# GOVT CO-ED POLYTECHNIC

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**LAB MANUAL**

Branch : Electrical Engineering

Year & Semester : 2nd Year / 3rd Semester

*2024365(024) – Electrical Workshop Practice-I (Lab)*

# EXPERIMENT-1

AIM- INTRODUCTION AND USE OF ELECTRICAL TOOLS, ELECTRICAL MATEIAL AND ABBREVIATION.

## INTRODUCTION :-

ELECTRICAL TOOLS ARE TOOLS USED TO WORK ON AN ELECTRICAL SYSTEM. THESE CAN INCLUDE A WIDE RANGE OF TOOLS SUCH AS WIRE AND CABLE CUTTERS, WIRE STRIPPERS, COAXIAL COMPRESSION TOOLS, TELEPHONY TOOLS, WIRE CUTTER/STRIPPERS, CABLE TIE TOOLS, ACCESSORIES AND EVEN MORE. WE ALL KNOW THAT THE RIGHT TOOL CAN MAKE ALL THE DIFFERENCE WHEN IT COMES TO COMPLETING A PROJECT. THEY MAKE THE DIFFERENCE BETWEEN DONE AND DONE RIGHT. THE BOTTOM LINE IS, THE BETTER THE TOOL, THE BETTER THE OUTCOME. WE STOCK THE BEST BRAND ELECTRICAL TOOLS IN THE INDUSTRY AT THE BEST PRICES. THIS WAY YOU CAN GET TO WORK AND GET THE JOB DONE CORRECTLY. THE FIRST STEP IN DETERMINING THE ELECTRICAL TOOLS YOU WILL NEED IS TO DETERMINE WHAT TASK NEEDS TO BE COMPLETED. NOT EVERY JOB WILL REQUIRE SPECIALTY TOOLS BUT USING THE RIGHT TOOL FOR THE JOB WILL MAKE ALL THE DIFFERENCE. TAKE A LOOK BELOW TO FIND OUT THE BASIC TYPES OF ELECTRICAL TOOLS WE CARRY AND LEARN MORE ABOUT TOOLS EVERY ELECTRICIAN SHOULD HAVE.

## TYPES OF DIFFERENT ELECTRICAL TOOLS:-

HAMMER

A HAMMER IS USED TO SECURE ELECTRICAL BOXES EQUIPPED WITH NAIL-ON BRACKETS TO WALL STUDS AND OTHER FRAMING MEMBERS IN A HOME.

## UTILITY KNIFE

A UTILITY KNIFE, OR BOX CUTTER, IS HANDY FOR CUTTING SHEATHING FROM NON-METALLIC CABLE, TO CUT OFF ELECTRICAL TAPE, AND TO OPEN CARDBOARD BOXES.

## SCREWDRIVERS

ELECTRICIANS KEEP SCREWDRIVERS WITH THEM AT ALL TIMES, FOR REMOVING AND INSTALLING COVER PLATES, OUTLETS, SWITCHES, AND MANY OTHER DEVICES.

Screwdrivers with insulating rubber jackets covering the handles are designed for better safety when doing electrical work.

## LINESMAN PLIERS

A pair of linesman pliers is an electrician's do-it-all tool. It has a squared-off end that is great for twisting wires together, a center cutting blade for trimming wire, and a grip area between the handles for pulling wire.

## NON-CONTACT VOLTAGE TESTER

Perhaps the most important specialty electrical tool you can own is a voltage tester. A voltage tester is used for a quick safety check to make sure there's no voltage in an electrical wire or device before you start working on it. Non-contact voltage testers, powered by batteries, are the simplest and safest types of testers because they can detect electricity just by being near an outlet slot or wire.

## ELECTRICAL MATERIAL:-

Electrical Materials Are Used For The Electrical Installations 48, In Case Of House Wiring Or Building Wiring Electrical Materials Are Used. We Can't Do The electrical 9 installations without using electrical materials.

## What is the purpose of electrical material

The electrical 5 materials have many purposes, they can be used to control the current flow in an electric circuit. There are certain electrical materials 15 like circuit breaker 8 and fuses which can be used to protect the electrical appliances and devices and it can prevent fire hazards and damage. Electrical material such as insulators can prevent users from getting electric shocks while operating electrical appliances or instruments. Electrical materials such as current-carrying wires 2 or conductors are used to transfer the current from source to the load.

## What are the most commonly used electrical materials?

### CONVENIENCE OUTLET

This electric material acts as a convenient source of electric energy for electrical appliances which requires electricity to

WORK. THE MALE PLUG OF THE APPLIANCES IS CONNECTED TO THIS MATERIAL. IT COULD BE SIMPLEX, DUPLEX, OR MULTIPLEX IT MAY BE SURFACE OR FLUSH TYPE.

## MALE PLUG

THE MALE PLUG IS A DEVICE THAT IS USED TO CONNECT THE ELECTRICAL APPLIANCE TO THE CONVENIENCE OUTLET. THE CONVENIENCE OUTLET WILL ACT AS A SOURCE OF ELECTRICAL ENERGY AND THE MALE PLUG IS ATTACHED TO A FLAT CORD. ONE END OF THE CORD IS CONNECTED TO THE MALE PLUG AND THE OTHER END IS CONNECTED TO THE APPLIANCE.


## LAMP HOLDERS

LAMP HOLDERS ARE A DEVICE THAT IS USED TO HOLD THE LAMP THEY ARE ALSO CALLED LAMP SOCKETS AND RECEPTACLES. THESE LAMP HOLDERS ARE IN ANY SIZE AND IN MANY DESIGNS.



## SWITCHES

SWITCHES ARE USED TO CONTROL THE FLOW OF ELECTRIC CURRENT IN A CIRCUIT THEY ARE USED TO CONNECT AND DISCONNECT THE FLOW OF ELECTRIC CURRENT IN A CIRCUIT. SWITCHES ARE IN MANY SHAPES AND SIZES.



## FUSES

A FUSE CAN BE CONSIDERED AS A CIRCUIT PROTECTION DEVICE THAT AUTOMATICALLY BLOWS AND CUTS THE CURRENT WHEN A SHORT CIRCUIT HAPPENS. SO IF THERE IS AN OVERVOLTAGE THE SWITCH WILL CUT THE CURRENT AND PROTECTS THE DEVICE.



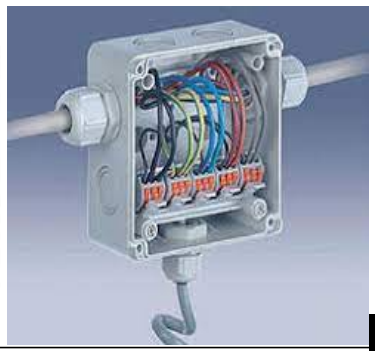
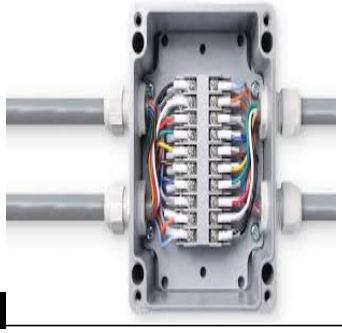
## CIRCUIT BREAKER

A CIRCUIT BREAKER IS ALSO A PROTECTIVE DEVICE THAT WILL PROTECT THE APPLIANCES FROM OVER-VOLTAGES. THE CIRCUIT BREAKER WILL AUTOMATICALLY BLOW AND CUTS WHEN SHORT CIRCUIT OR OVERVOLTAGE OCCURS.




## JUNCTION BOX

JUNCTION BOXES ARE ELECTRIC MATERIALS WHERE CONNECTIONS OR JOINTS OF WIRES ARE DONE. JUNCTION BOXES ARE MOSTLY MADE OF METAL OR PLASTICS.

## UTILITY BOX

UTILITY BOXES ARE MADE UP OF METAL OR PLASTIC MATERIAL, UTILITY BOXES ARE ATTACHED WITH THE FLUSH TYPE CONVENIENCE OUTLET AND SWITCH.

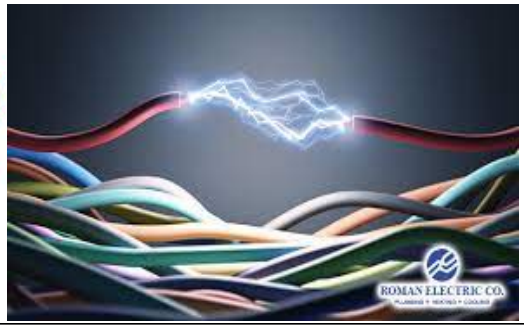
## FLAT CORD

IT IS A DUPLEX STRANDED WIRE WHICH IS USED FOR TEMPORARY WIRING INSTALLATIONS AND THEY ARE COMMONLY USED IN EXTENSION CORD ASSEMBLY.


## ELECTRICAL WIRE

ELECTRICAL WIRE IS A CONDUCTOR WHICH IS USED FOR THE TRANSFER OF ELECTRICITY, THE ELECTRIC WIRE IS THE BASIC MATERIAL FOR ELECTRICAL INSTALLATIONS. THE TRANSFER OF CURRENT FROM SOURCE TO LOAD IS

POSSIBLE WITH THE HELP OF AN ELECTRIC WIRE. STRANDED ELECTRIC WIRES ARE MADE UP OF MULTIPLE STRANDS JOINED TOGETHER AND SOLID WIRE IS MADE UP OF A SINGLE STRAND OF WIRE WHICH IS EITHER MADE UP OF COPPER OR ALUMINUM. THESE ARE USED IN WIRING INSTALLATIONS.

## ELECTRICAL ABBREVIATION:-

| | |
|---|---|
| **A** | Ampere |
| **AAAC** | All Aluminum Alloy Conductor |
| **AAC** | All Aluminum Conductor |
| **AC** | Alternating Current or Auxiliary Carry |
| **A/C** | Air Conditioning |
| **ACB** | Air Circuit Breaker |
| **ACCB** | Air Case Circuit Breaker |
| **ACDB** | Alternating Current Distribution Board |
| **ACSR** | Aluminum Conductor Steel Reinforced |
| **ADC** | Analog to Digital Converter |
| **AF** | Audio Frequence |

| | |
|---|---|
| **AFC** | Automated Frequency Control or Available Fault Current |
| **AFCI** | Arc Fault Circuit Interrupter |
| **AGC** | Automatic Gain Control |
| **AGMA** | American Gear Manufacturer's Association |
| **Ah** | Ampere-hour |
| **AHU** | Air Handling Unit |
| **AIC** | Ampere Interrupting Capacity |
| **Al** | Aluminum |
| **ALCI** | Appliance Leakage Current Interrupter |
| **ALE** | Address Latch Enable |
| **ALU** | Arithmetic Logic Unit |
| **AMD** | Advanced Micro Device |
| **ANSI** | American National Standards Institute |
| **APFC** | Automatic Power Factor Control |
| **ASI** | Asynchronous Serial Interface |
| **ASCI** | American Standard Code For Information |
| **Ask** | Amplitude Shift Keying |
| **ASTA** | Association of Short-circuit Testing Authorities |
| **ATC** | Automatic Temperature Control |
| **ATS** | Automatic Transfer Switch |
| **AVR** | Automatic Voltage Regulator |
| **AWA** | Aluminum wire Armour |

| | |
|---|---|
| **AWG** | American Wire Gauge |
| **B** | Electrical Susceptance or Base |
| **BBUL** | Bumpless Build-Up Layer |
| **BCD** | Binary Coded Decimal |
| **BGA** | Ball Grid Array |
| **BIL** | Breakdown Insulation Level |
| **BJT** | Bipolar Junction Transistor |
| **BLAC** | Brushless AC |
| **BLDC** | Brushless DC |
| **BMS** | Battery Management System |
| **BPSK** | Binary Phase Shift Keying |
| **BTB** | Branch Target Buffer |
| **BTU** | British Thermal Units |
| **C** | Capacitance or Capacitor or Collector or Celsius or Centigrade |
| **CAD** | Computer-Aided Design |
| **CATV** | Cable Television or Community Antennae Television |
| **CB** | Circuit Breaker or Common Base |
| **CBCU** | Circuit Breaker Control Unit |
| **CBM** | Certified Ballast Manufacturer |
| **CBR** | Constant Bitrate |
| **CC** | Common Collector |
| **CCR** | Central Control Room |

| | |
|---|---|
| **CCTV** | Closed Circuit Television |
| **CCU** | Central Control Unit |
| **CDA** | Common Drain Amplifier |
| **CDIP** | Ceramic Dual In-Line Package |
| **CDM** | Charged-Device Model |
| **CDMA** | Code Division Multiple Access |
| **CE** | Common Emitter or Chip Enable |
| **CEGB** | Central Electricity Generating Board |
| **CISC** | Complex Instruction Set Computer |
| **CLF** | Current Limiting Fuse |
| **CMOS** | Complementary Metal Oxide Semiconductor |
| **Cont.** | Continuous Quantity |
| **COR CU** | Corrugated Copper |
| **Cos φ** | Power Factor |
| **CPGA** | Ceramic Pin Grid Array |
| **CPT** | Control Power Transformer |
| **CPU** | Central Processing Unit |
| **CRO** | Cathode Ray Oscilloscope |
| **CRT** | Cathode Ray Tube |
| **CS** | Chip Select |
| **CSA** | Cross-Sectional Area or Common Source Amplifier |
| **CSI** | Current Source Inverter |

| | |
|---|---|
| **CSP** | Chloro-Sulfonated Polyethylene |
| **CSS** | Computerized Synchronising System |
| **CT** | Current Transformer |
| **CU** | Copper |
| **CUWB** | Copper Wire Braid |
| **dB** | Decibel |
| **D** | Degree or Diode |
| **DAC** | Digital to Analog Converter |
| **DB** | Distribution Board |
| **Db** | Decibel |
| **DC** | Direct Current |

# EXPERIMENT-2

## AIM-INTRODUCTION OF BASIC ELECTRICAL COMPOMENTS AND SYMBOLS.

### INTRODUCTION OF BASIC ELECTRICAL COMPOMENTS

AN ELECTRICAL COMPONENT IS A BASIC, DISCRETE DEVICE THAT IS OFTEN CONNECTED WITH OTHERS, TO FULFIL THE REQUIREMENTS OF A CIRCUIT.

