



PSPCL

Assistant Lineman (ALM)

Punjab State Power Corporation Limited (PSPCL)

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Technical Knowledge & Punjabi language



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# 1

## CHAPTER

# Occupational Safety & Health

## The "Golden Rules" of Electrical Safety

- **Work Permit (PTW):** Never start work on a line without a "Permit to Work" from the Shift Attendant/Sub-station in charge.
- **Dead Line Verification:** Always treat a line as "Live" until you have tested it with a neon tester or discharge rod.
- **Earthing for Safety:** Before working on a disconnected high-tension line, the line must be **Short-circuited and Earthed** to discharge any capacitive charge.

## Classification of Fires & Extinguishers

This is a high-yield area for Haryana SSC exams.

Class	Type of Fuel	Extinguisher to Use
Class A	Wood, Paper, Cloth, Trash	Water, Foam, ABC Powder
Class B	Flammable Liquids (Petrol, Oil, Paint)	Foam, CO <sub>2</sub> , Dry Powder
Class C	<b>Gaseous fires &amp; Electrical fires</b>	<b>CO<sub>2</sub>, Halon, Dry Powder</b>
Class D	Combustible Metals (Magnesium, Sodium)	Specialized Metal Powder

**Critical Note:** Never use Water or Foam on an electrical fire, as they conduct electricity and can cause a fatal shock to the operator.

## Personal Protective Equipment (PPE)

As per IS: 5983, PPE is mandatory for field staff.

- **Head Protection:** Industrial Safety Helmets (to protect against falling objects).
- **Foot Protection:** Steel-toe leather shoes or rubber boots (Insulated for electrical work).
- **Hand Protection:** Rubber gloves (Tested for specific voltage levels like 11kV or 33 kV).
- **Eye Protection:** Goggles or Face Shields (essential while grinding or battery maintenance).
- **Fall Protection:** Full-body safety harness/belt (Must for ALMs climbing poles).

## Treatment for Electric Shock (Artificial Respiration)

If a person is in contact with a live wire, first **break the contact** using a dry wooden stick or by switching off the mains.

- **Schaefer's Method:** The patient is placed **face down** (prone position). Used when there are burns on the chest.
- **Sylvester's Method:** The patient is placed **face up** (supine position). Used when there are burns on the back.
- **Mouth-to-Mouth:** The most effective modern method.
- **CPR (Cardiopulmonary Resuscitation):** Used if the heart has stopped.

## Warning (Danger) Signs

Warning signs are categorized as **Cautionary Signs**. Their primary function is to alert workers and the public to hazards that are not immediately obvious but are potentially life-threatening.

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## Standard Design Specifications

To identify a genuine Warning sign in an exam or on the field, look for these four specific elements:

- **Geometric Shape:** Always an **Equilateral Triangle**.
- **Background Color: Safety Yellow** (covers at least 50% of the sign area).
- **Symbol/Pictogram: Black** (placed centrally in the triangle).
- **Border: Black** (thick outer band).

## Common Electrical Warning Signs & Their Meanings

A Training Officer or Shift Attendant must be able to identify these common icons used in Haryana power substations:

- **The Lightning Bolt (Flash):** Indicates **Risk of Electric Shock**. This is found on distribution boxes, motor starters, and panel doors.
- **The Skull and Crossbones:** Indicates **Danger to Life**. Used specifically on High Tension (HT) poles and transformer fences.
- **The Exclamation Mark (!):** General Warning. Indicates that you must refer to the manual or proceed with extreme caution.
- **Overhead Symbol:** Warning of **Overhead Hazards** (low-hanging wires or moving cranes).
- **Corrosive Symbol:** Usually found in the **Battery Room**; warns of acid that can burn skin.

## Legal and Regulatory Requirements (IE Rules)

The display of danger signs isn't just a suggestion; it is a legal mandate under the **Indian Electricity Rules (1956)**:

- **IE Rule 35:** Requires "Danger Notices" to be permanently affixed in Hindi, English, and the local language (Punjabi/Haryanvi) on all installations of medium, high, and extra-high voltage.
- **Placement Height:** Signs on poles must be placed at a height where they are clearly visible but cannot be easily defaced or removed (typically **2 to 3 meters** from the ground).
- **Material:** Must be made of weather-resistant materials like **Vitreous Enamel** or galvanized iron to prevent rusting and fading.

## Hazard Levels: Danger vs. Warning vs. Caution

While often used interchangeably, professional rank files distinguish them as:

1. **DANGER (Red/White):** Imminently hazardous situation which, if not avoided, **will** result in death.
2. **WARNING (Yellow/Black):** Potentially hazardous situation which **could** result in death or serious injury.
3. **CAUTION (Yellow/Black):** Potentially hazardous situation which may result in **minor or moderate injury**.

## Essential Electrical Safety Rules

For a **Training Officer** or **Shift Attendant**, following these rules is mandatory under the **Indian Electricity (IE) Rules**.

### **A. General Safety Rules**

- ✓ **Never work alone:** Always have a "standby" person when working on high-voltage equipment.
- ✓ **Insulation check:** Before using any hand tool (pliers, screwdrivers), check that the insulation is not cracked or charred.
- ✓ **Dead line policy:** Consider every wire "Live" until you personally prove it is "Dead" using a verified voltage tester.
- ✓ **Moisture control:** Never operate electrical switches with wet hands or while standing on a wet floor.

## **B. Rules for Working on Overhead Lines (ALM Special)**

- ✓ **Use of Safety Belt:** Always wear a full-body harness when climbing poles.
- ✓ **Discharge Rod:** After turning off the power, use a discharge rod to connect the line to the earth to drain any "residual" or "static" charge.
- ✓ **Ladders:** Use only non-conductive ladders (Fiberglass or Wood). Never use Aluminum ladders near live wires.

## **The "Four" Categories of Safety Signs**

To ensure a high rank in the exam, you must distinguish between all four types:

Sign Category	Shape	Color Scheme	Example
Prohibition	Circular	Red Border / White Back	Do Not Smoke
Mandatory	Circular	Blue Background / White Symbol	Wear Safety Shoes
Warning	Triangular	Yellow Back / Black Border	Danger: High Voltage
Information	Square	Green Back / White Symbol	First Aid Post

## **Advanced First Aid & Injury Prevention**

### **The Science of Electrical Injury (Shock)**

Understanding the "pathway" of current is essential for a Shift Attendant.

- **Path of Current:** A shock from "Hand-to-Hand" is more dangerous than "Foot-to-Ground" because it passes through the heart and lungs.
- **Factors affecting Severity:**
  1. **Voltage:** Higher voltage breaks skin resistance faster.
  2. **Duration:** The longer the contact, the deeper the tissue damage.
  3. **Moisture:** Wet skin reduces body resistance from 100,000Ω to as low as 1,000Ω

### **Systematic First Aid: The DR-ABCDE Protocol**

For professional rescuers and ITI-trained staff, the "ABC" is expanded to ensure no hidden injuries are missed.

- **D (Danger):** Check for live wires, fire, or gas. **Self-preservation is first.**
- **R (Response):** Use the "Shake and Shout" method.
- **A (Airway):** Use the **Head-Tilt-Chin-Lift** maneuver. Ensure no broken teeth or vomit blocks the throat.
- **B (Breathing):** Look for chest rise. If absent, give 2 rescue breaths.
- **C (Circulation/Compressions):** Check the **Carotid pulse** (neck). If absent, start CPR.
- **D (Disability):** Check for responsiveness using the **AVPU scale** (Alert, Voice, Pain, Unresponsive).
- **E (Exposure):** Remove clothing near burns, but do not pull away clothes stuck to the skin.

### **Cardiopulmonary Resuscitation (CPR) - Technical Specs**

HSSC often asks for specific numbers regarding CPR.

- **Compression Depth:** 2 to 2.4 inches (5 - 6 cm) for adults.
- **Compression Rate:** 100--120 compressions per minute (to the beat of "Stayin' Alive").
- **Cycle:** 30 compressions followed by 2 breaths = **1 Cycle**. Perform 5 cycles in 2 minutes.
- **Hand Placement:** Lower half of the breastbone (Sternum).

### **Advanced Burn Management**

In electrical accidents, **Internal Burns** are common even if the skin looks okay.

- **Entry & Exit Wounds:** Current enters at one point and leaves at another (usually the feet). Both need dressing.

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- **Rule of Nines:** Used to calculate the percentage of body surface burned (e.g., each arm is 9%, each leg is 18%).
  - **DO NOTS:**
    - ✓ Do not use ice (it damages tissue further). Use cool running water.
    - ✓ Do not pop blisters (this leads to infection).
    - ✓ Do not apply "Cotton Wool" as fibers stick to the wound. Use **Sterile Gauze**.

