UNIT-V

1. Differentiate between primary and secondary cells.
2. What is a fuse? Mention the desirable properties of fuse element.
3. What is meant by earthing? Explain about pipe earthing and plate earthing.
4. What is the significance of Circuit breaker?.Explain construction and working of MCB,ELCB and MCCB.
5. With a block diagram, explain the working of online UPS. Classify the different UPS.
6. What are batteries? How are they classified?. State some important characteristics of Batteries.

[redacted]

7. What is earthing? What are the types of earthing? Explain about strip or wire earthing and rod earthing.
8. What is the importance of power factor?.Explain the disadvantages of low power factor. Explain the different methods to improves the power factor of the system.
9. Explain different components of LT switch gear.
10. Write the uses of standard wire gauge. Explain what specifications for wires for domestic wiring are normally required. Describe different types of cables used for domestic wiring.

Q1. Differentiate between Primary and Secondary Cells

Primary Cell	Secondary Cell
Cannot be recharged	Can be recharged and reused
Chemical reaction is irreversible	Chemical reaction is reversible
Used once and discarded	Used multiple times
Low initial cost	Higher initial cost
Example: Dry cell, Leclanché cell	Example: Lead-acid battery, Li-ion battery
Used in clocks, remotes, torches	Used in inverters, vehicles, laptops

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Q2. What is a Fuse? Mention the Desirable Properties of Fuse Element

What is a Fuse?

A **fuse** is a safety device that **protects electrical circuits** from overcurrent. It contains a **thin wire (fuse element)** that melts and breaks the circuit when current exceeds the safe limit.

Desirable Properties of Fuse Element:

- **Low melting point** (so it melts quickly)
- **High conductivity** (low resistance)
- **Should not oxidize easily**
- **Consistent melting behavior**
- **Economical and readily available**

Common materials used: Tin, Lead, Silver, Zinc, Copper alloys

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Q3. What is meant by Earthing? Explain Pipe Earthing and Plate Earthing.

✅ Earthing:

Earthing means connecting the **non-current-carrying parts** of electrical equipment (like metal body) to the **ground** to prevent electric shock during fault conditions.

It ensures that **fault current flows safely to the earth**, protecting both **people and equipment**.

🛠️ Types of Earthing:

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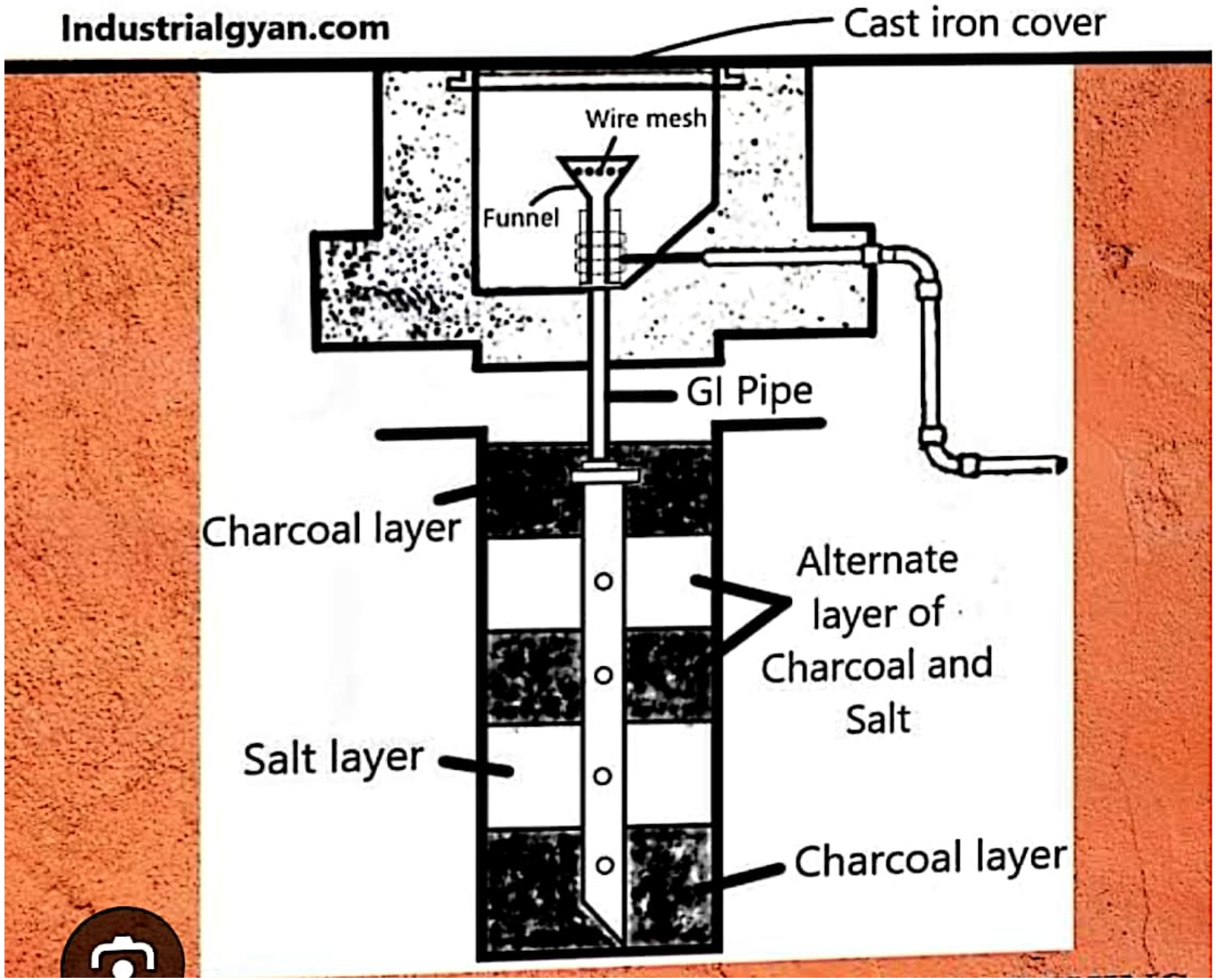
1. Pipe Earthing:

- A **GI pipe (2.5–3 meters long)** is placed vertically into the ground.
- Charcoal and salt layers are filled around the pipe to maintain conductivity.
- Water is added periodically to keep soil resistance low.
- A copper wire is connected from the pipe to the electrical system.

Used for: Residential areas and small buildings.

PIPE EARTHING



2. Plate Earthing:

- A **copper or GI plate** (60 cm × 60 cm) is buried vertically at a depth of 2–3 meters.
- Charcoal and salt layers are placed around the plate.
- A copper strip or wire connects the plate to the equipment.
- Water is added regularly.

Used for: Commercial or industrial earthing systems.

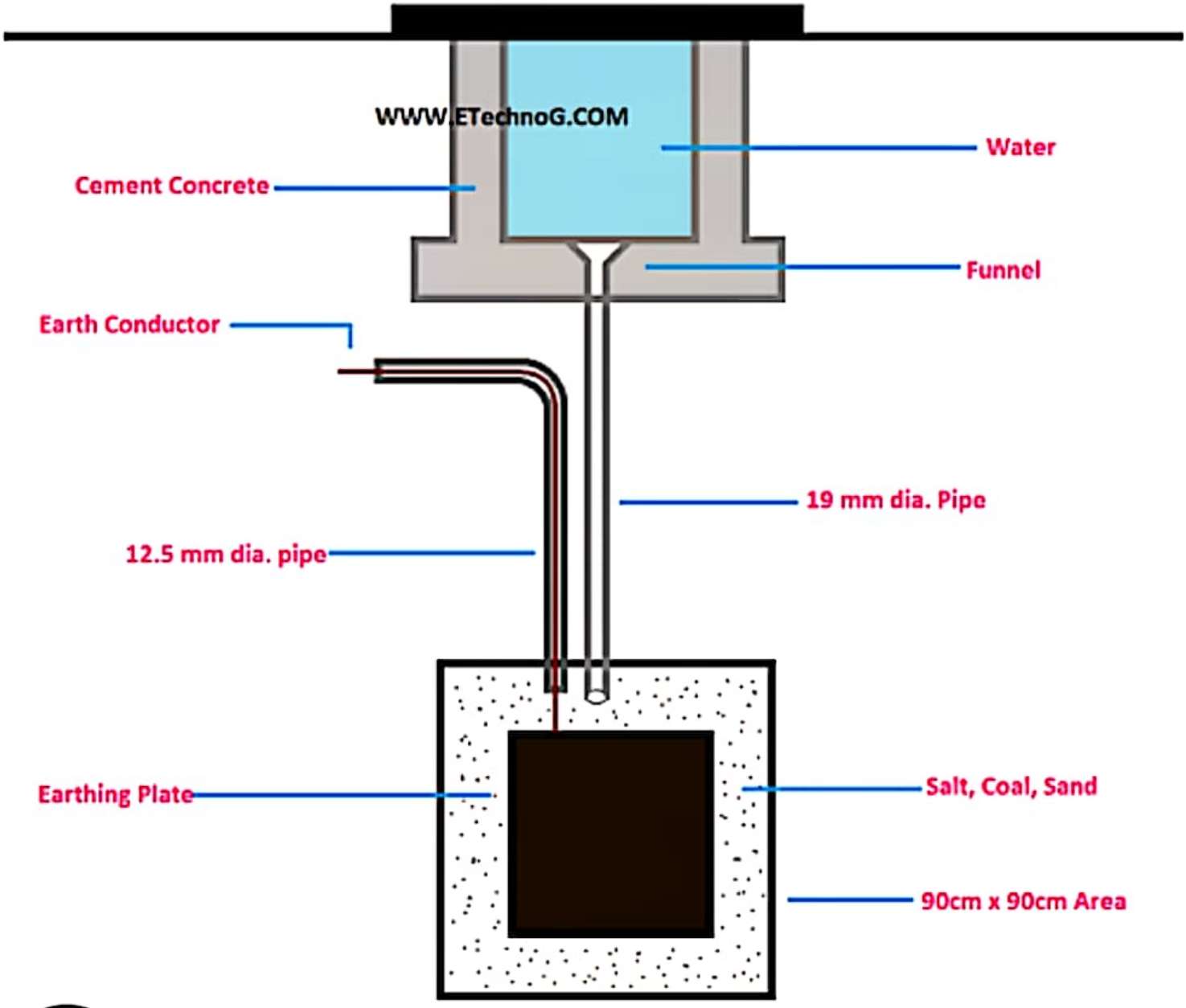


Plate Earthing Diagram

Q4. What is the Significance of Circuit Breaker? Explain MCB, ELCB, MCCB.

✅ Significance of Circuit Breaker:

A **circuit breaker** is an automatic safety device that **interrupts the current flow** when a **fault (overload or short circuit)** occurs in an electrical circuit.

Unlike fuses, **circuit breakers can be reset** after tripping.

🔌 Types of Circuit Breakers:

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1. MCB (Miniature Circuit Breaker):

- **Used for:** Protection against **overload and short circuits** in domestic wiring.
- **Rating:** Up to 100 A.
- **Working:** When current exceeds the rated value, **the bimetallic strip bends**, tripping the switch.
- **Can be reset manually** after fault.

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2. ELCB (Earth Leakage Circuit Breaker):

- **Used for:** Protection from **earth leakage currents** (like when someone touches a live wire).
- **Working:** It detects the **difference between live and neutral currents.** If leakage occurs, it trips the circuit.
- Prevents **electric shock.**

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3. MCCB (Moulded Case Circuit Breaker):

- **Used for:** High current applications in industries.
- **Rating:** Up to 1600 A.
- **Protects against:** Overload, short-circuit, and sometimes earth fault.
- Has adjustable settings and better **thermal-magnetic protection.**

Q5. With a block diagram, explain the working of Online UPS. Classify the different UPS.

✅ What is a UPS?

UPS (Uninterruptible Power Supply) is a device that provides **instant backup power** during power failure or voltage fluctuations to protect sensitive electronic equipment like computers, servers, and medical devices.

⚙️ Working of Online UPS (Double Conversion UPS):

In an **Online UPS**, power from the main supply **does not directly go** to the load. Instead, it goes through **two conversions**:

Block Diagram:

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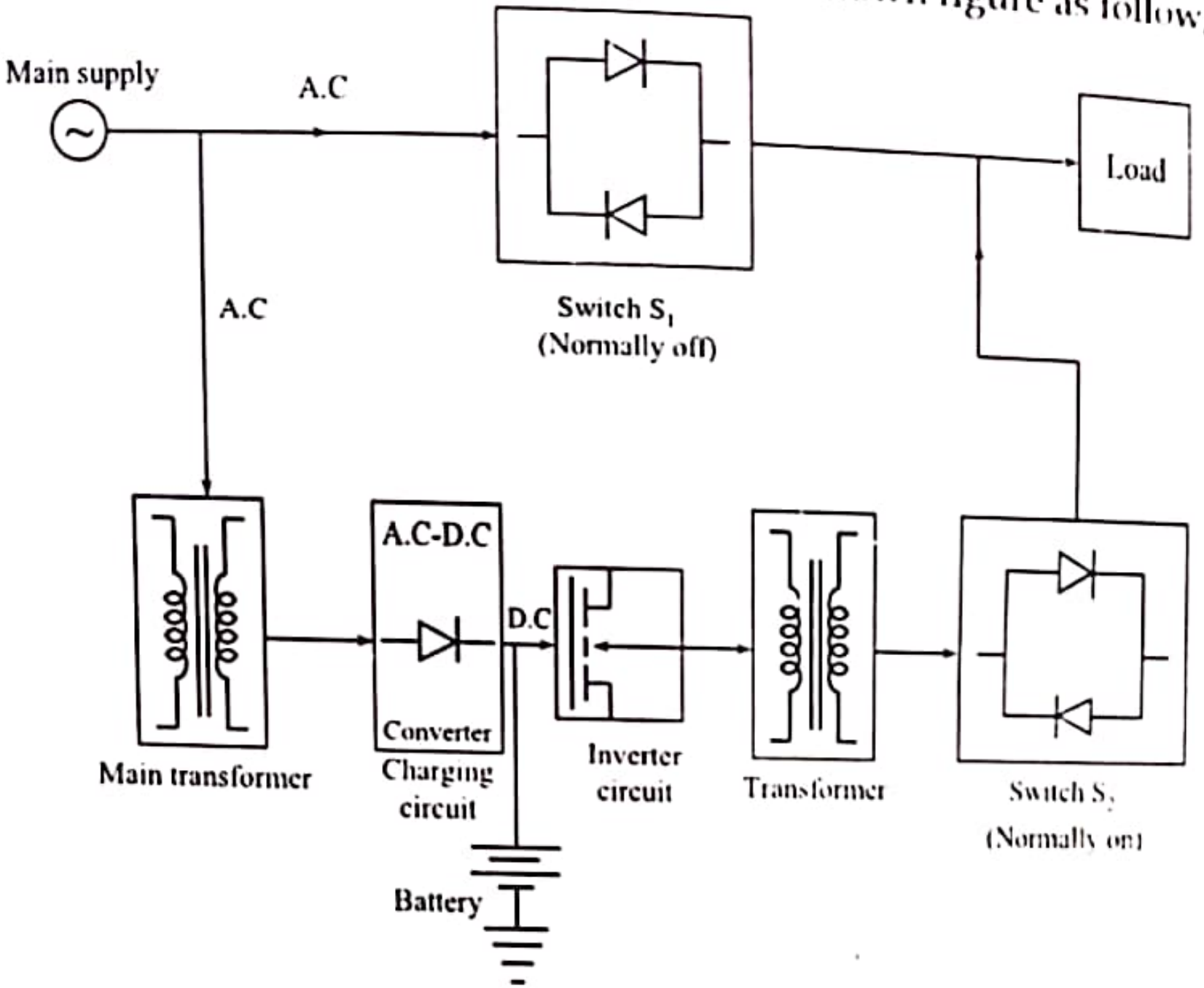
The block diagram of online UPS is shown figure as follow,



⬜ Working:

1. **Rectifier/Charger:** Converts incoming **AC to DC**, and charges the **battery**.
2. **Inverter:** Converts **DC back to AC** to supply **pure, continuous power** to the load.
3. **Battery:** Supplies DC power to Inverter during **power failure**, so there's **zero transfer time**.
4. **Bypass Switch (not shown):** Transfers load to mains supply in case of inverter failure.

✅ Advantages of Online UPS:

- **Zero transfer time**
- Ideal for **sensitive equipment**
- **Pure sine wave** output
- Protects against **voltage fluctuations, harmonics, surges**

📚 Classification of UPS:

1. **Offline / Standby UPS:**
   - Normally supplies power directly from mains.
   - Switches to battery **only during power failure.**
   - **Transfer time: 4–8 ms**
   - Used for: PCs, printers
2. **Line-Interactive UPS:**
   - Has **automatic voltage regulation (AVR).**
   - Inverter remains connected and regulates voltage.
   - **Transfer time: 2–4 ms**
   - Used for: Small servers, network devices
3. **Online UPS (Double Conversion):**
   - Power is always supplied through inverter.
   - **Zero transfer time**
   - Used for: Critical systems (e.g., data centers, hospitals)

Q6. What are batteries? How are they classified? State some important characteristics of batteries.

