LABORATORY MANUAL

GXESL106 ELECTRICAL WORKSHOP

Contributing Editors: AKT, MKP

DEPARTMENT OF ELECTRONICS ENGINEERING
MODEL ENGINEERING COLLEGE THRIKKAKARA
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LIST OF EXPERIMENTS

1. a) Demonstrate the precautionary measures / procedure followed in case of an electric shock.

   b) Familiarization of tools and symbols used in Electrical wiring.

   c)Identify the different types of cables, wires, switches, fuses, fuse carriers, MCB, ELCB and MCCB with ratings.

2. Wiring of simple light circuit for controlling light/fan and socket points(PVC conduit wiring)

3. Wiring of light/fan circuit using two-way switches.(Staircase wiring)

4. Wiring of Fluorescent lamps and light sockets(6A)with a power circuit for controlling power device. (16A socket)

5. Wiring of power distribution arrangement using single phase MCB distribution board, ELCB, main switch and Energy meter.

6. Identify different types of batteries with their specifications.

7. Demonstrate the Pipe and Plate Earthing Schemes using Charts/Site visit.

Experiment 1 a)

SAFETY MEASURES

Safety Precautions that we can follow to prevent electric shock

1. Ground all electrical equipments and the work piece.
2. Use approved tools, equipments and protective devices.
3. Read all instructions carefully before using the appliances.
4. Keep tools and equipments clean and in good working condition.
5. Always unplug an appliance before cleaning, or whenever it is not in use. Ensure that you pull by the plug and not by the cord
6. DO NOT operate any appliance with a damaged cord or plug.
7. Use the correct cable size.
8. Make sure that all electrical connections are tight, clean, and dry.
9. Keep dry. Moisture and water can conduct electricity. To prevent shock, it is advised to keep work area, equipment, and clothing dry at all times.
10. Make sure that you are well insulated. Wear dry gloves, rubber-soled shoes, or stand on a dry board or platform.
11. Keep cables and connectors in good condition. Improper or worn electrical connections can cause short circuits and can increase the chance of an electrical shock. Do not use worn, damaged, or bare cables.
12. Avoid keeping a live circuit open. Open-circuits and connections can cause electric shock
13. Do not work under poor lighting conditions or when you are tired.
14. Keep appliances away from heated surfaces and open flames.
15. Check the electric power supply from the switch position.

Electric shock and safety

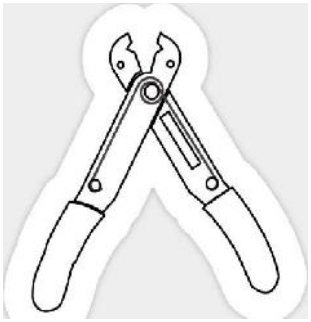
In the event of a shock:

1. Turn off power at the main breaker/ Emergency Breaker.
2. Don't touch the victim until you are certain that there is no live **e**lectricity.
3. If the victim is not breathing, first aid in this regard may be applied
4. If the victim has no pulse, begin CPR.
5. Treat burns with first aid kit.
6. Call an ambulance in case of emergency.

Expriment 1 b)

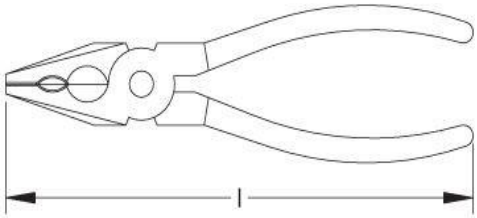
TOOLS USED FOR ELECTRICAL WIRING

WIRE STRIPPERA wire stripper is a small, hand-held device used to strip the electrical insulation from electric wires.



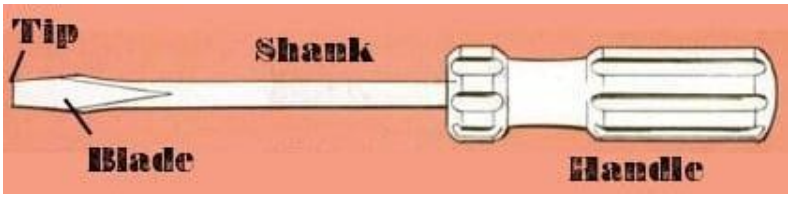
PLIER

Pliers are primarily used for gripping, twisting, bending and cutting wires, cables and small metalwork components.