### Injury Prevention: The "Hierarchy of Controls"

A Training Officer must know how to prevent injuries using this 5-step ladder:

1. **Elimination:** Physically remove the hazard (e.g., removing a faulty transformer).
2. **Substitution:** Replace the hazard (e.g., using 24V tools instead of 240V in damp areas).
3. **Engineering Controls:** Isolate people from the hazard (e.g., putting a fence around a substation).
4. **Administrative Controls:** Change the way people work (e.g., safety training, warning signs).
5. **PPE:** Protect the worker with gear (The **last line** of defense).

Moving forward with the **Hand Tools** module, which is essential for any **Haryana ALM/Electrician** aspirant. In the exam, questions often focus on the correct **size, material, and specific application** of these tools.

### Hand Tools & Their Specifications

#### Pliers (The Electrician's Primary Tool)

Pliers are used for gripping, twisting, and cutting wires.

- **Combination Pliers:** The most versatile. Used for gripping, twisting, and cutting.
  - ✓ *Standard Size:* **200 mm**.
  - ✓ *Specification:* Must have high-grade PVC insulation (rated for **1000V**).
  - ✓ *Note:* Never use pliers as a hammer; it damages the pivot and insulation.
- **Side Cutting Pliers (Diagonal Cutters):** Used specifically for cutting copper and aluminum wires in confined spaces.
- **Long Nose Pliers:** Used for holding small parts and making "loops" or "eyes" in wire ends for terminal connections.

#### Screwdrivers

- **Standard/Flat Head:** Used for slotted screws.
- **Phillips Head:** Used for cross-recessed screws.
- **Specification:** For electrical work, the **shank** must be insulated right down to the tip.
- **Connector Screwdriver:** A small, thin-bladed screwdriver used for fixing wires into terminal blocks (Connectors).

#### Stripping and Crimping Tools

- **Wire Stripper:** Used to remove the insulation from a wire without nicking the conductor.
  - ✓ *Auto-adjusting type:* Preferred for speed and precision.
- **Crimping Tool:** Used to fix "lugs" or "ferrules" onto the ends of stranded cables. This ensures a tight, low-resistance connection.

#### Striking & Boring Tools

- **Ball Pein Hammer:** The standard hammer for electricians. Used for punching and riveting.
  - ✓ *Weight:* Usually **400g to 500g** for general work.
- **Rawl Plug Tool & Jumper:** Used for making holes in stone or concrete walls for fixing conduit or switchboards.
- **Center Punch:** Used to mark the center of a hole before drilling in metal.

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## Measuring & Testing Tools

- **Steel Tape:** Usually **3m or 5m**. Used for measuring conduit lengths and wiring distances.
- **Try Square:** Used to check the 90° squareness of a switchboard or conduit layout.
- **Neon Tester (Phase Tester):** A tool used to check if a wire is "Live."
  - ✓ *Voltage Range:* Typically **100V to 500V**.
  - ✓ *Safety Tip:* Never use it without shoes or while standing on a highly insulated mat, as it needs a tiny bit of "leakage" to ground to glow.

## The 5S System (Workplace Organization)

The **5S System** is a Japanese methodology used to improve efficiency and safety. HSSC often asks for the English meaning of the Japanese terms.

Japanese Term	English Meaning	Action in Workshop
Seiri	Sort	Remove unnecessary tools from the bench.
Seiton	Set in Order	"A place for everything and everything in its place."
Seiso	Shine	Clean the tools and the work floor.
Seiketsu	Standardize	Create a consistent way of doing tasks.
Shitsuke	Sustain	Maintain the discipline of the first 4 steps.

## Hazard Identification & Avoidance

### Types of Hazards in Electrical Work

A hazard is anything with the potential to cause harm. For an electrician, hazards are classified into four main groups:

- **Electrical Hazards:** Unsafe grounding, exposed live parts, overloaded circuits, and inadequate wiring.
- **Physical Hazards:** Working at heights (on poles), slippery floors, loud noise (near generators), and extreme temperatures.
- **Chemical Hazards:** Battery acid (Sulphuric acid), cleaning solvents, and lead fumes during soldering.
- **Mechanical Hazards:** Moving parts of motors, fans, or pulley systems.

### Hazard Identification Techniques

Before starting any maintenance task, a Shift Attendant must perform a **Risk Assessment:**

1. **Look for "Arc Flash" Potential:** Identifying areas where high-voltage current might jump through the air.
2. **Check for "Step and Touch" Potential:** Ensuring the ground near a faulty transformer isn't energized.
3. **Visual Inspection:** Looking for frayed cables, burnt insulation, or loose terminal connections.
4. **Environmental Scan:** Checking for water puddles or flammable gases near electrical panels.

### Hazard Avoidance (The "Safe System of Work")

Avoidance is achieved through the **LOTO (Lock-Out Tag-Out)** procedure, which is a favorite topic in HSSC exams:

- **Step 1 (Notify):** Inform all affected employees.
- **Step 2 (Shut Down):** Turn off the equipment.
- **Step 3 (Isolate):** Disconnect from the energy source.
- **Step 4 (Lock/Tag):** Place a physical lock and a "DANGER: DO NOT OPERATE" tag. **The worker keeps the key.**
- **Step 5 (Verify):** Try to turn on the equipment to ensure it is truly "Dead."

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## Personal Protective Equipment (PPE)

PPE is the "Last Line of Defense." It does not eliminate the hazard but protects the worker from injury.

### **Essential PPE for Electricians (IS Standards)**

<b>Body Part</b>	<b>PPE Required</b>	<b>Technical Specification (IS Code)</b>
Head	Safety Helmet	IS: 2925 (Protects against impact and 20kV shock)
Eyes	Face Shield/Goggles	IS: 5983 (Protects against Arc Flash & acid splash)
Hands	Insulated Gloves	IS: 4770 (Classified by voltage: Class 0 to 4)
Feet	Safety Shoes	IS: 15298 (Steel-toe with electrical resistance)
Body	Cotton Clothing	Avoid synthetics; they melt onto skin during an arc flash.
Fall	Full Body Harness	IS: 3521 (Used for work above 1.8meters)

### Glove Classification

Gloves are rated based on the maximum voltage they can safely handle:

- **Class 00:** Up to 500V (AC)
- **Class 0:** Up to 1,000V (AC)
- **Class 1:** Up to 7,500V (AC)
- **Class 2:** Up to 17,000V (AC)

**Important Note:** Always perform an "Air Test" on gloves before use by rolling the cuff toward the fingers to trap air and checking for leaks.

### Waste Disposal & Environmental Safety

Disposing of hazardous waste correctly is part of the **5S Seiri (Sorting)** process.

- **Cotton Waste/Oily Rags:** Must be kept in a **covered metal container** to prevent spontaneous combustion.
- **Lead-Acid Batteries:** Must be sent to authorized recyclers (Lead is toxic).
- **Used Transformer Oil:** Should never be poured into the ground; it contains PCBs which are hazardous to groundwater.
- **Fluorescent Lamps:** Contain Mercury vapor; must be disposed of without breaking.

### Personal & Factory Safety

#### **Personal Safety (Worker-Centric)**

Personal safety focuses on the individual's habits and gear.

- **The "One-Hand" Rule:** When working on live panels, keep one hand in your pocket. This prevents current from forming a path through the chest (heart).
- **Jewelry Policy:** Never wear rings, metal watches, or chains. These are excellent conductors and can cause "arc-welding" to your skin if they touch a live terminal.
- **Clothing:** Use 100% cotton. Synthetic fibers (Nylon/Polyester) can melt into the skin during an electrical flash.

#### **Factory/Workshop Safety (Environment-Centric)**

Safety within the substation or workshop involves structural and procedural rules:

- **Insulated Matting:** As per **IS: 15652**, high-voltage switchboards must have "Insulating Mats" in front of them to isolate the operator from the earth.
- **Clearance/Working Space:** Adequate space must be maintained around electrical panels (usually **1 meter**) to allow for easy escape during an emergency.
- **Gangways:** Passages must be kept clear of scrap material (wires, old batteries) to prevent tripping.
- **Machine Guarding:** All moving parts (pulley belts of generators/motors) must be covered with a mesh guard.

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## Effects of Electric Current on the Human Body

The human body acts as a resistor. The effect of electricity depends on the **Current (I)**, not just the Voltage.

