MACHAKOS UNIVERSITY

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL & MANUFACTURING ENGINEERING

FIRST YEAR SECOND SEMESTER EXAMINATION FOR DIPLOMA IN MECHANICAL ENGINEERING (PLANT-TVET OPTION)

PLANT MAINTENANCE

INSTRUCTIONS **TIME:**

This paper consists of five questions, attempt ALL .

1 (a). Explain the need of lubrication. (5Marks)

(b). Using neat sketches illustrate the following lubrication methods;

I. Hydrodynamic
II. Aerodynamic
III. Boundary
IV. Solid film (10Marks)

(c).Mention Five desirable properties of good lubricant . (5Marks)

2 (a).Using neat diagram show constructional features of reciprocating air compressor and explain briefly the working principle. (10marks)

(b).Differentiate between reciprocating and centrifugal air compressors citing typical areas of application for each .

(10marks)

3 (a) .Describe Four methods of capacity control in air compressors (8marks)

(b)Mention Five factors to consider when selecting an air compressor for particular application. (5marks)

(c).Illustrate a typical compressed air distribution pipe layout plant showing exact location of the following
equipments; (7Marks)

I. Regulator
II. Strainer
III. Separator
IV. Lubricator
V. Drain cork.

4 . (a). Describe the following hydraulic principles . (6Marks)

Hydrostatic
Hydrodynamic
Hydrokinetic

(b).Discuss briefly the following hydraulic systems;

i. Hydraulic accumulator (8Marks)
ii. Torque converters

(c). Give Six maintenance checks can be done on hydraulic systems. (6Marks)

5 (a) .Discuss briefly classification of pumps. (6Marks)

(b).Describe construction of a centrifugal pump giving areas of application. (8marks)

(c). Explain why centrifugal pumps are widely used in most typical applications. (6Marks)

MARKING SCHEME

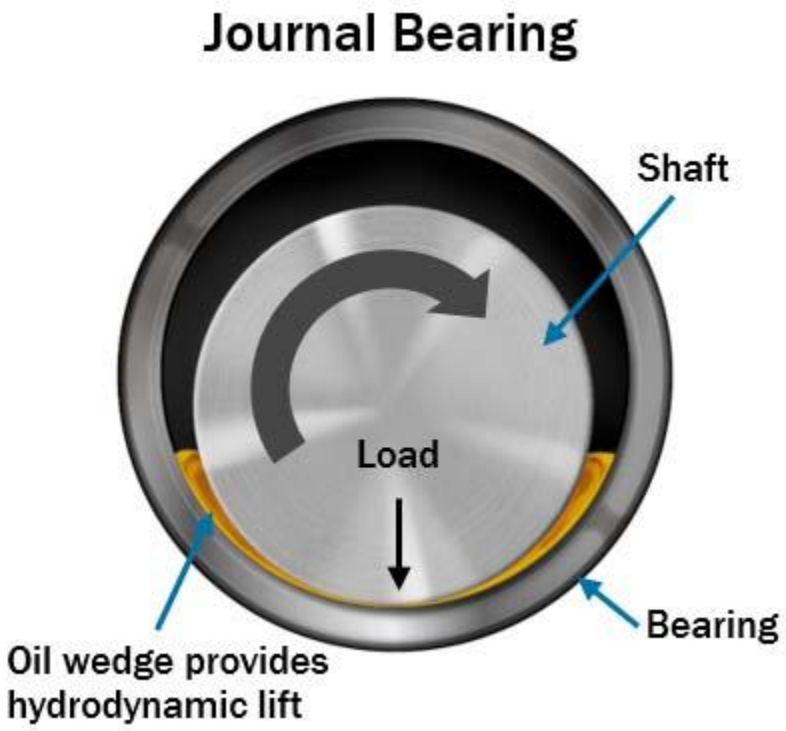
1(a**). Need of lubrication**

- ✓ Cooling (5Marks for any five0
- ✓ Sealing
- ✓ Cleaning
- ✓ Reduce friction and wear
- ✓ Damping
- ✓ Prevent rust and corrosion

(b). **Lubrication methods;**

- **hydrodynamic lubrication**

  Fluid film or **hydrodynamic lubrication** is the term given when a shaft rotating in a bearing is supported by a layer or wedge of oil so that the shaft is not in contact with the bearing material.