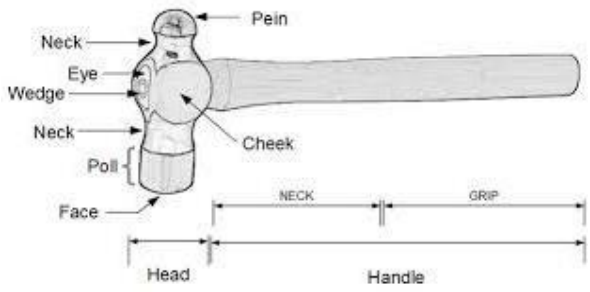
SCREWDRIVERS

Screw drivers are used to tighten screws in the switches and electrical machines. Screw drivers of various sizes are used in practice. Normally screw drivers used in electrical work are insulated.



HAMMERS

Ball peen hammers are commonly used in electrical work where greater power/impact is required for striking



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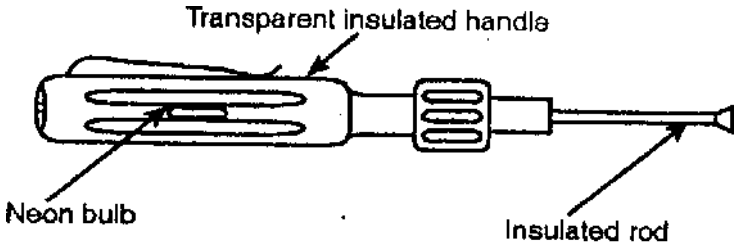
LINE TESTER

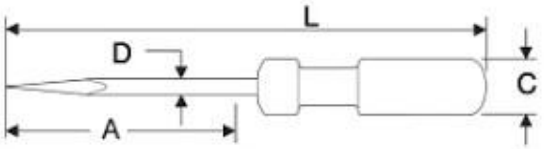
A line tester is used to check the electric supply in the line or phase wire. It has a small neon bulb which indicates the presence of power supply. It can also be used as a screw driver to tighten small screws in switches.



Line Tester

POKER

Poker is a tool used by an electrician tool. Poker is a tool which is used for making hole in wood for screws.