### The Threshold Table (Exam-Critical)

Current (mA)	Effect on Human Body
1 mA	Threshold of Perception: A faint tingling sensation.
5 mA	Mild Shock: Disturbing but not painful.
10 - 20 mA	"Let-Go" Threshold: Muscles contract; victim may not be able to release the wire.
50 mA	Severe Pain: Heart and respiratory functions are affected.
100 mA +	Ventricular Fibrillation: Heart muscles twitch randomly; usually fatal.
200 mA +	Severe Burns: Heart stops completely; severe tissue destruction.

### **Key Factors Influencing the Effect**

- **Body Resistance:**
  - ✓ Dry skin: 100,000 to 600,000Ω
  - ✓ Wet/Sweaty skin: As low as 1,000Ω.
- **Duration of Contact:** The longer the current flows, the more the internal organs "cook" (Joule's Heating Effect:  $H = I^2 RT$ ).
- **Path of Current:**
  - ✓ **Hand-to-Hand:** Highly dangerous (passes through the heart).
  - ✓ **Hand-to-Foot:** Highly dangerous (passes through the heart).
  - ✓ **Foot-to-Foot:** Known as **Step Potential**; dangerous during lightning or ground faults.

### Reasons For Electric Shock

An electric shock occurs when the human body becomes a part of an electrical circuit, allowing current to flow through the internal organs. This happens due to a **difference in potential** between two points of contact.

### Direct Contact with Live Conductors

This is the most common reason for accidents among field staff (ALMs).

- **Phase-to-Earth:** Touching a single live wire while standing on the ground without insulated boots. The body acts as a bridge to the earth.
- **Phase-to-Phase:** Touching two different phases (e.g., Red and Blue) simultaneously. This is extremely dangerous as the potential difference is much higher (415V instead of 240V).

### Failure of Insulation (Leakage Current)

When the internal insulation of an appliance (like a motor, heater, or transformer) fails, the metallic outer casing becomes energized.

- **Reason:** Aging of wires, overheating, or mechanical damage.
- **The Hazard:** If the equipment is not properly **Earthed**, a person touching the casing will receive a shock.
- **Safety Measure:** Proper Earthing and use of **ELCB/RCCB** (Earth Leakage Circuit Breakers).

### Step and Touch Potential (Substation Hazards)

In high-voltage substations, shocks can occur even without touching a wire directly.

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- **Step Potential:** During a ground fault (e.g., a wire falls to the ground), the voltage is highest at the point of contact and decreases as you move away. If a person walks near this area, the distance between their feet creates a "potential difference," and current flows from one leg to the other.
  - **Touch Potential:** This occurs when a person touches a grounded metallic structure (like a transformer fence) while a fault is occurring. The voltage difference between the hands and the feet causes the shock.

### Capacitive Discharge (Residual Charge)

Even after the power is switched off, certain components can store electricity.

- **Capacitors:** Large capacitor banks used for power factor correction can hold a fatal charge for minutes or hours.
- **Long Underground Cables:** These act like giant capacitors.
- **Reason for Shock:** Touching the terminals before they are "Discharged" to the ground.
- **Prevention:** Always use a **Discharge Rod** before starting work.

### Static Electricity

- **Reason:** Friction between moving parts (e.g., a leather belt on a pulley) or moving fluids in a pipe can build up high-voltage static charges.
- **The Hazard:** While usually not fatal, the sudden "jerk" from a static spark can cause a worker to fall from a height.

### Human Factors & Environmental Conditions

- **Moisture/Perspiration:** Pure water is a poor conductor, but sweat contains salts. Wet skin drops body resistance from 100,000Ω to nearly 1,000Ω increasing current flow drastically.
- **Incorrect Tools:** Using a screwdriver or plier with cracked or poor-quality insulation.
- **Lack of LOTO:** Someone accidentally switching on the power while a technician is working on the line.

### Disposal Procedure of Waste Materials

Proper waste disposal follows the **3R Principle** (Reduce, Reuse, Recycle) and is a core component of the **5S Methodology** (specifically *Seiri* - Sorting).

### Classification of Workshop Waste

Electrical workshops generate three main types of waste:

- **Non-Hazardous:** Paper, cardboard packaging, plastic insulation strippings.
- **Hazardous (Chemical/Toxic):** Used battery acid, lead-acid plates, used transformer oil.
- **Flammable:** Oily cotton waste, grease-soaked rags, solvents.

### Standard Disposal Methods

#### **A. Oily Cotton Waste & Rags**

This is the most dangerous waste in a substation due to **Spontaneous Combustion** (catching fire without an external spark).

- ✓ **Procedure:** Must be collected in **Closed Metal Bins** (not plastic).
- ✓ **Disposal:** Should be incinerated in controlled industrial environments or cleaned for reuse if possible.

#### **B. Used Batteries & Lead Acid**

Under the *Batteries (Management & Handling) Rules*, these cannot be thrown in regular trash.

- ✓ **Acid:** Before disposal, Sulphuric acid (H<sub>2</sub>SO<sub>4</sub>) must be **neutralized** using an alkaline solution like Soda Ash or Lime.
- ✓ **Lead:** Highly toxic. Old batteries must be returned to the manufacturer or sent to authorized recyclers.

### C. Transformer Oil (Mineral Oil)

- ✓ **Procedure:** Used oil contains PCBs (Polychlorinated Biphenyls). It must be collected in leak-proof drums.
- ✓ **Disposal:** Never pour oil onto the ground (it contaminates groundwater). It should be sent for "re-refining" or professional disposal.

### D. Metal Scrap (Copper/Aluminum)

- ✓ **Procedure:** Segregate based on the metal type.
- ✓ **Disposal:** Sold to scrap dealers for melting and recycling. This is high-value waste.

### Color Coding for Waste Bins (IS Standard)

For the exam, memorizing this table is essential for the "General Awareness/Safety" section:

Type of Waste	Bin Color
Paper	Blue
Plastic	Yellow
Metal	Red
Glass	Green
Food/Organic	Black
Hazardous/Electrical	Grey/Orange (Specific to site)

### Hazard Identification Symbols for Waste

Waste containers must be labeled with the correct hazard symbol:

- **Flame Symbol:** For flammable rags/solvents.
- **Skull and Crossbones:** For toxic lead or chemical waste.
- **Corrosive (Hand/Metal being eaten):** For battery acid.

### Emergency Response Procedures

#### Electrical Shock Emergency

If you see a colleague in contact with a live wire, **never touch them directly.**

- **Step 1: Isolate (The Most Critical Step):** Turn off the main switch or circuit breaker immediately. If the switch is far away, use a **non-conductive object** (dry wooden stick, plastic pipe, or rubber mat) to pull the victim away or push the wire.
- **Step 2: Check Vital Signs:** Once clear, check for **Airway, Breathing, and Circulation (Pulse)**.
- **Step 3: Medical Intervention:** \* If not breathing: Start **CPR** (30 compressions : 2 breaths).
  - ✓ If breathing but unconscious: Place in the **Recovery Position**.
- **Step 4: Treat Burns:** Electrical burns are internal. Cover the entry and exit wounds with a clean, dry cloth. Do not apply ointments.

#### Fire Emergencies

Fires in electrical installations are **Class C** (per Indian Standards) or **Class E** (International).

- **Immediate Action:** Raise the alarm (Shout "Fire! Fire!") and isolate the power source.
- **Selecting the Extinguisher:**
  - ✓ **DO USE:** CO<sub>2</sub> (Carbon Dioxide) or Halon/Dry Chemical Powder (DCP) extinguishers.
  - ✓ **NEVER USE:** Water or Foam (they conduct electricity and will cause further shock).
- **Technique:** Use the **P.A.S.S.** method (Pull, Aim, Squeeze, Sweep).
- **Evacuation:** If the fire is large, evacuate immediately. Crawl low to avoid inhaling toxic smoke.



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## **Battery Room Emergencies (Chemical/Explosion)**

Lead-Acid batteries release **Hydrogen gas** during charging, which is highly explosive.

- **Acid Splash:** If electrolyte (Sulphuric Acid) splashes on skin or eyes, wash with clean running water for at least **15–20 minutes** continuously.
- **Explosion/Fire:** If a battery explodes, evacuate the room to avoid inhaling lead and acid fumes. Use a Class D or specialized extinguisher if metal fires occur.
- **Ventilation:** Immediately turn on exhaust fans or open windows to disperse hydrogen gas.

## **Falls from Height (ALM Special)**

If an ALM falls from a pole:

- **Immobilization:** Do not move the victim. There may be a spinal or neck injury.
- **Check for Bleeding:** Apply direct pressure to any open wounds.
- **Treat for Shock:** Keep the victim warm with a blanket and elevate their legs slightly (unless a leg fracture is suspected).