✅ What are Batteries?

A **battery** is a device that stores **chemical energy** and converts it into **electrical energy** using electrochemical reactions.

🔋 Classification of Batteries:

1. **Primary Batteries:**
   - Non-rechargeable
   - Irreversible reaction
   - Used once (e.g., dry cell, alkaline battery)
2. **Secondary Batteries:**
   - Rechargeable
   - Reversible reaction
   - Used multiple times (e.g., lead-acid, Li-ion)
3. **Reserve Batteries:**
   - Activated when needed (e.g., military use)

⭐ Important Characteristics:

- **Voltage Rating:** Output voltage (e.g., 1.5V, 12V)
- **Capacity:** Charge storage (Ah or mAh)
- **Internal Resistance:** Affects performance
- **Energy Density:** Energy per unit weight or volume
- **Cycle Life:** Number of charge-discharge cycles
- **Self-Discharge:** Loss of charge over time
- **Temperature Tolerance:** Operating range

Q7. What is Earthing? What are the types of earthing? Explain about Strip/Wire Earthing and Rod Earthing.

✅ Earthing:

Earthing is the process of connecting the **non-current-carrying metallic parts** of an electrical system to the **ground**, to ensure safety by discharging fault current safely into the earth.

🔌 Types of Earthing:

1. Plate Earthing
2. Pipe Earthing
3. Rod Earthing
4. Strip or Wire Earthing

🔧 1. Strip or Wire Earthing:

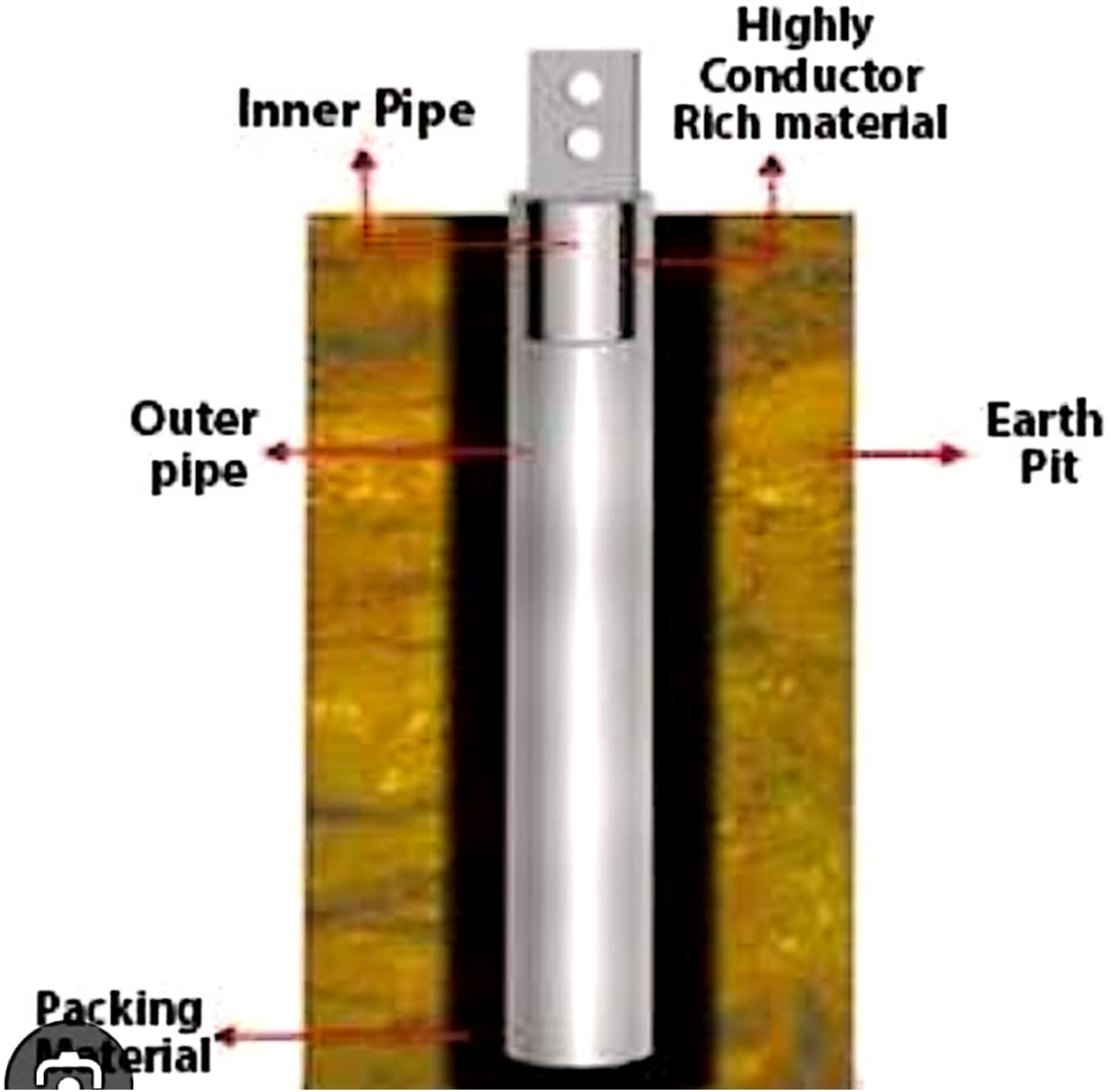
- In this method, a **GI (galvanized iron) or copper strip/wire** is buried in a **horizontal trench**.
- The strip is placed about **0.5 to 1 meter deep**, with **charcoal and salt** to improve conductivity.
- It is connected to the equipment body and the earth electrode.