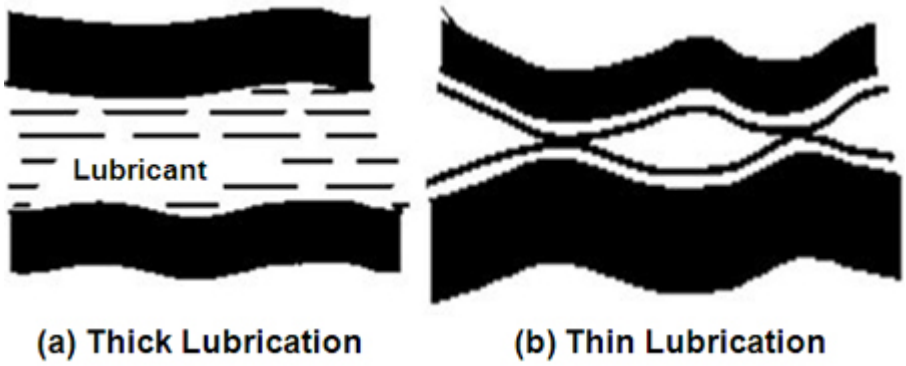


- **Boundary lubrication** is **lubrication** by a liquid under conditions where the solid surfaces are so close together that appreciable contact between opposing asperities is possible.

- **Boudary lubrication (thin film lubrication):**

- During starting and stopping, when the velocity is too low, the oil film is not capable of supporting the load. There will be metal to metal contact at some spots as shown in figure 7.11. Boundary lubrication exists also in a bearing if the load becomes too high or if the viscosity of the lubricant is too low. Mechanical and chemical properties of the bearing surfaces and the lubricants play a vital role.

- Oiliness of lubricant becomes an important property in boundary lubrication. Anti oxidants and Anti-corrosives are added to lubricants to improve their performance. Additives are added to improve the viscosity index of the lubricants.