## **Reporting and Documentation**

After the emergency is controlled, legal procedures must be followed:

- **Inform Superior:** Report to the Junior Engineer (JE) or SDO.
- **Logbook Entry:** Record the time, nature of the fault, and action taken in the Station Log.
- **Accident Report:** Fill out the mandatory accident report form as per **IE Rule 44A**.

## **Emergency Equipment Checklist**

<b>Equipment</b>	<b>Purpose</b>
First Aid Kit	Bandages, Antiseptics, Sterile Gauze.
Stretcher	To transport injured persons without further injury.
Fire Buckets	Kept filled with <b>Dry Sand</b> to smother small oil/electrical fires.
Rubber Gloves/Mats	Kept near the main panel for emergency isolation.
Emergency Lights	Must be functional in case of a total blackout (Grid Failure).

## **Response to Technical Emergencies**

### **Power Failure (Grid/Substation Blackout)**

A power failure can range from a local feeder trip to a total grid collapse.

- **Initial Action:** Identify if the failure is "External" (Grid side) or "Internal" (Local fault).
- **Safety Check:** Ensure all heavy motor loads and capacitors are disconnected to prevent a surge when power returns.
- **Procedure:**
  1. Check the **Annunciator Panel** to see which relay tripped (Overcurrent, Earth Fault, etc.).
  2. Check the **Battery Bank Voltage:** During a blackout, the DC system must stay alive to operate the protection relays and breakers.
  3. **Restoration:** Follow the "Load Shedding" protocol. Always energize the **Busbar** first, then the **Transformers**, and finally the **Feeders** one by one.
- **Communication:** Immediately inform the **Load Dispatch Center (LDC)** and record the "Trip Time" in the logbook.

### **Fire Emergencies (Electrical & Oil Fires)**

Fires in substations are usually caused by insulation failure, overloading, or transformer oil leakage.

- **The "Golden Rule":** Never use water on live electrical equipment or oil fires.
- **Classification:**
  1. **Class C (Electrical):** Use CO<sub>2</sub> or Dry Chemical Powder (DCP).
  2. **Class B (Oil Fires):** If a transformer catches fire, use Foam or DCP.

### ➤ **Response Steps:**

3. **Isolate:** Hit the **Emergency Trip Button** to de-energize the entire section.
4. **Contain:** Use **Sand Buckets** to prevent oil from spreading.
5. **Extinguish:** Use the **P.A.S.S.** technique (Pull, Aim, Squeeze, Sweep).
6. **Cooling:** For large transformers, the **Mulsifyre System** (Water spray) may be used, but **ONLY** after the power is confirmed OFF.

### **System Failure (Protection & Control)**

System failure refers to the breakdown of the "brains" of the substation (Relays, DC system, or SCADA).

- **DC System Failure:** This is the most dangerous failure. Without DC power, the Circuit Breakers cannot trip automatically during a fault.
  - ✓ *Action:* Switch to manual operation and try to restore the Battery Charger.
- **Relay Malfunction:** If a relay fails to trip during a fault, it leads to a "Busbar Fault," which can destroy the transformer.
  - ✓ *Action:* Use the **Backup Protection** or manually trip the upstream breaker.
- **CT/PT Failure:** If a Current Transformer (CT) secondary opens, it creates dangerously high voltage and can explode.
  - ✓ *Action:* Never open the secondary of a live CT. If it happens, de-energize the primary immediately.

### **Emergency Equipment & Legal Rules**

<b>Emergency</b>	<b>Critical Tool/Rule</b>	<b>Purpose</b>
Total Blackout	Emergency Lights/Inverter	To maintain visibility for the operator.
Transformer Fire	Soak Pit	The gravel pit under a transformer designed to drain and cool burning oil.
System Fault	Buchholz Relay	Protects the transformer from internal gas/oil pressure faults.
All Emergencies	IE Rule 44	Mandatory display of shock treatment and emergency charts.

### **Concept of Standards (BIS/ISI)**

Standards are a set of rules or guidelines that ensure electrical products are safe, reliable, and of good quality. In India, the **Bureau of Indian Standards (BIS)** is the national body.

### **What is BIS and ISI?**

- **BIS (Bureau of Indian Standards):** The organization that sets the quality standards.
- **ISI Mark:** A certification mark for industrial products in India. If an electrical appliance (like an iron or a motor) has the ISI mark, it means it has passed safety and quality tests.

### **Advantages of BIS/ISI for Electricians:**

1. **Safety:** Ensures the insulation can withstand the rated voltage without leaking.
2. **Reliability:** ISI-marked cables have a guaranteed current-carrying capacity.
3. **Interchangeability:** Standards ensure that a 5A plug from one brand will fit into a 5A socket from another.
4. **Legal Protection:** For government projects (like those in HVPNL/UHBVN), using non-ISI marked material is a legal violation.
5. **Reduced Losses:** Standardized conductors have fixed resistance values, reducing  $I^2RT$  (heat) losses.

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## Signs and Symbols of Electrical Accessories

Recognizing symbols is the most important skill for a **Shift Attendant** reading a single-line diagram (SLD).

### **Common Schematic Symbols:**

- **Ammeter:** A circle with 'A' inside (Connected in Series).
- **Voltmeter:** A circle with 'V' inside (Connected in Parallel).
- **One-Way Switch:** A circle with a single diagonal line and a dot.
- **Two-Way Switch:** A circle with two diagonal lines (used in staircase wiring).
- **Socket Outlet (5A/15A):** A semi-circle with two or three pins.
- **Earth Point:** Three horizontal lines of decreasing length (the "Tree" symbol).
- **Fuse:** A rectangle with a line passing through it.
- **Circuit Breaker:** A cross inside a square or a specific toggle symbol.

## Introduction to the 5S Concept

Originating from Japan, the **5S Concept** is a workplace organization method used to improve efficiency and safety in electrical workshops and substations.

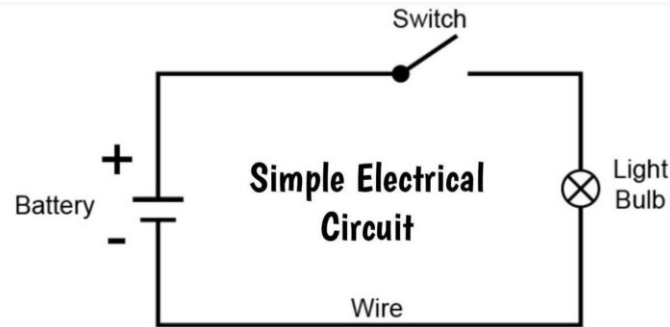
<b>Japanese Term</b>	<b>English Term</b>	<b>Meaning for an ALM/Electrician</b>
Seiri	Sort	Remove broken insulators, burnt fuses, and scrap wire from the floor.
Seiton	Set in Order	Keep pliers, testers, and hammers on a shadow board. "A place for everything."
Seiso	Shine	Clean oil leaks from transformers and dust from insulators to prevent tracking.
Seiketsu	Standardize	Use the same color coding for wires (R-Y-B) across all panels.
Shitsuke	Sustain	Follow these rules every single day without being told.

# 2

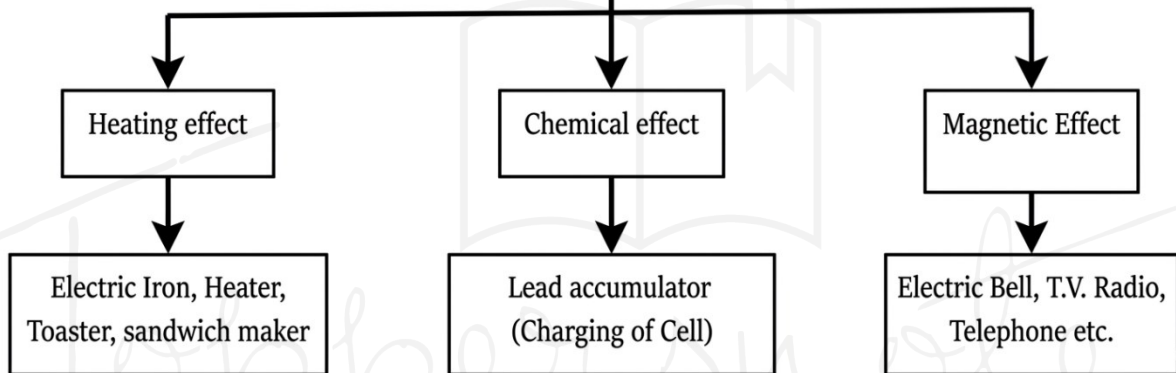
## CHAPTER

# Fundamental of Electricity

## Electricity



### Effects of electric Current



Electricity is the **flow of electric charge (electrons)** through a conductor.