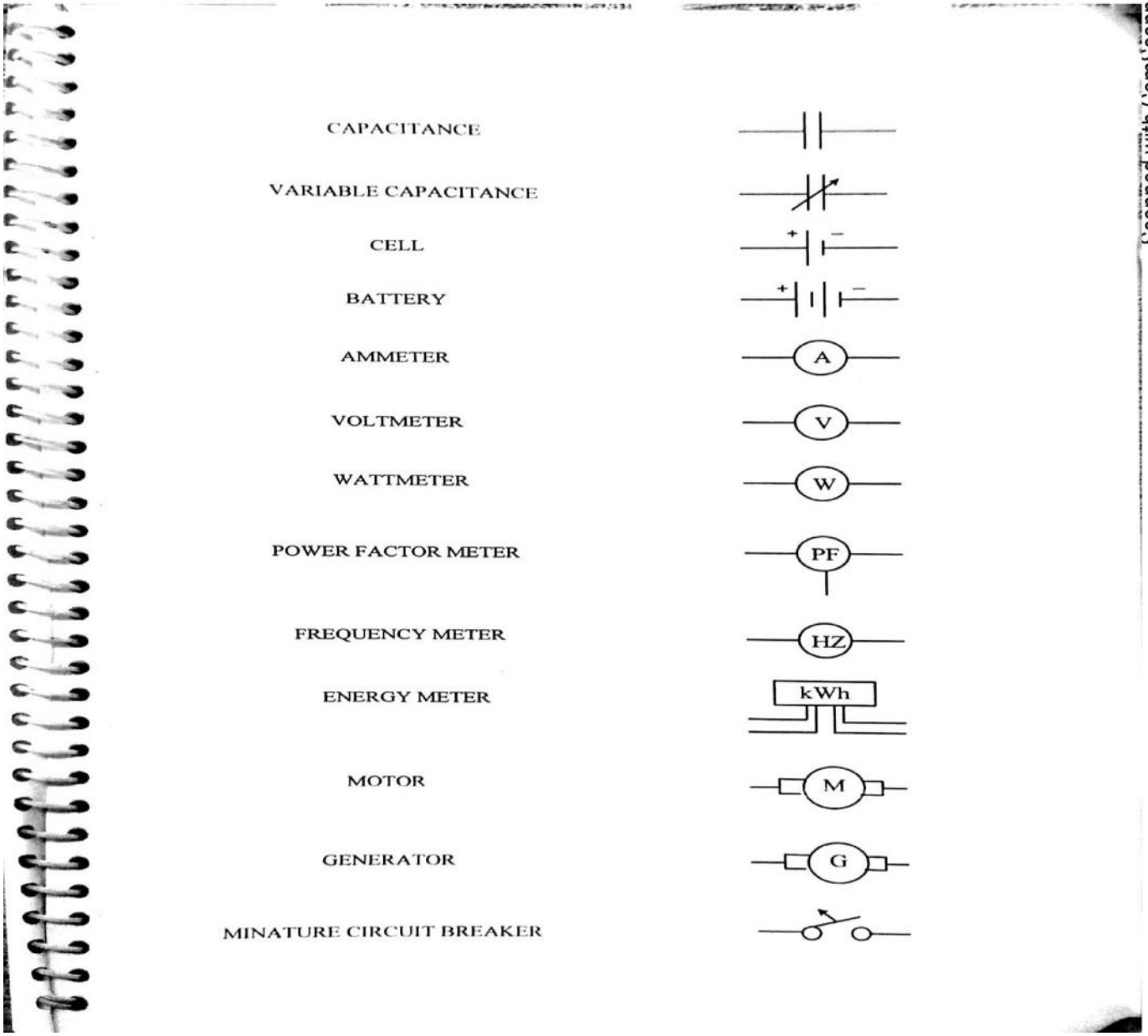


KNIFE

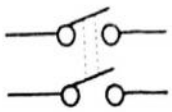
A knife is used to cut cable armor, conduit pipes etc.

GENERAL SYMBOLS USED IN ELECTRICAL CIRCUITS

DIRECT CURRENT	
POSITIVE	
NEGATIVE	
ALTERNATING CURRENT	
PHASE	P
NEUTRAL	N
SINGLE PHASE	1 Φ
THREE PHASE	3 Φ
PHASE SEQUENCE	RYB
CROSSED WIRES	
CONNECTED WIRES	
EARTH	
FUSE	
NEUTRAL LINK	
SINGLE POLE SWITCH	

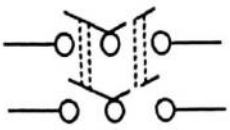


DOUBLE POLE SWITCH

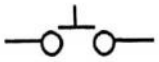


SINGLE POLE
DOUBLETHROW SWITCH

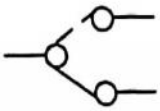
DOUBLE POLE
DOUBLETHROW SWITCH



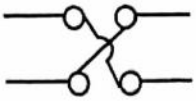
PUSH SWITCH



TWO WAY SWITCH



INTERMEDIATE SWITCH



LAMP

FAN

TWO PIN WALL SOCKET

THREE PIN WALL SOCKET

ELECTRIC BELL

RESISTANCE

VARIABLE RESISTANCE

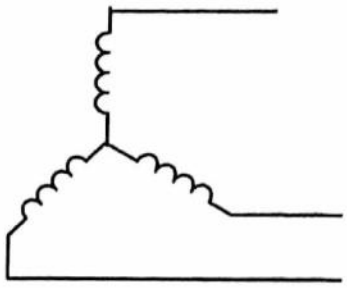
INDUCTANCE

VARIABLE INDUCTANCE

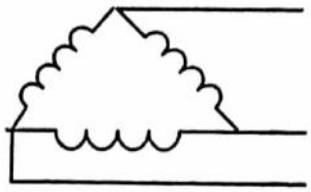
TRANSFORMER

LIGHTNING ARRESTOR

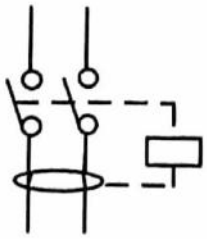
STAR CONNECTION



DELTA CONNECTION



EARTH LEAKAGE
CIRCUIT BREAKER

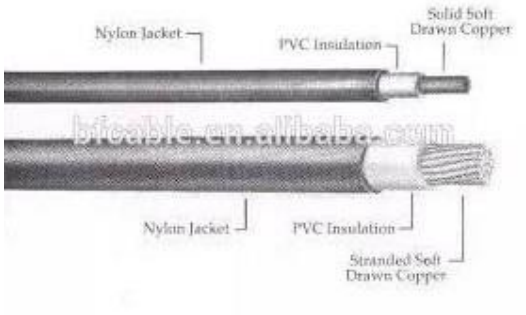


Experiment 1 c)

WIRING ACCESSORIES

WIRES

An electric wire is an insulated copper or aluminum wire and has one or more twisted strands. Poly vinyl chloride (PVC) wires are commonly used in house wiring.

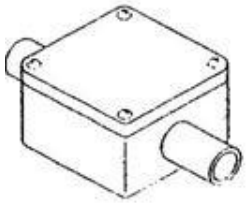


CONDUITS

An electrical conduit is a tube used to protect and route electrical wiring in a building or structure. Electrical conduit may be made of metal, plastic, fiber, or fired clay.

JUNCTION BOX

A junction box is an enclosure that protects a connection (the junction) of two or more wires carrying electrical current. When a junction box is used for every electrical connection in a building it is much easier to locate and repair any electrical problems that come up.



SWITCH BOX

A metal box containing the working parts of an electrical switch.