Used in:

- Places where **space is available** and **soil resistivity is low**
- Electrical installations with **light to medium load**

Advantages:

- Economical
- Easy to install
- Suitable for rural areas



⚙️ 2. Rod Earthing:

- A **copper or GI rod** (length 2–3 meters) **is driven vertically into the ground.**
- Multiple rods can be used in **parallel** for **better earthing.**
- It also uses **charcoal and salt** for **better conductivity** around the **rod.**

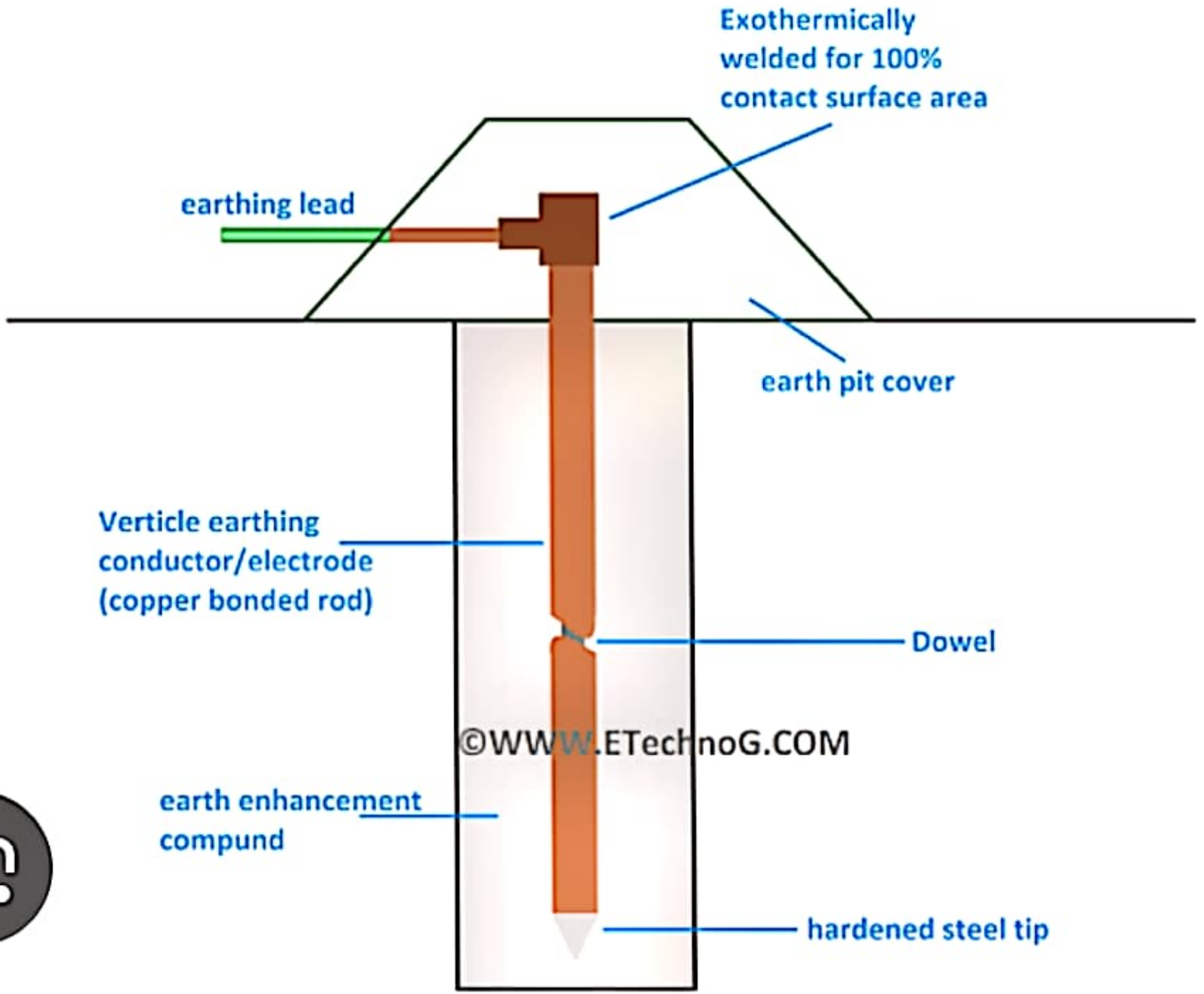
Used in:

- **Rocky or dry soil** where other methods **are not effective**
- Locations with **limited space**

Advantages:

- **Compact**
- **Effective even** in tough soil conditions
- **Easy to maintain**

Figure.01: Rod Earthing Picture and Constructional Diagram



Q8. What is the importance of power factor? Explain the disadvantages of low power factor. Explain the different methods to improve the power factor of the system.

⚡ What is Power Factor?

Power Factor (PF) is the **ratio of real power (kW)** to **apparent power (kVA)** in an AC electrical system:

$$\text{Power Factor} = \frac{\text{Real Power (kW)}}{\text{Apparent Power (kVA)}}$$

It indicates how effectively electrical power is being used. A **power factor close to 1** (or unity) is ideal.

✅ Importance of Power Factor:

- **Efficient Use of Power:** High PF means more real power is available for work.
- **Reduced Losses:** Less current flows through the system, reducing **I^2R losses**.
- **Lower Electricity Bills:** Many utilities charge penalties for low power factor.
- **Better Voltage Regulation:** High PF helps maintain constant voltage in the system.
- **Reduced Size of Equipment:** Transformers and generators can be smaller for the same load if PF is high.

❌ Disadvantages of Low Power Factor:

1. **Higher Current Requirement:** Low PF draws more current for the same power.
2. **Increased Losses:** More heat and power are lost due to higher current.
3. **Larger Conductor Size Needed:** Requires thicker cables, increasing cost.
4. **Poor Voltage Regulation:** Causes voltage drop in the system.
5. **Penalties by Electricity Board:** Increases overall operational cost.

🔧 Methods to Improve Power Factor:

1. **Capacitor Banks:**
   - Installed in parallel with the load.
   - They supply leading reactive power to cancel out lagging reactive power from inductive loads.
   - Used in industries and substations.
2. **Synchronous Condensers:**

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   - Used in industries and substations.
2. **Synchronous Condensers:**
   - Over-excited synchronous motors run without mechanical load.
   - They supply reactive power and improve PF.
   - Expensive but effective for large installations.
3. **Phase Advancers:**
   - Used with induction motors.
   - Supply the necessary magnetizing current to the rotor, improving PF.
4. **Using High PF Equipment:**
   - Choose equipment with a built-in power factor correction system.
   - E.g., power factor corrected LED lights and ACs.

9) ✅ What is LT Switchgear?

LT (Low Tension) Switchgear is a combination of **electrical devices** used to **protect, control, and isolate** electrical equipment in **low voltage systems** (up to 1000V AC). It ensures safety during normal operation and in fault conditions like short circuits and overloads.

🔧 Main Components of LT Switchgear:

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1. Circuit Breakers:

- Automatically break the circuit during overload or short-circuit.
- Types:
  - **MCB (Miniature Circuit Breaker):** Protects against overload & short circuit in homes/offices.
  - **MCCB (Molded Case Circuit Breaker):** For higher current ratings in industries.
  - **ACB (Air Circuit Breaker):** For large commercial setups (above MCCB range).

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2. Fuses:

- Simple protective device that melts and breaks the circuit during excessive current flow.
- Used in distribution boards and small-scale applications.

