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# NALANDA FOUNDATIONS POLYTECHNIC

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# FEEE - 25EE011

## I Year Common Subject

# Manual

Department of Electronics and Communication Engineering

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| Sl. NO. | NAME | Sign |
|---|---|---|
| 01 | Demonstrate use of Personal Protective Equipment (PPE) and its types | |
| 02 | Electrocution (Electric Shock): Use videos to demonstrate how to safely free a person | |
| 03 | Demonstration of Pipe and Plate Earthing methods | |
| 04 | Electrical lab familiarization: Components with symbols, and check earthing by measuring voltage between neutral and earth | |
| 05 | Video demonstration on identification and observation of different ranges and types of meters | |
| 06 | Verification of Ohm’s Law using a simple circuit | |
| 07 | Demonstrate Open, Closed, and Short circuit conditions in a simple series circuit | |
| 08 | Determine the equivalent resistance in a series resistive circuit | |
| 09 | Determine the equivalent resistance in a parallel resistive circuit | |
| 10 | Measure AC voltage. | |
| 11 | Demonstrate measurement of amplitude, peak-peak value, time period, and frequency using CRO and function generator | |
| 12 | Wire up and test PVC conduit wiring to control two lamps and one socket independently with protection | |
| 13 | Wire up and test two-way (staircase) wiring to control one lamp from two places | |
| 14 | Control a lamp using an electromagnetic relay | |
| 15 | Determine experimentally the transformation ratio of a transformer | |
| 16 | Video demonstration of construction of a three-phase induction motor | |
| 17 | Wire up a starter to start a 1-phase or 3-phase AC motor | |
| 18 | Construct a simple battery using primary cells to light an LED through a resistor | |
| 19 | Video demonstration on construction of a lithium-ion battery | |
| 20 | Test and report condition of a lead-acid or lithium-ion battery | |
| 21 | Video demonstration on working of a simple electric vehicle | |
| 22 | Video demonstration on solar-powered street lighting system | |
| 23 | Identify and determine values of resistance, inductance, and capacitance using LCR meter | |
| 24 | Compute the value of a resistor using color coding | |
| 25 | Identify terminals of a diode | |
| 26 | Connect diode in forward and reverse bias and observe LED response | |
| 27 | Trace input and output waveforms of an IC bridge rectifier | |
| 28 | Verify truth tables of AND, OR, NOT, NAND, NOR, and EX-OR gates | |
| 29 | Video demonstration on working of a simple mechanical/electrical actuator | |
| 30 | List commercially available PLCs | |

**Experiment 1**

**Personal Protective Equipment (PPE)**

Aim:

To demonstrate the correct use of Personal Protective Equipment (PPE) for electrical safety and understand how each item contributes to the protection of technicians and engineers during electrical tasks.

Theory:

PPE refers to specialized gear designed to protect workers from electrical hazards such as shocks, arc flashes, fire, and mechanical injury. Wearing PPE reduces risk and ensures compliance with safety regulations (such as IS and IEC standards).

Use of Each PPE Item

| PPE Item | Purpose |
|---|---|
| Helmet with face shield | Protects head and face from falling objects or arc flash |
| Insulated gloves | Prevents electric current from passing through hands |
| FR clothing | Minimizes injury from heat, arc flashes, or fire |
| Safety shoes | Insulate feet and prevent current from grounding via the body |
| Safety goggles | Protect eyes from electric sparks or flying particles |
| Ear plugs | Reduce impact from loud equipment noise |

Steps to Wear PPE for Electrical Safety:

1. Inspect all PPE

– Check for damage and certification (IS/IEC marks).

2. Wear Flame Resistant (FR) Clothing

– Fully cover arms and legs; zip or button properly.

3. Put on Safety Shoes

– Ensure shoes are dry, insulated, and cover the feet completely.

4. Wear Insulated Gloves

– Check for air leaks and proper fit.

5. Wear Safety Goggles

– Fit securely over the eyes.

6. Wear Helmet with Face Shield

– Adjust helmet for a snug fit; attach face shield.

7. Insert Earplugs (if needed)

– Roll, insert, and hold until expanded.

Types of PPE in Electrical Safety

| PPE Type | Purpose / Use |
|---|---|
| Insulated Gloves | Protect hands from electric shock |
| Safety Shoes | Prevent current from passing through feet to ground |
| Helmet with Face Shield | Protect head and face from arc flash or falling objects |
| Flame-Resistant (FR) Clothing | Reduces injury during arc flash or fire exposure |
| Safety Goggles | Shield eyes from sparks and flying particles |
| Ear Plugs or Earmuffs | Protect ears in high-noise environments |
| Insulating Mats | Provide insulation underfoot while working on live panels |
| Harness (for height work) | Prevent falls during elevated electrical installations |

Result:

Students successfully learned how to identify, wear, and use PPE items. They also understood how these items play a vital role in preventing injury or death during electrical maintenance or repair.

## Experiment 2

## Electrocution (Electric Shock)

Aim:

To understand the dangers of electrocution and learn the correct method to safely rescue a person from electric shock, using video demonstration.

Theory:

Electrocution refers to injury or death caused by the passage of electric current through the human body. It usually happens when a person comes in direct or indirect contact with live electrical conductors, faulty equipment, or exposed wiring.

When the human body becomes part of the electrical circuit, the current flows through muscles, tissues, or vital organs, leading to serious damage depending on the voltage, current level, and duration of contact.

Effects of Electric Shock on the Human Body:

- Muscle Spasms: Electric current can cause involuntary muscle contractions, making it impossible for the person to let go of the live wire.
- Burns: Entry and exit points of current can lead to deep skin and tissue burns.
- Unconsciousness: Electric shock may interrupt brain function and cause fainting or coma.
- Cardiac Arrest: Current passing through the chest can stop the heart or cause irregular heartbeat (ventricular fibrillation).
- Respiratory Paralysis: If current affects the chest muscles or nervous system, breathing may stop.

**Rescue Steps (as shown in the video):**

1. Do NOT touch the victim directly.

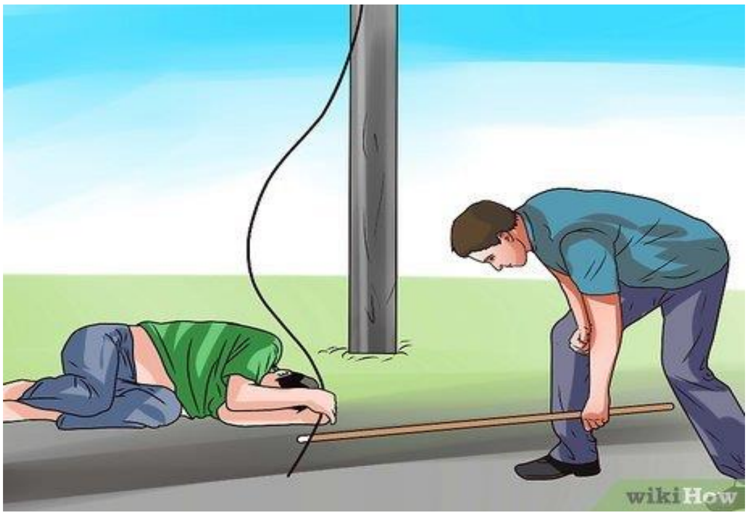
2. Immediately turn off the power from the main switch.

3. If switching off power is not possible, use a dry wooden stick or insulated object to move the wire or separate the person.

4. Call emergency number 108.

5. If the person is unconscious and not breathing, begin CPR if trained.

6. Stay with the victim until help arrives.




Result:

Students learned how to act quickly and safely during electrical accidents and understood that direct contact must be avoided at all times.

**Experiment 3**
**Pipe and Plate Earthing Methods**

Aim:

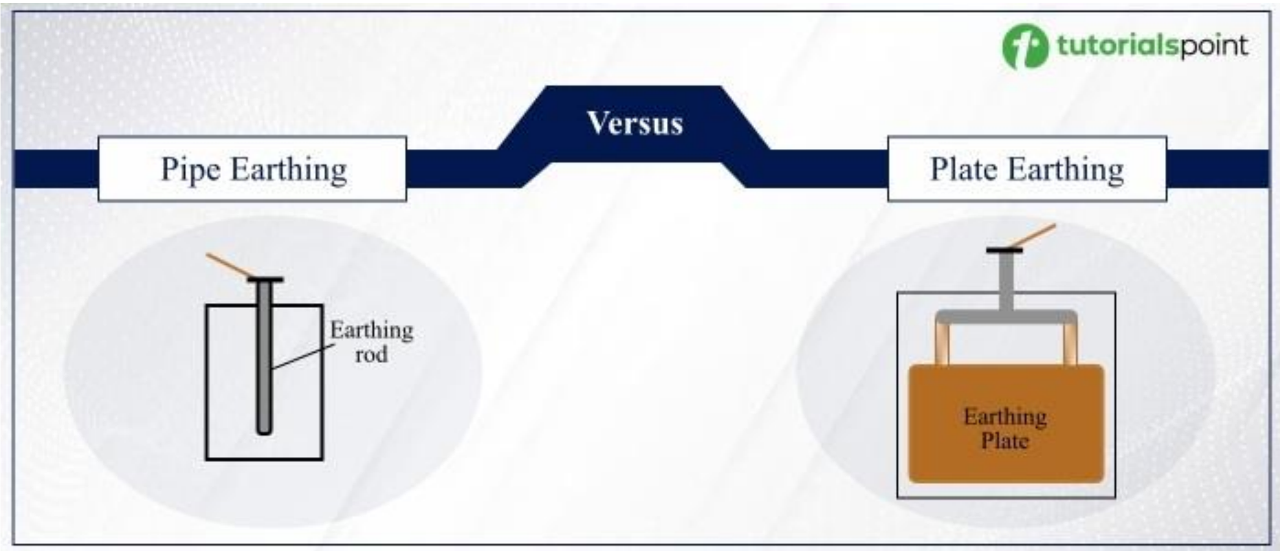
To demonstrate and understand the working and construction of pipe earthing and plate earthing systems used for electrical safety.

Theory:

Earthing is the method of connecting the non-current carrying parts of an electrical system to the earth. It ensures safety by directing fault current safely into the ground, reducing the risk of electric shock.

Types of Earthing Methods Demonstrated:

| Method | Description |
|---|---|
| Pipe Earthing | A GI pipe (38–75 mm diameter, 2–3 m long) is placed vertically into a pit with salt and charcoal for moisture retention. |
| Plate Earthing | A copper/GI plate (60 cm × 60 cm) is buried at 3 m depth with alternate layers of salt and charcoal. |




Result:

Both pipe and plate earthing setups were observed. Materials and arrangement for each type were explained.

## Experiment 4

## Electrical Lab Familiarization and Earthing Effectiveness Test

Aim:

To recognize common electrical symbols. To measure the voltage between neutral and earth to test the effectiveness of earthing.

Apparatus Used:

| Sl. No. | Name | Range | Quantity |
|---|---|---|---|
| 01 | Voltmeter | 0-20v | 01 |

Theory:

Lab familiarization helps students safely understand the working layout of power supplies, switching, and protection devices.

Symbols Identified:

| Symbol | Component |
|---|---|
| —— | Fuse |
| □ | Earth |
| S | Switch |
| 💡 | Lamp |

**Tabular Column:**

| SL. NO. | Actual Voltage | Measured voltage |
|---|---|---|
| **1** | 0-2 V | |

Procedure:

1. Set a voltmeter to AC voltage range.
2. Place one probe on the neutral terminal, and the other on the earth terminal.
3. Record the voltage reading.

Result:

Electrical supply parts and symbols were identified successfully. Neutral-to-earth voltage was found to be within safe limits.

## Experiment 5

### Identification and Observation of Different Ranges and Types of Electrical Meters

Aim:

To identify various types of electrical measuring instruments through video demonstration and understand their functions, measurement ranges, and applications in electrical circuits.