IN AN ELECTRICAL SYSTEM, SUCH AS THAT WHICH FORMS THE ELECTRICAL INSTALLATION OF A BUILDING, ELECTRICAL COMPONENTS COMPRISE ITEMS PROVIDED IN A MAINS CIRCUIT SUCH AS SWITCHING DEVICES, LIKE SWITCHES AND ISOLATORS, PROTECTION DEVICES SUCH AS CIRCUIT BREAKERS AND FUSES, AND WIRING CONNECTIONS.

BS 7671 (IET WIRING REGULATIONS) DOES NOT SPECIFICALLY RECOGNISE OR MAKE USE OF THE WORD 'COMPONENT' IN THIS SENSE, PREFERRING INSTEAD THE OFFICIAL TERM ELECTRICAL EQUIPMENT.

IT IS IN THE FIELD OF ELECTRONICS, AS OPPOSED TO BUILDINGS, WHERE THE TERM 'ELECTRICAL COMPONENT' IS MORE WIDELY USED.

IN AN ELECTRONIC CIRCUIT, VARIOUS COMPONENTS WILL BE ENCOUNTERED, WHICH GENERALLY FALL UNDER ONE OF TWO CATEGORIES:

ACTIVE COMPONENTS – THESE WOULD COMPRISE TRANSISTORS, INTEGRATED CIRCUITS (ICS), DIODES AND THERMIONIC VALVES.

PASSIVE COMPONENTS – THESE WOULD COMPRISE CAPACITORS, RESISTORS AND INDUCTORS.

AS FAR AS BUILDINGS ARE CONCERNED, THESE COMPONENTS WOULD BE FOUND WITHIN ELECTRICAL AND ELECTRONIC EQUIPMENT THAT ITSELF WOULD FORM PART OF THE BUILDING'S ELECTRICAL SYSTEM.

## BASIC ELECTRICALSYMBOLES:-

## Wire Symbols



### Electrical wire

### Connected wires

### Not Connected wires

## Ground Symbols

### EARTH GROUND

**CHASSIS GROUND**

**DIGITAL/COMMON GROUND**

## INDUCTOR/COIL SYMBOLS



**INDUCTOR**

**IRON CORE INDUCTOR**

**VARIABLE INDUCTOR**

**DEFINITION OF AN INDUCTOR:** IT IS A DEVICE THAT TEMPORARILY STORES ENERGY IN THE FORM OF A MAGNETIC FIELD.

## LAMP/LIGHT BULB SYMBOLS

**LAMP / LIGHT BULB**

**LAMP / LIGHT BULB**

**LAMP / LIGHT BULB**

## SWITCH AND RELAY SYMBOLS

**SPST TOGGLE SWITCH**

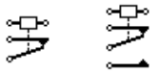
**SPDT TOGGLE SWITCH**

**JUMPER**

**DIP SWITCH**

**PUSHBUTTON SWITCH (N.C)**

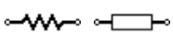
**PUSHBUTTON SWITCH (N.O)**



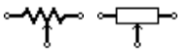
**SPST RELAY/SPDT RELAY**

**DEFINITION OF A RELAY:** IT CONTROLS CIRCUITS BY OPENING AND CLOSING CONTACTS IN ANOTHER CIRCUIT. RELAYS SWITCHES ARE USED TO OPEN AND CLOSE CIRCUITS ELECTROMECHANICALLY OR ELECTRONICALLY.

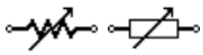
## RESISTOR SYMBOLS



**RESISTOR (IEEE)/ RESISTOR (IEC)**



**POTENTIOMETER (IEEE)/(IEC)**



**VARIABLE RESISTOR / RHEOSTAT (IEEE)/(IEC)**

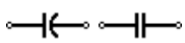
**TRIMMER RESISTOR**

**THERMISTOR**

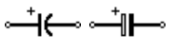
**PHOTORESISTOR / LIGHT-DEPENDENT RESISTOR (LDR**

**DEFINITION OF A RESISTOR:** AS THE NAME SUGGESTS, THEY RESIST THE FLOW OF EXCESSIVE ELECTRICAL POWER OR VOLTAGE PASSING THROUGH THE CIRCUIT, IN A PRECISE AND CONTROLLED MANNER.

## CAPACITOR SYMBOLS



**CAPACITOR**



**POLARIZED CAPACITOR**

**VARIABLE CAPACITOR**

**DEFINITION OF A CAPACITOR:** IT IS A DEVICE THAT IS USED TO STORE ELECTRICAL ENERGY IN AN ELECTRIC FIELD. IT IS A PASSIVE ELECTRONIC COMPONENT.

## ANTENNA SYMBOLS

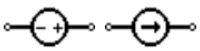
**ANTENNA / AERIAL**

**ANTENNA / AERIAL**

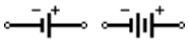
**DIPOLE ANTENNA**

**DEFINITION OF AN ANTENNA:** IT IS AN ELECTRICAL DEVICE THAT CONVERTS ELECTRIC POWER INTO RADIO WAVES AND VICE VERSA.

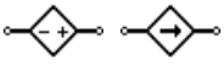
## POWER SUPPLY SYMBOLS



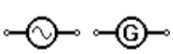
**VOLTAGE SOURCE/ CURRENT SOURCE**



**BATTERY CELL/ BATTERY**

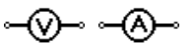


**CONTROLLED VOLTAGE SOURCE/CONTROLLED CURRENT SOURCE**

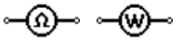


**AC VOLTAGE SOURCE/GENERATOR**

**METER SYMBOLS**

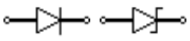



**VOLTMETER/AMMETER**

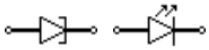



**OHMMETER/WATTMETER**

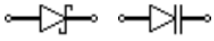
**DIODE/LED SYMBOLS**



**DIODE/ZENER DIODE**



**TUNNEL DIODE/LIGHT EMITTING DIODE**

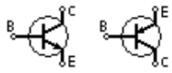


**SCHOTTKY DIODE/VARICAP DIODE**

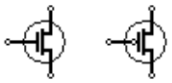
**PHOTODIODE**

**Definition of a LED:** It is a semiconductor device that emits light when an electric current is passed through it.

Transistor Symbols




**NPN Bipolar Transistor/ PNP Bipolar Transistor**



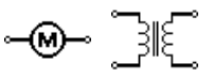
**NMOS/PMOS Transistor**

**JFET-N Transistor/ JFET-P Transistor**

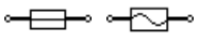
**Darlington Transistor**

**Definition of a Transistor:** It is a semiconductor device used to amplify or switch electronic signals and electrical power.

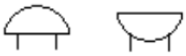
Miscellaneous Symbols



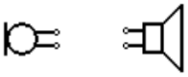
**MOTOR/ TRANSFORMER**



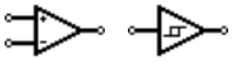
**FUSE**



**ELECTRIC BELL/BUZZER**



**MICROPHONE / LOUDSPEAKER**



**OP-AMP /SCHMITT TRIGGER**

**BUS**

**BUS**

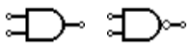
**ANALOG-TO-DIGITAL CONVERTER (ADC)**

## Digital-to-Analog Converter (DAC)

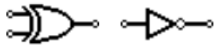
## Optocoupler

## Crystal Oscillator

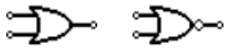
## Logic Gate Symbols



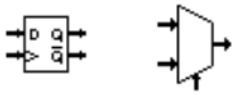
## AND /NAND Gate



## XOR Gate / NOT Gate



## OR /NOR Gate




## D flip flop /Multiplexer(MUX) 2 to 1

# EXPERIMENT-3

AIM:-STUDY OF RESISTANCE MEASURMENT [COLOUR CODING] AND CABLE IDENTIFICATION

## Standard Resistor Values and Color

COMPONENTS AND WIRES ARE CODED WITH COLORS TO IDENTIFY THEIR VALUE AND FUNCTION.

| Color | Digit | Multiplier | Tolerance (%) |
|---|---|---|---|
| Black | 0 | $10^0$ (1) | |
| Brown | 1 | $10^1$ | 1 |
| Red | 2 | $10^2$ | 2 |
| Orange | 3 | $10^3$ | |
| Yellow | 4 | $10^4$ | |
| Green | 5 | $10^5$ | 0.5 |
| Blue | 6 | $10^6$ | 0.25 |
| Violet | 7 | $10^7$ | 0.1 |
| Grey | 8 | $10^8$ | |
| White | 9 | $10^9$ | |
| Gold | | $10^{-1}$ | 5 |
| Silver | | $10^{-2}$ | 10 |
| (none) | | | 20 |

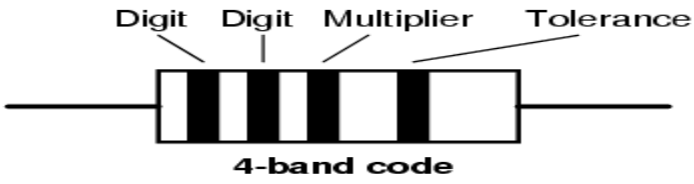
**Resistor Color Coding** uses colored bands to quickly identify a resistors resistive value and its percentage of tolerance with the physical size of the resistor indicating its wattage rating.

Generally, the resistance value, tolerance, and wattage rating are printed on the body of a resistor as numbers or letters when the resistors body is big enough to read the print, such as large power resistors.

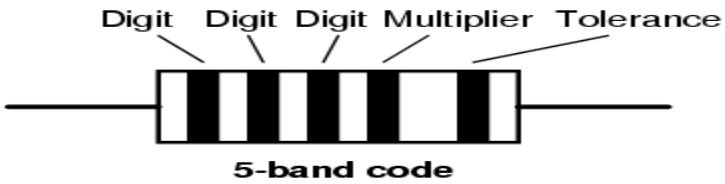
But when a resistor is smaller (example: 1/4 watt carbon or film type), the print is too small to read, so the specifications must be shown in another way.

The colors brown, red, green, blue, and violet are used as tolerance codes on 5-band resistors only. All 5-band resistors use a colored tolerance band.

The blank (20%) "band" is only used with the "4-band" code (3 colored bands + a blank "band").



4-band code



5-band code

## *Yellow-Violet-Orange-Gold Color Code*

A resistor colored *Yellow-Violet-Orange-Gold* would be 47 kΩ with a tolerance of +/- 5%.

## *Green-Red-Gold-Silver Color Code*

A resistor colored *Green-Red-Gold-Silver* would be 5.2 Ω with a tolerance of +/- 10%.

## *White-Violet-Black Color Code*

A resistor colored *White-Violet-Black* would be 97 Ω with a tolerance of +/- 20%. When you see only three color bands on a resistor, you know that it is actually a 4-band code with a blank (20%) tolerance band.

## *Orange-Orange-Black-Brown-Violet Color Code*

A resistor colored *Orange-Orange-Black-Brown-Violet* would be 3.3 kΩ with a tolerance of +/- 0.1%.

### *Brown-Green-Grey-Silver-Red Color Code*

A resistor colored *Brown-Green-Grey-Silver-Red* would be 1.58 Ω with a tolerance of +/- 2%.

### *Blue-Brown-Green-Silver-Blue Color Code*

A resistor colored *Blue-Brown-Green-Silver-Blue* would be 6.15 Ω with a tolerance of +/- 0.25%.

## Preferred Values or E-series

To make mass manufacturing of resistors easier, the IEC (International Electrotechnical Commision) defined tolerance and resistance values for resistors in 1952.

These are referred to as preferred values or E-series, published in standard IEC 60063:1963. Capactors, Zener diodes, and inductors also use these standards.

The purpose of this was so that when companies produce resistors with different values of resistance, they would equally space on a logarithmic scale.

THIS HELPS THE SUPPLIER WITH STOCKING DIFFERENT VALUES. RESISTORS PRODUCED BY DIFFERENT MANUFACTURERS ARE COMPATIBLE FOR THE SAME DESIGNS BECAUSE OF THE USE OF STANDARD VALUES.

## *Standard Resistor Value Series and Tolerances*

THE STANDARD E3, E6, E12, E24, E48 AND E96 RESISTOR VALUES ARE LISTED BELOW.

| E Series | Tolerance (SIG FIGS) | # of Values in Each Decade |
|---|---|---|
| E3 | 36%* | 3 |
| E6 | 20% | 6 |
| E12 | 10% | 12 |
| E24 | 5% | 24 |
| E48 | 2% | 48 |
| E96 | 1% | 96 |
| E192 | 0.5%, 0.25% and higher tolerances | |

*The calculated tolerance for this series is 36.60%, While the standard only specifies a
tolerance greater than 20%, other sources indicate 40% or 50%.

## E3 Standard Resistor Series

THESE ARE THE MOST WIDELY USED RESISTOR SERIES IN THE ELECTRONICS INDUSTRY AND ARE USEFUL FOR RESISTOR VALUES THAT ARE NOT CRITICAL.

THE NUMBER OF DIFFERENT COMPONENTS IN ANY ELECTRONIC CIRCUIT DESIGN CAN BE REDUCED BY KEEPING TO THIS SERIES.

| | | |
|---|---|---|
| 1 | 2.2 | 4.7 |

## E6 Standard Resistor Series

THE E6 SERIES OF RESISTORS ARE ALSO WIDELY USED IN THE ELECTRONICS INDUSTRY BECAUSE OF THEIR WIDER RANGE OF COMMON RESISTOR VALUES.

| | | |
|---|---|---|
| 1 | 1.5 | 2.2 |
| 3.3 | 4.7 | 6.8 |

## E12 Standard Resistor Series

| | | |
|---|---|---|
| 1 | 1.2 | 1.5 |
| 1.8 | 2.2 | 2.7 |
| 3.3 | 3.9 | 4.7 |

| | | |
|---|---|---|
| 5.6 | 6.8 | 8.2 |

## E24 Standard Resistor Series

Though, resistors in ranges up to E24 are available, it helps in any design to focus on using as small a number of resistor values as possible.