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3. Contactors:

- Electrically operated switches used to **control motors and large loads** remotely.
- Allow automation and remote control.

---

4. Overload Relays:

- Protect motors from prolonged **overcurrent** that does not trip a fuse.
- Work with contactors to disconnect supply during overload.

---

5. Isolators/Disconnectors:

- Used to **manually disconnect** the supply for maintenance or emergency.
- Do not operate automatically like breakers.

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6. Switches:

- Used to manually **make or break** the electrical connection.
- Examples: DP switches, changeover switches.

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7. Busbars:

- Metallic strips (usually copper or aluminum) that **carry power** from the incoming supply to outgoing feeders.
- Provide flexibility and ease in distribution.

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8. Meters and Indicators:

- **Voltmeters, ammeters, power factor meters, energy meters** show system parameters.
- **Indicator lamps** show ON/OFF status and faults.

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9. Enclosures and Panels:

- All components are installed inside metal **panels or boards** for protection against dust, moisture, and accidental contact.

Q10. Write the uses of Standard Wire Gauge. Explain what specifications for wires for domestic wiring are normally required. Describe different types of cables used for domestic wiring.

📏 Uses of Standard Wire Gauge (SWG):

Standard Wire Gauge (SWG) is used to measure the **diameter or thickness** of electrical wires. The number indicates the size of the wire—**smaller SWG means thicker wire.**

Uses:

- To select proper wire size for **current-carrying capacity.**
- Ensures **safe wiring** without overheating.
- Helps in estimating **resistance and voltage drop.**
- Used in **domestic, commercial, and industrial** wiring.

⚙️ Specifications for Wires in Domestic Wiring:

For domestic wiring, wires must meet the following specifications:

1. **Material:**
   - **Copper or aluminum** (copper is preferred for better conductivity).
2. **Wire Size (SWG):**
   - Typical sizes used: **14 SWG to 18 SWG.**
   - 14 SWG for heavy load (AC, geysers), 18 SWG for lighting.
3. **Insulation:**
   - PVC or FRLS (Flame Retardant Low Smoke) insulation for safety.
4. **Current Rating:**
   - Wire should be able to carry **sufficient current without overheating.**
5. **Color Coding:**
   - Red – Live, Black – Neutral, Green – Earth (as per IS standards).

🔌 Types of Cables Used in Domestic Wiring:

1. **Single Core Cable:**
   - Contains one conductor.
   - Used in conduits and panels.
2. **Twin Core Cable:**
   - Two insulated wires (Live and Neutral).
   - Used in old wiring systems.
3. **Three Core Cable:**
   - Live, Neutral, and Earth wires in one sheath.
   - Suitable for appliances needing earthing.
4. **Multi-Strand Wire:**
   - Many thin copper strands bundled together.
   - More flexible and durable.
5. **Flexible Cables:**
   - Used for **plug tops, extension boards, and small appliances.**
6. **Flat Cables:**
   - 2 or 3 insulated wires laid flat.
   - Common in lighting circuits.

✅ Conclusion:

Standard wire gauge helps in choosing the correct wire for safe and efficient wiring. Domestic wiring requires wires with proper size, insulation, and current rating. Using the right type of cable ensures safety, reliability, and long life of the wiring system.

Types of Wire and Cables

The wires used for internal wiring of building may be divided into groups according to

1. Conductor used a) Cu conductor cables b) Al conductor cables
2. Number of cores used a) Single core b) Twin core c) 3 core cables
3. Voltage grading a 250/440V b. 650/1100V (Voltage a conductor can withstand)
4. Type of insulation used:

a. Vulcanized Indian Rubber (VIR) cables 240/415V Cu conductor, cotton tape sheathed.
b. Tough rubber sheathed (TRS) cables VIR cable with outer protecting covering of TRS provide additional insulation
c. Lead sheathed cables VIR conductor covered with lead sheath provide protection against moisture.
d. Polyvinyl chloride PVC cables
e. Weather proof cables (outdoor)
f. Flexible cords and cables (consist of wires silk/cotton/plastic covered)
g. Multi strand cables. (n no. of strands)
h. XLPE cables. (Cross linked polyethylene) (↑ current rating, longer life)

* Single wire, may be bare or covered with insulation is called wire while several wires stranded together is called cable.
* PVC insulation is most widely used for covering wire/cables used in internal wire (as it provides better flexibility, has better insulating qualities, has no chemical effect on metal of wire and gives smaller diameter of cable).