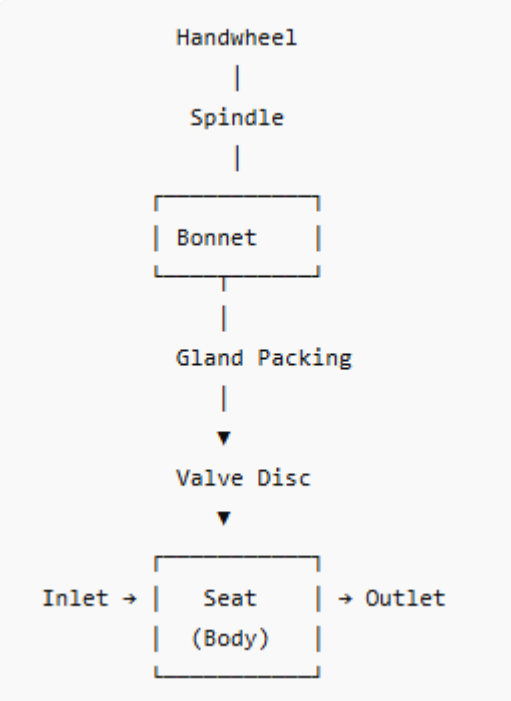
(a) Sketch a globe type screw lift valve suitable for sea water service. (7)

(b) State, with reasons, the materials used for the valve sketched in part (a). (3)



Main components to label:

- Handwheel
- Spindle (threaded)
- Bonnet
- Gland and packing
- Valve disc
- Valve seat
- Valve body
- Inlet and outlet

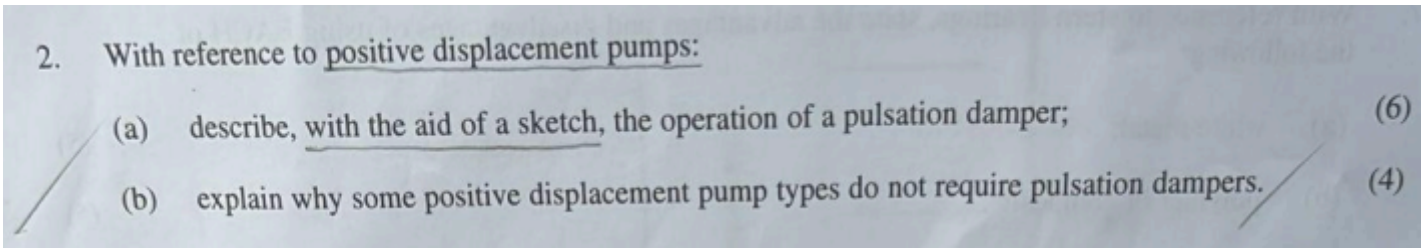
Description:

A globe valve consists of a **valve body** with an internal **seat**, and a **disc** attached to a threaded **spindle**. Turning the **handwheel** raises or lowers the disc, controlling flow through the valve. The flow changes direction within the valve body, allowing good throttling control. The **gland packing** prevents leakage along the spindle.

(b) Materials used (with reasons) (3 marks)

- **Body and bonnet:** Bronze or gunmetal
  → Good resistance to **seawater corrosion**.

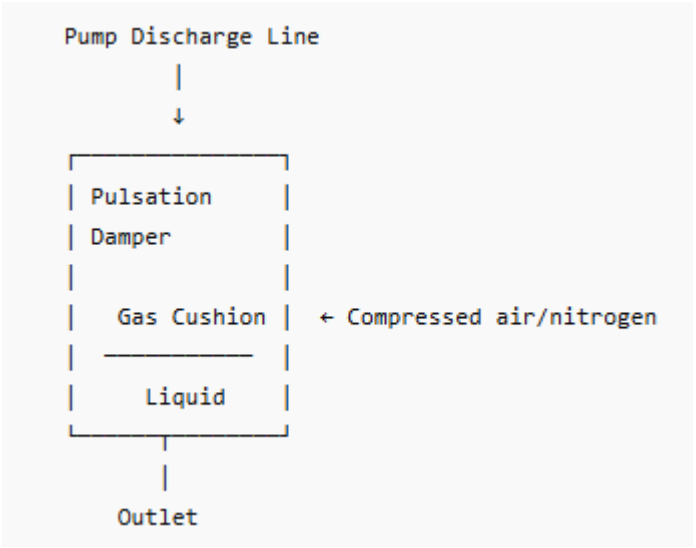
- **Valve seat and disc:** Stainless steel
  → Provides **wear resistance and durability**.
- **Spindle:** Stainless steel
  → High strength and corrosion resistance.
- **Packing:** Non-asbestos or PTFE
  → Provides effective sealing and chemical resistance.