Theory:

Electrical meters are used to measure current, voltage, power, resistance, and energy in both AC and DC systems. The accuracy and range of these instruments are crucial for proper testing, maintenance, and operation of circuits.

| Sl. No. | Description | Main Features | Common Uses |
|---|---|---|---|
| 1 | MEXTECH Multimeter | - Auto/manual range- Measures AC/DC Voltage, Current, Resistance- Diode, Continuity, Transistor test | General electronics, student labs |
| 2 | Compact Slim Multimeter | - Compact size- Auto/manual range- Basic AC/DC Voltage, Resistance | Quick voltage checks, battery testing |
| 3 | Industrial DMM | - Strong build- Wide range dial- Measures V, A, Ω- Basic continuity & diode test | Field testing, industrial maintenance |
| 4 | High Accuracy DMM | - 4-digit display- Auto range- Additional functions like frequency, capacitance, temperature | Advanced electronics, lab diagnostics |
| 5 | Basic DMM with Probes | - Manual range- Voltage, Resistance, Continuity- Fused for safety | Entry-level projects, education |

| | | | |
|---|---|---|---|
| 6 | Yellow Body Multimeter | - Large selector dial- Bright display- Clear labeling for V, A, Ω- Transistor socket | Versatile lab usage, panel work |
| 7 | Compact Auto-range DMM | - Minimalist design- Simple interface- Measures V, A, Ω- Battery indicator | Portable use, quick field diagnostics |

Observations:

- Voltmeter was used across a load to measure potential difference.
- Ammeter was connected in series to measure current.
- Wattmeter showed real power when both voltage and current were present.
- Clamp meter showed current reading without breaking the circuit.
- Multimeter was versatile for all low-voltage measurements.

Result:

The video clearly demonstrated the working, connection, and usage of different meters. Students were able to visually identify meters, read values, and understand their measuring ranges.

**Experiment 6**

**Ohm's Law**

**Aim:**

To verify **Ohm's Law** by measuring current through a resistor for different applied voltages and showing that **V ∝ I**.

**Apparatus Used:**

| Sl. No. | Name | Range | Quantity |
|---|---|---|---|
| 01 | RPS | 0-30v | 01 |
| 02 | Voltmeter | 0-20v | 01 |
| 03 | Ammeter | 0-20mA | 01 |
| 04 | Resistor | known value | 01 |
| 05 | Connecting wires | - | ~10 |
| 06 | Breadboard or test board | - | 01 |

**Theory:**

**Ohm's Law** states that the current flowing through a conductor is directly proportional to the potential difference across it, provided the temperature and physical conditions remain constant.

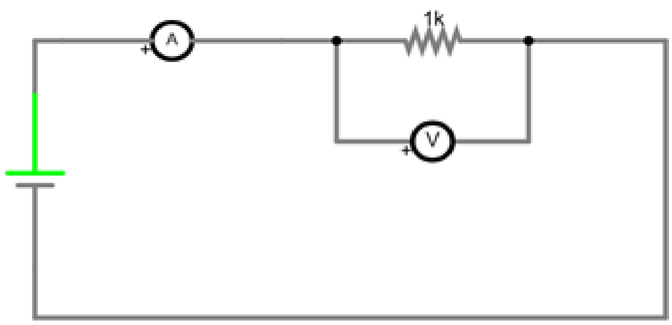
$$I = \frac{V}{R}$$

Where:

- $V$ = Voltage (Volts)
- $I$= Current (Amperes)
- $R$ = Resistance (Ohms, Ω)

According to the law, when voltage increases, current increases linearly if resistance remains constant.

**Circuit Diagram:**



**Tabular Column:**

| SL .No | Applied Voltage (V) | Voltage Across Register (V) | Voltage Across Current (mA) | Resistance (R = V/I) |
|---|---|---|---|---|
| 1 | 2 V | | | |
| 2 | 3 V | | | |
| 3 | 4 V | | | |
| 4 | 5 V | | | |
| 5 | 6 V | | | |
| 6 | 7 V | | | |

**Procedure:**

1. Connect the circuit as shown in the diagram.
2. Set the resistance value using a fixed resistor.
3. Vary the DC voltage from the power supply in steps.
4. Note the current for each voltage using the ammeter.
5. Record voltmeter and ammeter readings.

**Result:**

The calculated resistance remains constant. This **verifies Ohm's Law**.

**Experiment 7**

**Open, Closed, and Short circuit**

**Aim:**

To demonstrate and understand the behaviour of a **simple series circuit** under three conditions Open circuit, Closed circuit, Short circuit.

**Apparatus Used:**

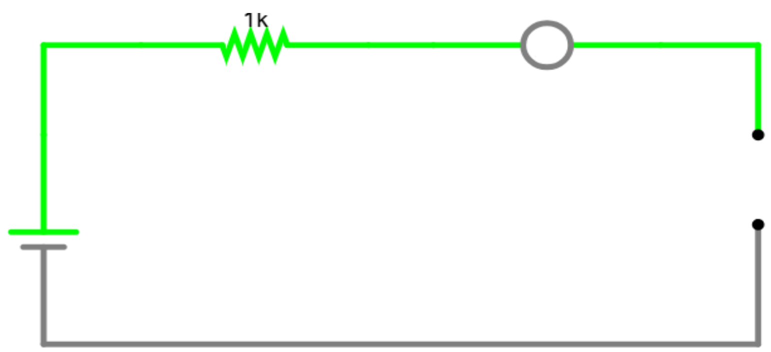
| Sl. No. | Name | Range | Quantity |
|---|---|---|---|
| 01 | RPS | 0-30v | 01 |
| 02 | LED | - | 03 |
| 04 | Resistor | 1kΩ | 03 |
| 05 | Connecting wires | - | ~10 |
| 06 | Breadboard or test board | - | 01 |

**Theory:**

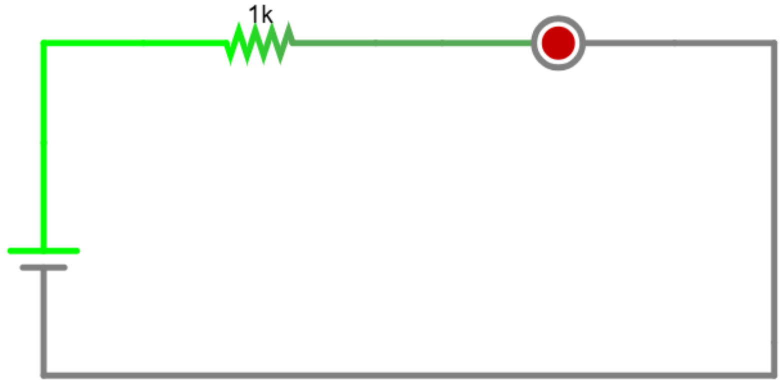
- **Open Circuit**: No current flows due to a break; the load does not operate.
- **Closed Circuit**: Continuous path; current flows and the lamp glows.
- **Short Circuit**: Load is bypassed; excessive current flows, posing safety risks.

**Circuit Diagrams:**

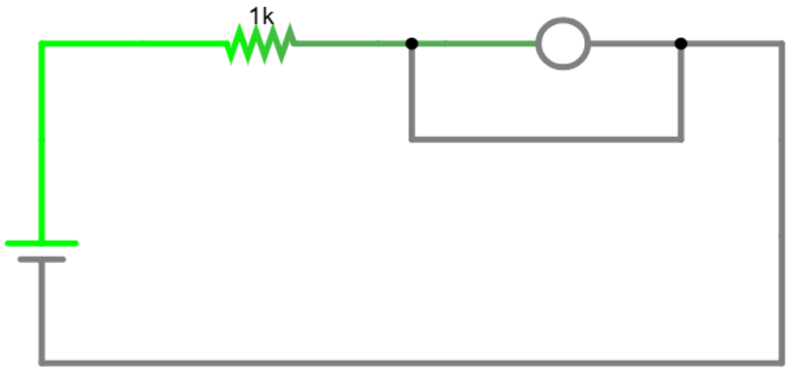
***1. Open Circuit***




**2. Closed Circuit**



### *3. Short Circuit*




**Tabular Column:**

| Condition | Circuit Complete | LED Status | Current Flow | Remarks |
|---|---|---|---|---|
| Open Circuit | No | OFF | No | Break in circuit |
| Closed Circuit | Yes | ON | Yes | Normal operation |
| Short Circuit | Yes (bypassed) | OFF | High (unsafe) | Load bypassed; risk of damage |

**Procedure:**

1. Connect the RPS to the breadboard.
2. For Open Circuit:
    a. Connect a resistor and LED in series but leave a wire disconnected.
    b. Turn ON RPS and observe.
3. For Closed Circuit:
    a. Complete the path (RPS → Resistor → LED → Ground).
    b. Turn ON RPS and observe LED glowing.
4. For Short Circuit:
    a. Bypass the resistor or LED by connecting a wire across it.
    b. Observe heating/fuse (ensure safety).
    c. Switch OFF supply after each setup and note the LED status.

**Result:**

The lamp only glows in the closed circuit condition. No current flows in an open circuit. Excessive current in a short circuit may cause fuse to blow or components to heat.

**Experiment 8**

**Equivalent resistance in a series resistive circuit**

**Aim:**

To determine the **equivalent resistance** of a **series resistive circuit**

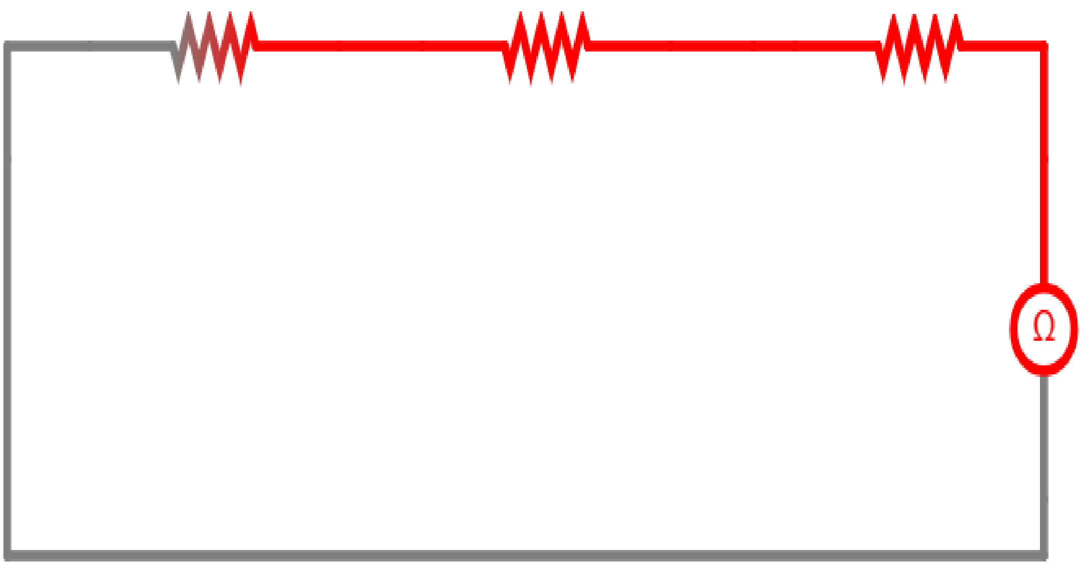
**Apparatus Used:**

| Sl. No. | Name | Range | Quantity |
|---|---|---|---|
| 01 | Resistor | Know | 03 |
| 02 | Multimeter | 0-200K Ω | 01 |
| 03 | Connecting wires | - | ~10 |
| 04 | Breadboard or test board | - | 01 |

**Theory:**

In a **series circuit**, the total or **equivalent resistance** is the sum of individual resistances: $Req=R1+R2+R3$. So for resistors 10 Ω, 20 Ω, and 30 Ω $Req=10+20+30=60\ \Omega$ Current is the same through all components, but **voltage divides** across each resistor.

**Circuit Diagram:**



**Observation Table:**

| SL. NO. | **Resistors Used** | **Req (Experimental)** | **Req (Theoretical)** |
|---|---|---|---|
| 01 | | | |
| 02 | | | |
| 03 | | | |
| 04 | | | |
| 05 | | | |

**Procedure:**

1. Connect **three resistors in series** on a breadboard (e.g., 1 kΩ each).
2. Set the **multimeter to resistance (Ω) mode**.
3. Place the **multimeter probes** at the two ends of the series connection.
4. **Read the total resistance** directly on the multimeter display.