This will reduce the number of components in a design and this will help reduce costs when considering large-scale production.

| | | |
|---|---|---|
| 1 | 1.1 | 1.2 |
| 1.3 | 1.5 | 1.6 |
| 1.8 | 2 | 2.2 |
| 2.4 | 2.7 | 3 |
| 3.3 | 3.6 | 3.9 |
| 4.3 | 4.7 | 5.1 |
| 5.6 | 6.2 | 6.8 |
| 7.5 | 8.2 | 9.1 |

## E48 Standard Resistor Series

| | | |
|---|---|---|
| 1 | 1.05 | 1.1 |
| 1.15 | 1.21 | 1.27 |
| 1.33 | 1.4 | 1.47 |
| 1.54 | 1.62 | 1.69 |
| 1.78 | 1.87 | 1.96 |
| 2.05 | 2.15 | 2.26 |
| 2.37 | 2.49 | 2.61 |
| 2.74 | 2.87 | 3.01 |
| 3.16 | 3.32 | 3.48 |
| 3.65 | 3.83 | 4.02 |
| 4.22 | 4.42 | 4.64 |
| 4.87 | 5.11 | 5.36 |
| 5.62 | 5.9 | 6.19 |
| 6.49 | 6.81 | 7.15 |
| 7.5 | 7.87 | 8.25 |
| 8.66 | 9.09 | 9.53 |

## *E96 Resistor Series and Beyond*

The E96 and E192 series of standard resistor values do exist, but they are not used as much as the Series mention previously.

Their tolerance is either 0.5 or 0.25% which can increase costs along with a much higher number of resistors in range.

## STUDY OF CABLE IDENTIFICATION :-

Cable and wire identification refers to the markers or labels that are typically affixed to a cable or wire for identification purposes. These markers provide a quick and easy way to identify a cable or wire and can be placed in a location that is easy to read, even in hard-to-reach areas

**Understanding Electrical Cable:-** An electrical cable also has different types, color and application as its determining factors. Here's a brief about cables that you need to understand to determine the correct cable for your home.

1. **Types of Electrical Cables** :-

   There are more than 20 different types of cables available today, designed for applications ranging from transmission to heavy industrial use. Some of the most commonly-used ones include:

   1. **Non-Metallic Sheathed Cable** : These cables are also known as non-metallic building wire or NM cables. They feature a flexible plastic jacket with two to four wires (TECK cables are

covered with thermoplastic insulation) and a bare wire for grounding. Special varieties of this cable are used for underground or outdoor use, but NM-B and NM-C non-metallic sheathed cables are the most common form of indoor residential cabling

2. **Underground Feeder Cable** : These cables are quite similar to NM cables, but instead of each wire being individually wrapped in thermoplastic, wires are grouped together and embedded in the flexible material. Available in a variety of gauge sizes, UF cables are often used for outdoor lighting and in-ground applications. Their high water-resistance makes them ideal for damp areas like gardens as well as open-to-air lamps, pumps, etc.
3. **Metallic Sheathed Cable** : Also known as armored or BX cables, metal-sheathed cables are often used to supply mains electricity or for large appliances. They feature three plain stranded copper wires (one wire for the current, one grounding wire and one neutral wire) that are insulated with cross-linked polyethylene, PVC bedding and a black PVC sheathing. BX cables with steel wire sheathing are often used for outdoor applications and high-stress installations.
4. **Multi-Conductor Cable :** This is a cable type that is commonly used in homes, since it is simple to use and well-insulated. Multi-conductor or multi-core (MC) cables feature more than one conductor, each of which is insulated individually. In addition, an outer insulation layer is added for extra security. Different varieties are used in industries, like the audio multicore 'snake cable' used in the music industry.
5. **Coaxial Cable** : A coaxial (sometimes heliax) cable features a tubular insulating layer that protects an inner conductor which

is further surrounded by a tubular conducting shield, and might also feature an outer sheath for extra insulation. Called 'coaxial' since the two inner shields share the same geometric axis, these cables are normally used for carrying television signals and connecting video equipment

6. **Unshielded Twisted Pair Cable** : Like the name suggests, this type consists of two wires that are twisted together. The individual wires are not insulated, which makes this cable perfect for signal transmission and video applications. Since they are more affordable than coaxial or optical fiber cables, UTP cables are often used in telephones, security cameras and data networks. For indoor use, UTP cables with copper wires or solid copper cores are a popular choice, since they are flexible and can be easily bent for in-wall installation.
7. **Ribbon Cable** : Ribbon cables are often used in computers and peripherals, with various conducting wires that run parallel to each other on a flat plane, leading to a visual resemblance to flat ribbons. These cables are quite flexible and can only handle low voltage applications.
8. **Direct-Buried Cable** : Also known as DBCs, these cables are specially-designed coaxial or bundled fiber-optic cables, which do not require any added sheathing, insulation or piping before being buried underground. They feature a heavy metal core with many layers of banded metal sheathing, heavy rubber coverings, shock-absorbing gel and waterproof wrapped thread-fortified tape. High tolerance to temperature changes, moisture and other environmental factors makes them a popular choice for transmission or communication requirements.

9. **Twin-Lead Cable** : These are flat two-wire cables that are used for transmission between an antenna and receiver, like TV and radio.
10. **Twinaxial Cable** : This is a variant of coaxial cables, which features two inner conductors instead of one and is used for very-short-range high-speed signals.
11. **Paired Cable** : With two individually insulated conductors, this cable is normally used in DC or low-frequency AC applications.
12. **Twisted Pair** : This cable is similar to paired cables, but the inner insulated wires are twisted or intertwined.

## 2. Cable Color Code

Color coding of cable insulation is done to determine active, neutral and earth conductors. The NEC has not prescribed any color for phase/active conductors. Different countries/regions have different cable color coding, and it is essential to know what is applicable in your region. However, active conductors cannot be green/yellow, green, yellow, light blue or black..

## 3. Cable Size

Cable size is the gauge of individual wires within the cable, such as 14, 12, 10 etc. – again, the bigger the number, the smaller the size. The number of wires follows the wire-gauge on a cable. So, 10/3 would indicate the presence of 3 wires of 10-gauge within the cable. Ground wire, if present, is not indicated by this number, and is represented by the letter 'G'. Safety is very important, and if your installation of wires and cables is not proper, it could

lead to accidents. Before you start any electrical project that includes wiring and cabling, you need to obtain permission from your local building inspector. Once the job is done, get the installation inspected for compliance with local codes and regulations.

An electrical cable is an assembly of one or more wires running side by side or bundled, which is used to carry electric current.A cable assembly is the composition of one or more electrical cables and their corresponding connectors.[1] A cable assembly is not necessarily suitable for connecting two devices but can be a partial product (e.g. to be soldered onto a printed circuit board with a connector mounted to the housing). Cable assemblies can also take the form of a cable tree or cable harness, used to connect many terminals together. Electrical cables are used to connect two or more devices, enabling the transfer of electrical signals or power from one device to the other. Cables are used for a wide range of purposes, and each must be tailored for that purpose. Cables are used extensively in electronic devices for power and signal circuits. Long-distance communication takes place over undersea cables. Power cables are used for bulk transmission of alternating and direct current power, especially using high-voltage cable. Electrical cables are extensively used in building wiring for lighting, power and control circuits permanently installed in buildings. Since all the circuit conductors required can be installed in a cable at one time, installation labor is saved compared to certain other wiring methods.

# EXPERIMENT-4

AIM:-VOLTAGE CURRENT MEASUREMENT USING [I] VOLTMETER AND AMMETER [II] MULTIMETER

## MULTIMETER

A MULTIMETER IS A MEASURING INSTRUMENT THAT WE WILL USE FREQUENTLY THROUGHOUT ELECTRICAL EXPERIMENTS. SO IT IS BETTER TO LEARN HOW TO USE A MULTIMETER. A MULTIMETER IS AN ELECTRONIC INSTRUMENT, EVERY ELECTRONIC TECHNICIAN AND ENGINEERS WIDELY USED PIECE OF TEST EQUIPMENT. A MULTIMETER IS MAINLY USED TO MEASURE THE THREE BASIC ELECTRICAL CHARACTERISTICS OF VOLTAGE, CURRENT, AND RESISTANCE. IT CAN ALSO BE USED TO TEST CONTINUITY BETWEEN TWO POINTS IN AN ELECTRICAL CIRCUIT. THIS POST MAINLY INTRODUCES THE BASIC INFORMATION OF MULTIMETERS, APPLICATIONS, AND TYPES OF MULTIMETERS ARE IN. LET'S SEE ALL OF THESE.THE MULTIMETER HAS MULTI FUNCTIONALITIES LIKE, IT ACTS LIKE AMMETER, VOLTMETER, AND OHMMETER. IT IS A HANDHELD DEVICE WITH POSITIVE AND NEGATIVE INDICATOR NEEDLE OVER A NUMERIC LCD DIGITAL DISPLAY. MULTIMETERS CAN BE USED FOR TESTING BATTERIES, HOUSEHOLD WIRING, ELECTRIC MOTORS, AND POWER SUPPLIES.


## Applications:

The applications of ammeter mainly involve in various electrical and electronic projects for components testing and also used in different measurement applications in the multimeter.

1 Temperature and Environmental Applications:- • Low-cost weather station • DMM internal temperature

2 Voltage Measurements:- • High and low-value DC measurement • Peak to Peak and DC average measurement

3 Current Measurements • DC measurement• True RMS AC

4 Resistance Measurement• Micro ohmmeter• Measuring resistance with constant voltage• Measuring resistance with constant current

5 Time and Frequency measurement• Fast frequency• Time measurement

## Types of Multimeters:

There are different types of multimeters like Analog, Digital, and Fluke multimeters.

## Digital Multimeter:

We mostly used multimeter is a digital multimeter (DMM). The DMM performs all functionsfrom AC to DC other than analog. It has two probes positive and negative indicated withblack and red color is shown in the figure. The black probe connected to COM JACK and red probe connected by user requirement to measure ohm, volt, or amperes. The jack marked VΩ and the COM jack on the right of the picture are used for measuring voltages,resistance, and for testing a diode. The two jacks are utilized when an LCD that shows what is being measured (volts, ohms, amps, etc.). Overload protection prevents damage tothe meter and the circuit and protects the user.


The Digital Multimeter consists of an LCD, a knob to select various ranges of the three electrical characteristics, an internal circuitry consisting of a signal conditioning circuitry, an analog to digital converter. The PCB consists of concentric rings which are connected or disconnected based on the position of the knob. Thus as the required parameter and the range are selected, the section of the PCB is activated to perform the corresponding measurement. To measure the resistance, current flows from a constant current source through the unknown resistor and the

VOLTAGE ACROSS THE RESISTOR ARE AMPLIFIED AND FED TO AN ANALOG TO DIGITAL CONVERTER AND THE RESULTANT OUTPUT IN FORM OF RESISTANCE IS DISPLAYED ON THE DIGITAL DISPLAY. TO MEASURE AN UNKNOWN AC VOLTAGE, THE VOLTAGE IS FIRST ATTENUATED TO GET THE SUITABLE RANGE AND THEN RECTIFIED TO DC SIGNAL AND THE ANALOG DC SIGNAL IS FED TO A/D CONVERTER TO GET THE DISPLAY, WHICH INDICATES THE RMS VALUE OF THE AC SIGNAL. SIMILARLY TO MEASURE AN AC OR DC, THE UNKNOWN INPUT IS FIRST CONVERTED TO A VOLTAGE SIGNAL AND THEN FED TO AN ANALOG TO DIGITAL CONVERTER TO GET THE DESIRED OUTPUT(WITH RECTIFICATION IN CASE OF AC SIGNAL).

ADVANTAGES OF A DIGITAL MULTIMETER ARE ITS OUTPUT DISPLAY WHICH DIRECTLY SHOWS THE MEASURED VALUE, HIGH ACCURACY, ABILITY TO READ BOTH POSITIVE AND NEGATIVE VALUES.

**ANALOG MULTIMETER**: THE ANALOG MULTIMETER OR VOM (VOLT-OHM-MILLIAMMETER) IS CONSTRUCTED USING A MOVING COIL METER AND A POINTER TO INDICATE THE READING ON THE SCALE. THE MOVING COIL METER CONSISTS OF A COIL WOUND AROUND A DRUM PLACED BETWEEN TWO PERMANENT MAGNETS. AS CURRENT PASSES THROUGH THE COIL, THE MAGNETIC FIELD IS INDUCED IN THE COIL WHICH REACTS WITH THE MAGNETIC FIELD OF THE PERMANENT MAGNETS AND THE RESULTANT FORCE CAUSES THE POINTER ATTACHED TO THE DRUM TO DEFLECT ON THE SCALE, INDICATING THE CURRENT READING. IT ALSO CONSISTS OF SPRINGS ATTACHED TO THE DRUM WHICH PROVIDES AN OPPOSING FORCE TO THE MOTION OF THE DRUM TO CONTROL THE DEFLECTION OF THE POINTER. FOR THE MEASUREMENT OF DC, THE D ARSONVAL MOVEMENT DESCRIBED ABOVE CAN BE DIRECTLY USED. HOWEVER, THE CURRENT TO BE MEASURED

SHOULD BE LESSER THAN THE FULL-SCALE DEFLECTION CURRENT OF THE METER. FOR HIGHER CURRENTS, THE CURRENT DIVIDER RULE IS APPLIED. USING DIFFERENT VALUES OF SHUNT RESISTORS, THE METER CAN ALSO BE USED FOR MULTI-RANGE CURRENT MEASUREMENTS. FOR CURRENT MEASUREMENT, THE INSTRUMENT IS TO BE CONNECTED IN SERIES WITH THE UNKNOWN CURRENT SOURCE. FOR MEASUREMENT OF DC VOLTAGE, A RESISTOR IS CONNECTED IN SERIES WITH THE METER, AND THE METER RESISTANCE IS TAKEN INTO ACCOUNT SUCH THAT THE CURRENT PASSING THROUGH THE RESISTOR IS THE SAME AS THE CURRENT PASSING THROUGH THE METER AND THE WHOLE READING INDICATES THE VOLTAGE READING. FOR VOLTAGE MEASUREMENT, THE INSTRUMENT IS TO BE CONNECTED IN PARALLEL WITH THE UNKNOWN VOLTAGE SOURCE. FOR MULTIRANGE MEASUREMENT, DIFFERENT RESISTORS OF DIFFERENT VALUES CAN BE USED, WHICH ARE CONNECTED IN SERIES WITH THE METER.