2. With reference to positive displacement pumps:

(a) describe, with the aid of a sketch, the operation of a pulsation damper; (6)

(b) explain why some positive displacement pump types do not require pulsation dampers. (4)



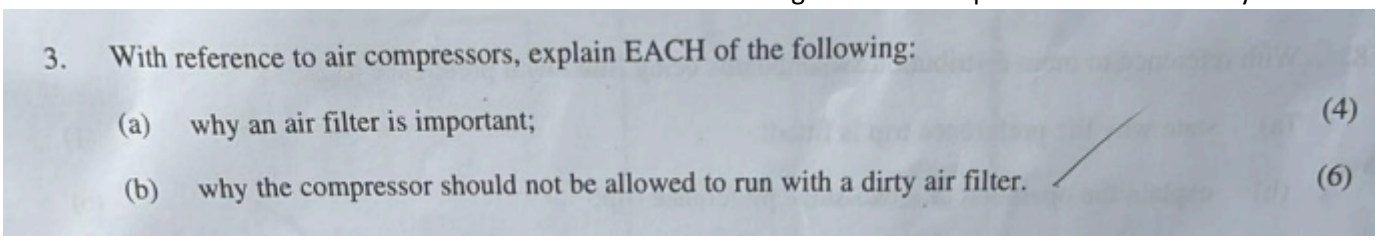
Description:

A pulsation damper is fitted on the **discharge side of a positive displacement pump** to smooth out pressure fluctuations. It consists of a chamber partially filled with liquid and topped with a **compressed gas cushion** (air or nitrogen).

When the pump delivers fluid in pulses, the **pressure rise compresses the gas cushion**, absorbing energy. During low-pressure periods between pulses, the compressed gas expands, **releasing energy back into the system**, maintaining a more uniform flow. This reduces **pressure surges, vibration, and pipe stress**.

(b) Why some positive displacement pumps do not require pulsation dampers (4 marks)

- Some pumps (e.g. **gear pumps, screw pumps**) provide a **continuous, smooth flow** rather than pulsating delivery.
- They have **multiple overlapping discharge paths**, reducing fluctuations.
- Therefore, there is **minimal pressure variation**, so pulsation dampers are not necessary.


3. With reference to air compressors, explain EACH of the following:

(a) why an air filter is important; (4)

(b) why the compressor should not be allowed to run with a dirty air filter. (6)

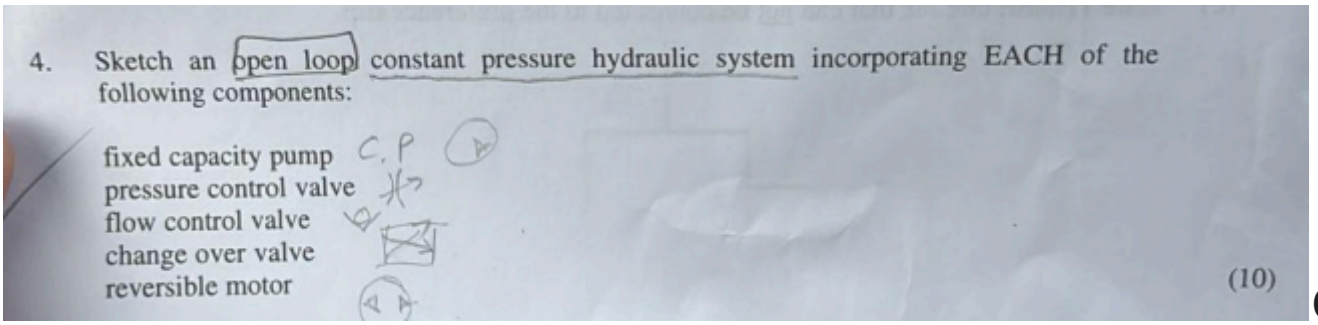
(a)

Why an air filter is important (4 marks)

- **Removes dust and dirt** from incoming air.
- Prevents **wear and damage** to compressor components (cylinders, valves).
- Ensures **clean air delivery** to the system.
- Improves **efficiency and reliability** of the compressor.