**Result:**

The experimentally calculated equivalent resistance of the series resistive circuit matched the theoretical value.

## Experiment 9

## Equivalent resistance in a parallel resistive circuit

**Aim:**

To calculate and verify the **equivalent resistance** of a **parallel resistive circuit**.

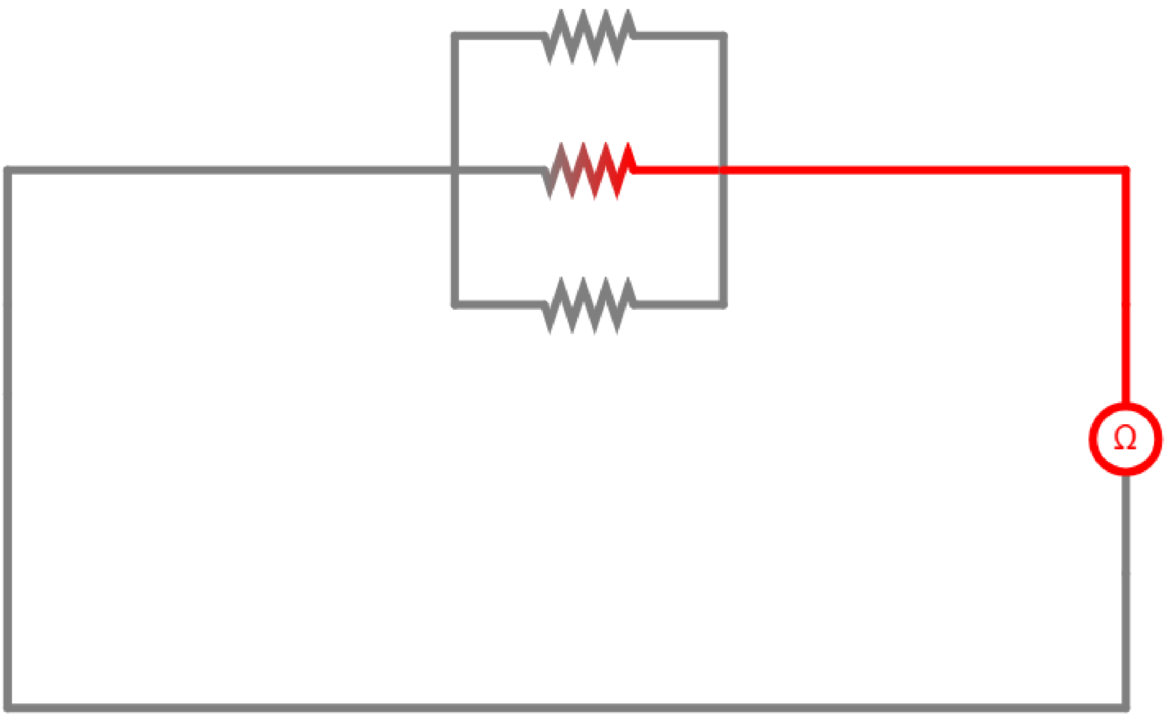
**Apparatus Used:**

| Sl. No. | Name | Range | Quantity |
|---|---|---|---|
| 01 | Resistor | Know | 03 |
| 02 | Multimeter | 0-200K Ω | 01 |
| 03 | Connecting wires | - | ~10 |
| 04 | Breadboard or test board | - | 01 |

**Theory:**

In a **parallel circuit**, the voltage across each resistor is the same, but the **current divides** among branches. The **equivalent resistance** $\frac{1}{Rt} = \frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3} + \ ... \ + \frac{1}{Rn}$

**Circuit Diagram:**



**Observation Table:**

| SL. No. | Resistors Used | Resistors (Experimental) | Resistors (Theoretical) |
|---|---|---|---|
| 01 | | | |
| 02 | | | |
| 03 | | | |
| 04 | | | |
| 05 | | | |

**Procedure:**

1. Connect **three resistors in series** on a breadboard (e.g., 1 kΩ each).
2. Set the **multimeter to resistance (Ω) mode**.
3. Place the **multimeter probes** at the two ends of the series connection.
4. **Read the total resistance** directly on the multimeter display.

**Result:**

The experimentally determined equivalent resistance was found which matches the theoretical calculation.

**Experiment 10**

**AC Voltage Using a Voltmeter**

## Aim:

To measure the **AC voltage** across a load using an **AC voltmeter**.

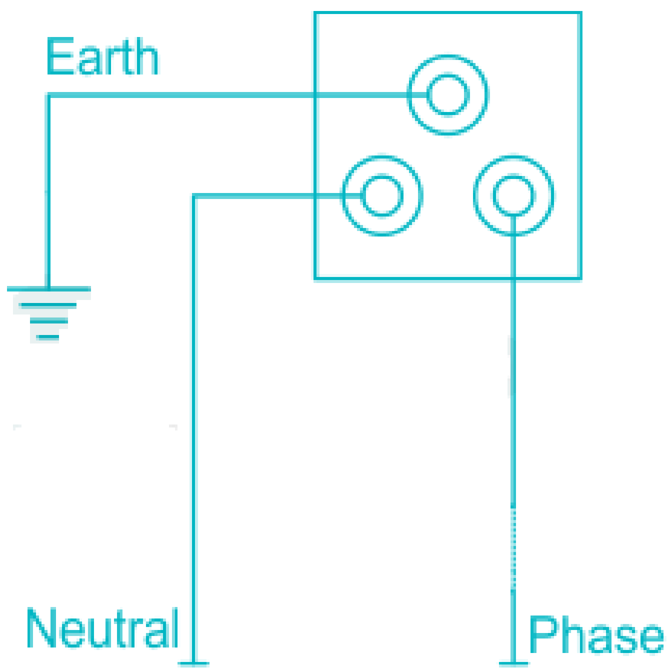
## Apparatus Used:

| Sl. No. | Name | Specification | Quantity |
|---|---|---|---|
| 01 | AC Voltmeter | 0–300 V (AC) | 01 |
| 02 | Regulated Power Supply (RPS) | 0–230 V AC | 01 |
| 03 | Load (e.g., resistor or lamp) | 100 Ω / 60 W | 01 |
| 04 | Connecting wires | – | As required |

## Theory:

An **AC voltmeter** is an instrument used to measure the **alternating voltage** in a circuit. It is always connected **in parallel** to the load so it can measure the potential difference **across** the component. AC voltages vary sinusoidally with time and are measured in **rms (root mean square)** values.

## Circuit diagram:



## Observation Table:

| S. No. | Condition | Socket voltage | Voltmeter Reading |
|---|---|---|---|
| 1 | Phase to Neutral | 230 V AC | |
| 2 | Phase to Earth | 230 V AC | |
| 03 | Neutral to Earth | <2 | |

## Procedure:

1. Set the **digital multimeter or AC voltmeter** to an appropriate **AC voltage range** (e.g., 0–250 V AC).
2. Insert the **probes directly into the live (L) and neutral (N)** terminals of the AC socket.
3. **Read the voltage** displayed on the meter (typically ~230 V in India).
4. Carefully **remove the probes** after recording the reading.
5. Switch OFF or disconnect the meter safely.

## Result:

The **AC voltage** across the load was successfully measured using a voltmeter. Readings matched the set supply voltage.

## Experiment 11

## Measurement of Amplitude, Peak-to-Peak Value, Time Period, and Frequency using CRO and Function Generator

**Aim:**

To measure **amplitude**, **peak-to-peak voltage**, **time period**, and **frequency** of an AC waveform using a **Cathode Ray Oscilloscope (CRO)** and a **Function Generator**.

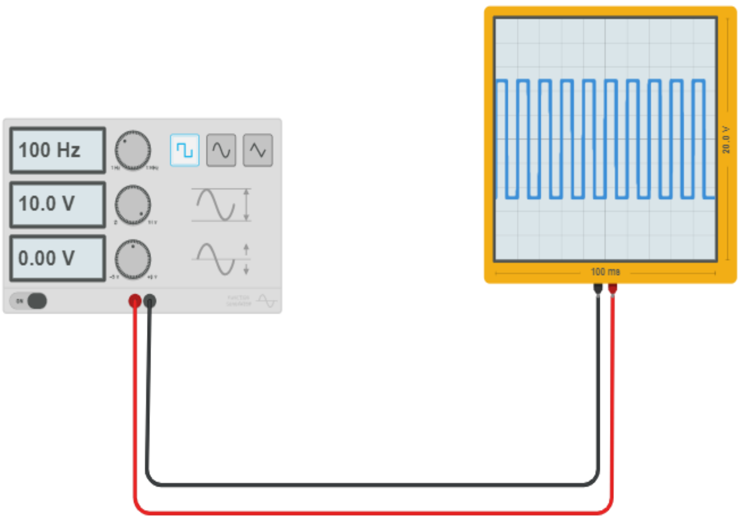
**Apparatus Used:**

| Sl. No. | Name | Range | Quantity |
|---|---|---|---|
| 01 | Cathode Ray Oscilloscope (CRO) | 0-30v | 01 |
| 02 | Function Generator | 0-3MHz | 01 |
| 03 | Connecting Probes and Leads | - | 01 |

**Theory:**

- **CRO** is an electronic display device used to observe varying signal voltages.
- **Function Generator** is used to generate electrical waveforms such as sine, square, and triangular waves.
- **Key Parameters Measured**:
  - **Amplitude (A)**: Maximum voltage from the center to the peak.
  - **Peak-to-Peak (Vpp)**: Voltage from the maximum positive to maximum negative point.
  - **Time Period (T)**: Time taken to complete one full cycle (in seconds).
  - **Frequency (f)**: Number of cycles per second (in Hz), *f=1Tf = \frac{1}{T}*

**Circuit Diagram:**



**Procedure:**

1. Connect the **output of the function generator** to the **input of the CRO (Channel 1)**.
2. Set the function generator to produce a **sine wave** (e.g., 1 kHz, 5V peak-to-peak).
3. Adjust **Time/Div** and **Volt/Div** knobs on the CRO for a clear waveform.
4. Count the number of vertical divisions between the highest and lowest points → Vpp.
   $$Vpp = No.\ of\ divisions \times Volt/Div$$
5. Measure **Amplitude (A)** = Vpp / 2
6. Count horizontal divisions for **one full cycle** → Time Period (T).
   $$T = No.\ of\ divisions \times Time/Div$$
7. Calculate frequency using f= $\frac{1}{T}$

**Observation Table:**

| Waveform | Volt/Div | Time/Div | Vpp (V) | Amplitude (V) | Time Period (ms) | Frequency (Hz) |
|---|---|---|---|---|---|---|
| Sine Wave | | | | | | |

**Result:**

The amplitude, peak-to-peak voltage, time period, and frequency were successfully measured using the CRO for the waveform generated by the function generator.

## Experiment 12

## Wire Up and PVC Conduit Wiring

### Aim:

To wire and test a **PVC conduit system** to independently control **two lamps** and **one socket** using appropriate protective devices like **MCB** and **fuse**.

