Summer – 16 EXAMINATION

Subject Code: **17522** **Model Answer** Page No: 1/20

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.

2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.

3) The language errors such as grammatical, spelling errors should not be given more importance. (Not applicable for subject English and Communication Skills).

4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.

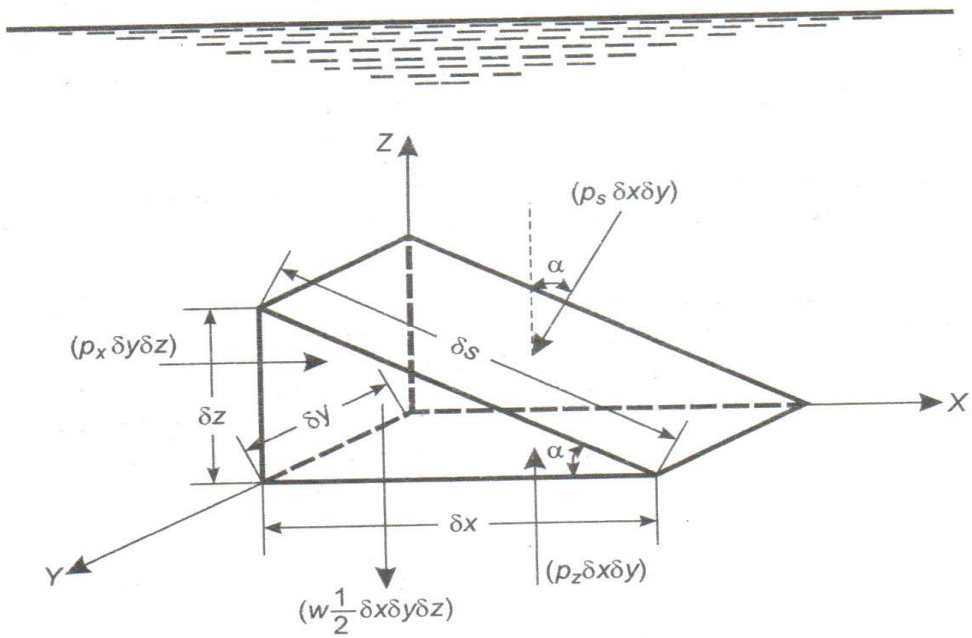
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.

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

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

……

Marks

1. **A) Attempt any THREE of the following:**	12
a) State and explain Pascal's law.	4
Answer : **Pascal's law**: It states that "The pressure at any point in a fluid at rest has the same magnitude 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. $p_x = p_y = p_z$ where, p_x = intensity of pressure in x direction, p_y = intensity of pressure in y direction; p_z = intensity of pressure in z direction;  	1

Consider an infinitesimal wedge shaped element of fluid at rest as a free body. The element is arbitrarily chosen and has the dimensions as shown in figure. Since in a fluid at rest there can be no shear forces, the only forces acting on the free body are the normal pressure forces exerted by the surrounding fluid on the plane surfaces and the weight of the element. As the element is in equilibrium, the sum of the force components on the element in any direction must be equal to zero. So the equation of equilibrium in the x and z directions are respectively. $\rho_x \, \delta y \, \delta z - \rho_s \delta_s \delta y \sin \alpha = 0$ $\rho_z \, \delta x \, \delta y - \rho_s \, \delta_s \, \delta y \cos \alpha - \omega \frac{1}{2} \delta x \, \delta y \, \delta z = 0$ In which ρ_x, ρ_z, ρ_s are the average pressure on the three faces and ω is the specific weight of the fluid. Science $\delta z = \delta s \sin \alpha$ and $\delta x = \delta s \cos \alpha$ the above equations simplify to $\rho_x \, \delta y \, \delta z - \rho_s \, \delta y \, \delta z = 0$ $\rho_z \, \delta x \, \delta y - \rho_s \, \delta x \, \delta y - \frac{1}{2} \omega \, \delta x \, \delta y \, \delta z = 0$ The third term of the second equation is much smaller than the other two terms (since it involves product of three infinitesimal quantities) and hence it may be neglected. By dividing the equations by $\delta y \, \delta z$ and $\delta x \, \delta y$ respectively and taking the limit, so that the element is reduced to a point, it follows from the equations that $\rho_s = \rho_x = \rho_z$ Since the angle α is chosen arbitrarily, this equation proves that the pressure is the same in all directions at a point in a static fluid.	3
b) Give two types of hydraulic actuators and write one application of each.	4
Answer: *(Any two types – 2marks and their applications- 2marks)* **Types of hydraulic actuators:** *(Any two- 1 mark each)* 1. **Linear Actuators:** Single acting cylinder, double acting cylinder, telescopic cylinder, tandem cylinder. 2. **Rotary Actuators:** Gear motor, vane motor, axial piston motor, swash plate, bent axis piston motor, radial piston motor. 3. **Semi-rotary Actuators:** Dual piston type, single vane type, two vane type **Applications of hydraulic actuators:** *(Any one application of each-1 mark)* 1. **Linear Actuators:** Machnine tools, Industrial machinery, Earth moving equipments, construction equipments, Space applications etc. 2. **Rotary Actuators:** Hydraulic motors, Engineering vehicles, Manufacturing machinery, Automotive transmission, LPG cylinder filling, Aviation service etc. 3. **Semi-rotary Actuators:** Industrial machinery, marine, subsea and in applications where high strength, corrosion resistance or hygiene are paramount factors.	2 2
c) Write purpose of i) Rotary spool valve ii) Non-return valve iii) Air motor iv) Hydraulic cylinder	4

Answer: *(Purpose of each - 1 mark)* — 4

i) Rotary spool valve: It is used to change the direction of fluid by rotating the spool.

ii) Non-return valve: It is unidirectional valve and permits the free flow in one direction only.

iii) Air motor: It is used to convert the compressed air energy to mechanical work through either linear or rotary motion

iv) Hydraulic cylinder: It is used to give unidirectional force through a unidirectional stroke .it has many applications, notably in construction equipment, manufacturing machinery, automobiles.

d) Write difference between filters and strainers. (4 points) — 4

Answer**: Difference between filters and strainers.** *(Any 4 points-1 mark each)* — 4

Sr.	Filters	Strainers
1	Filters remove particulates that are smaller than 40 microns	Strainers remove particulates that are larger than 40 microns.
2	If the particulate is too small to see with the naked eye the term "filter" is used.	Word "strainer" is typically used if the particulate being removed is visible to the naked eye
3	Filters have a screen that can be used once until it is clogged.	Strainer incorporates various screens which are reused.
4	If the screen is clogged, it must be changed. Filter screens are not re-used.	If the screen is clogged, it can be cleaned out and used again.
5	Filters are much more flow restrictive	Strainers are much less flow restrictive.
6	Filters are much better applied where positive pressure exists and where constant flow exists i.e. in return line	In most cases, strainers are connected in suction lines into a pump