(b) Why the compressor should not run with a dirty air filter (6 marks)

- **Restricted airflow** reduces air intake, lowering compressor efficiency.
- Causes **increased suction resistance**, leading to higher operating temperatures.
- May result in **poor lubrication and overheating**, increasing wear.
- Can lead to **carbon deposits** due to overheating and oil breakdown.
- Risk of **reduced output capacity** and poor performance.
- In extreme cases, may cause **mechanical damage or failure**.


4. Sketch an open loop constant pressure hydraulic system incorporating EACH of the following components:

fixed capacity pump C.P

pressure control valve

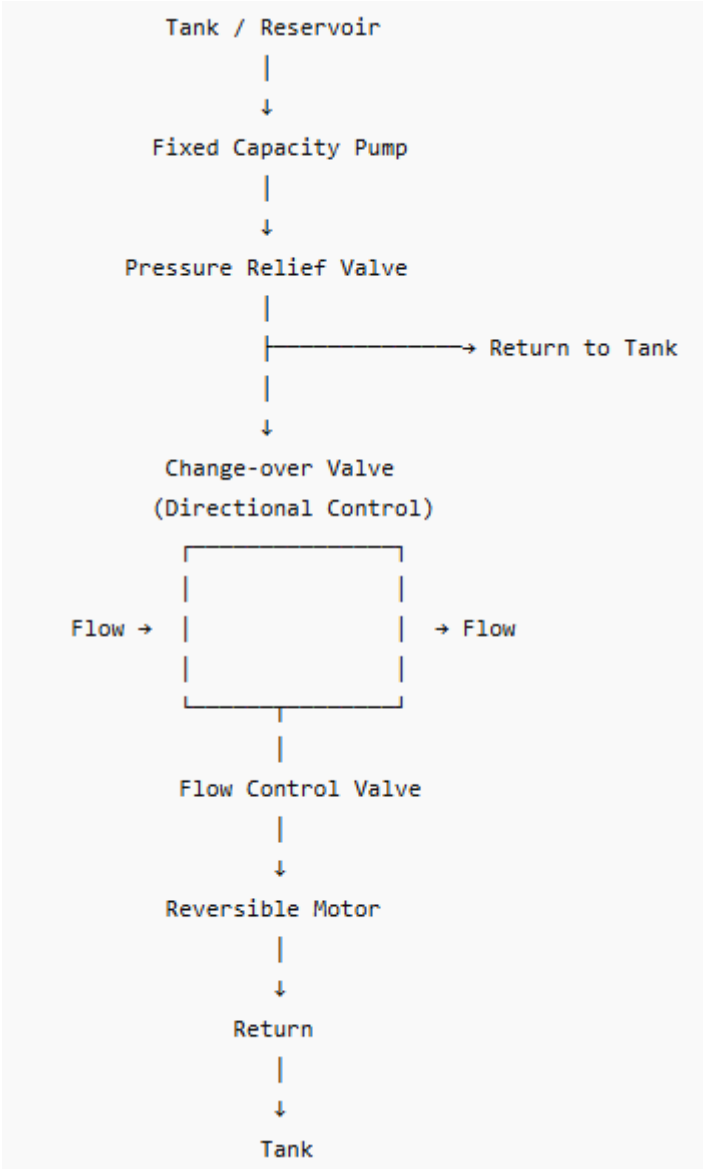
flow control valve

change over valve

reversible motor

(10)

Open loop constant pressure hydraulic system (10 marks)



Description:

In an **open loop constant pressure hydraulic system**, oil is drawn from the **reservoir** by a **fixed capacity pump**, which delivers a constant flow. The system pressure is maintained by a **pressure relief valve**, which diverts excess oil back to the tank when pressure exceeds the set value.

The flow is directed by a **change-over (directional control) valve**, which determines the direction of oil flow to the **reversible motor**, allowing it to rotate in either direction. A **flow control valve** is fitted to regulate the speed of the motor by controlling the flow rate.