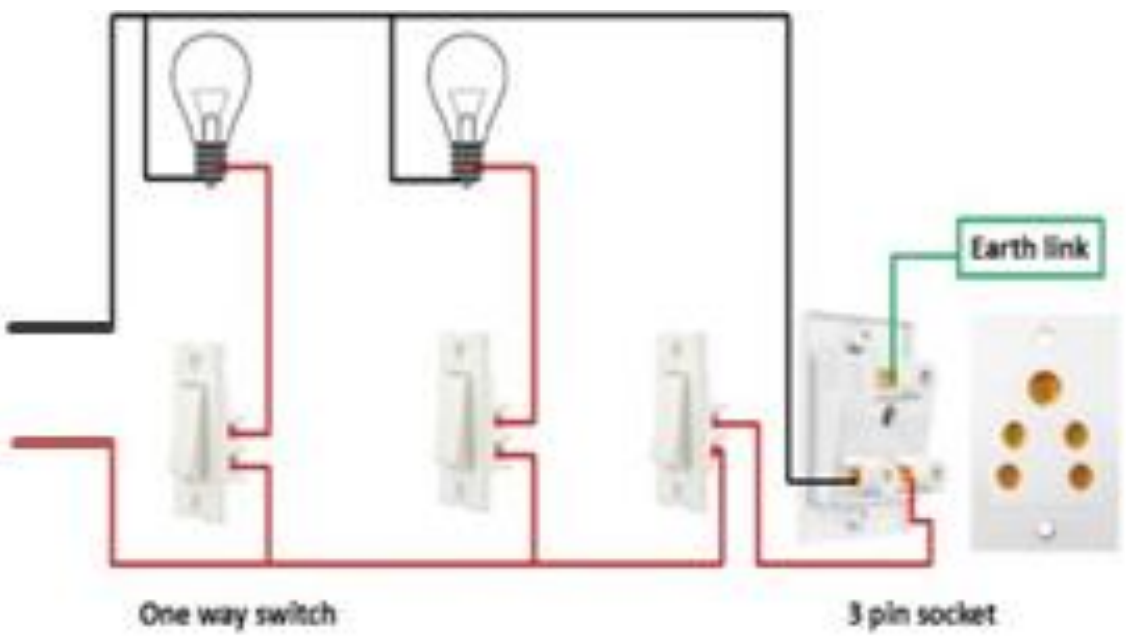
### Apparatus Used:

| Sl. No. | Name | Specification | Quantity |
|---|---|---|---|
| 01 | PVC Conduit pipe | 20 mm dia | As required |
| 02 | Switches | 6 A | 03 |
| 03 | Lamps | 230 V, 60 W | 02 |
| 04 | Socket | 6 A, 3-pin | 01 |
| 05 | MCB | 6 A single pole | 01 |
| 06 | Fuse | 6 A | 01 |
| 07 | Junction box, board | – | As required |
| 08 | Wires (Red, Black, Green) | 1 sq.mm | As required |

### Theory:

- **PVC conduit wiring** is a surface or concealed wiring system that routes wires through plastic pipes.
- The **lamps and socket** are wired **in parallel**, allowing them to be operated independently.
- **MCB** and **fuse** are used as **protective devices** to prevent overcurrent faults.

### Wiring Diagram:



## Procedure:

1. Fix the **PVC conduit, switchboard, and junction box** on a wiring board.
2. Connect **live wire from supply to MCB**, then distribute:
   - Through **Switch 1 → Lamp 1**
   - Through **Switch 2 → Lamp 2**
   - Through **Switch 3 → Socket**
3. Connect **neutral wires** from all loads to the neutral bar.
4. Connect **earth wire** from socket and metallic parts to earth terminal.
5. Fix lamps and a socket in their respective holders.
6. Ensure all terminations are tight and properly insulated.
7. **Switch ON** the supply and test:
   - Each lamp glows when its switch is ON.
   - Socket provides power when Switch 3 is ON.

## Result:

The PVC conduit wiring system was successfully completed. Each **lamp and socket operated independently**, and protection was ensured using MCB and fuse.

**Experiment 13**

**Wire up and Test Two-Way (Staircase) Wiring**

**Aim:**

To wire and test a **two-way switching (staircase wiring)** system to control a **single lamp** from **two different locations**.

**Apparatus Used:**

| Sl. No. | Name | Range | Quantity |
|---|---|---|---|
| 01 | 2 Two-way switches | 0-30v | 01 |
| 02 | 1 Lamp (230 V, 60 W) | Know | 03 |
| 03 | Switchboard | 0-200K Ω | 01 |
| 04 | PVC wires | - | ~10 |
| 05 | Lamp holder | - | 01 |
| 06 | Tester and screwdriver | | |

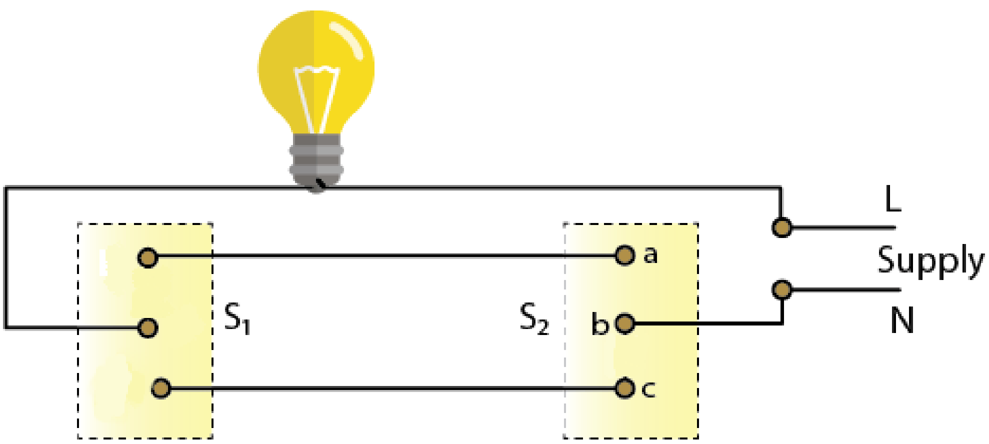
**Theory:**

**Two-way wiring** is commonly used in staircases, long hallways, and large rooms where a lamp needs to be controlled from **two locations**. It uses two **two-way switches** which can either connect or break the circuit depending on their positions.

***Working Logic:***

- The switches can change the **path of current flow**.
- If both switches are in the **same position**, the circuit is **closed**, and the lamp **glows**.
- If the switches are in **opposite positions**, the circuit is **open**, and the lamp is **OFF**.

**Circuit Diagram:**



**Procedure:**

1. Mount two-way switches and a lamp holder on the board.
2. Connect the **phase line** to the **common terminal** of **Switch 1**.
3. Connect **two traveler wires** between Switch 1 and Switch 2.
4. Connect the **common terminal of Switch 2** to one terminal of the **lamp**.
5. Connect the other lamp terminal to **neutral**.
6. Switch **ON** the supply and test lamp behavior by toggling both switches in all combinations.

**Observation Table:**

| SL. NO. | Switch 1 Position | Switch 2 Position | Lamp Status |
|---|---|---|---|
| 01 | UP | UP | ON |
| 02 | UP | DOWN | OFF |
| 03 | DOWN | UP | OFF |
| 04 | DOWN | DOWN | ON |

**Result:**

The lamp was successfully controlled from two different locations using two-way switches, confirming the staircase wiring operation.

**Experiment 14**

**Electromagnetic Relay**

**Aim:**

To **control a lamp** using an **electromagnetic relay** as a switching device with a low-voltage control circuit.

**Apparatus Used:**

| Sl. No. | Name | Range | Quantity |
|---|---|---|---|
| 01 | Electromagnetic relay | 15V DC | 01 |
| 02 | Lamp | 230V, 60W | 03 |
| 03 | RPS | 0-30V | 01 |
| 04 | Wire | - | ~10 |
| 05 | Breadboard or test board | - | 01 |

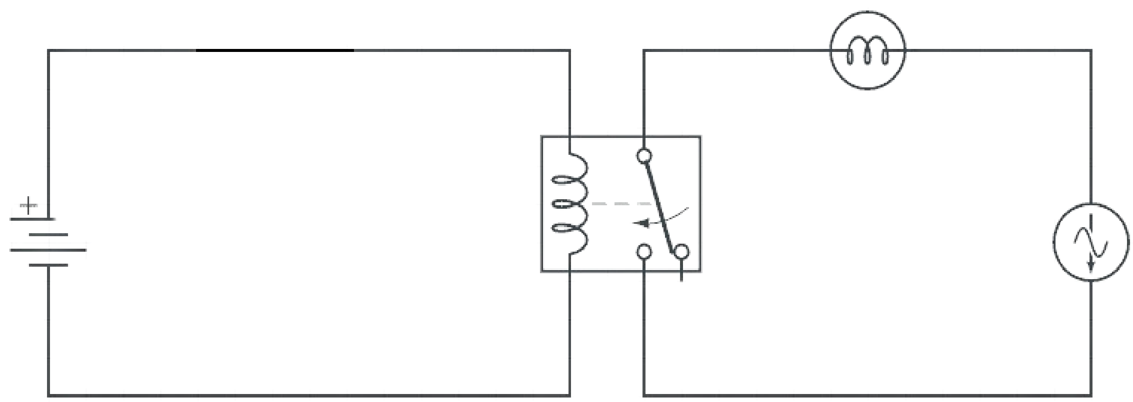
**Theory:**

A **relay** is an electromagnetic switch used to control high-voltage AC loads (like lamps) using a low-voltage DC circuit. It consists of:

- **Coil** (low voltage, triggers switching)
- **Common (COM)** terminal
- **Normally Open (NO)** contact
- **Normally Closed (NC)** contact

When DC voltage is applied to the coil, it **magnetizes** the relay and **shifts the contact**, allowing **AC to pass through NO** and power the lamp.

**Circuit Diagram:**



**Procedure:**

1. Connect the **relay coil** to a 15V DC circuit using a **RPS**.
2. Connect a **diode** across the relay coil to prevent back EMF.
3. Connect the **lamp in series with the relay's NO and COM terminals**, and supply 230V AC.
4. When the **push button** is pressed or control signal is applied, the **transistor conducts**, energizing the relay.
5. The relay **closes the NO contact**, turning **ON** the lamp.
6. Releasing the button **de-energizes** the relay, and the lamp turns **OFF**.

**Observation Table:**

| Sl. No | Control Signal (DC) | Relay Status | Lamp Status (AC side) |
|---|---|---|---|
| 01 | Not Pressed / LOW | | |
| 02 | Pressed / HIGH | | |

**Result:**

The lamp was successfully controlled using an **electromagnetic relay**, demonstrating the isolation and switching of a high-voltage circuit by a low-voltage control circuit.

**Experiment 15**

**Transformation Ratio of a Transformer**

## Aim:

To determine the **transformation ratio** (turns ratio) of a transformer by measuring the voltages on the primary and secondary windings.

## Apparatus Used:

| Sl. No. | Name | Specification | Quantity |
|---|---|---|---|
| 01 | Step-down transformer | 230 V/12 V | 01 |
| 02 | Connecting wires | – | As required |
| 03 | AC Voltmeter | 0–230 V adjustable | 01 |

## Theory:

The **transformation ratio (k)** of a transformer is the ratio of the secondary voltage ($V_2$) to the primary voltage ($V_1$):

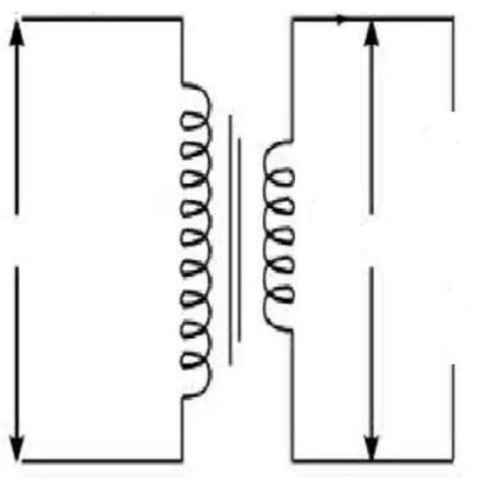
k=V2V1=N2N1k = \frac{V_2}{V_1} = \frac{N_2}{N_1}

Where:

- V1V_1: Primary voltage
- V2V_2: Secondary voltage
- N1N_1: Primary turns
- N2N_2: Secondary turns

A **step-down transformer** reduces voltage, while a **step-up transformer** increases it.

**Circuit diagram:**



## Observation Table:

| S. No. | Primary Voltage ($V_1$) | Secondary Voltage ($V_2$) | Ratio ($V_2$ / $V_1$) |
|---|---|---|---|
| 1 | | | 0.12 |
| 2 | | | 0.12 |

## Procedure:

1. Connect the primary side of the transformer to the **AC supply** (via Variac if variable input is required).
2. Connect **voltmeters** across both primary and secondary windings.
3. Set the input voltage (e.g., 100 V) and observe both voltmeter readings.
4. Record primary voltage V1V_1 and secondary voltage V2V_2.
5. Calculate the transformation ratio using:

   k=V2V1k = \frac{V_2}{V_1}

## Result:

The experimentally determined transformation ratio kk was found to be approximately **0.12**, confirming that the transformer is a **step-down** type (e.g., 230 V / 24 V transformer).