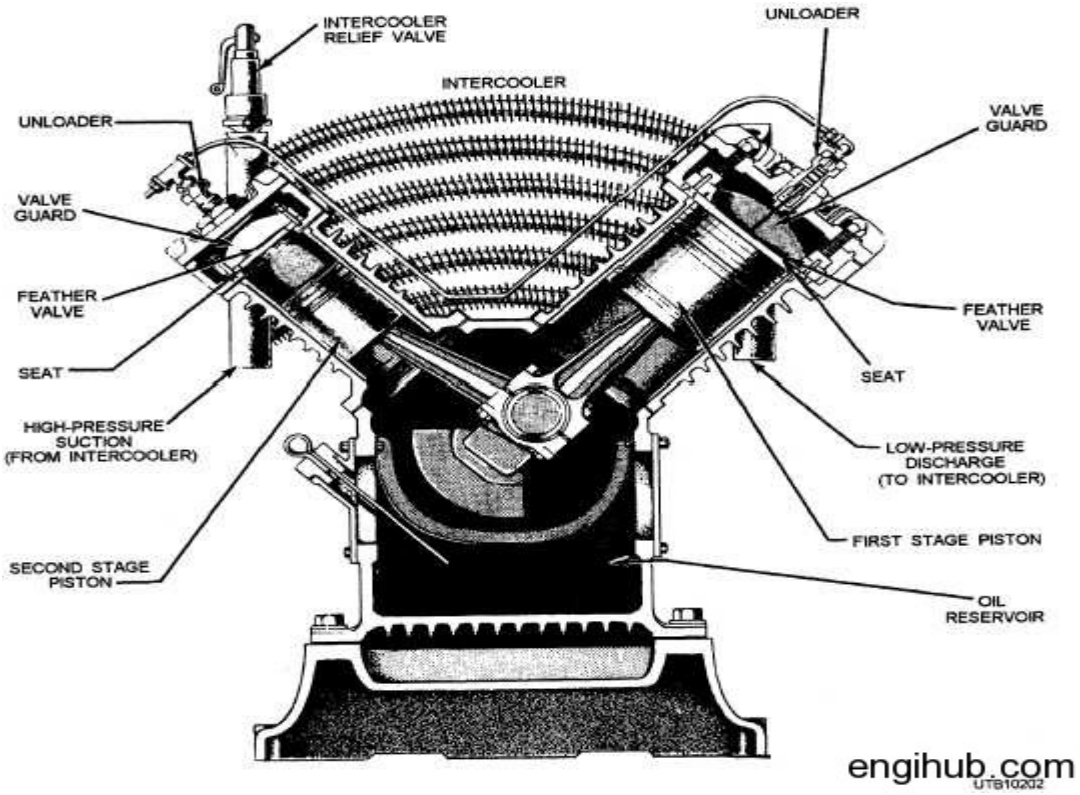


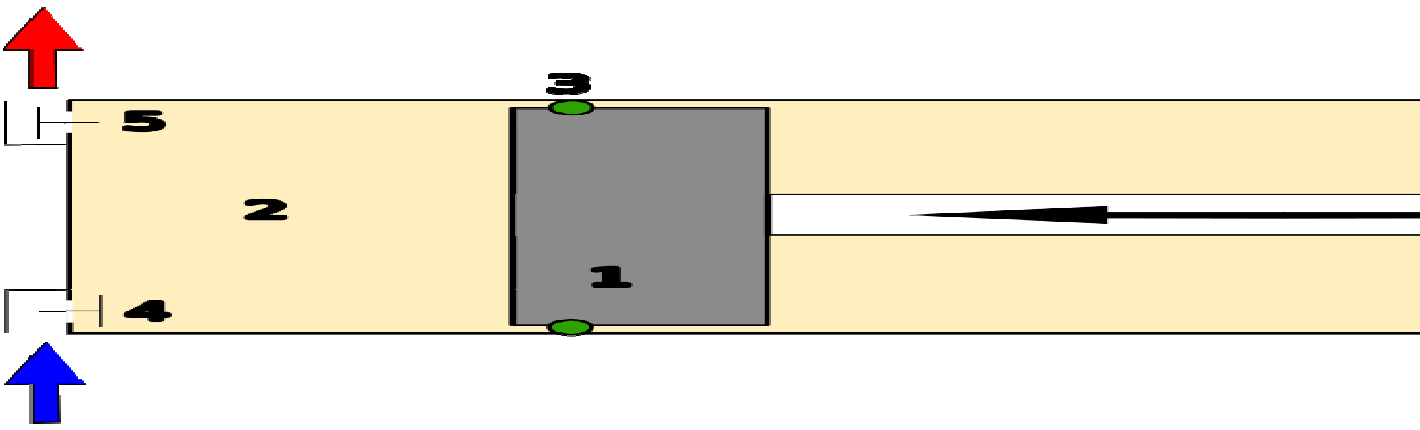
- **Solid film lubrication:** When bearings must be operated at extreme temperatures, a solid film lubricant such as graphite or molybdenum di-sulphide must be used because the ordinary mineral oils are not satisfactory at elevated temperatures. Much research is currently being carried out in an effort to find composite bearing materials with low wear rates as well as small frictional coefficients.

(c). **Five desirable properties of good lubricant** . (5Marks)

- ✓ A high boiling point and low freezing point (in order to stay liquid within a wide
- ✓ range of temperature)
- ✓ A high viscosity index.
- ✓ Thermal stability.
- ✓ Hydraulic stability.
- ✓ Demulsibility.
- ✓ Corrosion prevention.
- ✓ A high resistance to oxidation.