B) Attempt any ONE of the following: : — 6

a) State Bernoulli's theorem. Write meaning of each term. Give its two applications. — 6

Answer:

Bernoulli's Theorem:

This theorem states that whenever there is a continuous flow of liquid, the total energy at every section remains the same provided that there is no loss or addition of the energy. — 2

Mathematically,

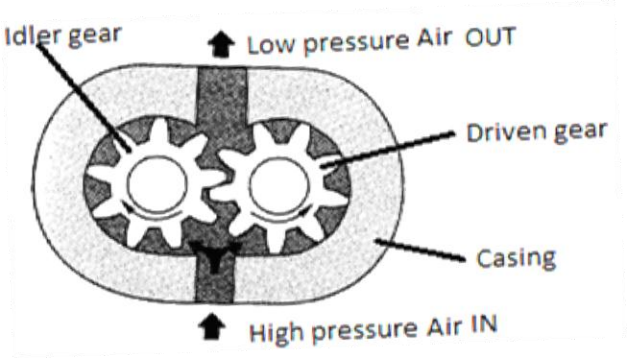
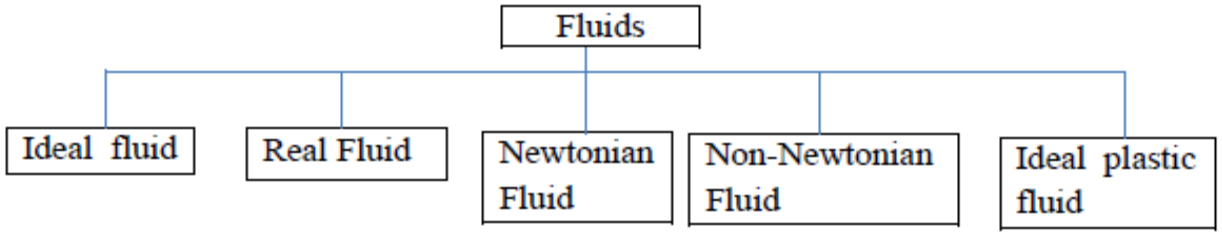
$$\frac{P}{w}+\frac{V^2}{2g}+Z=\text{Constant}$$

Where,

$\frac{P}{w}$ = Pressure energy, $\frac{V^2}{2g}$ = Kinetic energy, Z= Potential energy — 2

Applications of Bernoulli's Theorem : *(Any two)*

Venturimeter, Orifice meter, Nozzle meter or Flow nozzle, Rotameter, Elbow meter (or Pipe-bend Meter), Pitot Tube — 2

b) Describe with neat sketch construction and working of gear type air motor.	6
Answer: **Construction and working of gear type air motor:** It consists of two inter meshing gears inside a housing with one gear attached to the drive shaft. Figure shows a schematic diagram of Gear motor. Gear motors are imbalanced motors. The compressed air enters from the inlet. The pneumatic imbalance in a gear motor is caused by gear teeth unmeshing. As the gear teeth unmesh, all teeth subjected to system pressure are pneumatically balanced except for one side of one tooth on one gear. This is the point where the torque is developed. The larger the gear tooth or higher the pressure, more is the torque produced. The air exists from the exhaust port. Gear motors tend to leak at low speed, hence are generally used for medium speed applications.  Fig. Gear type air motor	3 3
2. Attempt any FOUR of the following:	16
a) Give classification of fluids and write one example of each.	4
Answer: **Classification of fluids**  **Example of fluids** *(Consider any one example of each fluid type)* 1. **Ideal fluid:** An Ideal Fluid is a fluid that has no viscosity. It is incompressible in nature. Practically, no ideal fluid exists. These are only imaginary fluid. The fluids which have low viscosity such as air, water, etc., may however be treated as ideal fluids without much errors. 2. **Real Fluid:** Those fluids which are actually available in nature possess properties like viscosity, surface tension and compressibility. Kerosene, Petrol, Castor oil 3. **Newtonian Fluid:** Water, Air, Mercury, Emulsions 4. **Non-Newtonian Fluid:** Paints, polymers, blood 5. **Ideal plastic fluid:** Printers ink and other thixotropic substance	2 2

b) Write causes and remedies for a symptom-"Low discharge through centrifugal pump." — 4

Answer: Causes and remedies for a symptom-**"Low discharge through centrifugal pump:** — 4

(*Any 4 points- 1mark each)*

Sr.	Causes	Remedies
1	Pump may not be properly primed	Re-prime the pump
2	Total head against which the pump is working may be more than the designed head.	Reduce the head or change the pump
3	Impeller, strainer or suction line, delivery line may be clogged.	Clean the pump parts.
4	Suction lift may be excessive.	Reduce the suction lift.
5	Speed of impeller may be low.	Check the speed with a tachometer and compare it with the design speed. Increase the speed.
6	There may be leakage of air into the pump through the suction line or the stuffing box.	Plug the leakage.
7	There may be excessive wear and tear. Some of the parts may be damaged.	Replace the damaged parts.

c) What is mean by 'Slip' in reciprocating pump? State significance of negative slip. — 4

Answer:

Slip in reciprocating Pump: — 1

Slip of pump means difference between the theoretical discharge and actual discharge of the pump. i.e. Slip = Q_{th} - $Q_{act.}$

Significance of negative slip. — 3

If actual discharge is more than the theoretical discharge, in which case C_d will be more than one and the slip of pump will be negative. In that case slip of the reciprocating pump is known as negative slip.

Negative slip occurs when delivery pipe is short, suction pipe is too long and pump is running at high speed. This is so because for such pumps the inertia pressure in the suction pipe will be large in comparison to the pressure on the outside of the delivery valve, which may cause delivery valve to open before the suction stroke is completed. Some liquid is thus pushed directly into the delivery pipe even before the delivery stroke is commenced, which results in making the actual discharge more than the theoretical discharge

d) Describe the working principle of hydraulic press. — 4

Answer: **Working principle of hydraulic press:** — 3

Consider ram and plunger operating in two cylinders of different diameters which are interconnected at the bottom through a chamber which is filled with some liquid. Let, A be the area of Ram and, a be the area of plunger. If F is the force applied to the plunger then corresponding pressure intensity developed is P (F/ a). But, according to Pascal's law, the same pressure intensity will be transmitted throughout the liquid, and therefore the Ram will also be subjected to the same pressure intensity. Accordingly, If W is the total weight weight lifted by the Ram then W = (P X A) and hence

$P = F/a = W/A$

$W = F \times (A/a)$

It may be seen that, by applying a small force F on the plunger, a large force W may be developed at the Ram. As such by suitable adjusting the area of the plunger and the Ram even a small force may be multiplied many times.