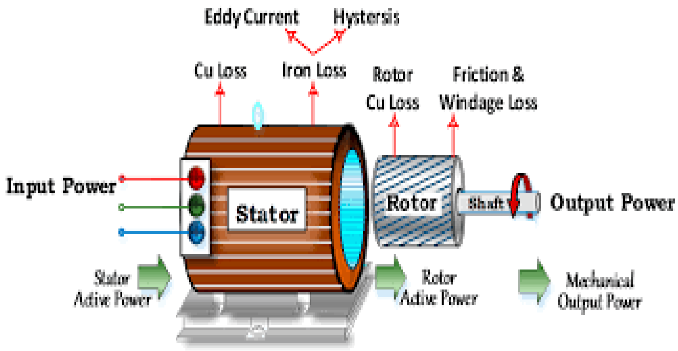
## Experiment 16

## Construction of a Three-Phase Induction Motor

**Aim:**

To understand the **internal construction** and **components** of a **three-phase induction motor** through video demonstration.

**Theory:**




A **three-phase induction motor** is the most commonly used AC motor in industries due to its **ruggedness**, **low cost**, and **self-starting** feature. It works on the principle of **electromagnetic induction**.

**Main Components Explained in the Video:**

| Component | Description |
|---|---|
| Stator | The stationary part of the motor. Contains 3-phase windings placed in slots of a laminated iron core. Connected to the power supply. |
| Rotor | The rotating part. Two types: Squirrel cage rotor (most common) Wound rotor (with external resistance control) |
| Air Gap | Small uniform gap between stator and rotor. Allows magnetic flux to pass. |
| Shaft | Transfers mechanical energy to the load. Connected to the rotor. |
| Bearings | Support the rotating shaft. Reduce friction. |
| End Shields | Enclose the motor and hold the bearings. |
| Cooling Fan | Mounted on shaft to cool motor during operation. |
| Terminal Box | Houses terminals to connect motor to external supply. |

**Result:**

The internal construction and functioning of a three-phase induction motor were understood through video demonstration, covering all major components and their roles.

**Experiment 17**

**Single Phase AC Motor**

**Aim:**

To wire and test a **starter circuit** to safely start and stop a **single-phase or three-phase AC motor** using suitable protective and switching devices.

**Apparatus Used:**

| Sl. No. | Name | Range | Quantity |
|---|---|---|---|
| 01 | AC motor (1-phase) | 0-30v | 01 |
| 02 | Manual starter | Know | 03 |
| 03 | Connecting wires and tools | 0-200K Ω | 01 |
| 04 | Supply (230V for 1-phase) | - | ~10 |

**Theory:**

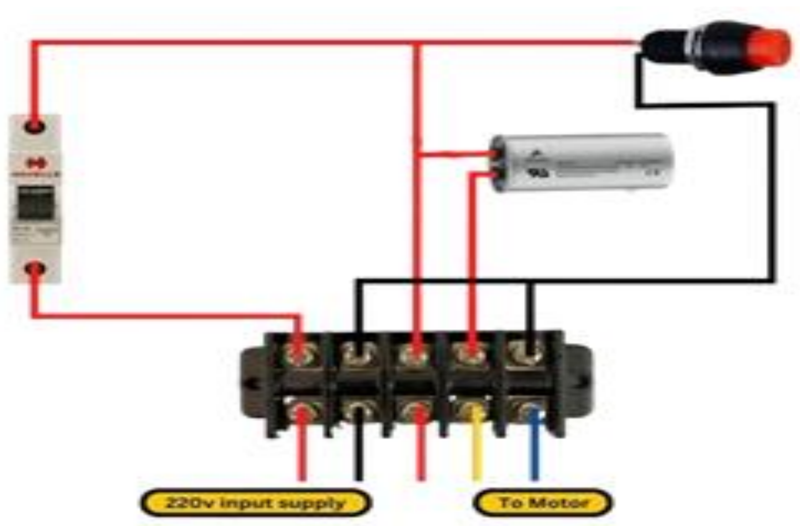
Starting an AC motor directly on supply can cause **high inrush current**, leading to **voltage dips** and possible **damage**. A **starter** ensures:

- Safe start and stop
- Overload protection
- Reduction in initial current surge (for large motors)

***Common Starters:***

- **1-Phase Motor**: Manual starter with ON/OFF switch, thermal overload

**Circuit Diagram:**



**Procedure:**

1. Connect the **starter terminals** to the **supply lines** (R, Y, B for 3-phase).
2. Connect the **output of the starter** to the motor terminals (U, V, W).
3. Connect the **ON (NO)** and **OFF (NC)** push buttons to the control circuit.
4. Ensure proper **earth connection** and **tight connections**.
5. Switch ON supply, press **START** → motor runs.
6. Press **STOP** → motor stops.

**Observation Table:**

| SL. NO. | Action | Motor Status | Indication |
|---|---|---|---|
| 01 | Press START | | |
| 02 | Press STOP | | |

**Result:**

The AC motor was successfully started and stopped using a starter. Protective features like overload trip were demonstrated.

**Experiment 18**
**Light an LED**

## Aim:

To construct a simple battery using primary cells and use it to power an LED through a current-limiting resistor.

## Apparatus Used:

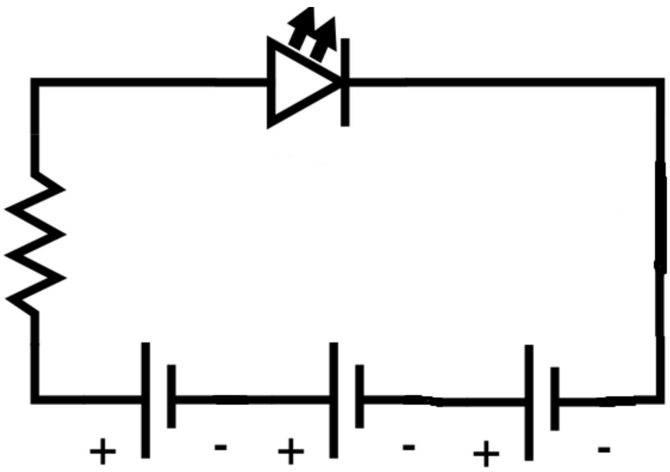
| Sl. No. | Name | Specification | Quantity |
|---|---|---|---|
| 01 | Primary Cells | 1.5 V (AA or dry cells) | 2 or 3 |
| 02 | LED | 2 V forward voltage | 01 |
| 03 | Resistor | 220 Ω – 470 Ω | 01 |
| 04 | Battery holder / clips | For series connection | 01 |
| 05 | Breadboard/Test board | – | 01 |
| 06 | Connecting wires | – | As required |

## Theory:

- A **primary cell** is a non-rechargeable source of DC voltage (e.g., dry cell).
- An **LED** requires a **forward voltage** of ~2 V and a **current-limiting resistor** to avoid damage.
- Connecting **cells in series** adds their voltages:

$$V_{total}=V1+V2+V3$$

## Circuit Diagram:




## Procedure:

1. Connect **two or three 1.5 V cells in series** to get ~3–4.5 V total.
2. Connect the **positive terminal of the battery to one end of the resistor**.
3. Connect the **other end of the resistor to the anode (+) of the LED**.
4. Connect the **cathode (–) of the LED to the negative terminal** of the battery.
5. Observe the **LED glow** when the circuit is completed.

**Observation Table:**

| SL. NO. | No. of Cell | Total voltage | Led status |
|---|---|---|---|
| 01 | | | |

Result:

A simple battery made of primary cells was successfully used to light an LED through a resistor. The circuit demonstrated the use of DC voltage sources in practical applications.

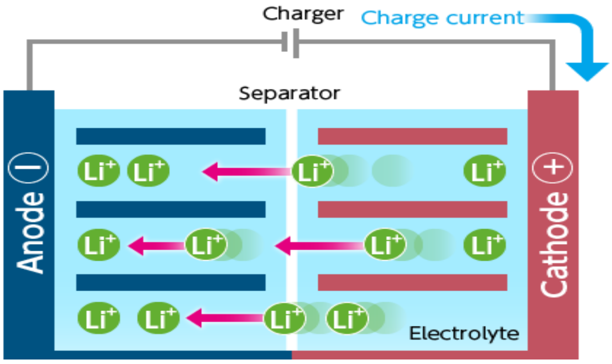
**Experiment 19**
**Lithium-Ion Battery**

**Aim:**

To understand the **internal construction**, **materials**, and **working principle** of a **Lithium-Ion (Li-ion) battery** through video demonstration.

**Theory:**

A **lithium-ion battery** is a **rechargeable energy storage device** widely used in mobile phones, laptops, electric vehicles, and solar systems. It provides **high energy density**, **lightweight design**, and **low self-discharge**.




**Construction Components:**

| Component | Description |
|---|---|
| Anode (–) | Made of graphite. Stores lithium ions during charging. |
| Cathode (+) | Made of lithium metal oxide (like $LiCoO_2$, $LiFePO_4$). Releases lithium ions. |
| Electrolyte | Lithium salt (e.g., $LiPF_6$) dissolved in organic solvent. Facilitates ion flow. |
| Separator | A porous membrane that prevents short circuit by keeping electrodes apart. |
| Current Collectors | Thin copper foil (anode) and aluminum foil (cathode) for current flow. |
| Battery Case | Encloses all parts in a compact, sealed cylinder or pouch. |

**Working Principle:**

- **Charging**: Lithium ions move from **cathode → anode**, electrons flow through external circuit.
- **Discharging**: Ions return **anode → cathode**, generating usable current.

**Result:**

The construction and working of a lithium-ion battery were clearly understood through video. Key materials and their roles in energy storage were identified.

## Experiment 20

## Condition of a Lithium-Ion Battery

**Aim:**

To **test the health and performance** of a **lead-acid** or **lithium-ion battery** using standard battery testing methods.

**Apparatus Used:**

| Sl. No. | Name | Range | Quantity |
|---|---|---|---|
| 01 | Battery under test | 6 - 12V | 01 |
| 02 | Digital Multimeter | 0-30 V | 01 |
| 03 | RPS | 0-30 V | 01 |

**Theory:**

Battery testing helps determine whether a battery is:

- Fully charged
- Partially discharged
- Needs replacement

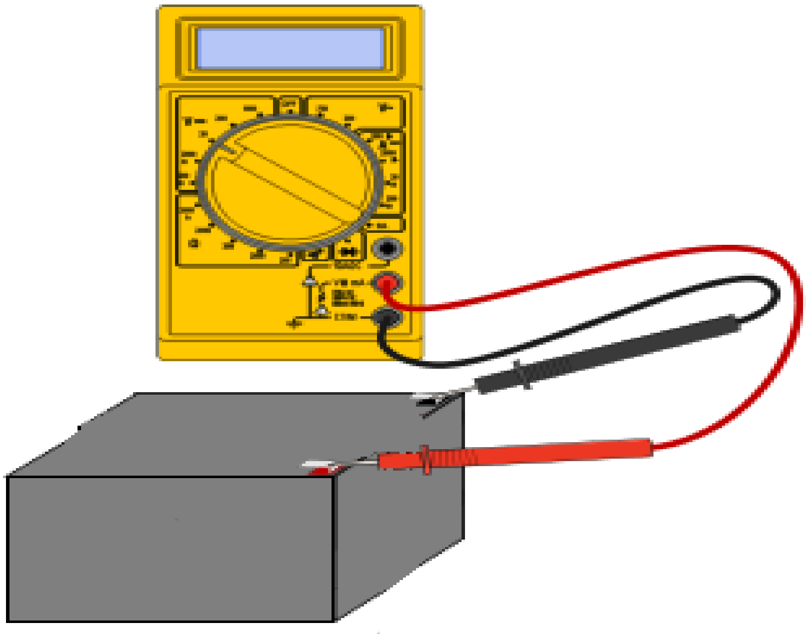
***For Lead-Acid Batteries:***

- Uses **electrolyte ($H_2SO_4$)**
- Voltage per cell ≈ 2V
- 12V battery → 6 cells
- **Fully charged**: 12.6V to 13.2V
- **Discharged**: below 11.8V

***For Lithium-Ion Batteries:***

- Common voltages: 3.7V, 7.4V, 11.1V
- Fully charged cell ≈ 4.2V
- Needs **Battery Management System (BMS)** for protection
- Voltage <3.0V → deep discharge

**Circuit diagram**



**Procedure:**

1. **Visual Inspection**:
    a. Check for bulging, leakage, corrosion at terminals.
2. **Open Circuit Voltage (OCV)** Test:
    a. Use multimeter to measure terminal voltage.
3. Recharge battery and retest to confirm recovery or failure.