2 (a). **Constructional features of reciprocating air compressor and explain briefly the working principle.** (10marks)





A **reciprocating compressor** or **piston compressor** is a positive-displacement compressor that uses pistons driven by a crankshaft to deliver gases at high pressure.[1][2]

The intake gas enters the suction manifold, then flows into the compression cylinder where it gets compressed by a piston driven in a reciprocating motion via a crankshaft, and is then discharged.

2(b). **Difference between reciprocating and centrifugal air compressor**.

1- Centrifugal compressors are used where larger quantity and lower pressure is required.

Reciprocating compressors are used where a less quantity and higher pressure I required.

2- Centrifugal compressors are less expensive than the reciprocating compressors.

3- Centrifugal compressors uses Impeller,blades where as reciprocating compressors uses piston, diaphragm.

4- The compression ratio of reciprocating compressor is higher than centrifugal compressor.

5- Centrifugal compressors have continuous flow and reciprocating compressors have pulsating flow.

6- Centrifugal compressors have better mechanical efficiency due to absence of sliding parts.

7- Centrifugal compressors operates at high speed than reciprocating compressors.

3 (a) . **Four methods of capacity control in air compressors**

Bypass control. As the name implies, this control method uses an external bypass around the compressor to recycle gas from the compressor discharge to the inlet, or to the atmosphere in the case of an air compressor. The take-off point for the bypass must be downstream of a heat exchanger so that cooled gas will be spilled back to the suction. If there is no exchanger in the discharge, the bypass must branch into the suction line upstream of an exchanger.

On/off control: This method is used for intermittent demand, where the compressor wastes power if run continuously. The capacity can be controlled by starting and stopping the motor, which is done manually or by a pressure control loop at certain pressures as per process requirements. This type of control would suffice for processes where continuous use is less than 50% of compressor capacity. Nowadays, with increasing capacity requirements, this method has limited use.

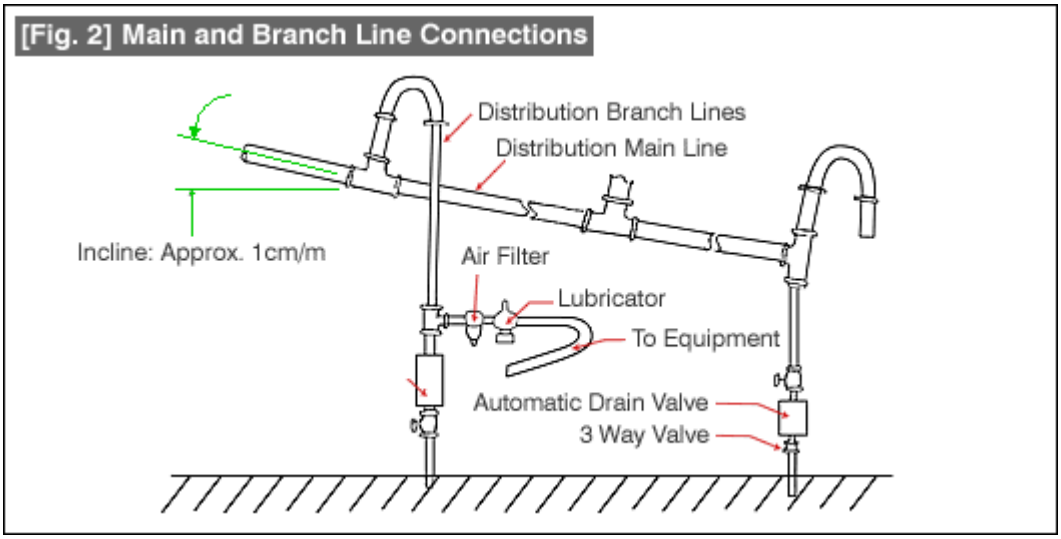
Constant-speed step control: Capacity variation is achieved by unloading one or more cylinder ends. The most common schemes are three- and five-step unloading. More steps saves more horsepower because they more closely match compressor output to demand.