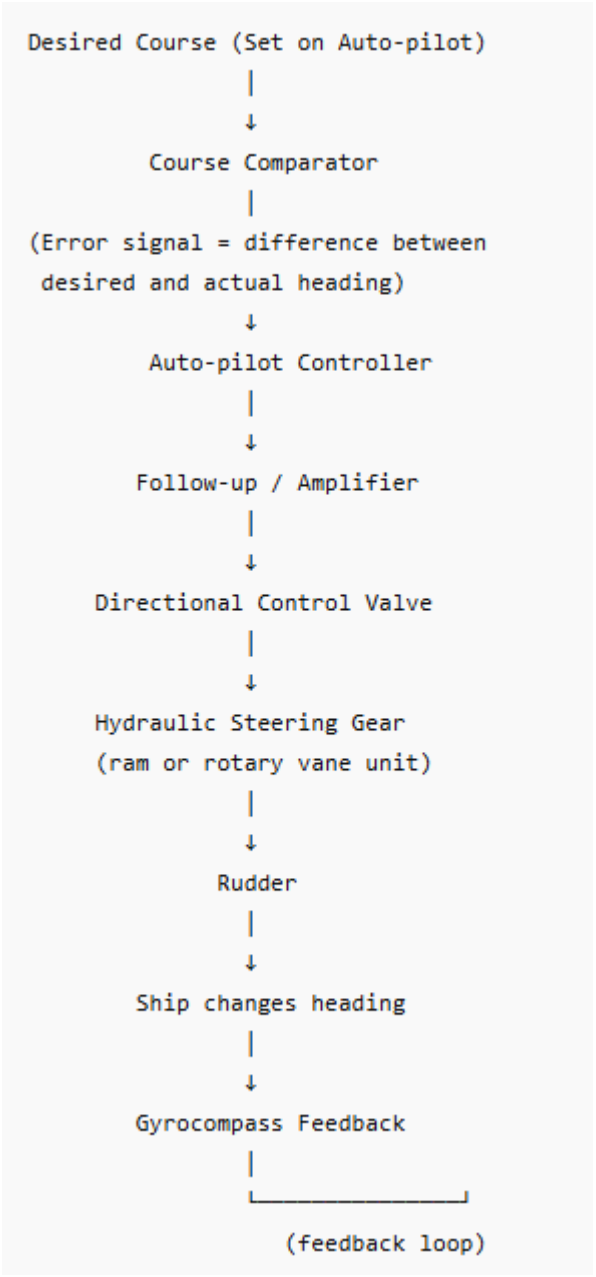
After passing through the motor, the oil returns to the **tank**, completing the open loop system.

Components (must be labelled for marks):

- Reservoir (tank)
- Fixed capacity pump
- Pressure relief/control valve
- Change-over (directional) valve
- Flow control valve
- Reversible motor

- Return lines

5. Describe, with the aid of a block diagram, the control of an automatic steering system, including auto-pilot and valve operated steering gear. (10)



Description:

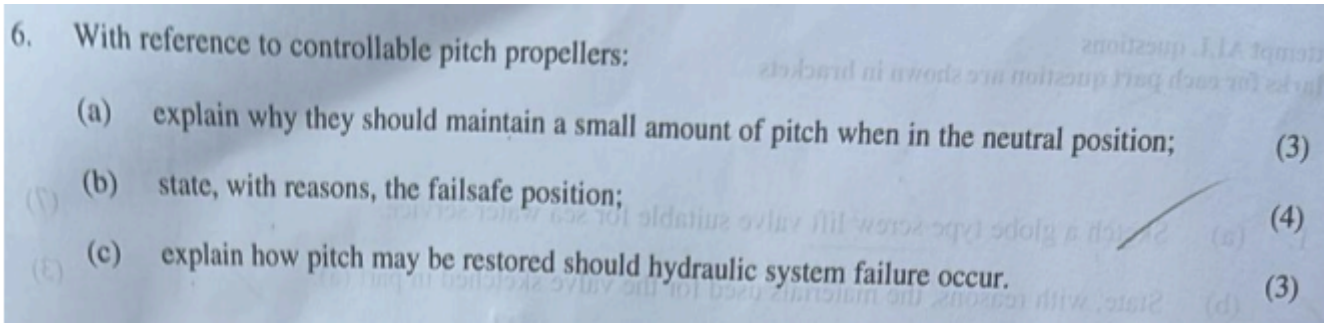
The automatic steering system operates as a **closed-loop control system**. The desired course is set on the **auto-pilot**, which compares it with the **actual heading** from the gyrocompass. The difference between the two produces an **error signal**.