FOR MEASUREMENT OF DC VOLTAGE, A RESISTOR IS CONNECTED IN SERIES WITH THE METER, AND THE METER RESISTANCE IS TAKEN INTO ACCOUNT SUCH THAT THE CURRENT PASSING THROUGH THE RESISTOR IS THE SAME AS THE CURRENT PASSING THROUGH THE METER AND THE WHOLE READING INDICATES THE VOLTAGE READING. FOR VOLTAGE MEASUREMENT, THE INSTRUMENT IS TO BE CONNECTED IN PARALLEL WITH THE UNKNOWN VOLTAGE SOURCE. FOR MULTIRANGE MEASUREMENT, DIFFERENT RESISTORS OF DIFFERENT VALUES CAN BE USED, WHICH ARE CONNECTED IN SERIES

WITH THE METER. FOR MEASUREMENT OF RESISTANCE, THE UNKNOWN RESISTANCE IS CONNECTED IN SERIES WITH THE METER AND ACROSS A BATTERY, SUCH THAT THE CURRENT PASSING THROUGH THE METER IS DIRECTLY PROPORTIONAL TO THE UNKNOWN RESISTANCE. FOR AC VOLTAGE OR CURRENT MEASUREMENT, THE SAME PRINCIPLE IS APPLIED, EXCEPT FOR THE FACT THAT THE AC PARAMETER TO BE MEASURED IS FIRST RECTIFIED AND FILTERED TO GET THE DC PARAMETER AND THE METER INDICATES THE RMS VALUE OF THE AC SIGNAL.

ANALOG MULTIMETER ADVANTAGES OF AN ANALOG MULTIMETER ARE THAT IT IS INEXPENSIVE, DOESN'T REQUIRE A BATTERY, CAN MEASURE FLUCTUATIONS IN THE READINGS. THE TWO MAIN FACTORS AFFECTING THE MEASUREMENT ARE SENSITIVITY AND ACCURACY. SENSITIVITY REFERS TO THE RECIPROCAL OF THE FULL-SCALE DEFLECTION CURRENT AND IS MEASURED IN OHMS PER VOLT

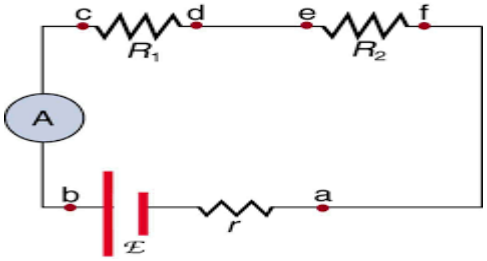
## VOLTMETER AND AMMETER :-

VOLTMETERS AND AMMETERS MEASURE THE VOLTAGE AND CURRENT, RESPECTIVELY, OF A CIRCUIT. SOME METERS IN AUTOMOBILE DASHBOARDS, DIGITAL CAMERAS, CELL PHONES, AND TUNER-AMPLIFIERS ARE VOLTMETERS OR AMMETERS.

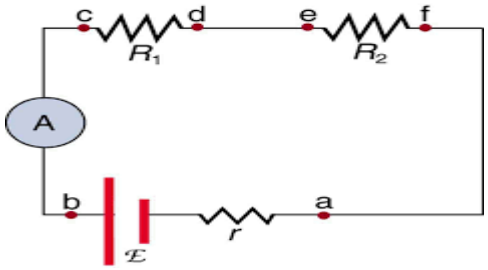
**VOLTMETERS:-** A VOLTMETER IS AN INSTRUMENT THAT MEASURES THE DIFFERENCE IN ELECTRICAL POTENTIAL BETWEEN TWO POINTS IN AN ELECTRIC CIRCUIT. AN ANALOG VOLTMETER MOVES A POINTER ACROSS A SCALE IN PROPORTION TO THE CIRCUIT'S VOLTAGE; A DIGITAL VOLTMETER PROVIDES A NUMERICAL DISPLAY. ANY MEASUREMENT THAT CAN BE

CONVERTED TO VOLTAGE CAN BE DISPLAYED ON A METER THAT IS PROPERLY CALIBRATED; SUCH MEASUREMENTS INCLUDE PRESSURE, TEMPERATURE, AND FLOW.


IN ORDER FOR A VOLTMETER TO MEASURE A DEVICE'S VOLTAGE, IT MUST BE CONNECTED IN PARALLEL TO THAT DEVICE. THIS IS NECESSARY BECAUSE OBJECTS IN PARALLEL EXPERIENCE THE SAME POTENTIAL DIFFERENCE.




**AMMETERS**:- AN AMMETER MEASURES THE ELECTRIC CURRENT IN A CIRCUIT. THE NAME IS DERIVED FROM THE NAME FOR THE SI UNIT FOR ELECTRIC CURRENT, AMPERES (A). IN ORDER FOR AN AMMETER TO MEASURE A DEVICE'S CURRENT, IT MUST BE CONNECTED IN SERIES TO THAT DEVICE. THIS IS NECESSARY BECAUSE OBJECTS IN SERIES EXPERIENCE THE SAME CURRENT. THEY MUST NOT BE CONNECTED TO A VOLTAGE SOURCE — AMMETERS ARE DESIGNED TO WORK UNDER A MINIMAL BURDEN, (WHICH REFERS TO THE VOLTAGE DROP ACROSS THE AMMETER, TYPICALLY A SMALL FRACTION OF A VOLT)




## Galvanometers (Analog Meters) :-

Analog meters have needles that swivel to point at numbers on a scale, as opposed to digital meters, which have numerical readouts.The heart of most analog meters is a device called a galvanometer, denoted by G. Current flow through a galvanometer, IG, produces a proportional movement, or deflection, of the needle. The two crucial characteristics of any galvanometer are its resistance and its current sensitivity. Current sensitivity is the current that gives a full-scale deflection of the galvanometer's needle — in other words, the maximum current that the instrument can measure. By connecting resistors to this galvanometer in different ways, you can use it as either a voltmeter or ammeter to measure a broad range of voltages or currents

Galvanometers as Voltmeters A galvanometer can function as a voltmeter when it is connected in series with a large resistance R. The value of R is determined by the maximum voltage that will be measured. Suppose you want 10 V to produce a full-scale deflection of a voltmeter containing a 25-Ω galvanometer with a 50-mA sensitivity. Then 10 V applied to the meter must produce a current of 50 mA. The total resistance must be:

$R_{TOT}=R+r=\frac{V}{I}=\frac{10V}{50mA}=200k\Omega, R_{TOT}=R+r=\frac{V}{I}=\frac{10V}{50mA}=200k\Omega,$ or: $R=R_{TOT}-r=200k\Omega-25\Omega\approx200k\Omega.$

(R is so large that the galvanometer resistance, r, is nearly negligible. ) Note that 5 V applied to this voltmeter produces a half-scale deflection by sending a 25-mA current through the meter, and so the voltmeter's reading is proportional to voltage, as desired. This voltmeter would not be useful for voltages less than about half a volt, because the meter deflection would be too small to read accurately. For other voltage ranges, other resistances are placed in series with the galvanometer. Many meters allow a choice of scales, which involves switching an appropriate resistance into series with the galvanometer.

## Galvanometers as Ammeters:-

The same galvanometer can also function as an ammeter when it is placed in parallel with a small resistance R, often called the shunt resistance. Since the shunt resistance is small, most of the current passes through it, allowing an ammeter to measure currents much greater than those that would produce a full-scale deflection of the galvanometer.

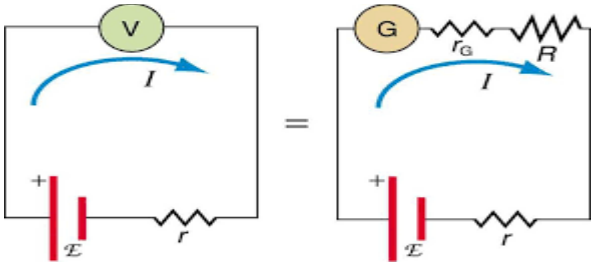
## Null Measurements:-

Null measurements balance voltages so there is no current flowing through the measuring devices that would interfere with the measurement. Standard measurements of voltage and current alter circuits, introducing numerical uncertainties. Voltmeters draw some extra current, whereas ammeters reduce

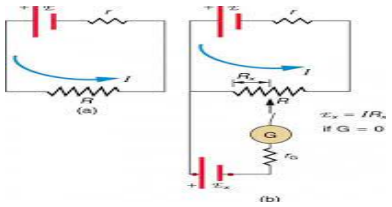
CURRENT FLOW. NULL MEASUREMENTS BALANCE VOLTAGES, SO THERE IS NO CURRENT FLOWING THROUGH THE MEASURING DEVICE AND THE CIRCUIT IS UNALTERED.

## THE POTENTIOMETER:-

WHEN MEASURING THE EMF OF A BATTERY AND CONNECTING THE BATTERY DIRECTLY TO A STANDARD VOLTMETER, AS SHOWN IN, THE ACTUAL QUANTITY MEASURED IS THE TERMINAL VOLTAGE V. VOLTAGE IS RELATED TO THE EMF OF THE BATTERY BY V=EMF−IR, WHERE I IS THE CURRENT THAT FLOWS AND R IS THE INTERNAL RESISTANCE OF THE BATTERY.




THE EMF COULD BE ACCURATELY CALCULATED IF R WERE KNOWN, WHICH IS RARE. IF THE CURRENT I COULD BE MADE ZERO, THEN V=EMF, AND EMF COULD BE DIRECTLY MEASURED. HOWEVER, STANDARD VOLTMETERS NEED A CURRENT TO OPERATE. A POTENTIOMETER IS A NULL MEASUREMENT DEVICE FOR MEASURING POTENTIALS (VOLTAGES). A VOLTAGE SOURCE IS CONNECTED TO RESISTOR R, PASSING A CONSTANT CURRENT THROUGH IT. THERE IS A STEADY DROP IN POTENTIAL (IR DROP) ALONG THE WIRE, SO A VARIABLE POTENTIAL IS OBTAINED THROUGH CONTACT ALONG THE WIRE. CONTACT POINT. SINCE NO CURRENT FLOWS THROUGH THE GALVANOMETER, NONE FLOWS THROUGH THE UNKNOWN EMF, AND EMFX IS SENSED.



STANDARD EMF IS SUBSTITUTED FOR EMFX, AND THE CONTACT POINT IS ADJUSTED UNTIL THE GALVANOMETER READS ZERO, SO THAT EMFS=IRS. IN BOTH CASES, NO CURRENT PASSES THROUGH THE GALVANOMETER. THE CURRENT I THROUGH THE LONG WIRE IS IDENTICAL.

# EXPERIMENT-5

AIM:-TO STUDY THE CURCUITOF A CEILLING FAN.

## INTRODUCTION

AS AN ELECTRICAL ENGINEER, I RECOMMEND EVERY PERSON TO KNOW ABOUT THE **WORKING PRINCIPLE OF A CEILING FAN**, WHICH WILL PIQUE YOUR INTEREST IN LEARNING ABOUT THE ELECTRICAL MOTOR.

THE WORKING PRINCIPLE OUTLINED HERE APPLIES TO ALL CEILING FAN BRANDS, INCLUDING **BAJAJ**, **ORIENT**, AND **KHAITAN** MAKES.

THIS ARTICLE DISCUSSES

1. CONSTRUCTION AND WORKING PRINCIPLE OF THE CEILING FANS,
2. WHAT ARE THE MAJOR PARTS OF CEILING FANS? AND

3. The circuit diagram of a ceiling fan.
4. Why Capacitor is required for ceiling fan.

## What is a Ceiling fan?

The term "ceiling fan" refers to a rotatory electrical device mounted vertically on the ceiling that provides continuous air that our skin can feel.

This ceiling fan rotates and distributes air throughout the room in all directions.

In general, an **energy-efficient** **ceiling fan** uses less power, but they are more expensive.

A typical local ceiling fan consumes a lot of power, ranging from 45 to 70 watts.

## Did you know? (ceiling fan direction)

Ceiling fans made in India rotate anticlockwise, while ceiling fans made in Australia rotate clockwise. This difference is due to the weather and the country's condition. Traditional ceiling fans have been given new designs and structures thanks to modern technology.

## Ceiling fan motor

The ceiling fan's motor is a single-phase induction motor, but due to the following factor, it has a variety of names.

We have all heard of **SINGLE-PHASE INDUCTION MOTORS** and their various types. The ceiling fan is also rotated by a single-phase induction motor.The ceiling fan requires a capacitor because the motor is not self-starting. As a result, the motor is referred to as a capacitor split-phase starting motor.

## Construction of single-phase induction motor

A single-phase induction motor typically has two windings: one for starting and the other for running.

## Other names

Because of the capacitor in the single-phase induction motor of a ceiling fan, it is also known as a "**CAPACITOR SPLIT-PHASE MOTOR**" or capacitor motor.

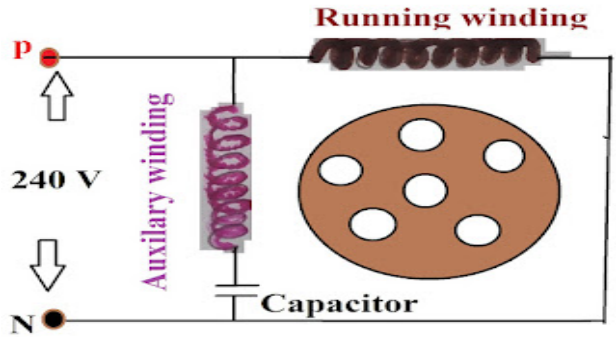
Capacitor split-phase motor is also one type of induction motor consists of main and auxiliary winding.

The capacitor split motor is also called **A SPLIT-PHASE STARTING MOTOR**.

## Ceiling fan circuit diagram

Because the circuit of the capacitor split-phase has only four basic elements, a ceiling fan circuit diagram is simple

TO UNDERSTAND. AS A RESULT, THE ASSEMBLY OF A CEILING FAN IS SIMPLE. THE CEILING FAN CIRCUIT DIAGRAM IS SHOWN BELOW.