**Observation Table:**

| Battery Type | Rated Voltage | Measured Voltage | Load Test Result | Condition |
|---|---|---|---|---|
| Lithium-Ion | | | | |

**Result:**

The battery's voltage and load performance were tested. Based on the readings, its **state of charge and usability** were assessed.

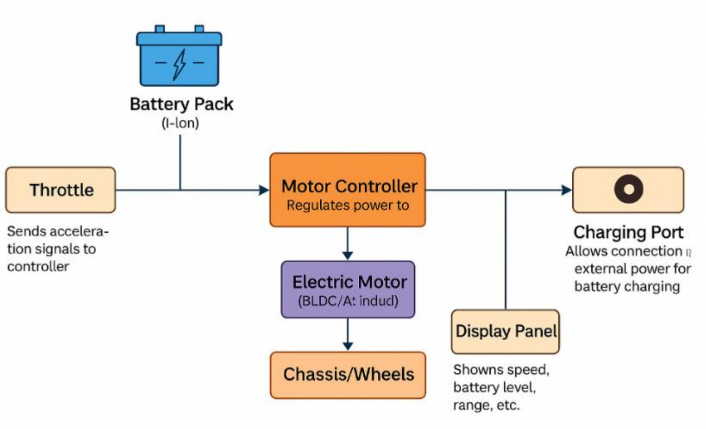
**Experiment 21**
**Simple Electric Vehicle (EV)**

**Aim:**

To understand the **working principle**, **key components**, and **energy flow** in a **simple electric vehicle** through video demonstration.

**Theory:**

An **Electric Vehicle (EV)** is powered by an electric motor instead of a conventional internal combustion engine. The motor runs using energy stored in **rechargeable batteries**. EVs are eco-friendly, efficient, and reduce dependence on fossil fuels.




**Major Components Explained in the Video:**

| Component | Function |
|---|---|
| **Battery Pack** | Stores DC electrical energy (typically Li-ion batteries) |
| **Motor Controller** | Regulates power from the battery to the motor |
| **Electric Motor (BLDC/AC Induction)** | Converts electrical energy into mechanical rotation |
| **Throttle** | Sends acceleration signals to the controller |
| **Chassis/Wheels** | Transfers torque to the wheels |
| **Charging Port** | Allows connection to external power for battery charging |
| **Display Panel** | Shows speed, battery level, range, etc. |

**Working Principle:**

1. Battery supplies **DC power** to the motor controller.
2. The **controller** regulates the power based on **throttle input**.
3. The **electric motor** receives power and rotates the wheels.
4. Regenerative braking (if available) sends energy back to the battery while braking.

**Result:**

The video demonstration helped visualize the functioning of a simple electric vehicle, highlighting component interconnections and energy flow.

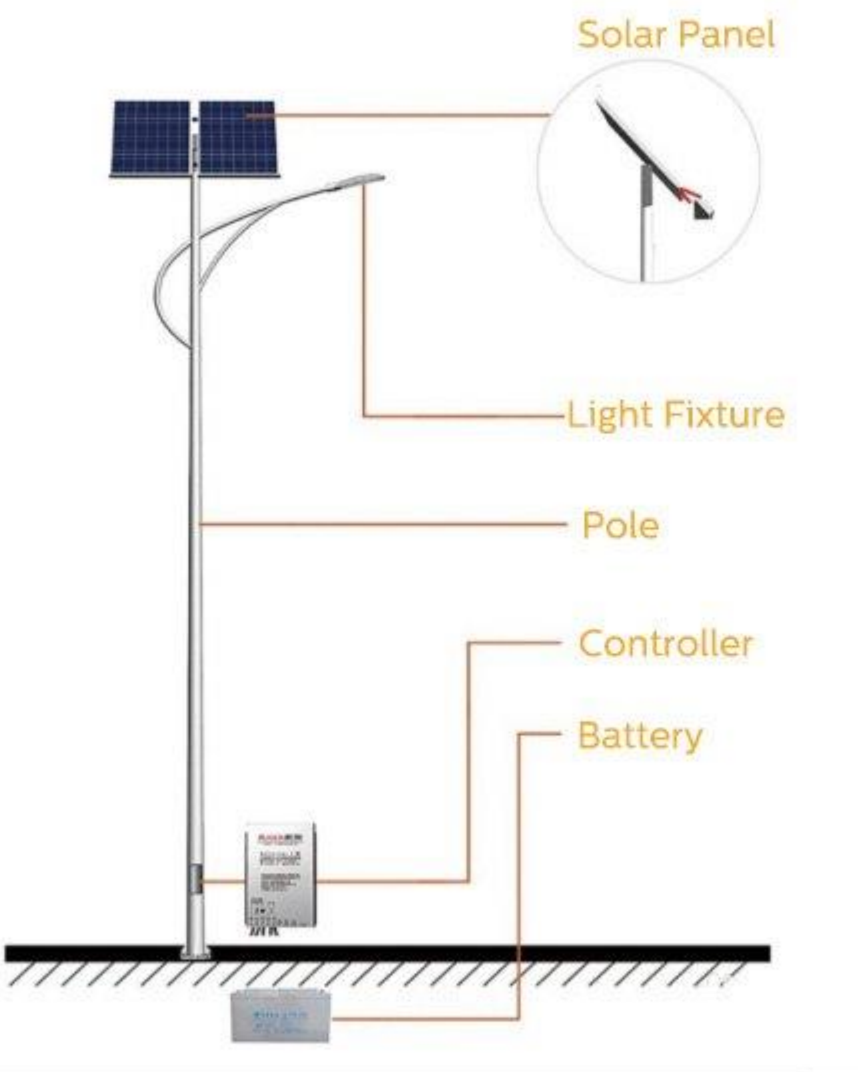
**Experiment 22**
**Solar-Powered Street Lighting System**

**Aim:**

To understand the **construction**, **working**, and **components** of a **solar-powered street lighting system** through a video demonstration.

**Theory:**

A **solar-powered street lighting system** uses **solar energy** to power **LED lamps** during nighttime. It is an eco-friendly, cost-effective, and sustainable solution, especially in remote areas without grid access.



**Main Components Explained**

| Component | Function |
|---|---|
| **Solar Panel** | Converts sunlight into DC electrical energy during the day |
| **Charge Controller** | Regulates voltage/current from the solar panel and protects the battery |
| **Battery** | Stores the solar energy for nighttime use (typically 12V or 24V) |
| **LED Street Light** | Efficient light source with low power consumption and high brightness |
| **Pole and Housing** | Mounts solar panel and LED lamp; protects from environment |
| **Sensors (Optional)** | Automatically turns ON/OFF lights based on daylight or motion |

**Working:**

1. During daytime, **solar panels** absorb sunlight and convert it into electricity.
2. This power is stored in a **rechargeable battery** via a **charge controller**.
3. At night, the **charge controller** detects darkness and powers the **LED lamp** from the battery.
4. In some systems, **motion sensors** increase brightness when movement is detected to save energy.
5. The lamp automatically turns OFF at sunrise.

**Result:**

The video clearly demonstrated how solar energy is harvested and used to power street lights, showcasing real components and operation steps.

## Experiment 23

## Resistance, Inductance, and Capacitance Using LCR Meter

**Aim:**

To use an **LCR meter** to measure the values of unknown **resistors (R)**, **inductors (L)**, and **capacitors (C)**.

**Apparatus Used:**

| Sl. No. | Name | Range | Quantity |
|---|---|---|---|
| 01 | Digital LCR meter | 0-30v | 01 |
| 02 | Resistor | Different value | 01 |
| 03 | Inductor | Different value | 01 |
| 04 | Capacitor | Different value | 01 |
| 05 | Connecting probes or clips | - | 02 |

**Theory:**

An **LCR meter** is an electronic test instrument used to **measure passive components**:

- **L** = Inductance (measured in Henry, H)
- **C** = Capacitance (measured in Farads, F)
- **R** = Resistance (measured in Ohms, Ω)

LCR meters use **AC signals** at various frequencies to determine the impedance of the component and calculate the required value.

**Circuit diagram**



**Procedure:**

1. **Switch ON** the LCR meter and allow it to auto-calibrate.
2. Set the meter to **AUTO** or manually select **R, L, or C** mode.
3. **Connect the component** to the test terminals using clips or test leads.
4. **Read the value** displayed on the screen along with unit (Ω, μH, μF).
5. Repeat for a **resistor**, **inductor**, and **capacitor** respectively.
6. Record values and compare with expected ratings (if labeled).

**Observation Table:**

| **Component Type** | **Expected Value** | **Measured Value (LCR meter)** | **Unit** | **Mode Used** |
|---|---|---|---|---|
| Resistor | | | Ohm (Ω) | R Mode |
| Inductor | | | mH | L Mode |
| Capacitor | | | μF | C Mode |

**Result:**

The resistance, inductance, and capacitance of the given components were successfully measured using an LCR meter.

**Experiment 24**
**Resistor Using Color Coding**

## Aim:

To identify the resistance value of a carbon resistor using the color code method.

## Apparatus Used:

| Sl. No. | Name | Specification | Quantity |
|---|---|---|---|
| 01 | Resistor | Color-coded (4-band or 5-band) | 01 |
| 02 | Multimeter | Digital/Analog | 01 |

## Theory:

Resistors are marked with **colored bands** that indicate their **resistance value** and **tolerance**. The **4-band resistor** code includes:

| Band | Represents |
|---|---|
| $1^{st}$ | First digit |
| $2^{nd}$ | Second digit |
| $3^{rd}$ | Multiplier ($\times 10^n$) |
| $4^{th}$ | Tolerance (%) |

**Color Code Table**:

| Color | Digit | Multiplier (Ω) | Tolerance (%) |
|---|---|---|---|
| Black | 0 | $\times 10^0$ | – |
| Brown | 1 | $\times 10^1$ | ±1% |
| Red | 2 | $\times 10^2$ | ±2% |
| Orange | 3 | $\times 10^3$ | – |
| Yellow | 4 | $\times 10^4$ | – |
| Green | 5 | $\times 10^5$ | ±0.5% |
| Blue | 6 | $\times 10^6$ | ±0.25% |
| Violet | 7 | $\times 10^7$ | ±0.1% |
| Gray | 8 | $\times 10^8$ | ±0.05% |
| White | 9 | $\times 10^9$ | – |
| Gold | – | $\times 10^{-1}$ | ±5% |
| Silver | – | $\times 10^{-2}$ | ±10% |

**Observation Table:**

| Component Type | Expected Value | Measured Value (LCR meter) | Unit | Mode Used |
|---|---|---|---|---|
| Resistor | | | Ohm (Ω) | R Mode |
| Inductor | | | mH | L Mode |
| Capacitor | | | µF | C Mode |

## Procedure:

1. **Note the colors** of the bands on the resistor (left to right).
2. Use the **first two bands** as digits, third as **multiplier**, and fourth as **tolerance**.
3. Apply the formula:

   Value=(A×10+B)×10C Ω

4. Cross-verify using a **multimeter** in resistance mode.

## Result:

The resistor value was calculated using the color code method and verified using a multimeter. The value matched within the tolerance limit.

**Experiment 25**
**Diode**

**Aim:**

To identify the **anode** and **cathode** terminals of a diode using **visual inspection** and **multimeter testing**.

**Apparatus Used:**

| Sl. No. | Name | Range | Quantity |
|---|---|---|---|
| 01 | PN Junction Diode | 1N4007 | 01 |
| 02 | Digital Multimeter | Diode mode | 01 |
| 03 | Connecting wires or probes | - | 03 |

**Theory:**

A **diode** is a semiconductor device that allows current to flow only in **one direction** — from **anode (+)** to **cathode (–)**. Identifying the terminals is important for correct circuit connections.