ROUND BLOCK

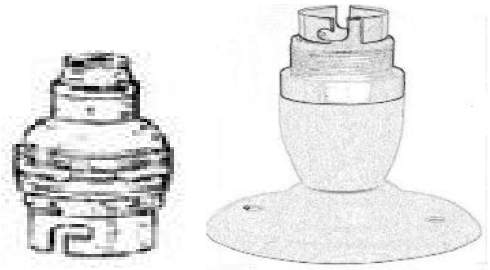
All surface mounting accessories like ceiling roses, batten lamps, holders, surface switches etc are fixed centrally over the round or mounting block. The cables are drawn in through about 6mm holes made in the block. The round blocks also fixed to the wooden gut ties on the walls with screws.

LAMP HOLDER

A lamp holder is used to hold the lamp required for lighting purposes. Lamp holder electrically connects the lamp to the supply. Holders are of two types.

1.Pendant holder2. Batten holder.

Pendant holder Batten holder



CEILING ROSE

It is used to provide a tapping to the pendant lamp–holder through the flexible wire or a connection to a fluorescent tube

Ceiling rose

SWITCH

A switch is used to make or break an electrical circuit. It is used to switch 'on' or 'off ' the supply of electricity to an appliance. There are various switches such as surface switch, flush switch, ceiling switch , pull switch ,push button switch ,bed switch

(i) Surface switch: It is mounted on wooden boards fixed on the surface of a wall. It is of three types 1. One-way switch 2. Two-way switch 3. Intermediate switch

One-way switch *Two-way switch* *Intermediate switch*

SADDLE CLIP

Saddles are most commonly used for securing the conduits to the wall. Saddles are fixed to the gut ties (which were already fixed to the wall) by means of two screws .

COLOUR CODE OF WIRES

Wiring for AC is generally colour coded for identification of individual wires as depticed in the below table.

Function	Label	colour
Protective ground	G	Green
Neutral	N	Black
Line	P	Red

STUDY OF CABLES, WIRES, SWITCHES, FUSES, MCB, ELCB AND MCCB

CABLE

Refers to a collection of two or more strands of wire or conductors. Basically, cable has a hot line to carry the current and a neutral line to complete the loop. They often have a third wire as that acts as a grounding wire.

Classified according to the number of wires it contains and their size or gauge. All cables are marked with a series of letters followed by a number, a dash and another number. The letters indicate the type of insulation (cord, wire and insulation). The first wire indicates the resistance of the wires in the cable, and the number following the dash indicates the number of individual conductors in the cable.

Two conductor cable contains one black wire and one white wire. The black wire is always the hot wire and must be fused. The white is always neutral and must never be fused. When current bridges the gap from the 110V hot wire to the neutral, it results in a 110V input to the appliances.

Three conductor cable contains a red wire in addition to black and white. The black and red wires are hot, carrying 110V each and both must be fused. The white remains neutral. This three-wire circuit is increasingly common in home wiring; it accommodates major 220V appliances and air conditioners.

WIRE

Different than cable. Cable refers to two or more wires or conductors grouped together in a jacket. Copper or tinned copper is the most common conductor in home wiring because it has minimum resistance at reasonable cost.

Wire is grouped by gauge number, running from 0000 to No.40 .The smaller the number, thicker the wire. For home use, the most common gauges are 10 and 20.Larger wire carries more current. Forcing two much current through a wire will cause it to overheat and trip a breaker.

Wire is also characterized by letters that correspond to the insulation type and electrical capacity. Grounding wire provides a path of least resistance from the frame or case of an appliance to the ground to guard against electric shocks. Both two and three conductor cables can carry grounding wires.

SWITCHES

In electrical and electronic system, a switch is a device, which can make or break an electrical circuit or we can say that switch is a controlling device, which interrupt the flow of current or direct the flow of current in another direction. Almost all the electrical and electronic system contains at least one switch, which is used to make the device ON or OFF. In addition, a switch is used to control the circuit operation and user may able to activate or de activate the whole or certain parts of the connected circuit.

Generally switches can be categorized as

a) Mechanical Switches

b) Electrical / Electronic Switches

Mechanical Switches:

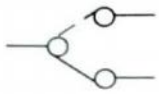
Mechanical switch is a switch in switch in which two metal plates touch each other to make physical contact for the current to flow and separate from each other to interrupt the flow of current. There are many types of mechanical switches and they are also be categorized on the basis of power handling capacity. The contact material is chosen by keeping in mind that the metal oxides, which produced do to corrosion, are mostly insulator and layers of such oxides on switch plates will hinder the normal operation of the switch.