THE CIRCUIT DIAGRAM OF THE CEILING FAN HAS THESE THREE IMPORTANT COMPONENTS

1. **MAIN WINDING**
2. **AUXILIARY WINDING**
3. **CAPACITOR OR CONDENSER**
4. **ROTOR**

### WORKING PRINCIPLE OF CEILING FAN

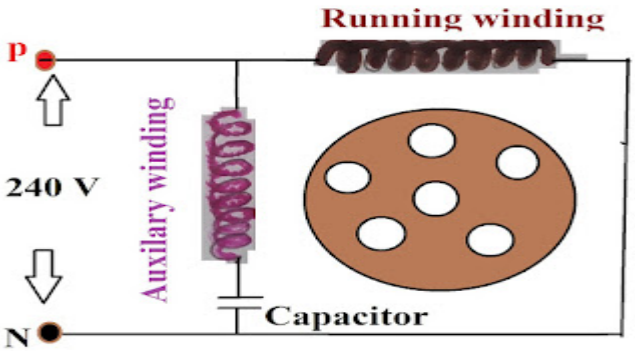
THE CEILING FAN'S OPERATION IS BASED ON THE LAW OF ELECTROMAGNETIC INDUCTION. THE CEILING FAN'S INDUCTION MOTOR CONVERTS ELECTRICAL ENERGY INTO MECHANICAL ENERGY. THE MOTOR REQUIRES A 250V SINGLE-PHASE ALTERNATING CURRENT SUPPLY.

THE CEILING FAN REQUIRES A ROTATING MAGNETIC FIELD FOR THE OPERATION WHICH CAN BE OBTAINED BY ENERGIZING THE COILS OF

THE INDUCTION MOTOR. THE MAIN ISSUE IS THAT A SINGLE-PHASE INDUCTION MOTOR CAN ONLY GENERATE A PULSATING MAGNETIC FIELD IN THE WINDING, NOT A ROTATING MAGNETIC FIELD.

**PULSATING MAGNETIC FIELD** - MAGNETIC FIELD BUILDS IN ONE DIRECTION AND BECOMES ZERO.


RUNNING WINDING REQUIRES A LEADING CURRENT (CURRENT LEADS VOLTAGE) TO CREATE TORQUE (ROTATING FORCE) ON THE ROTOR. THIS IS ACCOMPLISHED BY PERMANENTLY CONNECTING THE START AND RUN TYPE CAPACITOR TO THE AUXILIARY WINDING DURING START AND RUN CONDITIONS.




THE SERIES CAPACITOR PROVIDES A 90 ° PHASE SHIFT TO THE CURRENT AND VOLTAGE. DUE TO VARIATION IN THE PHASE ANGLE

OF CURRENT AND VOLTAGE THE CHANGING MAGNETIC FIELD CREATES TORQUE IN THE ROTOR. THE TORQUE IN THE WIND MOVES THE ROTOR FROM ONE POLE TO THE NEXT POLE.

THE MECHANICAL FORCE OF THE MOTOR EFFICIENTLY UTILIZES THE LAW OF AERODYNAMIC WITH THE HELP OF BLADES ON A CEILING FAN WHICH IS ATTACHED TO THE HOUSING OF THE ROTOR.

A CONCEPT RELATED TO THE WORKING PRINCIPLE OF THE CEILING FAN ARE:

## AERODYNAMIC BEHIND THE AIRFLOW

THE AIR MOVES DOWNWARD AS THE BLADES ROTATE ANTICLOCKWISE. WHEN THE FAN BLADE ROTATES, THE CURVATURE OF THE BLADE COLLIDES WITH THE AIR PARTICLES AND PUSHES THEM DOWNWARD.

## SPEED AND POWER CONSUMPTION

THE MOTOR'S SPEED DETERMINES THE REQUIREMENT OF POWER. THE SPEED OF THE CEILING FAN CAN BE CONTROLLED BY A REGULATOR.

THE VOLTAGE CAN BE ADJUSTED WITH THE HELP OF A REGULATOR.

## FINAL STEADY-STATE SPEED

When full current flows into the winding of the ceiling fan, the steady-state speed of the ceiling fan motor can be attained.

The formula for calculating the final steady speed of the fan

**$N = 120 * F/P$**

***P= No of poles of the stator winding***

***F=Frequency of the supply***

***N=steady speed***

**Components of ceiling fan**

Here I am going to classify the ceiling fan parts into two groups, for better understanding.

1. **Exterior component**
2. **Interior component**

**Exterior components**

The major components of a ceiling fan are its exterior components. The mechanical strength of a ceiling fan is provided by its external components. We can see the component with our own eyes. Its exterior elements are.

1. **Mounting bracket.**

2. **TOP CANOPY AND DOWN CANOPY**

3. **A SHAFT OR CONNECTING ROD**

4. **BLADES AND BRACKET FITTING**

5. **THE TOP COVER AND BOTTOM COVER HOUSING OF THE MOTOR**

## MOUNTING BRACKET

THE MOUNTING BRACKET FUNCTIONS AS A HOLDING ARM, HOLDING THE CEILING FAN VERTICALLY DOWNWARD.

## CEILING FAN BLADES

THE CEILING FAN SHOULD HAVE 3-4 BLADES AND AN ANGLE BETWEEN EACH BLADE SHOULD BE CORRECTLY MAINTAINED ACCORDING TO THE STANDARDS (IEC OR ANY OTHER NATIONAL STANDARDS).THE CEILING FAN BLADES ARE DESIGNED IN ACCORDANCE WITH AERODYNAMIC LAW BECAUSE THEY CREATE AIRFLOW WHEN THE CEILING FAN IS IN MOTION. A SLIGHT DOWNWARD CURVATURE SHOULD BE DESIGNED INTO THE BLADE.

# EXPERIMENT-6

AIM:-TO STUDY AND IMPLEMANT STAIRCASE WIRING USING TWO WAY SWITCHES.

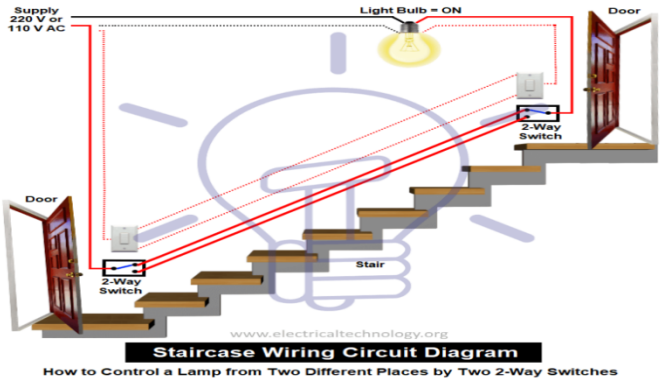
## INTRODUCTION

In today basic electrical wiring installation tutorial, we will discuss step by step method of staircase wiring installation by using 2-way switches (SPDT = Single Pole Double Through Switc). Also, the same wiring circuit diagram can be used for 2-way lighting or controlling electrical appliances from two different places by using two-way switches. The main purpose of two way switching circuit is that the appliances can be ON / OFF independently from any switch, no matter whatever is the current position of the switch.

Table of Contents

## Staircase Wiring Circuit Diagram Connection

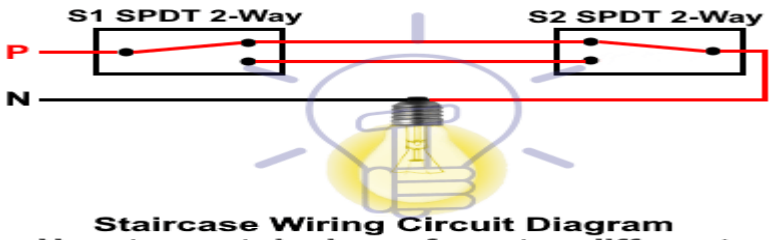
Below is old-school staircase wiring circuit diagram. Here we can control a bulb from two different places by using two 2-way switches.




## Working & Operation of Staircase Wiring – 2-Way Light Switching

Consider the above 2-way switch wiring diagram which has been used to control a bulb in staircase. The schematic shows that circuit is completed and bulb is ON. Suppose you want to OFF the bulb from the upper switch at top of stair ( (upper portion of staircase) ) simply Switch OFF the switch then circuit will break and the bulb will be OFF. To switch ON the bulb again, just switch ON the same switch at upper portion of staircase. In other words you can OFF and ON bulb from upper switch at the top of stair. Obviously; you can perform the same operation from the bottom switches installed in staircase.

Now, let's see how we can do that from the other switch installed at the bottom of stair.




**Staircase Wiring Circuit Diagram**
**How to contol a lamp from twodifferent places by two 2-way switches?**

FOR THIS PURPOSE, CONSIDER THE FIGURE GIVEN ABOVE. IN THIS CASE, YOU CAN SEE THAT CIRCUIT IS COMPLETE AND BULB IS ON. SUPPOSE YOU WANT TO OFF THE BULB FROM THE LOWER SWITCH AT BOTTOM OF STAIR. SIMPLY OFF THE SWITCH, THEN AGAIN CIRCUIT WILL BREAK AND THE BULB WILL BE OFF. YOU CAN SWITCH ON THE BULB AGAIN TO SWITCH ON THE SAME SWITCH INSTALLED AT THE BOTTOM OR DOWNSTAIRS AS SHOWN IN THE FIG.

TO GET THE SWITCHING POSITION IN ON CONDITION FOR LIGHT BULB, THE ABOVE OPERATION IS SAME AS THE EXCLUSIVE-NOR (EX-NOR) LOGIC GATE TRUTH TABLE WHICH IS GIVEN BELOW.

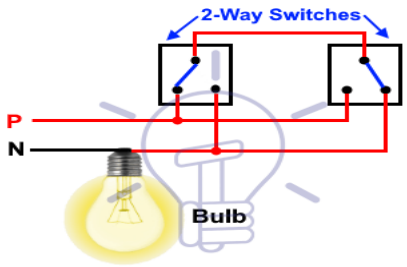
| Switch $_1$ | Switch $_2$ | Lamp Position |
|---|---|---|
| 0 = OFF | 0 = OFF | 1 = ON |
| 0 = OFF | 1 = ON | 0 = OFF |
| 1 = ON | 0 = OFF | 0 = OFF |
| 1 = ON | 1 = ON | 1 = ON |

## TWO WAY SWITCHING CONTROL USING THREE WIRES

IT IS THE NEW 2-WAY SWITCHING CONNECTION METHOD WHICH CAN BE USED FOR STAIRCASE WIRING AS WELL AS IT IS EFFICIENT AS COMPARED TO THE OLD-SCHOOL METHOD WHERE 2 WIRES ARE USED INSTEAD OF THREE WIRES.

THE CURRENT POSITION OF TWO WAY SWITCHING CONNECTION USING THREE WIRES CIRCUIT IS ON AND THE BULB IS GLOWING. THE CIRCUIT OPERATION IS SAME AS MENTIONED IN THE ABOVE FIGURES BUT THE CONNECTION METHOD IS DIFFERENT AS THE FIRST TERMINALS OF BOTH SWITCHES ARE CONNECTED TO THE LIVE (PHASE) WIRE. THE SECOND TERMINALS OF BOTH SWITCHES ARE CONNECTED TO THE BULB TO PROVIDE LIVE LINE SUPPLY WHILE THE NEUTRAL IS DIRECTLY CONNECTED TO THE BULB AS COMMON WIRING METHOD.

THIS BASIC CIRCUIT IS LITTLE CONFUSING AS BY LOOKING IN IT, IT MAKES A SHORT CIRCUIT (TO THE SAME WIRE WHICH IS NOT HARM IN THIS CASE) WHEN BOTH SWITCHES ARE ON OR OFF WHICH IS MAKING A LOOP TO DISCONNECT THE LIVE SUPPLY TO THE BULB, HENCE, BULB WILL NOT GLOW IN THAT CASE



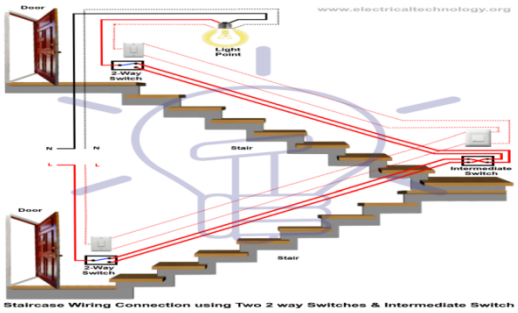
2-Way Light Switching

TO GET THE SWITCHING POSITION IN ON CONDITION FOR LIGHT BULB, THE ABOVE OPERATION IS SAME AS THE EXCLUSIVE-OR (EX-OR) LOGIC GATE TRUTH TABLE WHICH IS GIVEN BELOW.

| **Switch $_1$** | **Switch $_2$** | **Lamp Position** |
|---|---|---|
| 0 = OFF | 0 = OFF | 0 = OFF |
| 0 = OFF | 1 = ON | 1 = ON |
| 1 = ON | 0 = OFF | 1 = ON |
| 1 = ON | 1 = ON | 0 = OFF |

## Staircase Wiring using Intermediate Switch

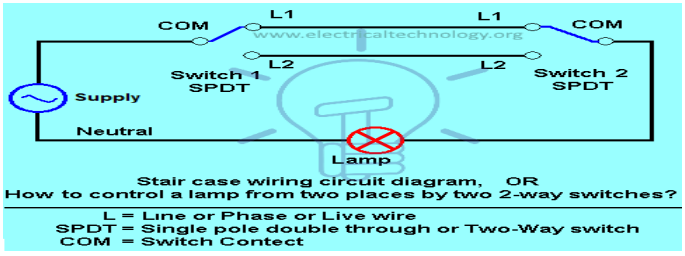
This is not always the case, but in some cases like shared flats and long stairs, we may control the light point in staircase wiring from three different places by using two 2-way switches and an INTERMEDIATE SWITCH as shown in fig below.



Staircase Wiring Connection using Two 2 way Switches & Intermediate Switch

Staircase wiring connection using 2 two way switches and intermediate switch to control a light point from three different places.