Dual capacity control

3(b) Factors to consider when selecting air compressor

- ✓ What motor horsepower do you require?
- ✓ How much pressure (psi) do you require?
- ✓ What are you using the compressed air for?
- ✓ Where will the compressor be located?
- ✓ How much air flow (cfm) do you require?

3(c).Typical compressed air distribution layout



4 . (a). **Hydraulic principles**

Hydrodynamics is the study of liquids in motion. Examples of applications include: determining the mass flow rate of petroleum through pipelines, measuring flows around bridge pylons and off shore rigs, ship hull designing, optimizing propulsion efficiency, predicting weather patterns and wave dynamics and measuring liquid metal flows. Decreased fuel consumption, reduced drag on structures, minimizing noise and vibration and mitigating unwanted effects, like fouling.

Hydrostatics is the study of fluids at rest, and the study of the forces that can be exerted by those fluids. If you put a fluidunder pressure, it can exert a force.

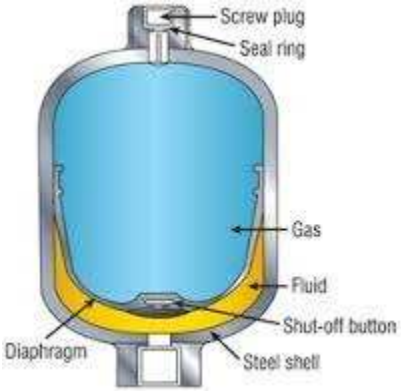
The most common and basic hydrostatic circuit you will come across is when you use a hydraulic jack to jack up a vehicle. Here, you use a mechanical lever to exert a force on a liquid. Pressure applied in one part of the system is equally and instantly applied everywhere in that system. This pressure acts on the ram of the jack, forcing it upwards and thus lifting the VEHICLE

Hydrokinetics refers to the motions of fluids or the forces which produce or affect such motions

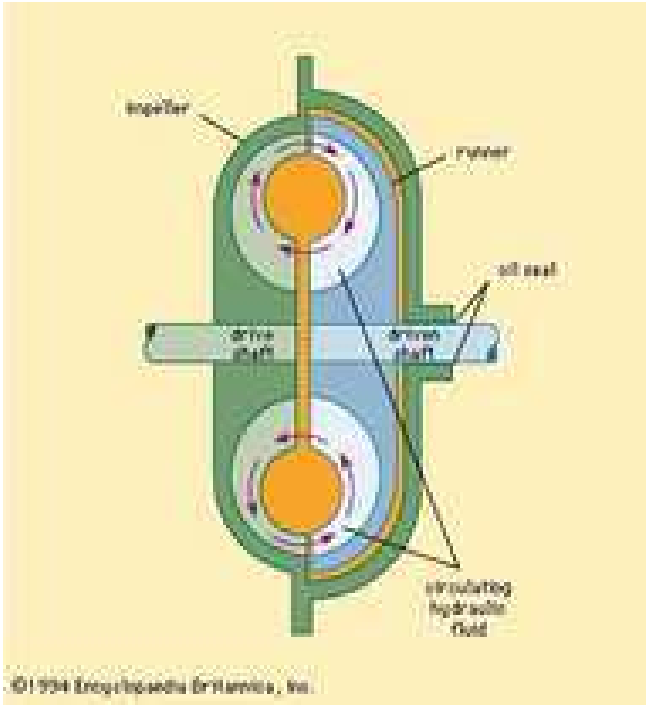
4(b). hydraulic systems;

A **hydraulic accumulator** is a pressure storage reservoir in which a non-compressible **hydraulic** fluid is held under pressure that is applied by an external source. The

external source can be a spring, a raised weight, or a compressed gas.