Mechanical Switches can be categorized on the basis of their operation as,

SPST (Single Pole Single Throw) Switch

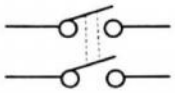
This is a simple ON/ OFF switch. It also called as one way Switch. When a user press the button of the switch, then the plates of the switch connect with each other and the current starts to flow and vice versa.

SPDT (Single Pole Double Throw) Switch



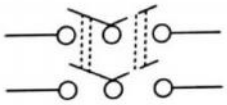
This button has three pin in which, one pin is used as common and called two way switch. We can send two different signals to same pin by using this switch.

DPST (Double Pole, Single Throw) Switch



This switch is basically two SPST switches in one package and can be operated by a single lever. This switch is mostly used, where we have to break both ground and lines at the same time.

DPDT (Double Pole Double Throw) switch



This switch is equivalent to two SPDT switches packaged in one pack. This switch has two common pins and four signal pins. Total four different combinations of signals can be applied to the input pins of this switch.

FUSE

The fuse is an electronic device, which is used to protect circuit from over current, overload and make sure that protection of the circuit. There are many types of fuses available in the market, but function of all these fuses is same.

Fuse consists of a low resistance metallic wire enclosed in a non-combustible material. Whenever a short circuit or over current or mismatched load

connection occurs, then the thin wire inside the fuse melts because of the heat generated by the heavy current flowing through it. Therefore, it disconnects the power supply from the connected system. In normal operation of the circuit, fuse wire is just a very low resistance component and does not affect the normal operation of the system connected to power supply.

TYPES OF FUSES

Fuses can be divided in to two main categories. According to the type of input supply voltage as DC fuses and AC fuses. In a dc system, when the metallic wire melts because of the heat generated by the over current, then arc is produced and it is very difficult to extinct this arc because of DC constant value.

So in order to minimize the fuse arcing, DC fuse are little bigger than AC fuse which increase the distance between the electrodes to reduce the arc in the Fuse. On the other hand, i.e. in the AC system, voltage with 60Hz or 50Hz frequency changes it altitude from zero to 60 times every second, so arc can be extinct easily as compared to DC fuses. Fuses can also be categorized based on one time or multiple operations as One time use only fuses and Resettable fuses.

ONE TIME USE ONLY FUSES:

One time use fuses contain a metallic wire, which burns out, over current, over load or mismatched load connect event occur, user has to manually replace these fuses. Such fuses are cheap and widely used in almost all the electrical and electronic systems. Such types of fuses can be categorized on the following basis.

Fuse current carrying capacity

Breaking capacity

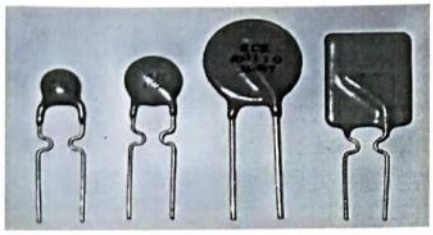
I^2t value of fuse

Response characteristic

Rated voltage of fuses

Packaging size

RESETTABLE FUSES:



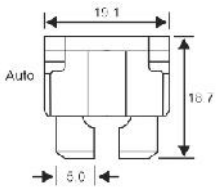
Resettable fuse is a device, which can be used multiple times without replacing it. They open the circuit, when an over current event occurs and after some specific time they connect the circuit again. Polymeric positive temperature coefficient device (PPTC) commonly known as resettable fuse.

OTHER TYPES OF FUSES

CARTRIDGE FUSES:

Cartridge fuses are used to protect electrical appliances such as motors, air conditions, refrigerators, pumps etc, where high voltage rating and currents required. They are available up to 600A and 600V AC and widely used in industries, commercial as well as home distribution panels. There are two types of cartridge fuses. They are General purpose fuses with no time delay and Heavy duty cartridge fuses with time delay. Both are available in 250V AC to 600V AC and its rating can be found on the end cap or knife blade.

BLADE TYPE FUSES:



This type of fuses also known as spade or plug in fuses comes in plastic body and two metal capes to fit in the socket. Mostly they are used in automobiles for wiring and short circuit protection.

TYPICAL USES AND APPLICATION OF FUSES

Electronic fuses can be used in all types of electrical and electronic applications including:

Motors

Air conditioners

Home distribution boards

General electrical appliances and devices

Laptops

Cell phones

Game systems

Printers

Digital cameras

DVD players

Portable electronics

LCD monitors

Scanners

Battery packs

Hard disk drives

Power convertors

MCB (MINIATURE CIRCUIT BREAKER)

Miniature circuit breaker works on magnetic mechanism. The magnetic mechanism uses a solenoid with an iron piece. It is used for short circuit protection .MCB actually switches off the electrical circuit during abnormal condition of the network both in overload condition as well as faulty condition.