## 2-Way Switching Applications and Uses




- The main purpose of two-way switching connection is to connect and control AC appliances and equipments from two separate locations. It is also used in rooms having large area which has two entry and exit gates. It is used to control any electrical (AC or DC) appliance or equipment like fan, light bulbs etc from two different places.

# EXPERIMENT-7

AIM:- MEASURNMENT OF RESISTANCE TO EARTH OF AN ELECTRICAL EQUIPMENT

THERE IS MANY WAY TO MEASURE THE EARTH RESISTANCE BUT WE WILL SEE THE **THREE POINT (FALL-OF-POTENTIAL) METHOD.**

**THREE POINT (FALL-OF-POTENTIAL) METHOD.**

- THE FALL-OF-POTENTIAL METHOD OR THREE-TERMINAL METHOD IS THE MOST COMMON WAY TO MEASURE EARTH ELECTRODE SYSTEM RESISTANCE, BUT IT REQUIRES SPECIAL PROCEDURES WHEN USED TO MEASURE LARGE ELECTRODE SYSTEMS
- THERE ARE THREE BASIC FALL-OF-POTENTIAL TEST METHOD.
- **FULL FALL-OF-POTENTIAL:** A NUMBER OF TESTS ARE MADE AT DIFFERENT SPACES OF POTENTIAL PROBE "P" AND THE RESISTANCE CURVE IS PLOTTED.
- **SIMPLIFIED FALL-OF-POTENTIAL:** THREE MEASUREMENTS ARE MADE AT DEFINED DISTANCE OF POTENTIAL PROBE "P" AND MATHEMATICAL CALCULATIONS ARE USED TO DETERMINE THE RESISTANCE.
- **8% RULE**: A SINGLE MEASUREMENT IS MADE WITH POTENTIAL PROBE "P" AT A DISTANCE 61.8% (62%) OF THE DISTANCE BETWEEN THE ELECTRODE UNDER TEST AND "C".

**REQUIRED EQUIPMENT:**

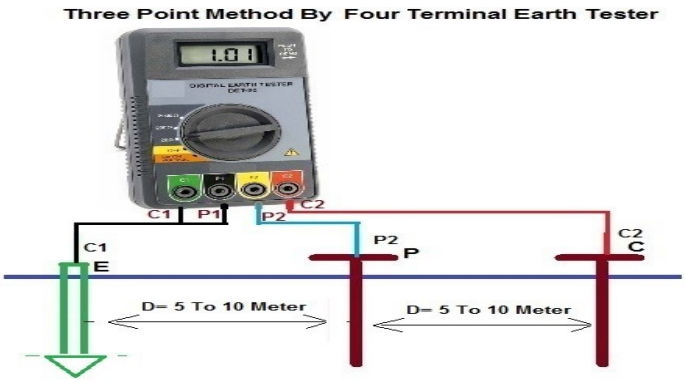
- EARTH TESTER (4 TERMINAL OR 3 TERMINAL)

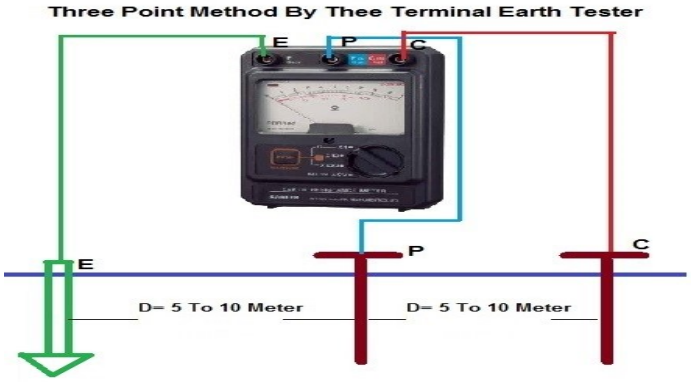
- 4 No's of Electrodes (Spike)
- 4 No's of Insulated Wires
- Hammer
- Measuring Tap

**Connections:**

- First, isolate the grounding electrode under measurement by disconnecting it from the rest of the system.
- **For Small System:**
- For 4 Terminal Earth Tester Short Current Terminal **(C1)** and Potential Terminal **(P1)** together with a short jumper on the earth tester and connect it to earthing electrode under test.
- For 3 Terminal Earth Tester Connect current terminal **(C1)** to the earth electrode under measurement.
- Drive another Current Electrode **(C2)** into the earth 100 to 200 feet at depth of 6 to 12 inches from the center of the electrode and connect to **C2** Terminal of earth tester.
- Drive another potential terminal **(P2)** at depth of 6 to 12 inches into the earth midway between the Current Electrode **(C1)** and Current Electrode **(C2)** and connect to Earth Tester on **P2**
- **For Large System**
- Place the current electrode **(C2)** 400 to 600 feet from the measuring Earth Current Electrode **(C1)**

- PLACE THE POTENTIAL ELECTRODE **(P1)**8% OF THE DISTANCE FROM THE EARTH CURRENT ELECTRODE (C1)
- MEASURE THE RESISTANCE
- MOVE THE CURRENT ELECTRODE (C2) FARTHER 50 TO 100 FEET AWAY FROM ITS PRESENT POSITION.
- PLACE THE POTENTIAL ELECTRODE (P2) 61.8% OF THE DISTANCE FROM THE EARTH CURRENT ELECTRODE (C1).
- SPIKE LENGTH IN THE EARTH SHOULD NOT BE MORE THAN 1/20TH DISTANCE BETWEEN TWO SPIKES.




**TESTING PROCEDURE:**

- Press START and read out the resistance value. This is the actual value of the ground electrode under test.
- Move the potential electrode 10 feet farther away from the electrode and make a second Measurement.
- Move the potential probe 10 feet closer to the electrode and make a third measurement.
- If the three measurements agree with each other within a few percent of their average, then the average of the three measurements may be used as the electrode resistance.
- If the three measurements disagree by more than a few percent from their average, then additional measurement procedures are required.
- The electrode center location seldom is known. In this case, at least three sets of measurements are made, each with the current probe a different distance from the electrode, preferably in different directions.
- When space is not available and it prevent measurements in different directions, suitable measurements can be made by moving the current probe in a line away from or closer to the electrode.
- For example, the measurement may be made with the current probe located 200, 300 and 400 feet along a line from the electrode.

- Each set of measurements involves placing the current probe and then moving the potential probe in 10 feet increments toward or away from the electrode.
- The starting point is not critical but should be 20 to 30 feet from the electrode connection point, in which case the potential probe is moved in 10 feet increments toward the current probe, or 20 to 30 feet from the current probe, in which case the potential probe is moved in 10 feet increments back toward the electrode.
- The spacing between successive potential probe locations is not particularly critical, and does not have to be 10 feet, as long as the measurements are taken at equal intervals along a line between the electrode connection and the current probe.
- Larger spacing means quicker measurements with fewer data points. Smaller spacing means more data points with slower measurements.
- Once all measurements have been made, the data is plotted with the distance from the electrode on the horizontal scale and the measured resistance on the vertical scale.

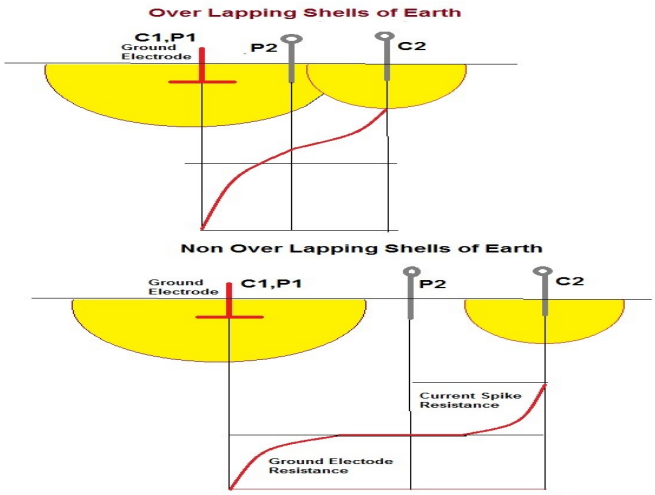
## Importance of Position of Current Electrode (C2):

- **Fall-of-Potential measurements are based on the distance of the current and potential probes from the center of the electrode under test.**

- For highest degree of accuracy, it is necessary that the probe is placed outside the sphere of influence of the ground electrode under test and the auxiliary earth.
- If we Place Current Electrode (C2) too near to Earth Electrode (C1) then the sphere of influence, the effective areas of resistance will overlap and invalidate measurements taken.
- For the accurate results and to ensure that the ground stakes are outside the spheres of influence.
- Reposition the inner Potation Electrode (P1) 1meter in either direction and take a fresh measurement. If there is a significant change in the reading (30 %), we need to increase the distance between the ground rod under test, the inner stake (probe) and the outer stake (auxiliary ground) until the measured values remain fairly constant when repositioning the inner stake (probe).
- **The best distance for the current probe is at least 10 to 20 times the largest dimension of the electrode.**
- The table is a guide for appropriately setting the probe (inner stake) and

| Distance of Probe | | |
|---|---|---|
| **Depth of the ground electrode** | **Distance to the inner stake** | **Distance to the outer stake** |
| 2m | 15 | 24m |
| 3m | 20 | 30m |
| 6m | 25 | 40m |
| 10m | 30 | 50m |

- AUXILIARY GROUND (OUTER STAKE).




**APPLICATION:**

- IT IS ADVISABLE FOR HIGH ELECTRICAL LOAD.
- IT IS SUITABLE FOR SMALL AND MEDIUM ELECTRODES SYSTEM (1 OR 2 RODS/PLATES). .
- IT IS USEFUL FOR HOMOGENEOUS SOIL

**ADVANTAGE:**

- THE THREE-POINT METHOD IS THE MOST RELIABLE TEST METHOD;
- THIS TEST IS THE MOST SUITABLE TEST FOR LARGE GROUNDING SYSTEMS.
- THREE-TERMINAL IS THE QUICKER AND SIMPLER, WITH ONE LESS LEAD TO STRING SPACING FOR CURRENT PROBE

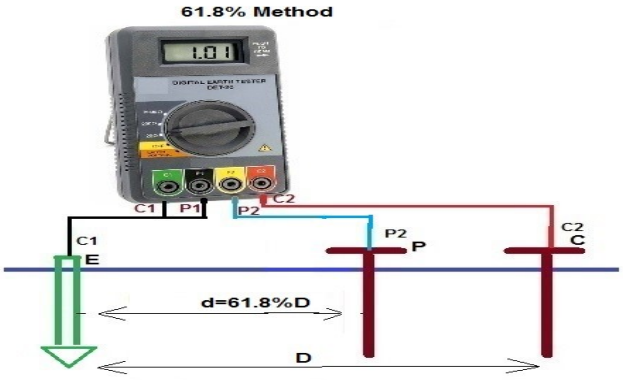
**DISADVANTAGE:**

- INDIVIDUAL GROUND ELECTRODES MUST BE DISCONNECTED FROM THE SYSTEM TO BE MEASURED.

- It is extremely time consuming and labor intensive.
- There are situations where disconnection is not possible.
- Knowledge of location of center probe is necessary

## 61.8% Rule:

- It is proven that the actual electrode resistance is measured when the potential probe is located 61.8% of the distance between the center of the electrode and the current probe. For example, if the current probe is located 400 feet from the electrode center, then the resistance can be measured with the potential probe located 61.8% x 400 = 247 feet from the electrode center.
- The 61.8% measurement point assumes the current and potential probes are located in a straight line and the soil is homogeneous (same type of soil surrounding the electrode area and to a depth equal to 10 times the largest electrode dimension).
- The 61.8% measurement point still provides suitable accuracy for most measurements.



**APPLICATION:**

- IT IS SUITABLE FOR SMALL AND MEDIUM ELECTRODES SYSTEM.
- IT IS USEFUL FOR HOMOGENEOUS SOIL

**ADVANTAGE:**

- SIMPLEST TO CARRY OUT.
- REQUIRED MINIMUM CALCULATION;
- FEWEST NUMBER OF TEST PROBE MOVES.

**DISADVANTAGE:**

- SOIL MUST BE HOMOGENEOUS.
- LESS ACCURATE
- SUSCEPTIBLE FOR NON-HOMOGENEOUS SOIL

# EXPERIMENT-8

AIM:-MEASUREMENT OF ENERGY USING SINGLE PHASE ENERGY METER.

**APPARATUS:** - ONE SINGLE PHASE ENERGY METER, ONE SINGLE PHASE LOAD, STOP WATCH AND CONNECTING WIRES.

**THEORY**: - ENERGY METER IS AN INSTRUMENT WHICH MEASURES ELECTRICAL ENERGY. IT IS ALSO KNOWN AS WATT-HOUR (WH) METER. IT IS AN INTEGRATING DEVICE. THERE ARE SEVERAL TYPES OF ENERGY METERS SINGLE PHASE INDUCTION TYPE ENERGY METER ARE VERY COMMONLY USED TO MEASURE ELECTRICAL ENERGY CONSUMED IN DOMESTIC AND COMMERCIAL INSTALLATION. ELECTRICAL ENERGY IS MEASURED IN KILO WATT-HOURS (KWH) BY THIS ENERGY METER.

**CONSTRUCTION:** - A SINGLE PHASE INDUCTION TYPE ENERGY METER CONSISTS OF DRIVING SYSTEM, MOVING SYSTEM, BRAKING SYSTEM AND REGISTERING SYSTEM. EACH OF THE SYSTEMS IS BRIEFLY EXPLAINED BELOW.