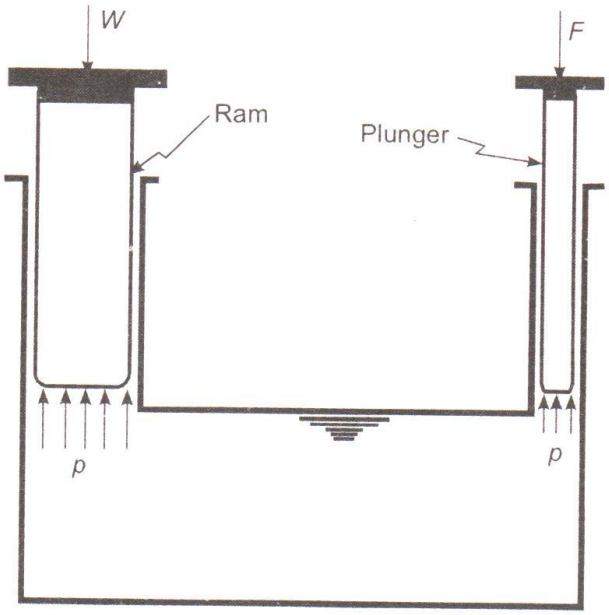


Fig. Working principle of hydraulic press — 1

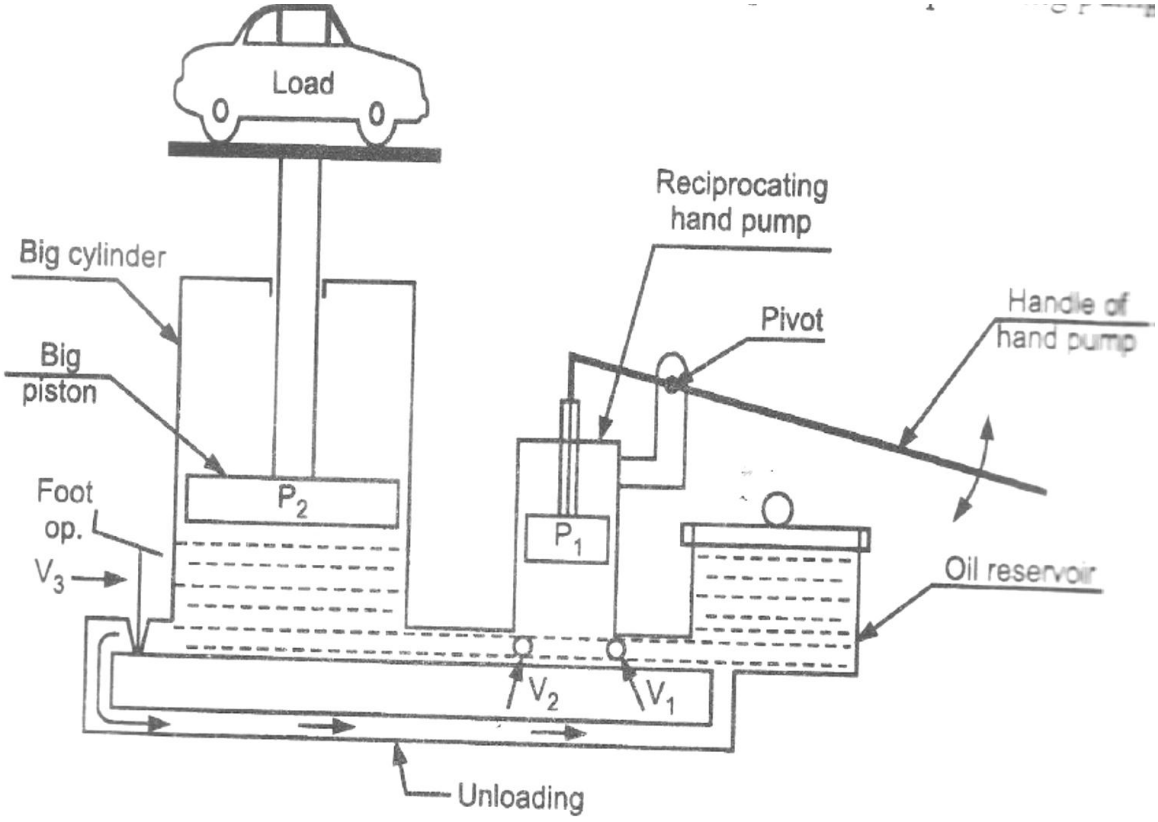
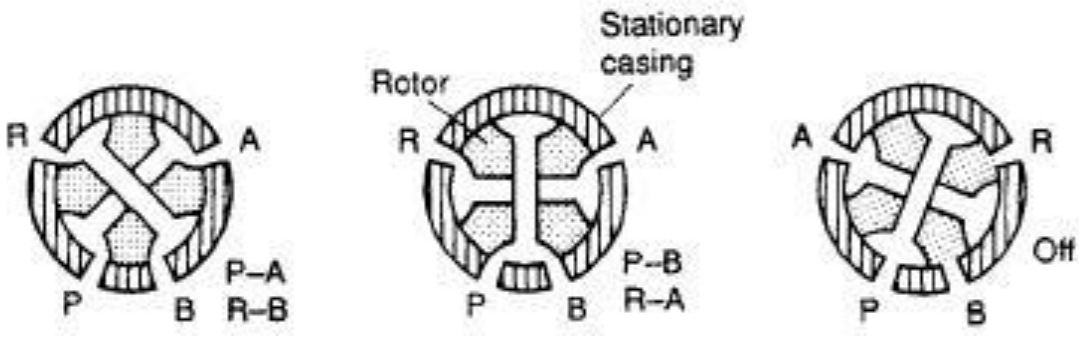
e) Compare gear pump with vane pump on the basis of — 4
   i) Discharge pressure
   ii) Speed
   iii) Overall efficiency
   iv) Application