This error signal is processed by the **auto-pilot controller**, which sends a command to the **follow-up/amplifier system**. The amplifier operates the **directional control valve**, directing hydraulic oil to the steering gear.

The **steering gear (ram or rotary vane type)** moves the rudder to correct the ship's heading. As the ship turns, the **gyrocompass provides feedback**, reducing the error signal. When the desired course is reached, the system stabilises and the rudder returns to neutral.

Key components to mention:

- Auto-pilot (course setter)
- Comparator (error detector)
- Amplifier / follow-up system
- Directional control valve
- Hydraulic steering gear
- Rudder
- Gyrocompass (feedback)


6. With reference to controllable pitch propellers:

(a) explain why they should maintain a small amount of pitch when in the neutral position; (3)

(b) state, with reasons, the failsafe position; (4)

(c) explain how pitch may be restored should hydraulic system failure occur. (3)

Here's a clear **exam-ready answer**:

(a) Why a small amount of pitch is maintained in neutral (3 marks)

- Prevents **uncontrolled blade movement** due to hydraulic leakage or external forces.
- Ensures **better control response** when moving out of neutral.
- Avoids **instability or hunting** of the pitch mechanism around zero pitch.

(b) Failsafe position (with reasons) (4 marks)

- The failsafe position is usually **full astern pitch**.

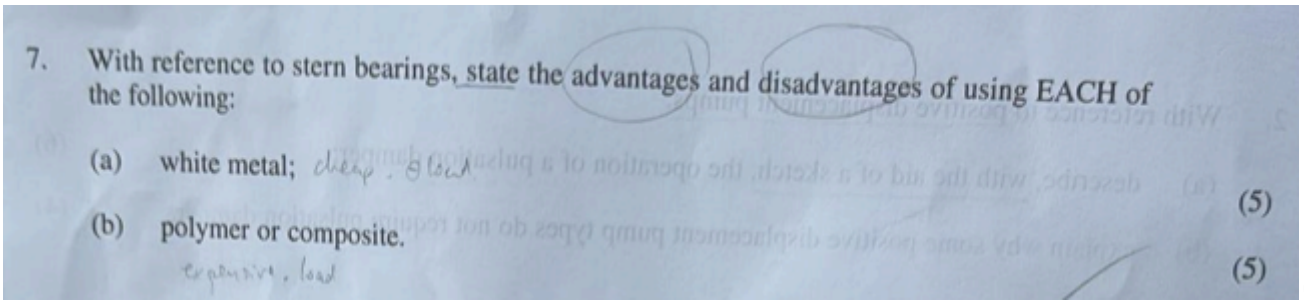
Reasons:

- Provides a **braking effect**, helping to slow or stop the vessel.
- Ensures the vessel does not continue moving ahead uncontrollably.
- Enhances **safety in case of hydraulic or control failure**.

(c) How pitch may be restored after hydraulic system failure (3 marks)

- Use of an **emergency hydraulic system** (manual or standby pump).

- Operation of a **hand pump or local control system** to adjust pitch.
- Some systems allow **mechanical locking or positioning** of blades.


7. With reference to stern bearings, state the advantages and disadvantages of using EACH of the following:

(a) white metal; (5)

(b) polymer or composite. (5)

(a)

White metal stern bearings (5 marks)

Advantages:

- **Good load carrying capacity**
- **Excellent conformability** (can accommodate slight misalignment)
- **Good embeddability** (absorbs small particles without damage)
- **Suitable for oil lubrication systems**

Disadvantages:

- Requires **continuous oil lubrication system** (more complex)
- **Risk of oil leakage** → pollution concerns
- **Sensitive to contamination and overheating**
- Higher **maintenance requirements**