A **torque converter** is a type of fluid coupling which transfers rotating power from a prime mover, like an internal combustion engine, to a rotating driven load. In a vehicle with an automatic transmission, the torque converter connects the power source to the load. It is usually located between the engine's flexplate and the transmission. The equivalent location in a manual transmission would be the mechanical clutch.



4(c) **maintenance checks can be done on hydraulic systems.**

5 (a) .classification of pumps

- ✓ According to type of pumping element
- ✓ According to stages
- ✓ According to pressures and flow rates

(b). ***construction of a centrifugal pump giving areas of application***

A **centrifugal pump** is a mechanical device designed to move a fluid by means of the transfer of rotational energy from one or more driven rotors, called impellers. Fluid enters the rapidly rotating impeller along its axis and is cast out by **centrifugal** for

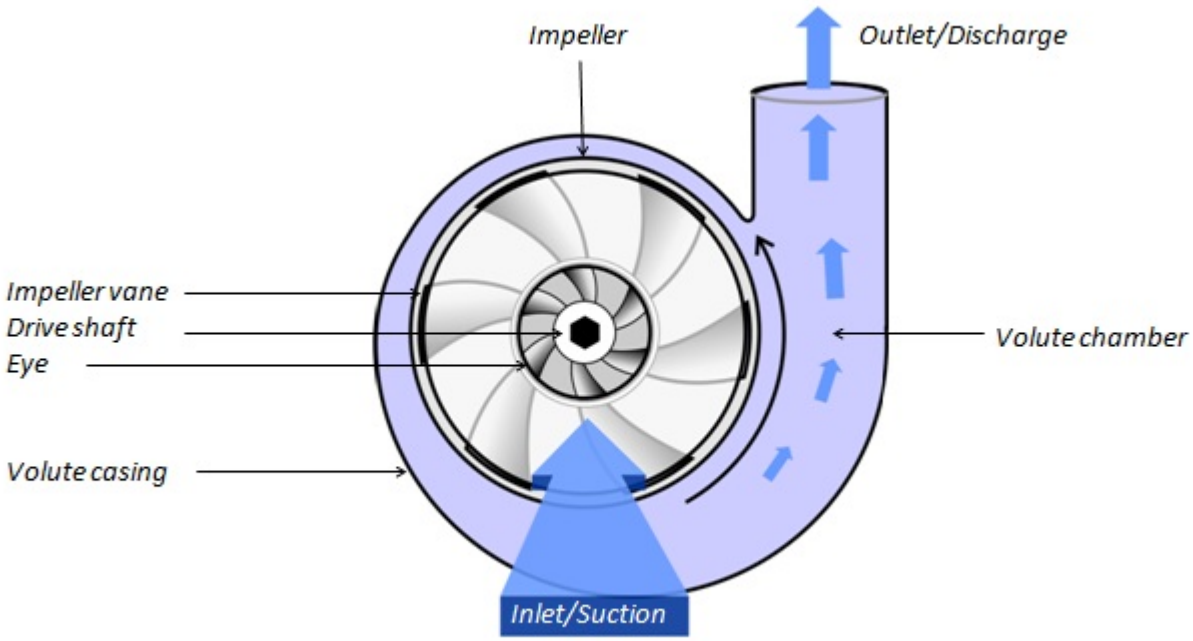


Figure 2. Volute case design

Applications. Most of the industrial processes include the conduction of fluids or energy transfer. ... These **pumps** are used for different **applications** including pressure boosting, wastewater, water supply, heating and cooling distribution and other industrial applications.

5(c). **Why centrifugal pumps are widely used ?**

- ✓ It uses kinetic energy of its impeller such that it continuously supplies fluid
- ✓ It can be **used** to **pump** fluids with high viscosity.
- ✓ Efficiency of a **centrifugal pump** is higher than a reciprocating **pump**.
- ✓ Simple construction
- ✓ Easy to maintain
- ✓ Cheap in cost