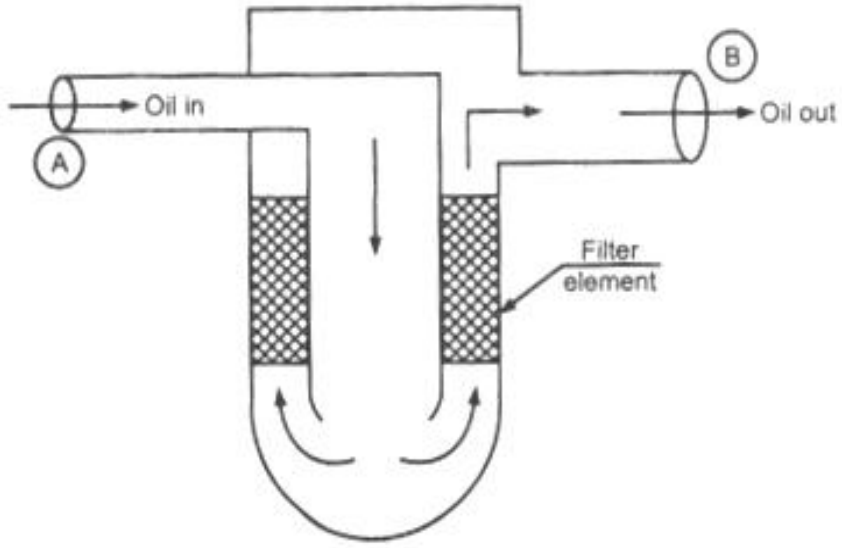
Answer: Comparison of gear pump with vane pump: *(Each point of comparison- 1 mark)* — 4

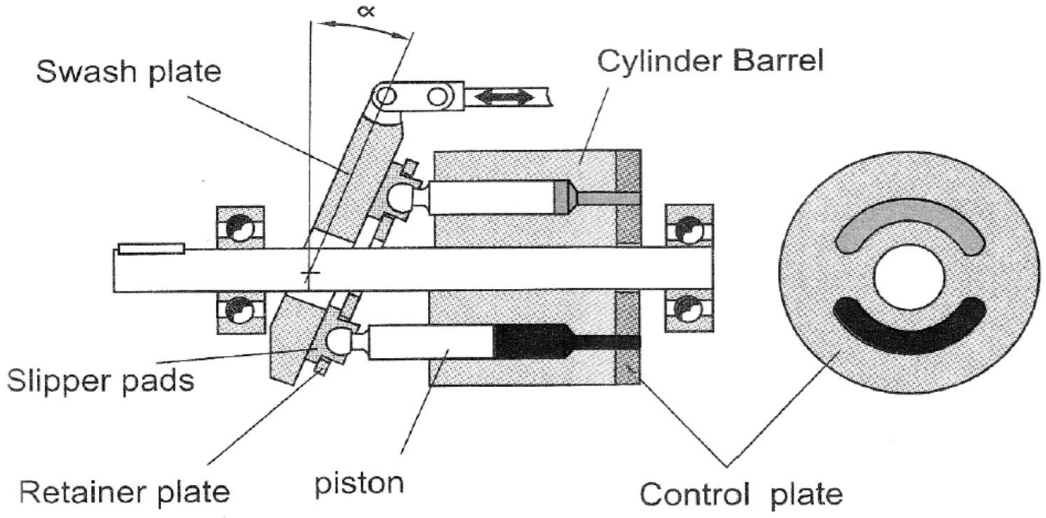
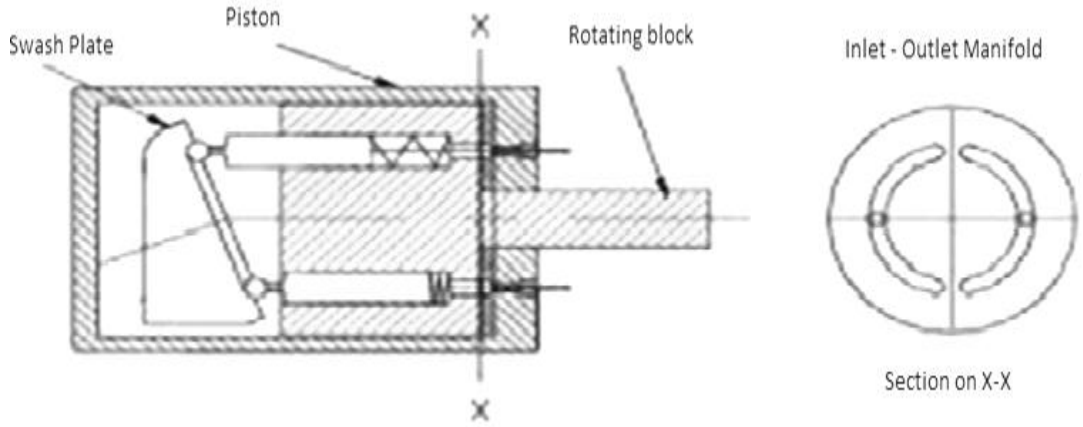
Sr.	Basis	Gear pump	Vane pump
i)	Discharge pressure	Upto 200 bar	70 to 135 bar pressure
ii)	Speed	500 to 2500 rpm	1000 to 1750 rpm
iii)	Overall efficiency	Less efficient than vane pumps	More efficient than gear pumps.
iv)	Application	Industrial and mobile hydraulic applications e.g. lifts, log splitters. Acids and caustic, fuel oils and lube oils, chemical mixing and blending.	Auto Industry- Fuel, Lubes, Refrigeration coolants Aviation service-Fuel transfer, Deicing LPG cylinder filling, Aqueous solution

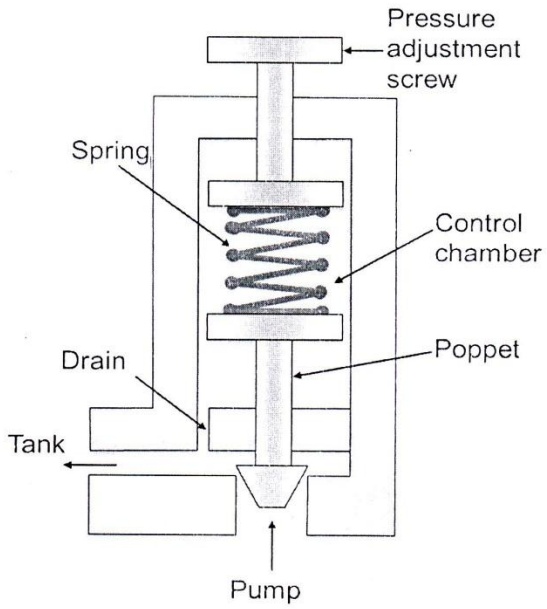
3. Attempt any FOUR of the following:

a) Draw a schematic diagram of hydraulic Jack and label the components. — 4

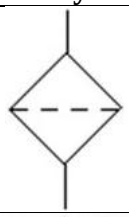
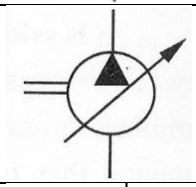
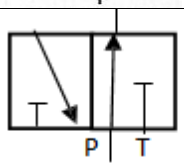
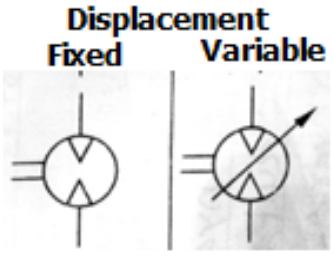
Answer**: Schematic diagram of hydraulic Jack**  	4
b**)** Draw a neat labelled sketch of rotary spool type DC valve.	16
Answer**: Labeled sketch of rotary spool type DC valve**  	4
c) What is Air motor? Give its two applications.	4
Answer: **Air motor:** Air motor generally converts the compressed air energy to mechanical work through either linear or rotary motion. Linear motion can come from either a diaphragm or piston actuator, while rotary motion is supplied by either a vane type air motor, piston air motor, air turbine or gear type motor. Air motors ranging in size from hand-held motors to engines of up to several hundred horsepower. Pneumatic motors have found widespread success in the hand-held tool industry, industrial applications.	2

Applications of air motor *(Any two)* 1. Pneumatic drill 2. Pneumatic screw driver 3. Pneumatic wood borer 4. Pneumatic wrenches and nut runners 5. Pneumatic grinder	2
d) State two functions of seals and gaskets. Give two applications in hydraulic circuit.	4
Answer: **Function of seals and gaskets:** *(Any two)* 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. **Application of Seals and gaskets:** *(Any two)* Hydraulic pump, hydraulic motors, hydraulic actuators, valves, filter, reservoir	2 2
e) Draw full flow filter and describe its working.	4
Answer: Working of Full flow type 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.  Fig. full flow filter	2 2
f) Define- i) Atmospheric pressure ii) Gauge pressure iii) Vacuum pressure iv) Absolute pressure	4

Answer: *(Each correct definition – 1 mark)* i) **Atmospheric pressure:** At the earth surface, the pressure due to the weight of air above the earth surface is called as atmospheric pressure. ii) **Gauge pressure:** If the pressure is measured above the atmospheric pressure it is called as gauge pressure. **iii) Vacuum pressure:** If the pressure is measured below the atmospheric pressure it is called as Vacuum pressure. **iv) Absolute pressure:** Absolute Pressure is defined as the pressure which is measure with reference to Absolute vacuum pressure.	4
4. A) Attempt any THREE of the following:	12
a) Draw a neat sketch of swash plate type gear pump and label it.	4
Answer: **Labeled sketch of Swash plate type pump:**  **OR**  	4

b) Describe construction and working of pressure relief valve.	4
Answer: **Construction and working of pressure relief valve:** This type of valves has two ports; one of which is connected to the pump and another is connected to the tank. It consists of a spring chamber where poppet is balanced with a spring force. Generally, spring is adjustable to set the maximum pressure limit of the system. The poppet is held in position by combined effect of spring force and dead weight of spool. As the pressure exceeds this combined force, the poppet raises and excess fluid by passed to the reservoir. The poppet again resets as the pressure drops below the pre-set value. A drain is also provided in the control chamber. It sends the fluid collected due to small leakage to the tank and there by prevents the failure of the valve.  Fig. Pressure relief valve	2 2
c) What is FRL unit? Describe the function of each component.	4
Answer: **FRL unit:** Filter, Pressure regulator, and Lubricator are combined in a unit. These three units together are called FRL unit or Service unit. Compressed air from compressor comes in FRL unit where in, air is filtered, controlled and lubricated. Such prepared and controlled air is delivered to the pneumatic system. **Function of FRL Unit:-** *(Function of each component- 1 mark)* 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.	1 3

d) Draw symbols for- i) Filter ii) Unidirectional variable displacement hydraulic pump iii) 3 X 2 DC valve iv) Bi-directional air motor	4
Answer: *(Each correct symbol - 1 mark)*	4

Sr.	Symbols
i) Filter	
ii) Unidirectional variable displacement hydraulic pump	
iii) 3 X 2 DC valve	
iv) Bi-directional air motor	

B) Attempt **any ONE of the following:**:	6
a) Draw meter – in circuit and state its two applications.	6
Answer: **Applications of Meter in circuit:** *(Any two-1 mark each)* 1. Grinding machine 2. Milling machine 3. Meter in circuit are generally used when load characteristics are constant and positive	2