Characteristics

Rated current not more than 100A

Trip characteristics normally not adjustable

Thermal or thermal magnetic operation

MCB Selection

The first characteristic is the overload which is intended to prevent the accidental overloading of the cable in a no fault situation. The speed of the MCB tripping will vary with the degree of the overload. This is usually achieved by the use thermal device in the MCB.

The second characteristic is the magnetic fault protection, which is intended to operate when the fault reaches a predetermined level and to trip the MCB within one tenth of a second. The level of this magnetic trip gives the MCB its type characteristics as follows

Type	Tripping Current	Operating Time
Type **B**	3 to 5 times full load current	0.04 to 13 sec
Type **C**	5 to10 times full load current	0.04 to 5 sec
Type **D**	10 to 20 times full load current	0.04 to 3 sec

The third characteristic is the short circuit protection, which is intended to protect against heavy faults may be in thousands of amps caused by short circuit faults.

The capability of the MCB to operate under these conditions gives its short circuit rating in kilo amps (kA). In general for consumer units a 6kA fault level is adequate whereas for industrial boards 10kA fault capabilities or above may be required.

MCCB (MOULDED CASE CIRCUIT BREAKER)

Characteristics

Rated current up to 1000A

Trip current may be adjustable

Thermal or thermal magnetic operation

ELCB (EARTH LEAKAGE CIRCUIT BREAKER)

An ELCB is a good fault protection device installed in a distribution board of a consumer. This device is used primarily to protect against electric shock. If any current leaks from any electrical installations i.e., there must be any fault like short circuit or insulation failure in the electrical installation it must be properly

detected and isolated. An ELCB does it effectively by making the power supply off by operating the associated circuit breaker.

Characteristics

Phase (line), Neutral and Earth wire connected through ELCB.

ELCB is working based on Earth leakage current.

Operating time of ELCB:

The safest limit of current which human body can withstand is 30mAsec. Suppose human body resistance is 500Ω and voltage to ground is 230V. The body current will be 500/230 = 460mA. Hence ELCB must be operated in 30mAsec/460mA = 0.65msec

Experiment No. 2

a) ONE LAMP CONTROLLED BY ONE SWITCH

b) ONE LAMP AND SOCKET CONTROLLED BY SWITCHES

Aim:

To Wire up a Circuit to control one lamp using one switch

Conditions:

Switch (S1)	Lamp (L1)
ON	ON
OFF	OFF

Tools Required:

1) Steel Ruler
2) Poker
3) Mallet
4) Wire Stripper
5) Screw Driver
6) Hand Saw
7) Claw Hammer
8) Combination Plier
9) Nose Plier
10) Chisel
11) Line Tester

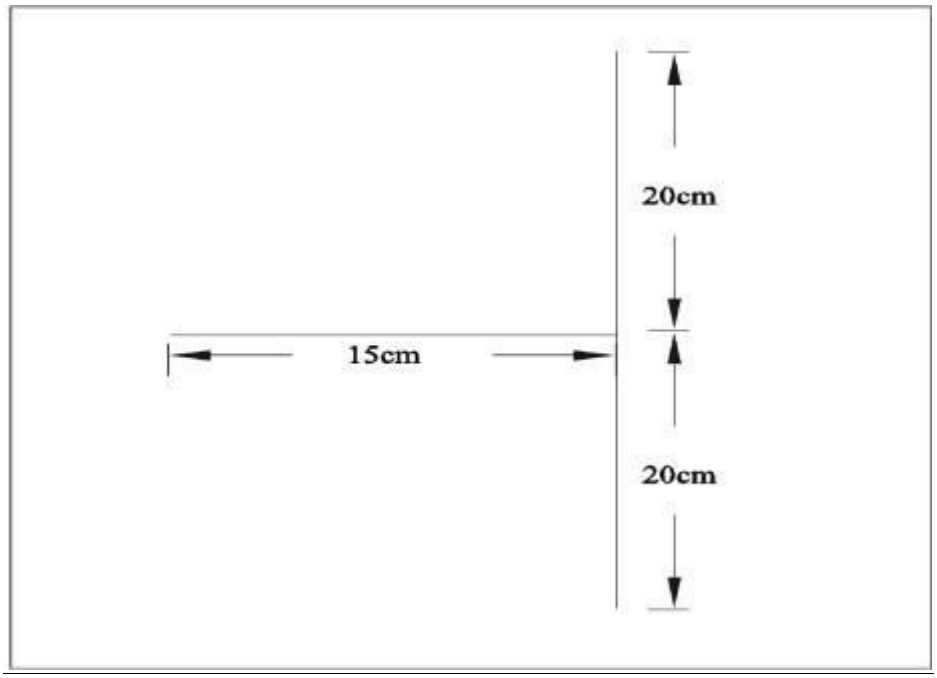
Procedure:

Two 20 cm & a 15 cm conduits are cut out. They are fixed by screwing them on the working board, with the help of 1/2‖ screws. Wire is cut out & is drawn through the conduit. Holes are made on the wooden board block & they are fixed on wooden board. Some extra wire is taken for connection. Necessary connections are made with the batten holder & piano switch fixed on the wooden board. One wire is connected between one of the terminals of the lamp and the switch. Other terminal of lamp is connected to neutral & the free terminal of the switch is connected to the fuse to which the phase wire is connected. Holder is connected to the Round Block. Connections are completed and the circuit is checked by giving supply.

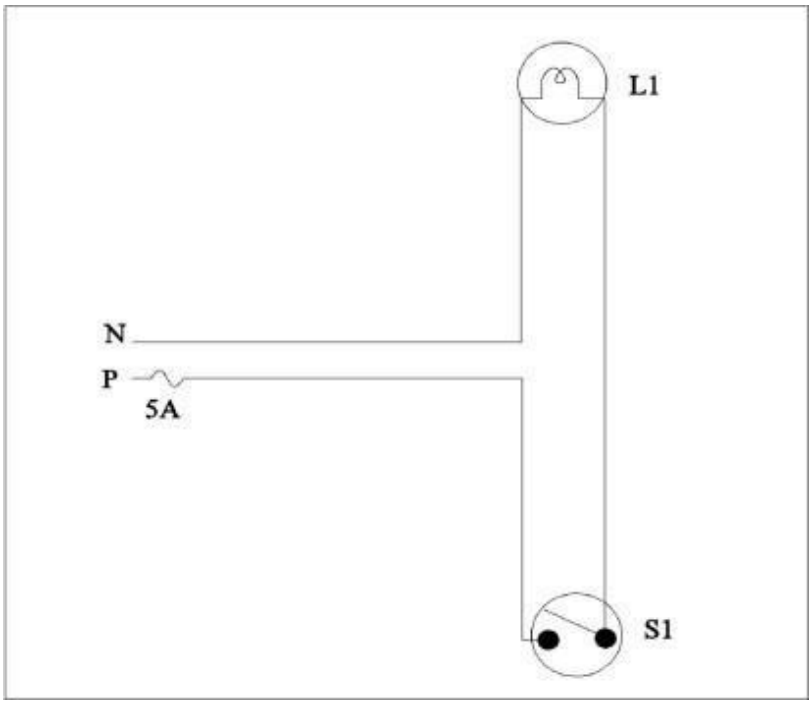
Precautions

1) Tools should be used carefully
2) All connections should be tight
3) All fittings should be proper
4) Wires should not be seen loose at ends.

LAY OUT



CIRCUIT DIAGRAM

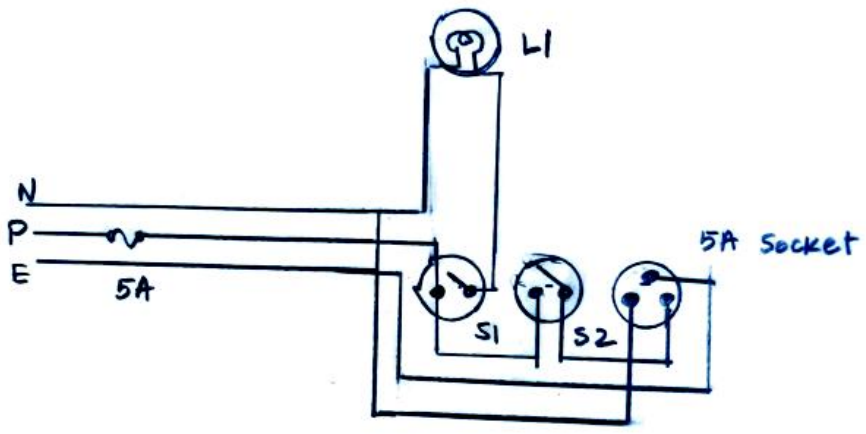


Estimate

Sl.No	Components	Specifications	Quantity
1	Wire	PVC insulated 1.5mm^2 flexible Cu wire	120 cm
2	Conduit	20 mm PVC	55 cm
3	Saddle clips	20 mm PVC	5 no
4	Screws	½ – 1‖	13 no 3 no
5	Switch	One way, piano type6 A, 240 V	1 no
6	Round Block	Teak Wood	1 no
7	Holder	Straight batten6 A, 240 V	1 no
8	Fuse Unit	Kit Kat 6 A, 240 V	1 no
9	Incandescent lamp	60 W, 240 V	1 no
10	Junction Box	3 way, 20mm PVC	1 no.