- Direction of electron flow: **Negative** → **Positive**
- Conventional current direction: **Positive** → **Negative**

## Fundamental Terms

### Electric Charge (Q)

- Property of matter due to which it experiences force in an electric field
- Unit: **Coulomb (C)**
- Charge of 1 electron =  $-1.6 \times 10^{-19}$  C

### Electric Current (I)

- Rate of flow of charge
- Formula:  $I = Q/t$
- Unit: **Ampere (A)**
- 1 Ampere = flow of 1 Coulomb charge per second

### Voltage (V)

- Potential difference between two points
- It drives current in a circuit
- Unit: **Volt (V)**

## Resistance (R)

- Opposition offered to flow of current
- Unit: **Ohm ( $\Omega$ )**

## Conductance (G)

- Reciprocal of resistance  $G = 1/R$
- Unit: **Siemens (S)**

## Power (P)

- Rate of electrical energy consumption  $P = VI$
- Unit: **Watt (W)**

## Energy (E)

$$E = P \times t = VI t$$

- Unit: **Joule (J)** or **kWh**

## Units & Standard Values

Quantity	Symbol	Unit	Expression
Charge	Q	Coulomb	$I \times t$
Current	I	Ampere	$Q/t$
Voltage	V	Volt	$W/Q$
Resistance	R	Ohm	$V/I$
Power	P	Watt	$VI$
Energy	E	Joule	$VI t$

## Effects of Electric Current

### Heating Effect

- Current produces heat in conductor
- Used in: Heater, Iron, Fuse
- Formula:  
 $H = I^2 R t$

### Magnetic Effect

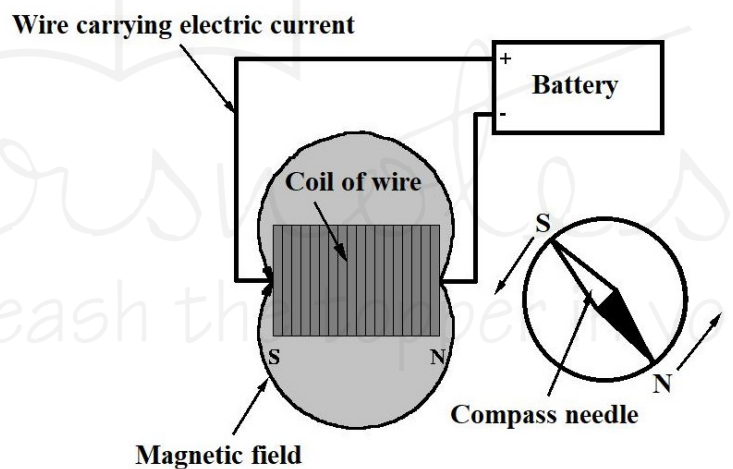
- Current produces magnetic field
- Used in: Motor, Transformer

### Chemical Effect

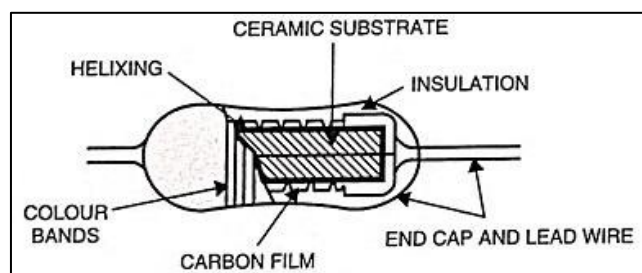
- Current causes chemical changes
- Used in: Electroplating, Batteries

### Physiological Effect

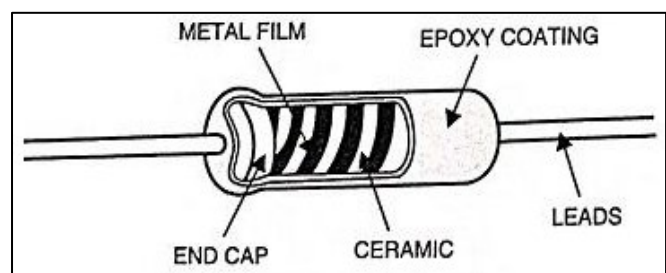
- Electric shock affects human body



## Types of Resistors



**Carbon Film Resistor**



**Metal Film Resistor**

# 13

## ਅਧਿਆਇ

# ਵਾਧਾ ਅਤੇ ਵਿਕਾਸ

### ਭਾਸ਼ਾ ਜਾਂ ਬੋਲੀ

ਭਾਸ਼ਾ ਜਾਂ ਬੋਲੀ ਇੱਕ ਅਜਿਹਾ ਸੰਚਾਰ ਸਾਧਨ ਹੈ ਜਿਸ ਰਾਹੀਂ ਮਨੁੱਖ ਆਪਣੇ ਵਿਚਾਰਾਂ ਜਾਂ ਮਨੋਭਾਵਾਂ ਨੂੰ ਦੂਸਰੇ ਮਨੁੱਖਾਂ ਨਾਲ ਸਾਂਝਾ ਕਰਦਾ ਹੈ।

ਭਾਸ਼ਾ ਦੇ ਪ੍ਰਕਾਰ ਦੀ ਹੁੰਦੀ ਹੈ:

1. ਆਮ ਬੋਲ-ਚਾਲ ਦੀ ਭਾਸ਼ਾ
2. ਸਾਹਿਤਕ ਜਾਂ ਟਕਸਾਲੀ ਭਾਸ਼ਾ (ਲਿਖਤੀ ਭਾਸ਼ਾ)