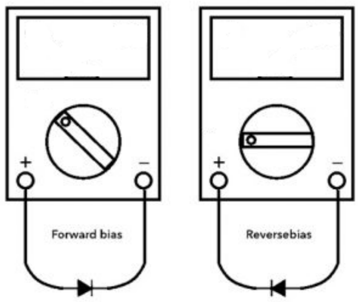
◆ ***Visual Identification:***

- The **cathode terminal** is marked with a **silver or white band**.
- The **anode terminal** is the opposite end.

◆ ***Using Multimeter (Diode Mode):***

- In **diode mode**, multimeter applies a small voltage across the probes.
- When **red probe on anode** and **black on cathode**, it shows a **forward voltage drop** (≈0.6–0.7V for silicon diode).
- If reversed, it shows **OL (over-limit)** or **no reading**, indicating reverse bias.

Circuit diagram



**Observation Table:**

| Multimeter Probe Position | Reading (V) | Terminal Identified |
|---|---|---|
| Red → Terminal A, Black → B | 0.65 V | A = Anode, B = Cathode |
| Red → B, Black → A | OL (∞) | Reverse-biased |

**Procedure:**

1. Set the multimeter to **Diode Test Mode (🔔)**.
2. Connect the **red probe** to one terminal and the **black probe** to the other.
3. If reading is between **0.6V–0.7V**, the red probe is on the **anode**, and the black on the **cathode**.
4. Reverse the probes to verify that the display shows **OL**.
5. Confirm visual identification with the **band marking** on the diode.

**Result:**

The **anode and cathode terminals** of the diode were correctly identified using both **visual marking** and **multimeter diode test**.

**Experiment 26**

**Diode's Forward and Reverse Bias**

**Aim:**

To connect a diode in both **forward** and **reverse bias** configurations and observe its effect on the **LED status**.

**Apparatus Used:**

| Sl. No. | Name | Range | Quantity |
|---|---|---|---|
| 01 | PN Junction Diode | 1N4007 | 01 |
| 02 | LED | Any color | 01 |
| 03 | DC Power Supply | 0-300V | 01 |
| 04 | Series resistor | (330 Ω ,1 kΩ) | 01 |
| 05 | Breadboard and connecting wires | - | ~10 |

**Theory:**

A **diode** is a **unidirectional device** that conducts current only in **forward bias**:

- **Forward Bias**: Anode is connected to **positive**, cathode to **negative**. Diode conducts.
- **Reverse Bias**: Anode is connected to **negative**, cathode to **positive**. Diode blocks current.

An **LED (Light Emitting Diode)** lights up only when sufficient **forward current** flows through it.

**Circuit Diagrams:**

***Forward Bias:***

◆ ***Reverse Bias:***

**Observation Table:**

| Bias Type | LED Status | Explanation |
|---|---|---|
| Forward Bias | | Diode conducts → current flows through LED |
| Reverse Bias | | Diode blocks → no current → LED off |

**Procedure:**

1. Connect the diode in **forward bias** with a **series resistor** and an LED in the circuit.
2. Power the circuit using **DC supply** or a 9V battery.
3. Observe the LED – it should **glow** in forward bias.
4. Reverse the diode (reverse bias).
5. Observe the LED – it should **remain OFF**.
6. Measure current using a multimeter (optional) to confirm conduction/blocking.

**Result:**

The diode conducted in forward bias allowing the LED to glow, while it blocked current in reverse bias, keeping the LED off. This confirms the **unidirectional property** of diodes.

**Experiment 27**

**IC Bridge Rectifier**

**Aim:**

To observe and trace the **input (AC)** and **output (DC)** waveforms of an **IC bridge rectifier** using a **CRO (Cathode Ray Oscilloscope)**.

**Apparatus Used:**

| Sl. No. | Name | Range | Quantity |
|---|---|---|---|
| 01 | IC Bridge Rectifier Module | IC 4-diode module | 01 |
| 02 | Step-down Transformer | (230V to 12V AC) | 01 |
| 03 | Load resistor | 1K Ω | 01 |
| 04 | Cathode Ray Oscilloscope (CRO) | 0-30MHz | 01 |
| 05 | Connecting wires and probes | - | ~10 |

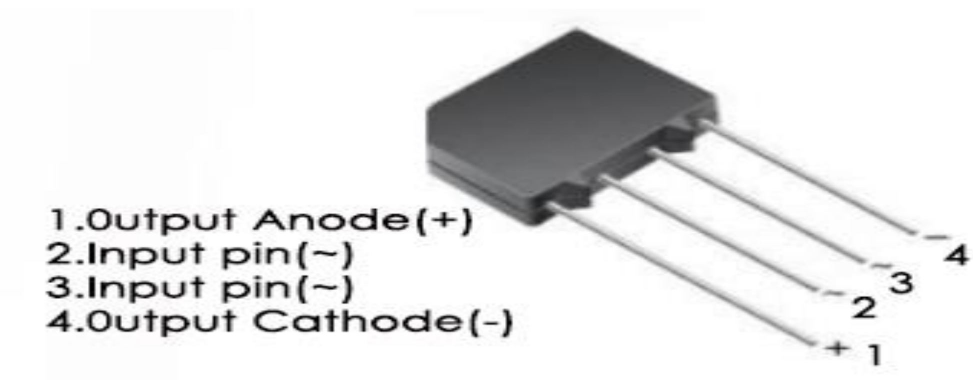
**Theory:**

A **bridge rectifier** converts **AC to DC** using four diodes connected in a bridge configuration. The output is **full-wave rectified** — both halves of the AC waveform are used.

***Operation:***

- During **positive half-cycle**, two diodes conduct and current flows through the load in one direction.
- During **negative half-cycle**, the other two diodes conduct, maintaining the **same polarity** across the load.
- Output: **Pulsating DC** (full-wave rectified).

**Circuit Diagram:**



**Procedure:**

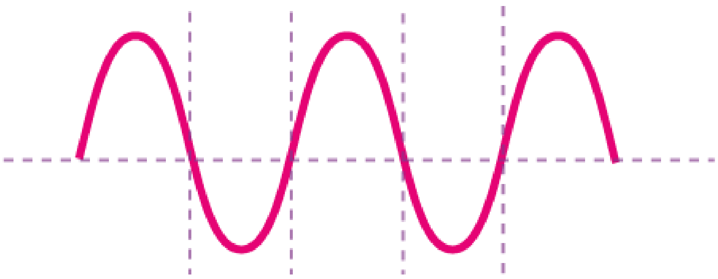
1. Connect the **AC supply** to the transformer input.
2. Connect transformer output (12V AC) to the **AC input terminals** of the bridge rectifier.
3. Connect the **load resistor** across the **DC output** terminals.
4. Connect **Channel 1 of CRO** across the **AC input** (to see input waveform).
5. Connect **Channel 2 of CRO** across the **DC output** (to see rectified waveform).
6. Power ON and observe both waveforms.

**Waveform Observation:**

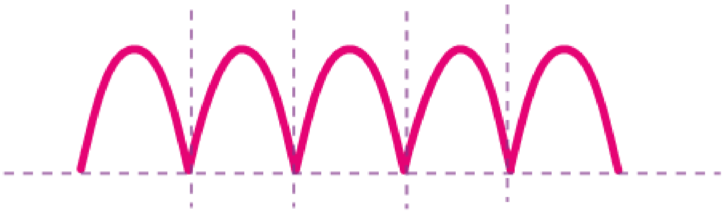
| Measurement | Waveform Type | Remarks |
|---|---|---|
| AC Input (Channel 1) | Pure sine wave | From transformer (12V AC peak) |
| DC Output (Channel 2) | Full-wave rectified (pulsating) | Positive cycle only (pulses) |

**Expected Waveforms:**

**Input**:



**Output**:



**Result:**

The input AC and full-wave rectified output DC waveforms of the bridge rectifier were successfully traced using the CRO.

**Experiment 28**

**Digital Gates**

**Aim:**

To **verify the truth tables** of basic logic gates — **AND, OR, NOT, NAND, NOR, EX-OR** — using a digital trainer kit or ICs.

**Apparatus Used:**

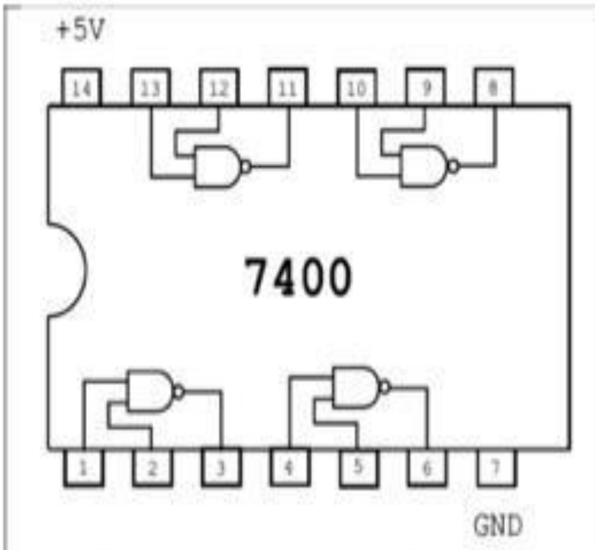
| Sl. No. | Name | Range | Quantity |
|---|---|---|---|
| 01 | Digital IC Trainer Kit | - | 01 |
| 02 | **7408** (AND) | - | 01 |
| 03 | **7432** (OR) | - | 01 |
| 04 | **7404** (NOT) | - | 01 |
| 05 | **7400** (NAND) | - | 01 |
| 06 | **7402** (NOR) | - | 01 |
| 07 | **7486** (EX-OR) | - | 01 |
| 08 | Connecting wires | - | ~10 |

**Theory:**

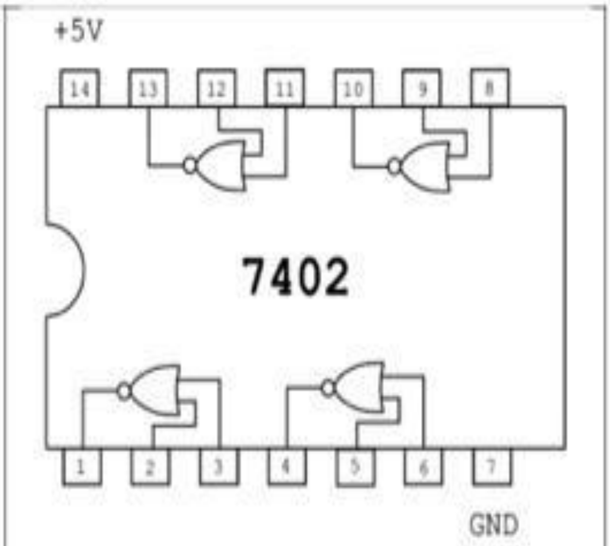
**Logic gates** are fundamental digital circuits that follow **Boolean algebra**.

They take binary inputs (0 or 1) and produce a single binary output based on the type of gate.

