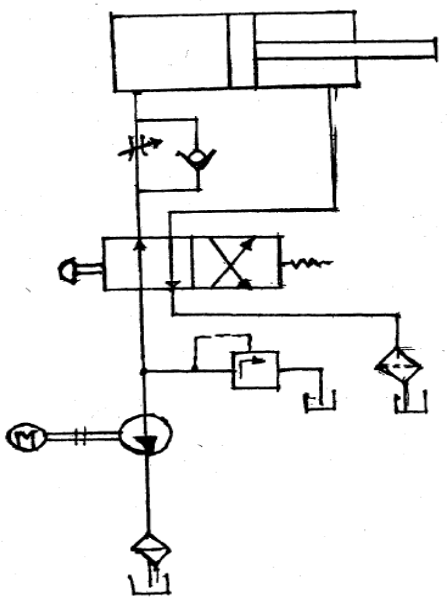


Fig. No. 1 Q. 6 (3)

Answer :

a) The given figure is of Meter in circuit. 01

b) Corrected labeled Figure of meter in circuit: 04

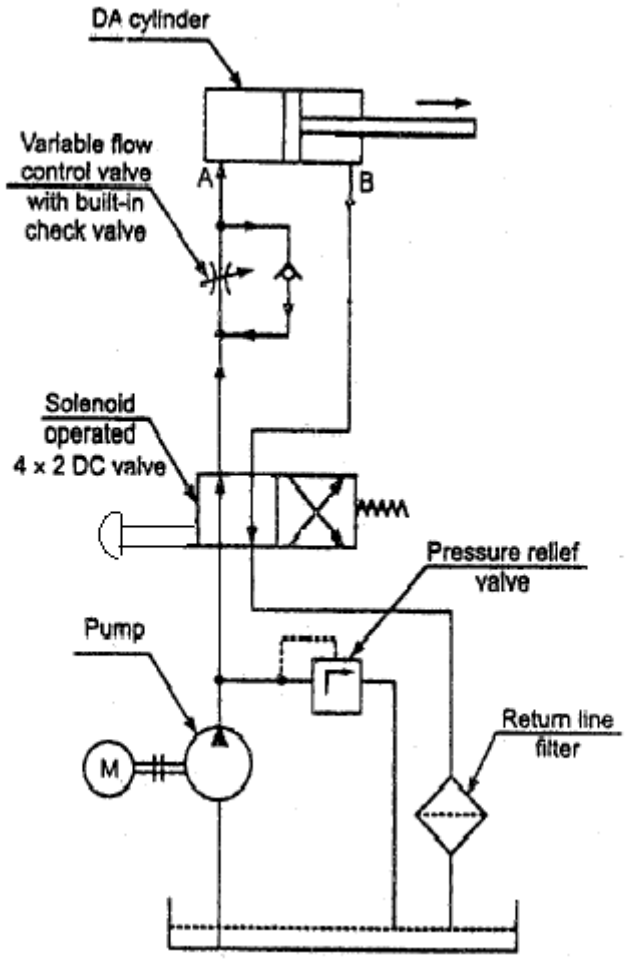


Figure: Meter in Circuit.

Working of Meter in Circuit:

Figure shows circuit connections of 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 head end of the cylinder. Meter in circuit are generally used when load characteristics are constant and positive. 02

Applications: Meter in circuits are used in- **Surface Grinder, Milling machine.** 01