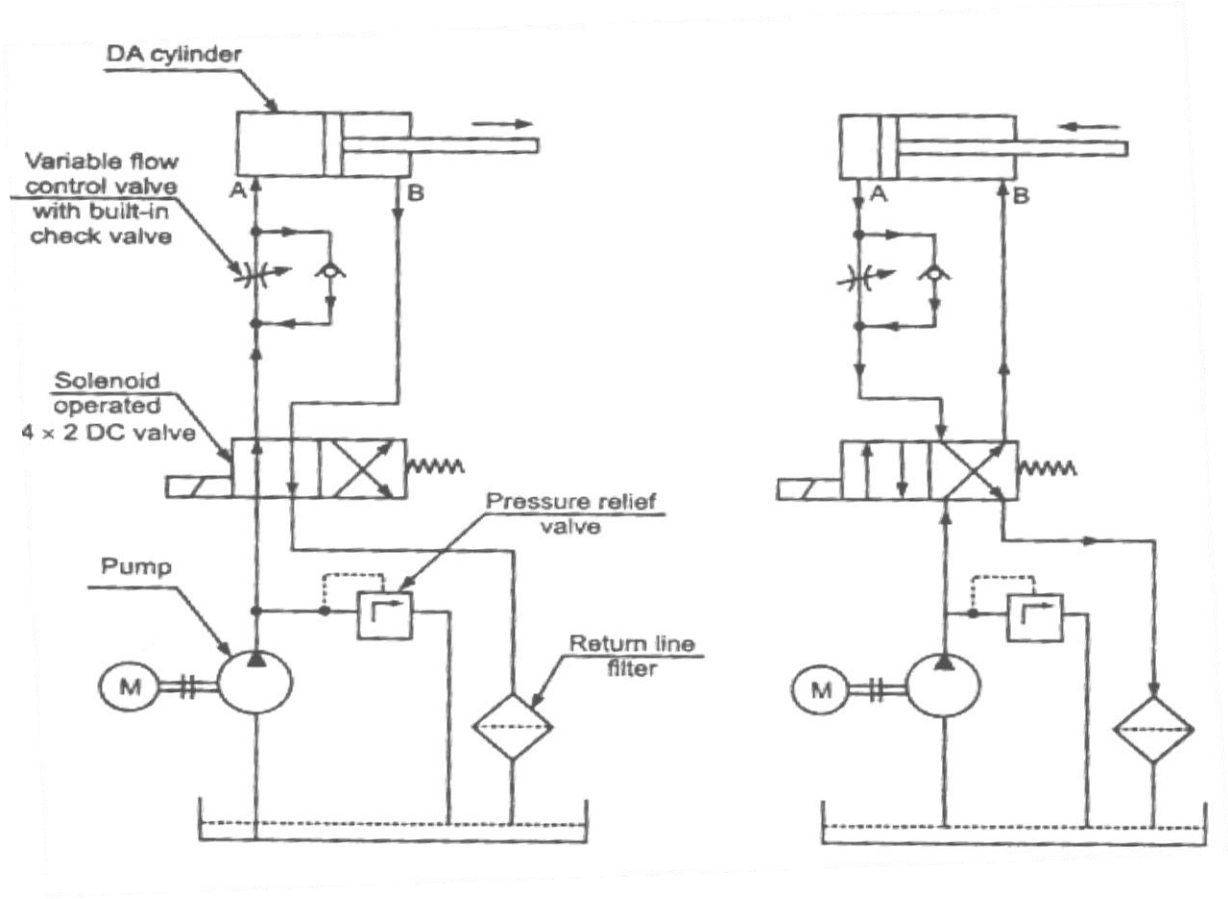


Fig. Meter in Circuit

4

b) Explain air brake with neat labeled sketch. 6

Answer: Air brake:

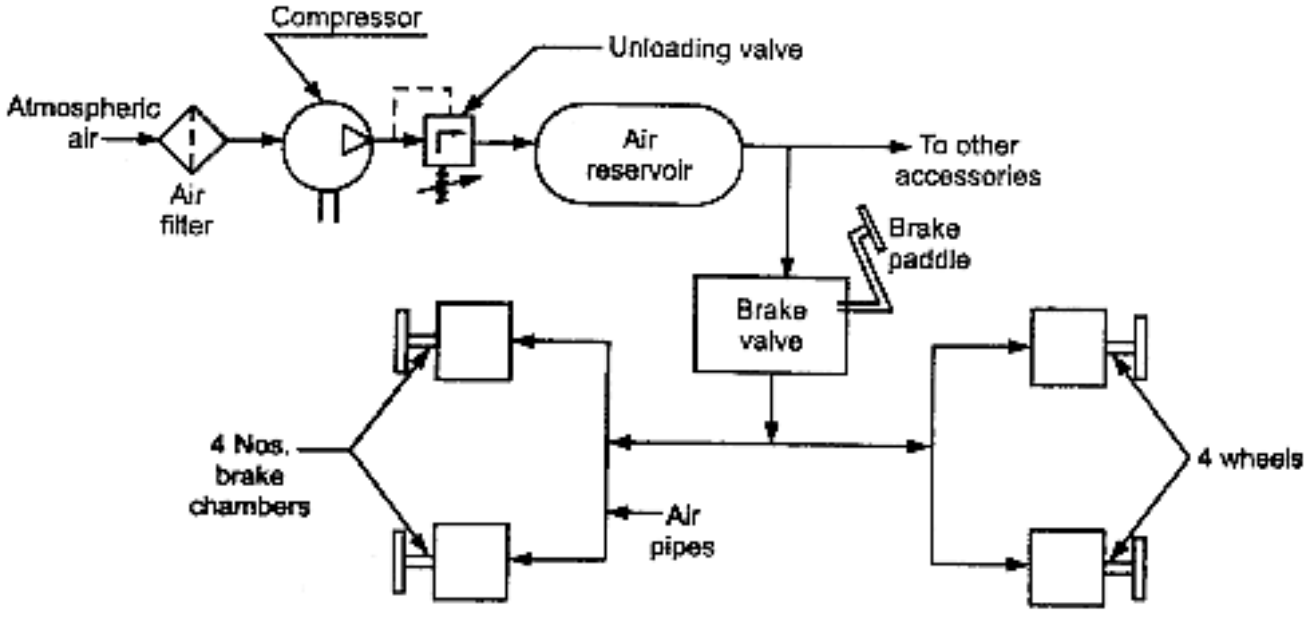
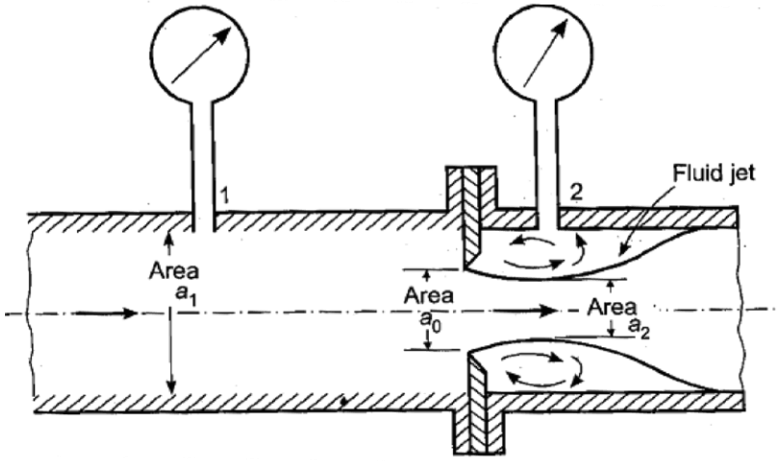


Figure: Air Brake System

3

Figure 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. 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 vehicle 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.	3
5. Attempt any FOUR of the following:	16
a) Derive an expression for discharge through orifice meter by applying Bernoulli's theorem.	8

Answer: **Expression for discharge through orifice meter by applying Bernoulli's theorem:**



2

Figure: Orifice meter.