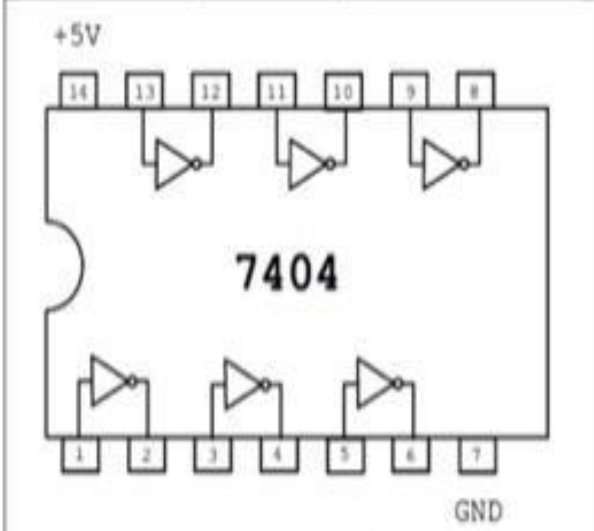
| **Gate** | **Symbol** | **Boolean Expression** | **IC Number** |
|---|---|---|---|
| AND | A·B | Y = A · B | 7408 |
| OR | A+B | Y = A + B | 7432 |
| NOT | ¬A or $\bar{A}$ | Y = ¬A | 7404 |
| NAND | ¬(A·B) | Y = (A · B)‾ | 7400 |
| NOR | ¬(A+B) | Y = (A + B)‾ | 7402 |
| EX-OR | A⊕B | Y = A ⊕ B | 7486 |



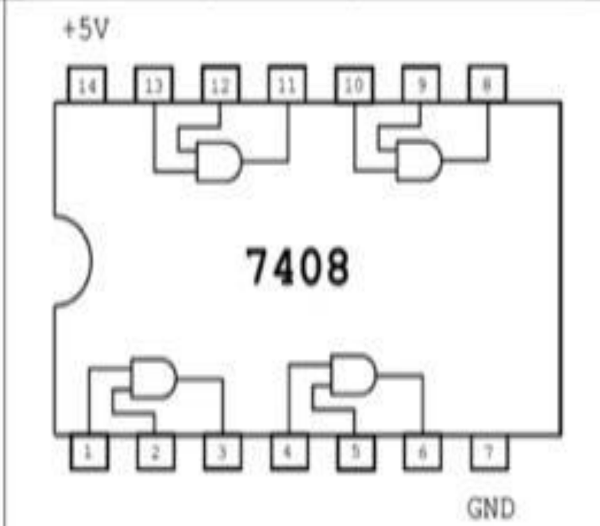

7400 quad 2-input NAND



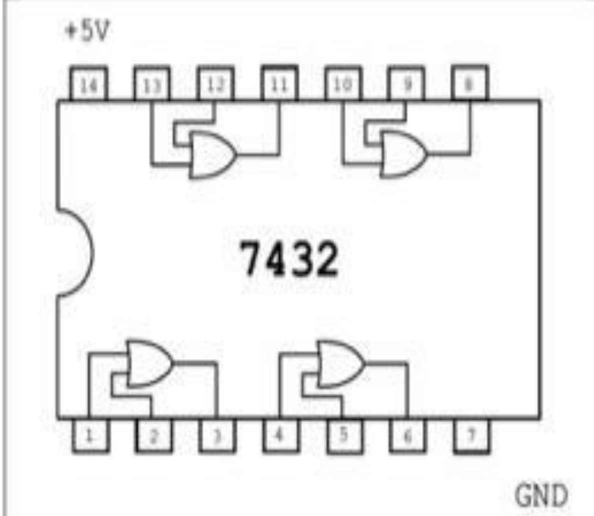

7402 quad 2-input NOR



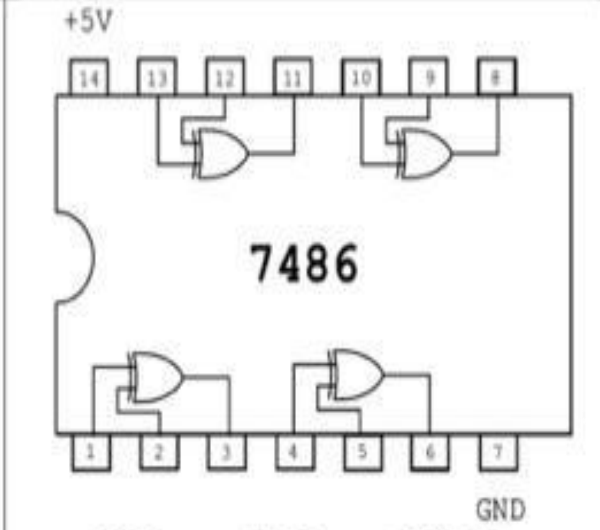

7404 hex NOT




7408 quad 2-input AND



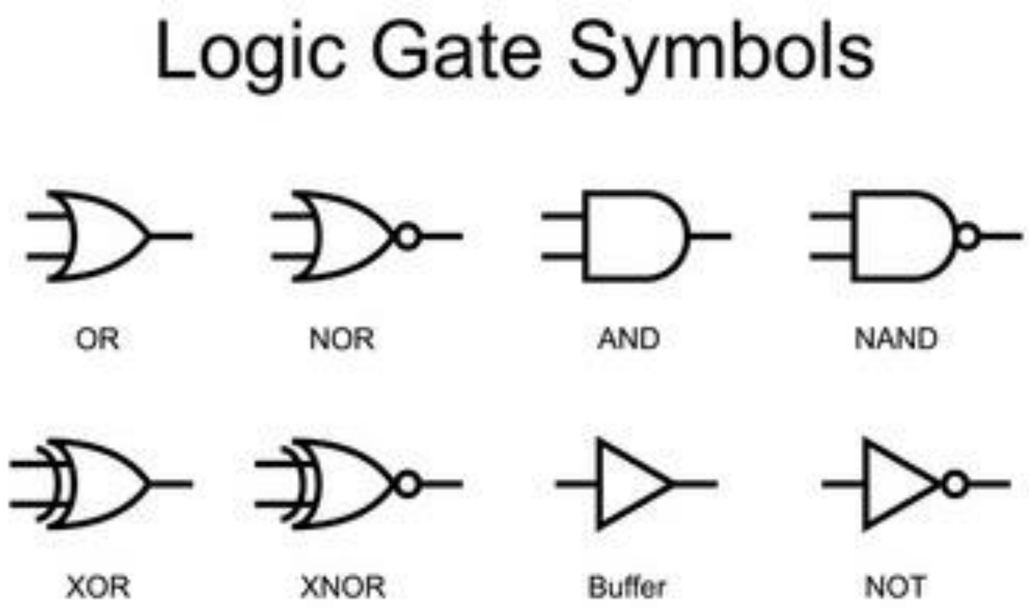

7432 quad 2-input OR




7486 quad 2-input EX-OR

**Procedure:**

1. Place the selected IC (e.g., 7408 for AND) into the trainer kit socket.
2. Connect Vcc (Pin 14) and GND (Pin 7) of the IC.
3. Connect inputs A and B using toggle switches.
4. Connect output Y to an LED via a current-limiting resistor.
5. Test all input combinations and note the output.
6. Repeat the process for each gate using the respective ICs.




**Truth Tables:**

***AND Gate (7408)***

| A | B | Y = A·B |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 1 |

***OR Gate (7432)***

| A | B | Y = A+B |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 1 |

***NOT Gate (7404)***

| A | Y = ¬A |
|---|---|
| 0 | 1 |
| 1 | 0 |

***NAND Gate (7400)***

| A | B | Y = (A·B)̅ |
|---|---|---|
| 0 | 0 | 1 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 0 |

***NOR Gate (7402)***

| A | B | Y = (A+B)̅ |
|---|---|---|
| 0 | 0 | 1 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 0 |

***EX-OR Gate (7486)***

| A | B | Y = A⊕B |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 0 |

**Result:**

The truth tables of AND, OR, NOT, NAND, NOR, and EX-OR gates were verified successfully using corresponding ICs on a digital trainer kit.

## Experiment 29
## Mechanical/Electrical Actuator

**Aim:**

To understand the **working principle**, **types**, and **applications** of a **simple actuator** (mechanical or electrical) through video demonstration.

**Theory:**

An **actuator** is a device that **converts energy into motion**. It receives a control signal and produces **mechanical movement**, which can be linear or rotary. Actuators are key components in automation, robotics, and control systems.

**Types of Actuators:**

| Actuator Type | Working Principle | Example Device |
|---|---|---|
| **Electrical Actuator** | Converts electrical energy into motion | servo motor, stepper motor |
| **Mechanical Actuator** | Uses mechanical force, levers, or gears | Manual lever, gear train |
| **Electromechanical** | Combination of electric motor + mechanical linkage | Car wiper motor, printer head |



**Result:**

The video effectively demonstrated the working of various types of actuators. Their applications and control methods were clearly understood.

## Experiment 30
## PLCs (Programmable Logic Controllers)

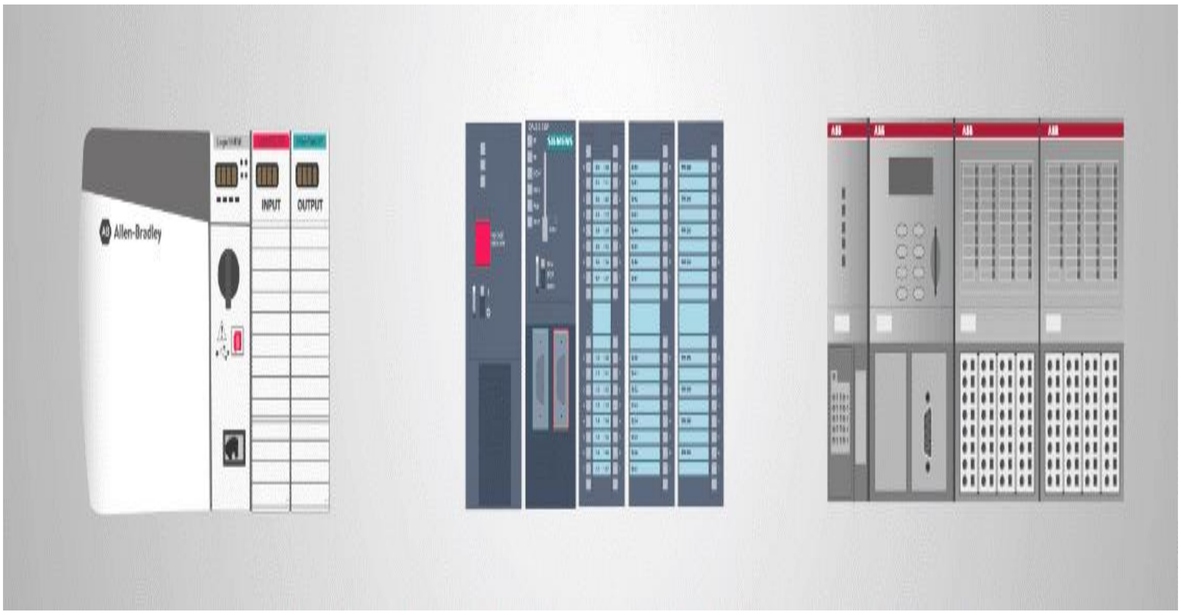
**Aim:**

To identify and list commonly used **commercial PLCs** available in the market, along with their manufacturers and basic features.

**Theory:**

A **PLC (Programmable Logic Controller)** is an industrial computer used to **automate machines, processes, and systems**. It continuously monitors input devices and makes decisions based on a custom program to control output devices.

PLCs are widely used in industries such as **manufacturing, packaging, water treatment, elevators, and automation**.




**List of Commercially Available PLCs:**

| Brand / Manufacturer | PLC Series/Model | Key Features | Application Area |
|---|---|---|---|
| **Siemens** (Germany) | S7-200, S7-1200, S7-300, LOGO! | Modular design, advanced networking, HMI support | Industrial automation, robotics |
| **Allen-Bradley** (USA) | MicroLogix, CompactLogix | High-speed IO, Ethernet/IP support, rugged design | Packaging, motion control |
| **Mitsubishi** (Japan) | FX3U, FX5U | Built-in analog/digital IO, fast scan time | HVAC, lift control, manufacturing |
| **Schneider Electric** (France) | Modicon M221, M340, M580 | EcoStruxure support, real-time control | Building automation, energy |

| | | | |
|---|---|---|---|
| **Delta Electronics** (Taiwan) | DVP Series (DVP-ES2, DVP-SE) | Compact, cost-effective, good for small automation | Panel automation, OEM machines |
| **ABB** (Switzerland) | AC500 Series | Scalable, integrated safety and motion control | Utilities, power systems |
| **Omron** (Japan) | CP1E, CJ2M, NX1P | Fast data processing, compact HMI integration | Conveyor systems, process control |
| **Panasonic** (Japan) | FP-X, FP0R Series | Compact PLCs, low power, reliable | Light automation, labs |

**Result:**

Several major PLC brands were identified along with their popular models and features. These are widely used across different sectors of industrial automation.