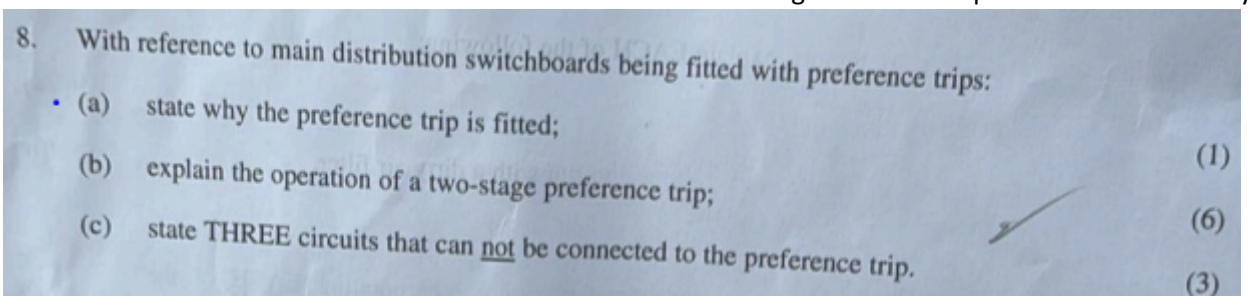
(b) Polymer / composite stern bearings (5 marks)

Advantages:

- Can operate with **water lubrication** → no oil pollution risk
- **Lower maintenance** and simpler system
- Good **corrosion resistance**
- **Better tolerance to debris** in water-lubricated systems

Disadvantages:

- **Lower load carrying capacity** compared to white metal
- **Higher wear rates** under heavy load
- May be affected by **temperature and deformation**
- Requires **good water supply** for lubrication



8. With reference to main distribution switchboards being fitted with preference trips:

(a) state why the preference trip is fitted; (1)

(b) explain the operation of a two-stage preference trip; (6)

(c) state THREE circuits that can not be connected to the preference trip. (3)

(a) Why a preference trip is fitted (1 mark)

- To **automatically shed non-essential loads** and prevent **overloading of generators**, avoiding blackout.

(b) Operation of a two-stage preference trip (6 marks)

- When the generator becomes **overloaded**, the system detects excessive current or load.
- **First stage:**
  → The preference trip disconnects **non-essential loads** (e.g. air conditioning, galley equipment).
  → This reduces load and allows the generator to recover.
- If overload persists:
  Second stage:
  → Additional loads are shed (less critical but still non-essential).
  → Ensures further reduction in demand to protect the generator.
- The system operates **automatically** and may be time-delayed between stages.
- Once load stabilises, circuits may be **manually or automatically restored**.

(c) THREE circuits that must NOT be connected to preference trip (3 marks)

1. **Steering gear system**
2. **Navigation equipment (e.g. radar, gyrocompass)**
3. **Essential lighting / emergency systems**

9. The figure shows the main generation layout of a fully automatic switchboard, No 1 generator is running, No 2 is on stand-by.

Describe the automatic sequence that occurs to restore power should No 1 generator suffer a sudden failure.