Let,

P_1 = Pressure at section 1

V_1= Velocity at section 1

a_1 = area of pipe at section 1

P_2, V_2, a_2 are corresponding values at section 2

Applying Bernoulli's equation at section 1 and 2

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

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

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

$$h=\frac{V_2^2}{2g}-\frac{V_1^2}{2g}=\frac{V_2^2-V_1^2}{2g}$$ 1

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

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

$V_2 = \sqrt{2gh + V_1^2}$ ……(1)

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

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

Thus, Actual velocity at section 2

$V_2 = C_v\sqrt{2gh + V_1^2}$ ……(2) 1

Discharge at section 1 & 2 is

$Q = a_1 v_1 = a_2 v_2$ ……..(3) 1

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

$a_2 = c_c . a_0$

C_c = Coefficient of contraction

Thus introducing value of a_2 in equation (3)

$a_1 v_1 = a_2 v_2$

$a_1 v_1 = c_c . a_0 v_2$

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

By substituting value of v_1 in equation (2)

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

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

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

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

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

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

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

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

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

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

Now $Q = a_2 v_2$

$Q = c_c.a_0 v_2$

Put valve of a_2

And $c_c.c_v = c_d$

c_d = coefficient of discharge through orifice

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

1

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

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

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

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

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

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

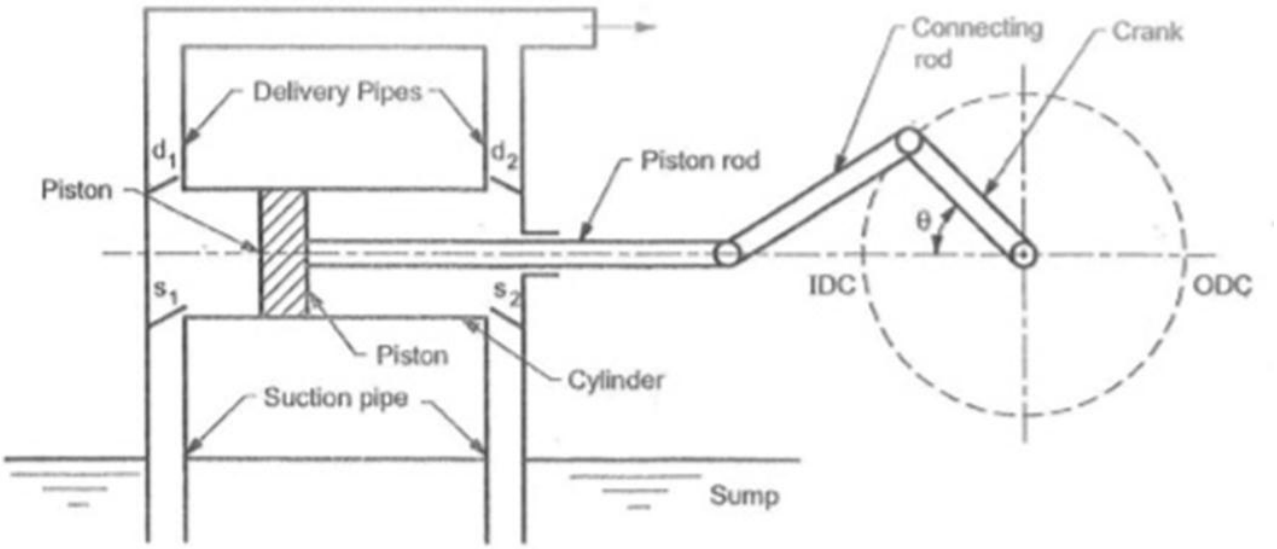
$$Q = \frac{c . a_0 . \sqrt{2gh}}{\sqrt{\frac{a_1^2 - a_0^2}{a_1^2}}}$$

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

1

c = coefficient of discharge for and orifice meter

Above equation gives expression for discharge through an orifice meter.

b) Describe with neat sketch construction and working of double acting reciprocating pump.	8
Answer: Construction and working of double acting reciprocating pump  Figure: Double acting reciprocating pump **Construction:** Figure shows a double 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. **Working:** This type of pump operates in exactly the same way as the single acting with respect to its action. The difference is that the cylinder has inlet and outlet ports at each end of the cylinder. As the piston moves forward, liquid is being drawn into the cylinder at the back end while, at the front end, liquid is being discharged. When the piston direction is reversed, the sequence is reversed. With a double acting pump, the output pulsation is much less than the single acting.	4 2 2
c) Draw circuit diagram for hydraulic power steering and describe its working.	8
Answer: Working of Hydraulic steering system: In this system, Pump is driven by engine of vehicle. Pump supplies pressurized oil through specially designed direction control valve. When steering wheel is almost steady and there are very low manual effort at steering wheel the hydraulic oil enters into double acting cylinder through port A and B in equal amount and applies equal and opposite pressure on piston, hence piston is steady. As soon as the driver applies more efforts than predetermined value, the steering arm actuates the direct control valve. This valve senses the input pressure at steering wheel and directs the pressurized oil to double acting cylinder through port A. Naturally piston will move towards left. The piston rod	4

will move the rack towards left and pinion will rotate to help the driver. Due to additional efforts driver can easily turn the steering wheel.