### ਭਾਸ਼ਾ ਦੀਆਂ ਵਿਸ਼ੇਸ਼ਤਾਵਾਂ

1. ਭਾਸ਼ਾ ਸੰਚਾਰ ਸਾਧਨ ਹੈ- ਭਾਸ਼ਾ ਸਵੈ- ਅਭਿਵਿਅਕਤੀ ਦਾ ਇੱਕ ਸੰਪੂਰਨ ਸਾਧਨ ਹੈ।
2. ਭਾਸ਼ਾ ਸੀਮਤ ਧੁਨੀਆਂ ਦਾ ਸਮੂਹ ਹੈ। ਇਹ ਸਾਰਥਕ ਧੁਨੀਆਂ ਹਨ। ਹਰ ਭਾਸ਼ਾ ਵਿੱਚ ਧੁਨੀਆਤਮਕ ਵਖਰੇਵਾਂ ਹੋ ਸਕਦਾ ਹੈ। ਭਾਸ਼ਾ ਸਮਾਜਿਕ ਰੂਪ ਵਿੱਚ ਆਪਸੀ ਸਮਝ ਦਾ ਪ੍ਰਬੰਧ ਹੈ।
3. ਭਾਸ਼ਾ ਅੰਤਰ-ਵਟਾਂਦਰਾ (Inter changeability) ਅਧਾਰਿਤ ਹੈ।
4. ਭਾਸ਼ਾ ਆਪਹੁਦਰਾ (Arbitrariness) ਚਿਹਨ ਪ੍ਰਬੰਧ ਹੈ। ਭਾਸ਼ਾ ਪ੍ਰਤੀਕਾਤਮਕ ਹੈ।
5. ਭਾਸ਼ਾ ਇੱਕ ਸਮਾਜਿਕ ਵਸਤੂ ਹੈ। ਭਾਸ਼ਾ ਅਤੇ ਸਮਾਜ ਇੱਕ ਦੂਜੇ ਉੱਤੇ ਨਿਰਭਰ ਹਨ।
6. ਭਾਸ਼ਾ ਪ੍ਰਬੰਧਾਂ ਦਾ ਪ੍ਰਬੰਧ ਹੈ। ਭਾਸ਼ਾਈ ਪ੍ਰਬੰਧ ਦੇ-ਪੱਖੀ ਹੈ। ਇੱਕ ਧੁਨੀ ਦੇ ਪੱਧਰ 'ਤੇ ਇੱਕ ਸ਼ਬਦ ਦੇ ਪੱਧਰ 'ਤੇ। ਇਸੇ ਨੂੰ ਭਾਸ਼ਾ ਦੀ ਦੁਪੱਖਤਾ (Duality) ਕਿਹਾ ਜਾਂਦਾ ਹੈ।
7. ਭਾਸ਼ਾ ਪਰਿਵਰਤਨਸ਼ੀਲ ਹੈ। ਭਾਸ਼ਾ ਵਿਕਾਸਸ਼ੀਲ ਹੈ।
8. ਭਾਸ਼ਾਈ ਪਰਿਵਰਤਨ ਬੇਮੁਹਾਰਾ ਨਹੀਂ ਹੁੰਦਾ ਬਲਕੀ ਵਿਸ਼ੇਸ਼ ਨਿਯਮਾਂ ਅਧੀਨ ਚਲਦਾ ਹੈ। ਪਰਿਵਰਤਨ ਦੀ ਦਿਸ਼ਾ ਔਖ ਤੋਂ ਸੌਖ ਵੱਲ ਹੁੰਦੀ ਹੈ।
9. ਭਾਸ਼ਾ ਦੀ ਇੱਕ ਵਿਸ਼ੇਸ਼ਤਾ ਉਤਪਾਦਕਤਾ ਜਾਂ ਸਿਰਜਨਾਤਮਕਤਾ (Productivity) ਹੈ।
10. ਮਨੁੱਖੀ ਭਾਸ਼ਾ ਵਿਸਥਾਪਿਤ (Displacement) ਹੋ ਸਕਦੀ ਹੈ। ਸਮੇਂ ਸਥਾਨ ਜਾਂ ਸਥਿਤੀ ਦੀ ਮੁਥਾਜ ਨਹੀਂ ਹੈ। ਭਾਸ਼ਾ ਬਿਰਤਾਂਤਿਕਤਾ, ਵਿਆਖਿਆਤਮਕਤਾ ਦੀ ਅਸੀਮ ਪਹੁੰਚ ਰੱਖਦੀ ਹੈ।
11. ਭਾਸ਼ਾ ਦੀ ਇੱਕ ਵਿਸ਼ੇਸ਼ਤਾ ਵਿਸ਼ੇਸ਼ਗਤਾ (Specialization) ਹੈ, ਭਾਵ ਭਾਸ਼ਾ ਦੀ ਵਰਤੋਂ ਕਰਦੇ ਹੋਏ ਤੁਸੀਂ ਹੋਰ ਕੰਮ ਵੀ ਕਰ ਸਕਦੇ ਹੋ ਇਹ ਨਹੀਂ ਕਿ ਤੁਸੀਂ ਭਾਸ਼ਾ ਦੀ ਵਰਤੋਂ ਕਰ ਰਹੇ ਹੋਵੋ ਅਤੇ ਹਥਲੇ ਕੰਮ ਤੁਹਾਨੂੰ ਛੱਡਣੇ ਪੈਣ।
12. ਪਰਿਵਰਤਨ ਭਾਸ਼ਾ ਦੇ ਹਰੇਕ ਅੰਗ ਵਿੱਚ ਵਾਪਰਦਾ ਹੈ। ਧੁਨੀ, ਸ਼ਬਦ, ਅਰਥ, ਵਾਕ ਆਦਿ।
13. ਭਾਸ਼ਾ ਮਨੁੱਖੀ ਭਾਵਾਂ ਦਾ ਧੁਨੀਆਤਮਕ ਪ੍ਰਗਟਾਵਾ ਹੈ।
14. ਭਾਸ਼ਾ ਇੱਕ ਜਟਿਲ ਸੰਰਚਨਾ ਹੈ।
15. ਭਾਸ਼ਾ ਸਮਾਜਿਕ ਵਰਤਾਰੇ ਦਾ ਇੱਕ ਰੂਪ ਹੈ।
16. ਭਾਸ਼ਾ ਸੱਭਿਆਚਾਰਕ ਉਚਾਰ ਪ੍ਰਬੰਧ ਹੈ। ਸੱਭਿਆਚਾਰਕ ਸੰਚਾਰਨ (Cultural transmission) ਹੈ।

## ਪੰਜਾਬੀ ਵਿਆਕਰਨ

ਕਿਸੇ ਬੋਲੀ ਜਾਂ ਭਾਸ਼ਾ ਨੂੰ ਸੁਧ ਰੂਪ ਵਿੱਚ ਲਿਖਣ ਜਾਂ ਬੋਲਣ ਲਈ ਜਿਨ੍ਹਾਂ ਨਿਯਮਾਂ ਦੀ ਵਰਤੋਂ ਕੀਤੀ ਜਾਂਦੀ ਹੈ, ਉਸ ਨਿਯਮਾਵਲੀ ਨੂੰ ਵਿਆਕਰਨ ਕਿਹਾ ਜਾਂਦਾ ਹੈ।

**ਵਿਆਕਰਨ ਦੇ ਮੁੱਖ ਤੌਰ 'ਤੇ ਚਾਰ ਭਾਗ ਹਨ:**

1. ਧੁਨੀ-ਬੋਧ, ਅੱਖਰ-ਬੋਧ ਜਾਂ ਵਰਨ-ਬੋਧ
2. ਸ਼ਬਦ-ਬੋਧ
3. ਅਰਥ-ਬੋਧ
4. ਵਾਕ-ਬੋਧ

### 1. ਧੁਨੀ-ਬੋਧ, ਅੱਖਰ-ਬੋਧ ਜਾਂ ਵਰਨ-ਬੋਧ

ਭਾਸ਼ਾ ਦੀ ਸਭ ਤੋਂ ਛੋਟੀ ਇਕਾਈ ਧੁਨੀ ਹੈ। ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਬੋਲਣ ਵੇਲੇ ਮੂੰਹ ਵਿੱਚੋਂ ਜਿਹੜੀਆਂ ਆਵਾਜ਼ਾਂ ਨਿਕਲਦੀਆਂ ਹਨ, ਉਹ ਪੰਜਾਬੀ ਦੀਆਂ ਧੁਨੀਆਂ ਹਨ।

### 2. ਸ਼ਬਦ-ਬੋਧ

ਧੁਨੀਆਂ ਜਾਂ ਵਰਨਾਂ ਦੇ ਸੁਮੇਲ ਤੋਂ ਸ਼ਬਦ ਬਣਦਾ ਹੈ। ਧੁਨੀ ਦਾ ਲਿਖਤੀ ਚਿੰਨ੍ਹ ਅੱਖਰ ਹੁੰਦਾ ਹੈ। ਉਹ ਬੋਧ ਜਿਸ ਰਾਹੀਂ ਅੱਖਰਾਂ ਦੀ ਸਹੀ ਵਰਤੋਂ ਦਾ ਪਤਾ ਲੱਗੇ ਉਸ ਨੂੰ ਸ਼ਬਦ-ਬੋਧ ਕਿਹਾ ਜਾਂਦਾ ਹੈ।

### 3. ਅਰਥ-ਬੋਧ

ਅਰਥ-ਬੋਧ ਤੋਂ ਭਾਵ ਹੈ ਅਰਥਾਂ ਦੇ ਪੱਖ ਤੋਂ ਸ਼ਬਦ ਦੀ ਵਿਆਖਿਆ। ਇਸ ਵਿੱਚ ਬਹੁਅਰਥਕ ਸ਼ਬਦ, ਸਮਾਨਾਰਥਕ ਸ਼ਬਦ, ਬਹੁਤੇ ਸ਼ਬਦਾਂ ਦੀ ਥਾਂ ਇੱਕ ਸ਼ਬਦ ਅਤੇ ਵਿਰੋਧਾਰਥਕ ਸ਼ਬਦਾਂ ਬਾਰੇ ਜਾਣਕਾਰੀ ਦਿੱਤੀ ਜਾਂਦੀ ਹੈ।

### 4. ਵਾਕ-ਬੋਧ

ਵਿਆਕਰਨ ਦੇ ਇਸ ਭਾਗ ਵਿੱਚ ਵਾਕ-ਰਚਨਾ ਦੇ ਨਿਯਮਾਂ ਬਾਰੇ ਅਤੇ ਵਾਕਾਂ ਸੰਬੰਧੀ ਵਿਚਾਰ ਕੀਤੀ ਜਾਂਦੀ ਹੈ।

## ਲਿੱਪੀ

ਭਾਸ਼ਾ ਜਾਂ ਬੋਲੀ ਨੂੰ ਲਿਖਤੀ ਰੂਪ ਵਿੱਚ ਪ੍ਰਗਟ ਕਰਨ ਲਈ ਜਿਹੜੇ ਅੱਖਰਾਂ ਅਤੇ ਚਿੰਨ੍ਹਾਂ ਦੀ ਵਰਤੋਂ ਕੀਤੀ ਜਾਂਦੀ ਹੈ ਉਹਨਾਂ ਦੇ ਸਮੂਹ ਨੂੰ ਲਿੱਪੀ ਕਹਿੰਦੇ ਹਨ।

- ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਨੂੰ ਲਿਖਣ ਲਈ ਗੁਰਮੁਖੀ ਲਿੱਪੀ ਦੀ ਵਰਤੋਂ ਕੀਤੀ ਜਾਂਦੀ ਹੈ।
- ਹਿੰਦੀ ਭਾਸ਼ਾ ਦੀ ਲਿੱਪੀ ਦੇਵਨਾਗਰੀ ਅਤੇ ਅੰਗਰੇਜ਼ੀ ਭਾਸ਼ਾ ਦੀ ਲਿੱਪੀ ਰੋਮਨ ਹੈ।

## ਗੁਰਮੁਖੀ ਵਰਨਮਾਲਾ

ਮੁਖ ਵਰਗ	ੳ	ਅ	ੲ	ਸ	ਹ	
ਕ ਵਰਗ	ਕ	ਖ	ਗ	ਘ	ਙ	
ਚ ਵਰਗ	ਚ	ਛ	ਜ	ਝ	ਞ	
ਟ ਵਰਗ	ਟ	ਠ	ਡ	ਢ	ਣ	
ਤ ਵਰਗ	ਤ	ਥ	ਦ	ਧ	ਨ	
ਪ ਵਰਗ	ਪ	ਫ	ਬ	ਭ	ਮ	
ਯ ਵਰਗ	ਯ	ਰ	ਲ	ਵ	ੜ	
ਨਵੀਨ ਟੇਲੀ	ਸ਼	ਖ਼	ਗ਼	ਜ਼	ਫ਼	ਲ਼

**ਗੁਰਮੁਖੀ ਅੱਖਰ** ਜਦੋਂ ਨਿਸ਼ਿਚਤ ਤਰਤੀਬ ਵਿੱਚ ਰੱਖੇ ਜਾਂਦੇ ਹਨ ਤਾਂ ਉਸ ਨੂੰ **ਗੁਰਮੁਖੀ ਵਰਨਮਾਲਾ** ਕਿਹਾ ਜਾਂਦਾ ਹੈ। ਗੁਰਮੁਖੀ ਲਿੱਪੀ ਦੇ ਪਹਿਲਾਂ 35 ਅੱਖਰ ਸਨ। ਇਸੇ ਕਰਕੇ ਇਸ ਨੂੰ 'ਪੈਂਤੀ ਅੱਖਰੀ' ਵੀ ਕਿਹਾ ਜਾਂਦਾ ਸੀ। ਅਰਬੀ ਅਤੇ ਫ਼ਾਰਸੀ ਯੁਨੀਆਂ ਨੂੰ ਅੰਕਿਤ ਕਰਨ ਲਈ ਪੰਜ ਅੱਖਰਾਂ ਸ ਖ ਗ ਜ ਫ ਦੇ ਪੈਰਾਂ ਵਿੱਚ ਬਿੰਦੀ ਦੀ ਵਰਤੋਂ ਕਰਕੇ ਸ ਖ ਗ ਜ ਫ ਅੱਖਰ ਬਣਾ ਲਏ ਗਏ। ਇਸ ਪ੍ਰਕਾਰ ਗੁਰਮੁਖੀ ਵਰਨ-ਮਾਲਾ ਵਿੱਚ ਅੱਖਰਾਂ ਦੀ ਗਿਣਤੀ 40 ਹੋ ਗਈ। ਉਸਤੋਂ ਬਾਅਦ ਲ ਅੱਖਰ ਦੇ ਪੈਰ ਵਿੱਚ ਬਿੰਦੀ ਲਾ ਕੇ ਲ ਅੱਖਰ ਬਣਾ ਲਿਆ ਗਿਆ। ਇਸ ਤਰ੍ਹਾਂ ਪੰਜਾਬੀ ਵਰਨਮਾਲਾ ਦੀ ਗਿਣਤੀ 41 ਹੋ ਗਈ ਹੈ।

### ਦੁੱਤ ਅੱਖਰ

ਉਹ ਅੱਖਰ ਜਿਹੜਾ ਦੋ ਅੱਖਰਾਂ ਦੇ ਮੇਲ ਤੋਂ ਬਣੇ ਉਸ ਨੂੰ ਦੁੱਤ ਅੱਖਰ ਕਿਹਾ ਜਾਂਦਾ ਹੈ। ਇਸ ਵਿੱਚ ਇੱਕ ਅੱਖਰ ਦੂਜੇ ਅੱਖਰ ਦੇ ਪੈਰ ਵਿੱਚ ਲਿਖਿਆ ਜਾਂਦਾ ਹੈ ਅਤੇ ਦੋਵੇਂ ਅੱਖਰ ਮਿਲ ਕੇ ਇੱਕ ਆਵਾਜ਼ ਪੈਦਾ ਕਰਦੇ ਹਨ। ਗੁਰਮੁਖੀ ਲਿੱਪੀ ਵਿੱਚ ਕੇਵਲ ਤਿੰਨ ਅੱਖਰਾਂ ਦੀ ਵਰਤੋਂ ਅੱਖਰ ਦੇ ਪੈਰ ਵਿੱਚ ਕੀਤੀ ਜਾਂਦੀ ਹੈ। ਉਹ ਹਨ:

ਹ ਰ ਵ

ਹ - ਪੜ੍ਹਾਈ, ਜੜ੍ਹ, ਉਠਾਂ

ਰ - ਪ੍ਰਗਟ, ਪ੍ਰਸ਼ਨ, ਪ੍ਰਾਰਥਨਾ, ਪ੍ਰੋਫੈਸਰ

ਵ - ਸ਼ੈਜੀਵਨੀ, ਸ਼ੈਮਾਣ, ਸ਼ੈਵਿਸ਼ਵਾਸ

### ਲਗਾਂ

**ਲਗਾਂ** ਯੁਨੀਆਂ ਨੂੰ ਅੰਕਿਤ ਕਰਨ ਵਾਲੇ ਲਿੱਪੀ- ਚਿੰਨ੍ਹ ਹਨ। ਅੱਖਰਾਂ ਬਿਨਾਂ ਲਗਾਂ ਦਾ ਕੋਈ ਮਹੱਤਵ ਨਹੀਂ ਹੈ। ਗੁਰਮੁਖੀ ਲਿੱਪੀ ਦੀਆਂ ਦਸ ਲਗਾਂ ਹਨ:

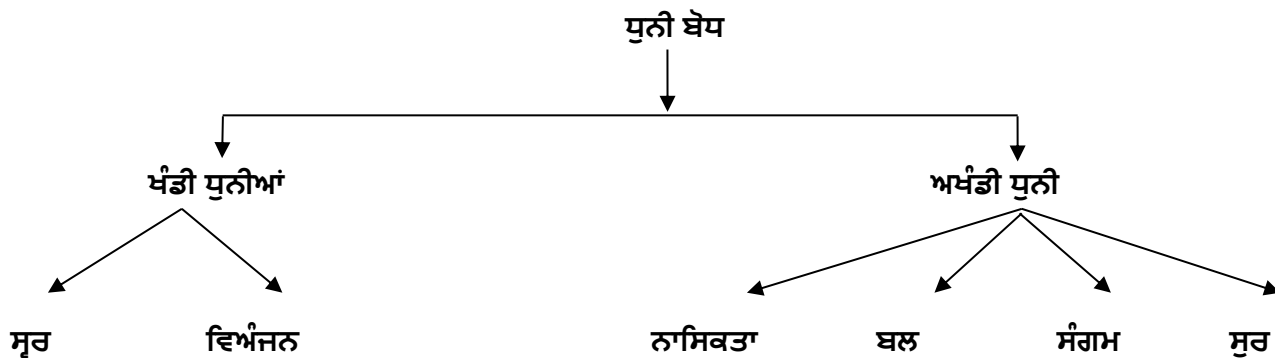
ਕ੍ਰਮ ਨੰ.	ਨਾਂ	ਚਿੰਨ੍ਹ		ਉਦਾਹਰਨ
1	ਮੁਕਤਾ	ਕੋਈ ਚਿੰਨ੍ਹ ਨਹੀਂ	ਸ	ਸਰਦ, ਸਬਰ, ਸਤਰ
2	ਕੰਨਾ		ਸਾ	ਸਾਲ, ਸਾਬ, ਸਾਫ਼
3	ਸਿਹਾਰੀ		ਸਿ	ਸਿਰ, ਸਿੱਕਾ, ਸਿੱਟਾ
4	ਬਿਹਾਰੀ		ਸੀ	ਸੀਮਾ, ਸੀਲ, ਸੀਸ
5	ਅੱਕੜ		ਸੁ	ਹੁਣ, ਸੁਣ, ਸੁਰ
6	ਦੁਲੈਕੜ		ਸੂ	ਸੂਰਮਾ, ਸੂਤ, ਸੂਚੀ
7	ਲਾਂ		ਸੇ	ਕੇਲਾ, ਸੇਕ, ਸੇਰ
8	ਦੁਲਾਵਾਂ		ਸੈ	ਸੈਰ, ਸੈਨਾ, ਸੈਨਤ
9	ਹੇੜਾ		ਸੇ	ਸੇਹਣਾ, ਸੇਚ, ਸੇਨਾ
10	ਕਨੇੜਾ		ਸੇਂ	ਸੇਂ, ਸੇਖਾ, ਸੇੜਾ