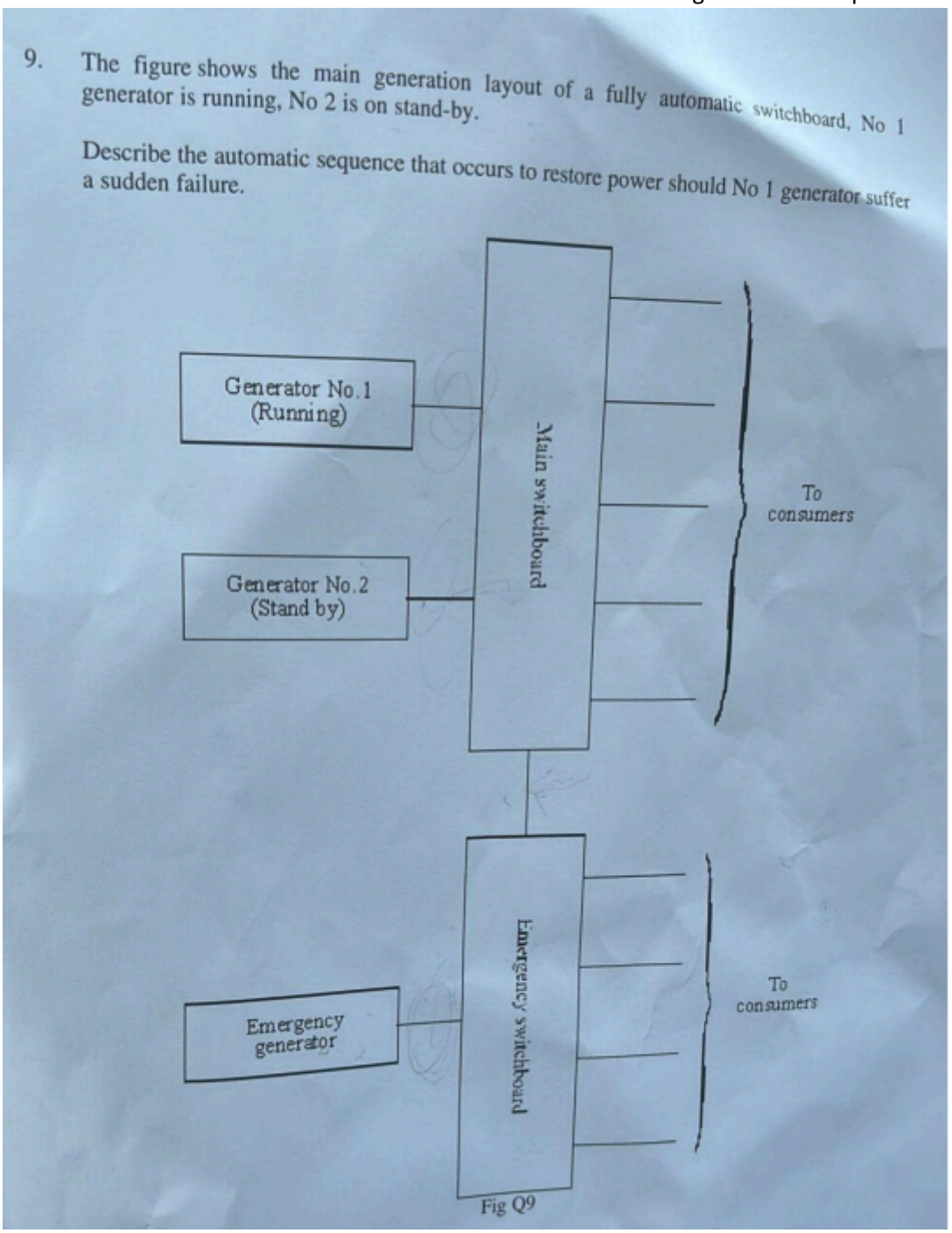
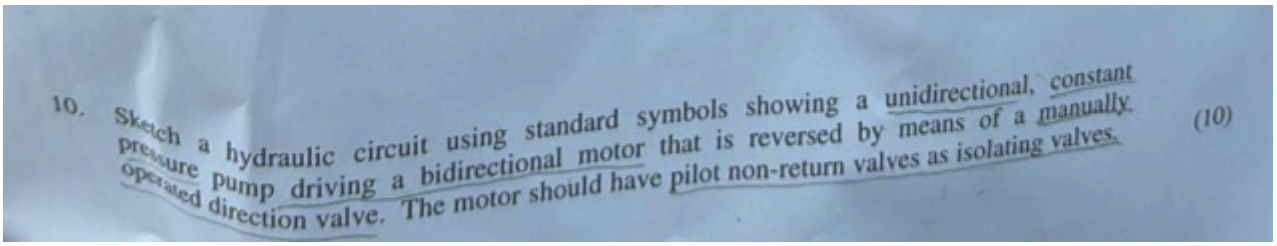