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

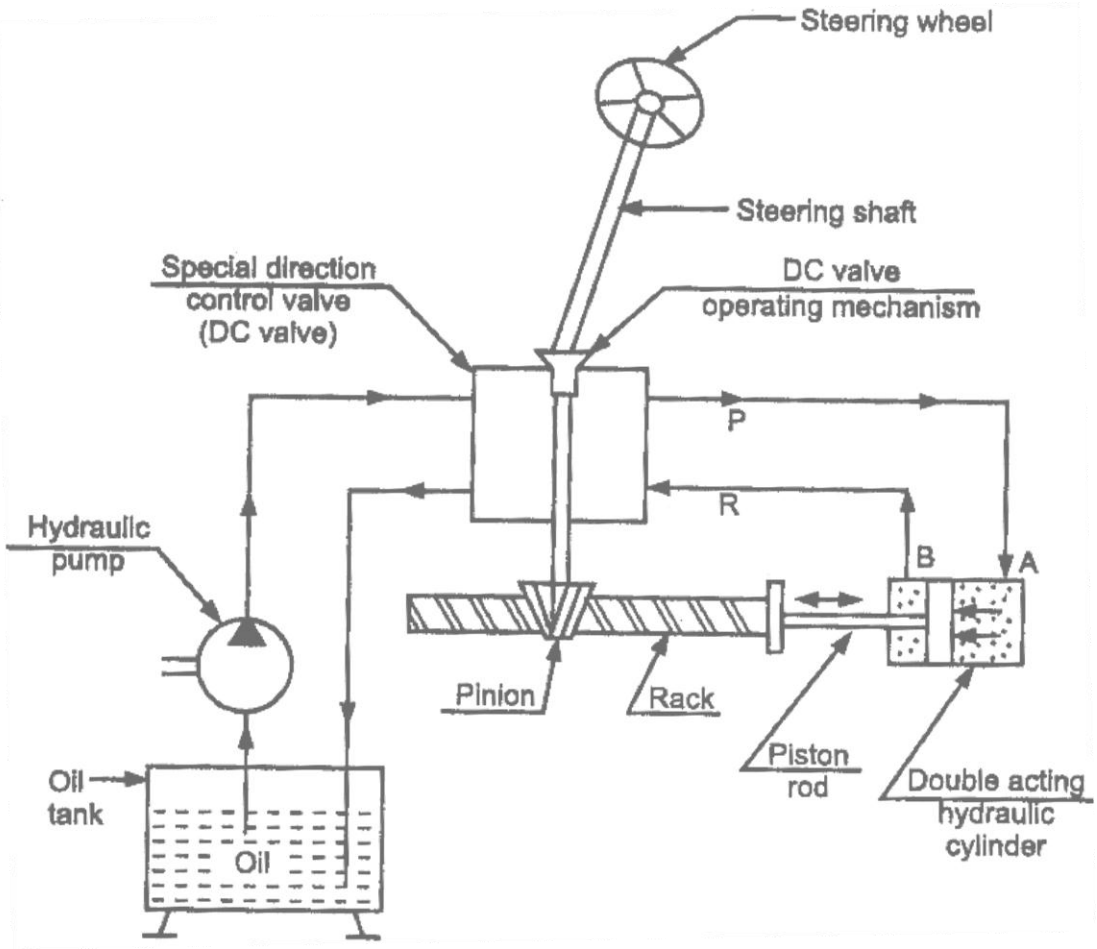


Fig. Circuit diagram for hydraulic power steering. 4

6 Attempt any TWO of the following: 16

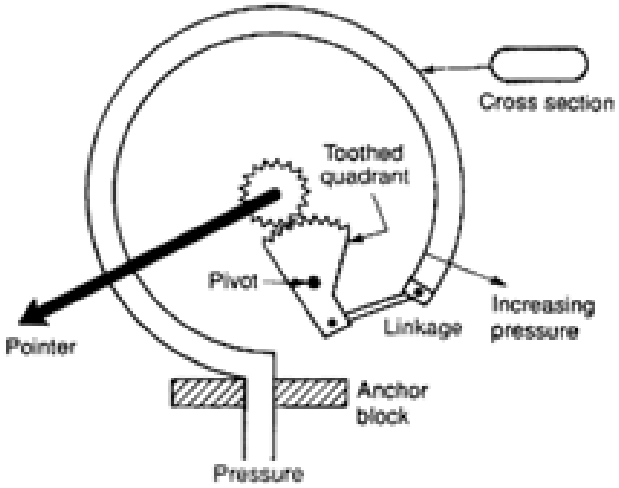
a) State four pressure measuring gauges. Describe construction and working of Bourdon tube pressure gauge and give its two applications. 8

Answer: Pressure measuring gauges: *(½ mark each)* 2

1. Diaphragm pressure gauge
2. Bourdon tube pressure gauge
3. Dead weight pressure gauge
4. Bellows pressure gauge

Bourdon tube pressure gauge

Bourdon tube pressure gauge is a device which is used for the measurement of high pressure as well as pressure above or below the Atmospheric Pressure.

Construction and Working: 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	3
 Fig. Bourdon tube pressure gauge	2
Application : *(Any two- 1/2 mark each)* 1. For measuring high pressures e.g. in steam boilers, compressors. 2. For measuring pressures in vehicles tube tyre. 3. In hydraulic system.	1
b) i) Why priming is necessary in centrifugal pump? What are methods of priming? ii) What factors are to be considered for selection of pump?	8
Answer: *(Necessity of priming – 2 marks, Methods of priming- 2 marks)* **i) Necessity 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.	2
Methods of Priming: *(Any two)* 1. **Liquid pouring:** Small pumps are usually primed by pouring the liquid through a funnel into the casing from some external source. The air vent provided in the casing is opened to facilitate the exit of the air. When all air has been removed from the suction pipe and the pump casing, the air vent is closed and the pump is primed. 2. **Casing evacuation:** Large pumps are primed by evacuating the casing and suction pipe with the aid of an air pump or stream ejector, the liquid is thus sucked into the suction pipe from the sump. 3. **Automatic priming:** In some pumps, their internal construction is such that special arrangement containing a supply of liquid are provided in the suction pipe which facilitate automatic priming of the pump. Such pumps known as 'Self primed pumps'.	2

ii) **Factors to be considered while selecting a pump:** *(Any four)* — 4

1. **Speed of Pump:** When the specific speed is low and it is possible to increase the pump speed it is better to use multi stage pump. The number of stages is decided on the basis of the head and the type of the pump to be used.
2. **Flow of pressurized Fluid:** From the values of discharge (Q), head (H) and speed (N), values of specific speed of the pump is calculated and subsequently the type of the pump can be decided.
3. **Availability and Cost of Pump:** There is different variety of pumps available in market according to application we can choose it by economical aspect cost of the pump and its spare should be less.
4. **Compatibility with working medium:** The meaning of compatibility is nothing but acceptance or familiar. Due to lack of proper working medium, pump will not give a good performance.
5. **The type of impeller** :
   i) Impeller shrouded type - for pumping fresh clean water
   ii) Impeller un-shrouded or propeller type for pumping solid - liquid mixture or near plastic material
   iii) Mixed flow impellers with diffuser vanes used for deep well or submersible pumps.
6. **Head available.**

c) Compare hydraulic and pneumatic circuits. — 8

Answer: Comparison of hydraulic and pneumatic circuits *(Any eight points- 1 mark each)* — 8

SR.	Hydraulic circuit	Pneumatic circuit
01	Used for circuits up to 700 bar pressure	Operative below 10 bar pressure.
02	Uses hydraulic oil as a medium	Uses air as a medium
03	Pump is used to pressurize the oil	Compressor is used to pressurize the air.
04	Since hydraulic oil is reused in the circuit hydraulic oil tank is a must and there are return lines	Air is taken from atmosphere and is vented to atmosphere after use. Hence no return lines. Air reservoir is used to store pressurized air.
05	The rigidity of the system using hydraulic circuit is good.	The rigidity of the system using hydraulic circuit is poor.
06	Moderate operating cost.	Operating cost is low.
07	Maintenance is critical.	Maintenance is simple.
08	Very suitable for accurate speed/feed movement of cutting tool mechanism.	No accuracy in movement.
09	The system using hydraulic circuit is not clean due to oil leakages.	Pneumatic circuits are very clean.
10	Weight to pressure ratio is small.	Weight to pressure ratio is high.
11	Problem of cavitation is serious in hydraulic circuit.	No problem of cavitation.
12	Oil is changed as per schedule.	No need of change of air as per schedule.
13	Hydraulic circuits are used in tackling heavy loads, hence used in earthmoving equipments, CNC-VMC machines.	Pneumatic circuits are used when loads are much lighter. Hence used in transferring the light weight components, vacuum handling in printing press, food industry.