**DRIVING SYSTEM**: - THIS SYSTEM OF THE ENERGY METER CONSISTS OF TWO SILICON STEEL LAMINATED ELECTROMAGNETS. M1 & M2 AS SHOWN IN FIG.1THE ELECTROMAGNET M1 IS CALLED THE SERIES MAGNET AND THE ELECTROMAGNET M2 IS CALLED THE SHUNT MAGNET. THE SERIES MAGNET M1 CARRIES A COIL CONSISTING OF A FEW TURNS

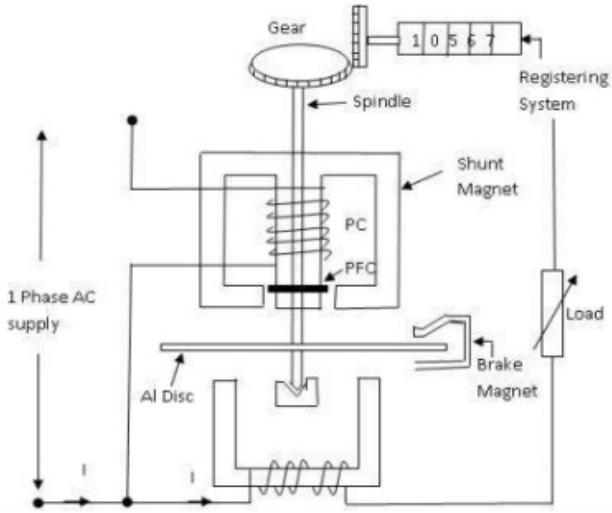
OF THICK WIRE. THIS COIL IS CALLED THE CURRENT COIL (CC) AND IT IS CONNECTED IN SERIES WITH THE CIRCUIT. THE LOAD CURRENT FLOWS THROUGH THIS COIL. THE SHUNT MAGNET M2 CARRIES A COIL CONSISTING MANY TURNS OF THIN WIRE. THIS COIL IS CALLED THE VOLTAGE COIL (VC) AND IS CONNECTED ACROSS THE SUPPLY IT CONSIST OF CURRENT PROPORTIONAL TO THE SUPPLY VOLTAGE. SHORT CIRCUITED COPPER BANDS ARE PROVIDED ON THE LOWER PART OF THE CENTRAL LIMB OF THE SHUNT MAGNET. BY ADJUSTING THE POSITION OF THESE LOOPS THE SHUNT MAGNET FLUX CAN BE MADE TO LAG BEHIND THE SUPPLY VOLTAGE EXACTLY 90° . THESE COPPER BANDS ARE CALLED POWER FACTOR COMPENSATOR (PFC). A COPPER SHADING BAND IS PROVIDED ON EACH OUTER LIMB OF THE SHUNT MAGNET (FC1 &FC2) THESE BAND PROVIDES FRICTIONAL COMPENSATION.

**MOVING SYSTEM**: - THE MOVING SYSTEM CONSISTS OF A THIN ALUMINUM DISC MOUNTED ON A SPINDLE AND IS PLACED IN THE AIR GAP BETWEEN THE SERIES AND THE SHUNT MAGNETS. IT CUTS THE FLUX OF BOTH THE MAGNET FORCES ARE PRODUCED BY THE FLUXES OF EACH OF THE MAGNETS WITH THE EDDY CURRENT INDUCED IN THE DISC BY THE FLUX OF THE OTHER MAGNETS. BOTH THESE FORCES ACT ON THE DISC. THESE TWO FORCES CONSTITUTE A DEFLECTING TORQUE.

**BRAKING SYSTEM:** - THE BRAKING SYSTEM CONSISTS OF A PERMANENT MAGNET CALLED BRAKE MAGNET. IT IS PLACED NEAR THE EDGE OF THE DISC AS THE DISC ROTATES IN THE FIELD OF BRAKE MAGNET EDDY

CURRENT ARE INDUCED IN IT. THESE EDDIES CURRENT REACT WITH THE FLUX AND EXERT A TORQUE. THIS TORQUE ACTS IN DIRECTION SO THAT IT OPPOSES THE MOTION OF DISC. THE BRAKING TORQUE IS PROPORTIONAL TO THE SPEED OF THE DISC.

**REGISTERING SYSTEM**: - THE DISC SPINDLE IS CONNECTED TO A COUNTING MECHANISM THIS MECHANISM RECORDS A NUMBER WHICH IS PROPORTIONAL TO THE NUMBER OF REVOLUTIONS OF THE DISC THE COUNTER IS CALIBRATED TO INDICATE THE ENERGY CONSUMED DIRECTLY IN KILO WATTS-HOUR (KWH)



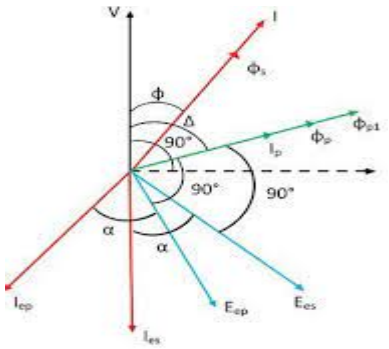

1 FC1 = FRICTION COMPENSATORS

PFC = POWER FACTOR COMPENSATOR

CC = CURRENT COIL

VC = VOLTAGE COIL

WORKING:- LET V=SUPPLY VOLTAGE I=LOAD CURRENT LAGGING BEHIND V BY Φ COS Φ = LOAD POWER FACTOR (LAGGING) ISH= CURRENT SETUP BY ΦSH IN DISC ISE= CURRENT SETUP BY ΦSE IN DISC.




Phasor Diagram of Energy Meter

TD ∝ (ΨSHISE-ΨSEISH) WHERE Ψ & I ARE INSTANTANEOUS VALUES AVERAGE DEFLECTING TOQUE

TD ∝ [ΦSHISECOSΦ – ΦSEISHCOS(180-Φ)] WHERE Φ & I ARE RMS VALUES

TD ∝ [ΦSHISECOSΦ + ΦSEISHCOSΦ]

TD ∝ [ΦSHISE +ΦSEISH] COSΦ

WE KNOW ΦSH ∝ V, ISE ∝ I, ΦSE ∝ I, ISH ∝ V

SO

TD ∝ [VI+VI] COSΦ

TD ∝ VICOSΦ

∝ POWER

NO OF REVOLUTION MADE IN T SEC

$\int$ T NDT 0 $\propto$ $\int$ T PDT 0 $\propto$ ENERGY CONSUMED IN T SEC

METER CONSTANT

$$K = \frac{No\ of\ Revolution\ made}{KWh}$$

**CALCULATIONS**:- METER CONSTANT K= ENERGY CALCULATED = K N KWH = KWH = KWH

RESULTS: - STUDY HAS BEEN DONE ON 1 PHASE ENERGY METER AND VERIFICATION OF ENERGY IS DONE AS SHOWN IN THE ABOVE OBSERVATION TABLE

**PRECAUTIONS**:- (I) CONNECTION SHOULD BE TIGHT. (II) VOLTAGE AND CURRENT SHOULD NOT EXCEED THE RATED ONE.

# EXPERIMENT-9

AIM:- TO STUDY AND OBSERVE WORKING OF a)FLUORESCENT TUBE LIGHT WITH AND WITHOUT STARTER b) COMPACT FLUORESCENT LIGHT (CFL) c) STUDY OF MERCURY VAPOUR LAMP AND SODIUM VAPOUR LAMP.

## A COMPACT FLUORESCENT LAMP (CFL)

A COMPACT FLUORESCENT LAMP (CFL), ALSO CALLED COMPACT FLUORESCENT LIGHT, ENERGY-SAVING LIGHT AND COMPACT FLUORESCENT TUBE, IS A FLUORESCENT LAMP DESIGNED TO REPLACE AN INCANDESCENT LIGHT BULB; SOME TYPES FIT INTO LIGHT FIXTURES DESIGNED FOR INCANDESCENT BULBS. THE LAMPS USE A TUBE THAT IS CURVED OR FOLDED TO FIT INTO THE SPACE OF AN INCANDESCENT BULB, AND A COMPACT ELECTRONIC BALLAST IN THE BASE OF THE LAMP.

COMPARED TO GENERAL-SERVICE INCANDESCENT LAMPS GIVING THE SAME AMOUNT OF VISIBLE LIGHT, CFLS USE ONE-FIFTH TO ONE-THIRD THE ELECTRIC POWER, AND LAST EIGHT TO FIFTEEN TIMES LONGER. A CFL HAS A HIGHER PURCHASE PRICE THAN AN INCANDESCENT LAMP, BUT CAN SAVE OVER FIVE TIMES ITS PURCHASE PRICE IN ELECTRICITY COSTS OVER THE LAMP'S LIFETIME.[1] LIKE ALL FLUORESCENT LAMPS, CFLS CONTAIN TOXIC MERCURY,[2] WHICH COMPLICATES THEIR

DISPOSAL. IN MANY COUNTRIES, GOVERNMENTS HAVE BANNED THE DISPOSAL OF CFLS TOGETHER WITH REGULAR GARBAGE. THESE COUNTRIES HAVE ESTABLISHED SPECIAL COLLECTION SYSTEMS FOR CFLS AND OTHER HAZARDOUS WASTE.

## APPLICATIONS

COMPACT FLUORESCENTS ARE BEING USED IN RESIDENTIAL APPLICATIONS REPLACING INCANDESCENT AND HALOGEN LIGHTS. THEY PROVIDE RELATIVELY SHADOW-FREE LIGHTING IN RESIDENTIAL APPLICATIONS AND BECAUSE OF THEIR SMALL SIZE CAN FIT NICELY INTO SCONCES, CEILING LIGHTS AND TABLE LAMPS.THE LUMEN OUTPUT OF A COMPACT FLUORESCENT BULB IS QUITE HIGH COMPARED TO INCANDESCENT LIGHT SOURCES THAT USE A LOT MORE ENERGY. IN COMMERCIAL APPLICATIONS COMPACT FLUORESCENTS ARE EXTREMELY POPULAR FOR HALLWAY SCONCES IN HOTELS AND CONDOMINIUM ASSOCIATIONS AS WELL AS RECESSED LIGHTS IN OFFICES. THEY HAVE AN AVERAGE 10,000 HOUR LIFE COMPARED TO AN AVERAGE OF 2000 HOURS FOR STANDARD HALOGEN LIGHTS. COMPACT FLUORESCENT EMIT A CRISP, BRIGHT LIGHT THAT IS WELL-SUITED FOR DETAILED TASK WORK AS WELL AS AMBIENT LIGHTING.MANY WAREHOUSES AND OUTDOOR SECURITY LIGHTS ARE BEING RETROFITTED WITH LARGE, HIGH WATTAGE COMPACT FLUROESCENT BULBS THAT CAN EVEN REPLACE 250W METAL HALIDE BULBS IN WAREHOUSE FIXTURES OR PARKING GARAGE CEILING LIGHTS. COMPACT FLUORESCENT BULBS ARE NOW

AVAILABLE FROM AS LOW AS 5 WATT MINI CFLS TO AS HIGH AS 105 WATT LARGE (12 INCH) CFLS.

### ADVANTAGES / PRO'S

- ENERGY STAR QUALIFIED CFLS USE AT LEAST TWO-THIRDS LESS ENERGY THAN STANDARD INCANDESCENT BULBS
- CFLS CAN LAST ABOUT 6 TIMES LONGER (AVERAGE LIFESPAN OF A CFL IS FIVE TO SIX YEARS).
- CFLS SAVE $30 OR MORE IN ENERGY COSTS OVER EACH BULB'S LIFETIME.
- CFLS PRODUCE 70 PERCENT LESS HEAT, MAKING THEM SAFER TO OPERATE.

### DISADVANTAGES

- SKIN CANCER RISK, DUE TO LEAKING UV RADIATION, IS A CONCERN, WHICH ONLY CAME TO LIGHT (SO TO SPEAK) IN JULY 2012.
- LIKE ALL FLUORESCENT LAMPS, CFLS CONTAIN MERCURY, WHICH COMPLICATES THEIR DISPOSAL AND IF THE BULBS ARE BROKEN INDOORS, DOES PRESENT A HEALTH RISK, ESPECIALLY TO SMALL CHILDREN.

## STUDY OF MERCURY VAPOUR LAMP AND SODIUM VAPOUR LAMP

## MERCURY VAPOUR LAMP

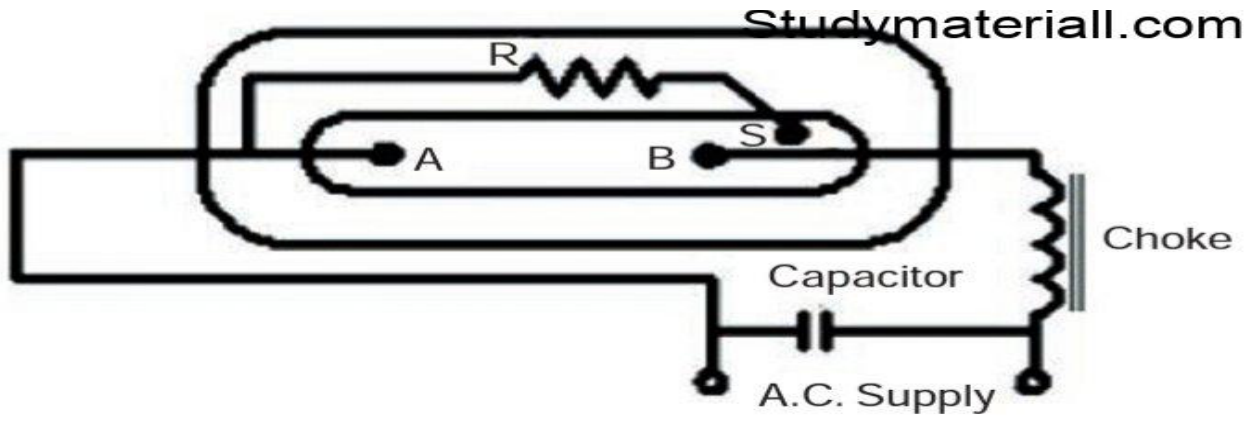
ON THE BASIS OF PRESSURE INSIDE THE DISCHARGE TUBE, THE MERCURY VAPOUR LAMPS ARE CLASSIFIED AS HIGH PRESSURE MERCURY VAPOUR LAMP AND LOW PRESSURE MERCURY VAPOUR LAMP. HIGH PRESSURE MERCURY VAPOUR LAMPS ARE CLASSIFIED AS:

1. MA TYPE (MERCURY VAPOUR LAMP WITH AUXILIARY ELECTRODE) THESE ARE OPERATED AT 220 - 250 VOLT, AC SUPPLY AND MANUFACTURED IN 250 TO 400 WATTS.