Fig Q9

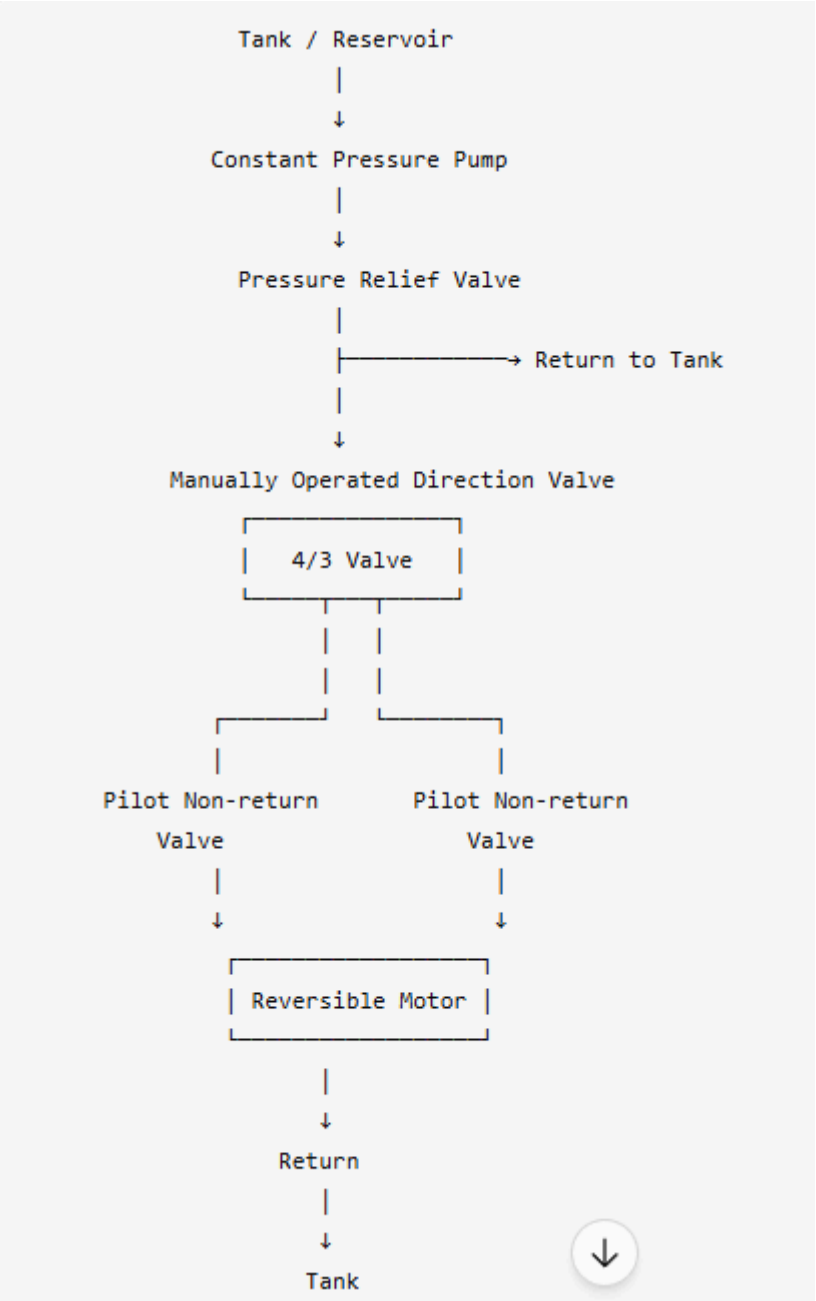
Automatic sequence following failure of Generator No.1 (10 marks)

1. **Failure detected**
   → Generator No.1 trips due to fault (e.g. overload, under-voltage, frequency drop).
2. **Main busbar de-energises (if severe fault)**
   → Voltage falls and is detected by the control system.
3. **Automatic start signal to standby generator (No.2)**
   → Generator No.2 starts automatically.
4. **Standby generator accelerates and builds up voltage**
   → Reaches correct speed, voltage, and frequency.
5. **Automatic synchronisation (if required)**
   → If bus is still live, generator is synchronised; if dead bus, direct connection is made.

6. **Circuit breaker closes**
   → **Generator No.2 is connected to the main switchboard.**
7. **Load is restored**
   → **Essential loads are supplied first; non-essential loads may be reconnected gradually.**
8. **Preference trip/load shedding (if necessary)**
   → **Prevents overload of the incoming generator.**
9. **If restoration fails or delay occurs**
   → **Emergency generator starts automatically.**
10. **Emergency switchboard energised**
    → **Supplies essential services (e.g. emergency lighting, steering gear).**



10. Sketch a hydraulic circuit using standard symbols showing a unidirectional, constant pressure pump driving a bidirectional motor that is reversed by means of a manually operated direction valve. The motor should have pilot non-return valves as isolating valves. (10)



Key features required (for marks):

- **Unidirectional constant pressure pump**
  → Supplies oil in one direction.
- **Pressure relief valve**
  → Maintains system pressure and protects components.
- **Manually operated directional control valve (4/3)**
  → Reverses flow to the motor.
- **Reversible hydraulic motor**
  → Rotates in either direction depending on flow.
- **Pilot-operated non-return valves** (on both lines)
  → Lock the motor in position when no pilot pressure is applied.
- **Return line to tank**
  → Completes the circuit (open loop).

How it works:

- Pump delivers oil at constant pressure.
- Direction valve directs flow to either side of the motor → **forward or reverse rotation**.
- Pilot non-return valves **lock the motor** when the valve is centred.
- Relief valve protects system from overpressure.
- Oil returns to tank after passing through the motor.