### ਲਗਾਖਰ

ਲਗਾਂ ਦਾ ਸੰਬੰਧ ਅੱਖਰਾਂ ਨਾਲ ਹੁੰਦਾ ਹੈ। ਲਗਾਖਰ ਉਹ ਚਿੰਨ੍ਹ ਹਨ, ਜਿਹੜੇ ਲਗਾਂ ਦੇ ਨਾਲ ਵਰਤੇ ਜਾਂਦੇ ਹਨ। ਗੁਰਮੁਖੀ ਲਿੱਪੀ ਵਿੱਚ ਤਿੰਨ ਲਗਾਖਰ ਹਨ: ਬਿੰਦੀ, ਟਿੱਪੀ ਅਤੇ ਅੱਧਕ।

ਕ੍ਰਮ ਨੰ:	ਲਗਾਖਰ ਦਾ ਨਾਂ	ਰੂਪ (ਚਿੰਨ੍ਹ)	ਉਦਾਹਰਨਾਂ
1	ਬਿੰਦੀ	◌ੰ	ਗੋਂਦ, ਗਾਂ, ਨੀਂਦ
2	ਟਿੱਪੀ	◌ੁ	ਸੰਘ, ਸੰਦ, ਚੰਦ
3	ਅੱਧਕ	◌ੱ	ਸੱਚ, ਪੱਤਾ, ਮੱਕੀ

## ਧੁਨੀ-ਬੋਧ



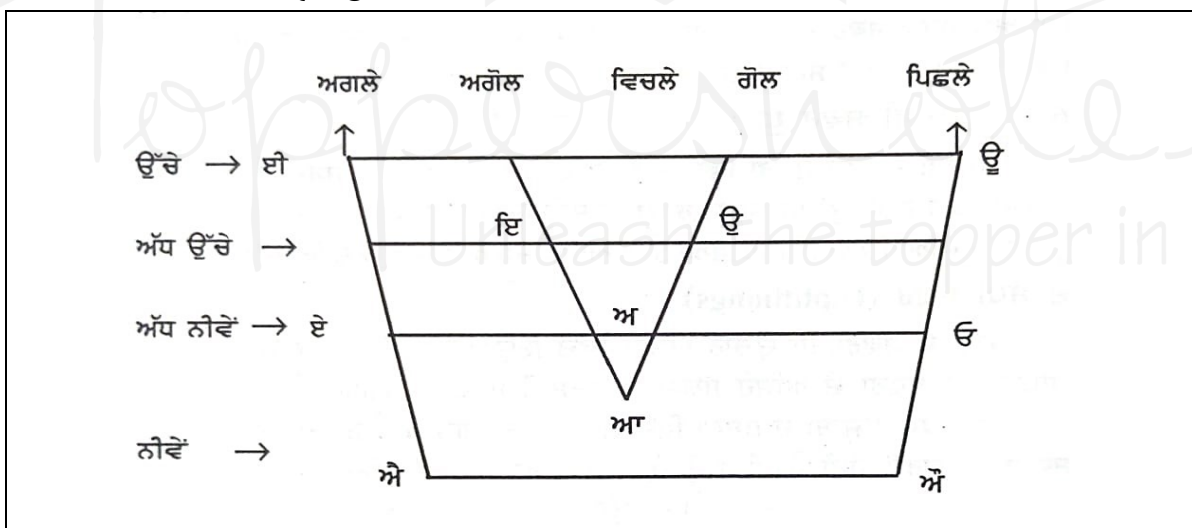
**ਖੰਡੀ ਧੁਨੀਆਂ ਦੇ ਕਿਸਮ ਦੀਆਂ ਹਨ:**

1. ਸ੍ਰ
2. ਵਿਅੰਜਨ

**ਸ੍ਰ** :- ਸ੍ਰ ਉਹ ਧੁਨੀਆਂ ਹਨ, ਜਿਨ੍ਹਾਂ ਨੂੰ ਬੋਲਣ ਸਮੇਂ ਉਚਾਰਨ ਅੰਗ ਕੋਈ ਰੁਕਾਵਟ ਨਹੀਂ ਪਾਉਂਦੇ। ਆਵਾਜ਼ ਮੂੰਹ ਵਿੱਚੋਂ ਬੇਰੋਕ ਬਾਹਰ ਨਿਕਲਦੀ ਹੈ। ਓ, ਅ, ਏ ਤਿੰਨ ਸ੍ਰ ਅੱਖਰ ਹਨ ਪਰ ਉਚਾਰਨ ਪੱਖੋਂ ਸ੍ਰ-ਧੁਨੀਆਂ ਦਸ ਹਨ। ਇਸ ਕਰਕੇ ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਵਿੱਚ ਸ੍ਰਾਂ ਦੀ ਗਿਣਤੀ ਦਸ ਮੰਨੀ ਜਾਂਦੀ ਹੈ। ਇਹ ਸ੍ਰ ਧੁਨੀਆਂ ਹਨ:

**ਅ ਆ ਇ ਈ ਉ ਊ ਏ ਐ ਓ ਔ**

1. ਸਾਹ ਦੀ ਮਾਤਰਾ ਦੇ ਅਧਾਰ ਤੇ ਸ੍ਰਾਂ ਨੂੰ ਦੋ ਭਾਗਾਂ ਵਿੱਚ ਵੰਡਿਆ ਜਾਂਦਾ ਹੈ-  
ਲਘੁ ਸ੍ਰ - 3 - ਉ, ਅ, ਇ  
ਦੀਰਘ ਸ੍ਰ - 7 - ਆ, ਈ, ਊ, ਏ, ਐ, ਓ, ਔ
2. ਜੀਭ ਅਤੇ ਬੁੱਲਾਂ ਦੇ ਅਧਾਰ ਤੇ ਸ੍ਰਾਂ ਨੂੰ ਹੇਠ ਦਿੱਤੇ ਢੰਗ ਨਾਲ ਵੰਡਿਆ ਜਾਂਦਾ ਹੈ-



**ਵਿਅੰਜਨ** :- ਵਿਅੰਜਨ ਉਹ ਧੁਨੀਆਂ ਹਨ, ਜਿਨ੍ਹਾਂ ਨੂੰ ਬੋਲਣ ਸਮੇਂ ਉਚਾਰਨ ਅੰਗ ਥੋੜ੍ਹੀ-ਬਹੁਤ ਰੁਕਾਵਟ ਪਾਉਂਦੇ ਹਨ। ਇਹਨਾਂ ਨੂੰ ਬੋਲਣ ਸਮੇਂ ਜੀਭ ਕਦੇ ਤਾਲੂ ਨਾਲ ਅਤੇ ਕਦੇ ਦੰਦਾਂ ਦੇ ਅੰਦਰਲੇ ਪਾਸੇ ਛੂੰਹਦੀ ਹੈ ਅਤੇ ਕਈ ਵਾਰੀ ਬੁੱਲ੍ਹ ਥੋੜ੍ਹੀ ਦੇਰ ਲਈ ਮੀਟੇ ਜਾਂਦੇ ਹਨ। ਪੰਜਾਬੀ ਵਰਨਮਾਲਾ ਵਿੱਚ ਸ ਤੋਂ ਲ ਤੱਕ 38 ਵਿਅੰਜਨ ਅੱਖਰ ਹਨ।

**ਅਨੁਨਾਸਿਕੀ ਵਿਅੰਜਨ**

ਅਨੁਨਾਸਿਕੀ ਵਿਅੰਜਨ ਉਹ ਧੁਨੀਆਂ ਹਨ ਜਿਨ੍ਹਾਂ ਦੇ ਉਚਾਰਨ ਸਮੇਂ ਆਵਾਜ਼ ਨੱਕ ਵਿੱਚੋਂ ਨਿਕਲਦੀ ਹੈ।

ਗੁਰਮੁਖੀ ਲਿੱਪੀ ਵਿੱਚ ਅਨੁਨਾਸਿਕੀ ਧੁਨੀਆਂ ਨੂੰ ਅੰਕਿਤ ਕਰਨ ਲਈ ਪੰਜ ਅੱਖਰ ਇਹ ਹਨ:

**ਙ ਞ ਣ ਨ ਮ**