2. MAT TYPE (MERCURY VAPOUR LAMP WITH TUNGSTEN FILAMENT) THESE ARE MANUFACTURED BETWEEN 300 TO 500 WATTS AND WORKS AT 200 TO 250V (BOTH AC AND DC)

3. MB TYPE (MERCURY VAPOUR LAMP WITH AUXILIARY ELECTRODE AND BAYONET CAP) THIS TYPE IS OPERATED AT 200 – 250 VOLT, (AC AND MADE IN 80 WATTS AND 125 WATTS)

A. CONSTRUCTION



IT CONSISTS OF HARD GLASS TUBE ENCLOSED IN OUTER BULB OF ORDINARY GLASS. THE SPACE BETWEEN TWO BULB IS COMPLETELY EVACUATED TO PREVENT HEAT LOSS BY CONVECTION FROM THE INNER BULB. THE OUTER BULB ABSORBS HARMFUL ULTRAVIOLET RAYS. THE INNER BULB CONTAINS ARGON GAS WITH A CERTAIN QUANTITY OF MERCURY. IN ADDITION TO TWO ELECTRODES, STARTING ELECTRODE HAVING HIGH RESISTANCE, CONNECTED IN SERIES IS ALSO PROVIDED. THE MAIN ELECTRODES ARE MADE OF TUNGSTEN WIRE IN A HELICAL SHAPE. THE LAMP HAS A SCREWED CAP AND IS CONNECTED TO SUPPLY WITH A CHOKE. A CAPACITOR IS CONNECTED ACROSS SUPPLY TO IMPROVE POWER FACTOR.

B. WORKING PRINCIPLE

THE TUBE WHEN THE SUPPLY IS SWITCHED ON, FULL VOLTAGE IS APPLIED ACROSS MAIN AND STARTING ELECTRODES. THIS VOLTAGE FILLS THE GAP BETWEEN THE ELECTRODES AND DISCHARGE THROUGH ARGON GAS. AS THE LAMP WARMS UP, MERCURY IS VAPORIZED, WHICH INCREASES THE VAPOUR PRESSURE. AFTER 5 MINUTES, THE LAMP GIVES FULL LIGHT. IT GIVES A GREENISH BLUE COLOUR LIGHT. THIS LAMP IS ALWAYS KEPT IN VERTICAL. OTHERWISE THE INNER GLASS TUBE MAY BREAK DUE TO EXCESS HEAT.

C. ADVANTAGES

1. MERCURY VAPOUR LAMPS ARE MORE ENERGY EFFICIENT THAN INCANDESCENT LAMPS.

2. It has high luminous efficacies of 35 to 65 lumens / watt.

3. It is durable. (in the range of 24,000 hours)

4. It has a high intensity.

5. It gives clear white light output which has made them ideal for outdoor use

d. Applications

1. Mercury vapour lamps are used in lighting applications.

2. It is used in streets and parking places.

3. It is used for landscape lighting.

4. It is used in factories.

5. It is used in gymnasiums.

## Sodium vapour lamp

Sodium vapour lamps are some of the most efficient lamps in the world. They have an efficiency of up to 190 lumens per watt compared to an incandescent street lamp which has between 15 and 19 lumens per watt.

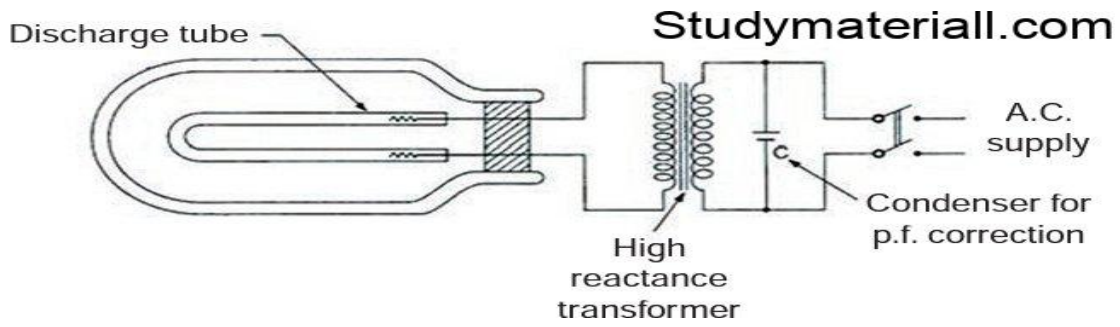
This sodium vapour lamps comes in two major groups:

1. High pressure sodium vapour lamps (HPS)

## 2. Low pressure sodium vapour lamps (LPS)

This lamp consists of discharge tube made from special heat resistance glass, containing a small amount of metallic sodium, neon gas and two electrodes. Neon gas is added to start the discharge and to develop enough heat to vapour sodium. A long tube is required to get more light from this lamp. To reduce overall dimensions of the lamp, the tube is generally bent into U-shape.

### a. Working principle




The construction of sodium vapour lamp is Electric discharge lamps require a high voltage at start and a low voltage during operation. The tungsten-coated electrodes are connected across auto-transformer, having high leakage reactance. The open-circuit voltage of this transformer is about 450 V which is sufficient to initiate a discharge through the neon gas. After 10 to 15 minutes, the voltage falls to 150 V, due to low power factor. A

CAPACITOR IS CONNECTED ACROSS THE SUPPLY TO IMPROVE THE POWER FACTOR. THE COLOUR OF LIGHT PRODUCED IS YELLOWISH.

B. APPLICATIONS

1. LPS LAMPS ARE RARELY USED FOR INDOOR LIGHTING AND ARE BEST SUITED FOR OUTDOOR LIGHTING.

2. LPS LAMPS ARE USED IN SECURITY LIGHTING AS THEIR HIGH EFFICIENCY.

3. LPS LAMPS ARE ALSO OFTEN USED IN LONG TUNNELS.

## ADVANTAGES:

- MOST ENERGY EFFICIENT AMONG ALL ARTIFICIAL LIGHT SOURCES.
- VERY LONG LIFE SPAN UP TO 50000 HOURS.
- COLOR TEMPERATURE IS ALWAYS WARM
- THEY ARE IDEAL FOR USING AT AIRPORTS, SEAPORTS, STREETS, RAILWAY MARSHALLING YARD AND CROSSINGS ETC.

## DISADVANTAGES:

- ONLY MONOCHROMATIC COLOR.
- BAD COLOR RENDERING INDEX
- UNUSABLE FOR COLOR RECOGNITION PLACES.
- SODIUM IS HAZARDOUS AND CAN CATCH FIRE IN CONTACT OF AIR.

# EXPERIMENT-10

## AIM:-TO STUDY RESIDENTIAL HOUSE WIRING USING FUSE,SWITCH,INDICATOR,LAMP AND ENERGY METER

### ELECTRICAL WIRING:

**ELECTRICAL WIRING** IN GENERAL REFERS TO INSULATED CONDUCTORS USED TO CARRY ELECTRICITY. MATERIALS FOR WIRING INTERIOR ELECTRICAL SYSTEMS IN BUILDINGS VARY DEPENDING ON:

- INTENDED USE AND AMOUNT OF POWER NEEDED OF THE CIRCUIT
- TYPE OF OCCUPANCY AND SIZE OF THE BUILDING
- NATIONAL AND LOCAL REGULATIONS
- ENVIRONMENT IN WHICH THE WIRING MUST OPERATE.

WIRING SYSTEMS IN A SINGLE FAMILY HOME OR DUPLEX, FOR EXAMPLE, ARE SIMPLE, WITH RELATIVELY LOW POWER REQUIREMENTS, INFREQUENT CHANGES TO THE BUILDING STRUCTURE AND LAYOUT, USUALLY WITH DRY, MODERATE TEMPERATURE, AND NON CORROSIVE ENVIRONMENTAL CONDITIONS. IN A LIGHT COMMERCIAL ENVIRONMENT, MORE FREQUENT WIRING CHANGES CAN BE EXPECTED, LARGE APPARATUS MAY BE INSTALLED, AND SPECIAL CONDITIONS OF HEAT OR MOISTURE MAY APPLY.

TYPES OF WIRING SYSTEMS:

1. CLEAT WIRING
2. CASING CAPPING WIRING

3. METAL SHEATHED WIRING

4. CONDUIT WIRING

## RULES FOR ELECTRIC WIRING:

AS PER I.S.I. RULES THE FOLLOWING POINT TO BE NOTED:

1. A.C. AND D.C. CIRCUIT SHOULD BE SEPARATED. 3 PHASES SHOULD BE INDICATED WITH RED, YELLOW AND BLUE COLOUR AND THE NEUTRAL SHOULD BE INDICATED WITH BLACK COLOUR. IN D.C. WE SHOULD BE INDICATE +VE WITH RED, -VE WITH BLUE AND NEUTRAL WITH BLACK.

2. IF THE VOLTAGE EXCEEDS 250 VOLT, THE DISTRIBUTION BOARD AND MAIN SWITCHES SHOULD BE PROVIDED WITH DANGER BOARD SYMBOL.

3. NUMBER OF POINTS SHOULD NOT BE MORE THAN TEN AND TOTAL LOAD IN A CIRCUIT SHOULD NOT EXCEED MORE THAN 800 WATT.

4. CORRECT SIZE OF THE CONDUCTOR SHOULD BE USED, SUCH THAT THE VOLTAGE DROP SHOULD NOT INCREASE MORE THAN 3% OF THE CONNECTED VOLTAGE WHEN FULL LOAD CURRENT IS FOLLOWING.

5. ALL DISTRIBUTION BOARDS SHOULD BE MARKED AS PDB (POWER DISTRIBUTION BOARD) OR LDB (LIGHT DISTRIBUTION BOARD).

6. ALL THE ACCESSORIES SHOULD BE FIXED ON THE ROUND BLOCKS OR BOARD WITH SCREWS.

7. IN THE DOMESTIC WIRING 3-PIN PLUG SHOULD BE USED.

8. ALL THE IRON CLAD APPLIANCES, SWITCHES, ETC., SHOULD BE EARTHED

9. ALL THE SWITCHES SHOULD BE CONNECTED THROUGH LIVE WIRE.

10. ALL SWITCHBOARDS SHOULD BE FIXED AT A HEIGHT OF 1.L5 METERS.

11. ALL THE BOARDS AND SWITCHES SHOULD BE FIXED ON LEFT HAND SIDE OF THE ENTRANCE.

## THE THREE CONDUCTORS:

IN MOST COUNTRIES, HOUSEHOLD POWER IS SINGLE-PHASE ELECTRIC POWER, IN WHICH A SINGLE LIVE CONDUCTOR BRINGS ALTERNATING CURRENT INTO A HOUSE, AND A NEUTRAL RETURNS IT TO THE POWER SUPPLY. MANY PLUGS AND SOCKETS INCLUDE A THIRD CONTACT USED FOR A PROTECTIVE EARTH GROUND, WHICH ONLY CARRIES CURRENT IN CASE OF A FAULT IN THE CONNECTED EQUIPMENT.

- **LIVE OR PHASE**

THE **LIVE** CONDUCTOR (ALSO KNOWN AS **PHASE**, **HOT** OR **ACTIVE**) CARRIES ALTERNATING CURRENT FROM THE POWER SOURCE TO THE EQUIPMENT.

- **NEUTRAL**

THE **NEUTRAL** CONDUCTOR RETURNS CURRENT FROM THE EQUIPMENT BACK TO THE POWER SOURCE OR DISTRIBUTION PANEL. IT IS IN MOST (BUT NOT ALL) CASES REFERENCED TO THE EARTH. EXCEPT UNDER FAULT CONDITIONS IT DOES NOT POSE A DANGER BECAUSE THE VOLTAGE BETWEEN THE NEUTRAL CONTACT AND THE EARTH IS CLOSE TO ZERO, BUT IS NEVERTHELESS TREATED AS LIVE IN MOST INSTALLATION PRACTICES BECAUSE IT CAN DEVELOP A HIGH VOLTAGE UNDER FAULT CONDITIONS.

THE MAIN DANGER POSED BY THE NEUTRAL IS THE VOLTAGE CAN RISE AS HIGH AS THE VOLTAGE ON THE LIVE CONDUCTOR IF A BROKEN NEUTRAL CABLE IN

THE WIRING DISCONNECTS THE NEUTRAL BUT LEAVES THE LIVE CONDUCTOR CONNECTED.

- **EARTH/GROUND**

THE **EARTH** CONTACT (KNOWN AS **GROUND** IN AMERICAN ENGLISH) IS ONLY INTENDED TO CARRY ELECTRIC CURRENT WHEN CONNECTED TO EQUIPMENT THAT HAS DEVELOPED AN INSULATION FAULT. THE EARTH CONNECTION WAS ADDED TO MODERN PLUGS BECAUSE, IF A LIVE WIRE OR OTHER COMPONENT IN A DEVICE TOUCHES THE METAL CASING, ANYBODY TOUCHING THE DEVICE MAY RECEIVE A DANGEROUS ELECTRIC SHOCK. IN MANY COUNTRIES DEVICES WITH METAL CASES MUST HAVE THE CASE CONNECTED TO THE EARTH CONTACT. THIS REDUCES BUT DOES NOT ELIMINATE THE POSSIBILITY OF THE CASE DEVELOPING A HIGH VOLTAGE RELATIVE TO THE EARTH AND GROUNDED METALWORK.

IT IS A COMMON MISCONCEPTION THAT THE PURPOSE OF THE EARTH CONNECTION IS TO TAKE FAULT CURRENTS SAFELY TO EARTH. THE PRIMARY PURPOSE OF THE EARTHING SYSTEM IS TO CAUSE A FUSE TO BLOW OR A BREAKER TO TRIP TO AUTOMATICALLY DISCONNECT THE POWER SUPPLY TO ANY DEVICE OR CABLE WHICH DEVELOPS A WIRING FAULT. THE SECONDARY PURPOSE IS TO HOLD ALL TOUCHABLE METAL IN A HOUSE TO THE SAME VOLTAGE TO PREVENT ELECTRICAL SHOCKS WHEN TOUCHING TWO METAL OBJECTS AT THE SAME TIME. IN ADDITION, SOME EQUIPMENT SUCH AS SURGE PROTECTORS REQUIRED AN EARTH CONNECTION TO FUNCTION PROPERLY BECAUSE THEY OPERATE BY SHORTING THE EXCESS CURRENT TO THE EARTH.

-**-