Exercise

One lamp along with one socket controlled by separate switches



Estimate

Sl.No	Components	Specifications	Quantity
1	Wire	PVC insulated 1.5mm^2 flexible Cu wire	120 cm
2	Conduit	20 mm PVC	55 cm
3	Saddle clips	20 mm PVC	5 no
4	Screws	½ – 1‖	13 no 3 no
5	Switch	One way, piano type6 A, 240 V	2 no
6	Round Block	Teak Wood	1 no
7	Holder	Straight batten6 A, 240 V	1 no
8	Fuse Unit	Kit Kat 6 A, 240 V	1 no
9	Incandescent lamp	60 W, 240 V	1 no
10	Junction Box	3 way, 20mm PVC	1 no.
11	3 Pin socket	5A	1 no

Result

The circuits were set up and tested.

Experiment No. 3

STAIRCASE WIRING

Aim:

To wire up a circuit to control one lamp using two switches as per the given layout.

Conditions:

Switch (S1)	Switch (S2)	Lamp (L1)
UP	UP	BRIGHT
UP	DOWN	DARK
DOWN	DOWN	BRIGHT
DOWN	UP	DARK

Tools Required:

1) Claw Hammer
2) Steel Rule
3) Chisel
4) Cutting Plier
5) Combination Plier
6) Wire Stripper
7) Screw Driver
8) Poker
9) Mallet
10) Hand Saw

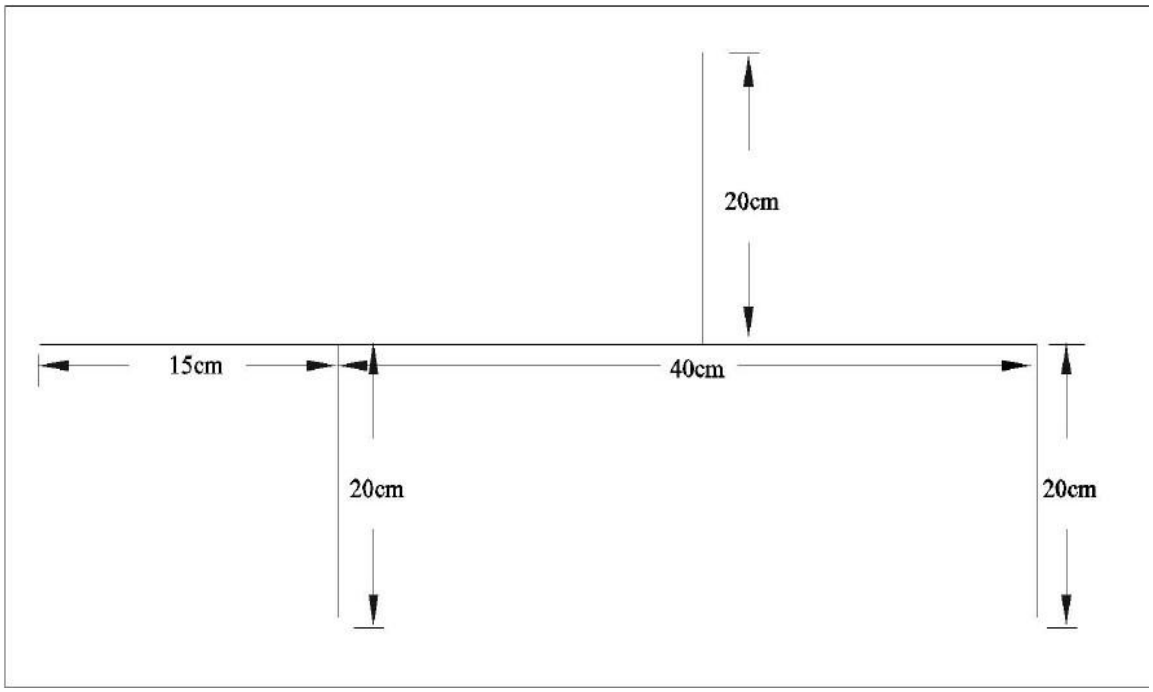
Procedure:

A 20 cm, 15 cm conduits are cut out and are screwed on to the wooden board using suitable number of saddle clips. Wires are cut out and they are drawn through the conduits. Wire from the middle terminal of one of the two-way switches, say S1, is taken as the phase to which a fuse is also inserted. Upper terminal S1 is connected to the upper terminal of the other switch say S2 and the lower terminal of S1 to lower terminal to S2. The middle terminal of S2 is connected to one of the terminal of the lamp holder whose other terminal is wired as the neutral. The holder is fixed on the round block and the lamp is inserted. Connections are over and the circuit is checked by giving supply.

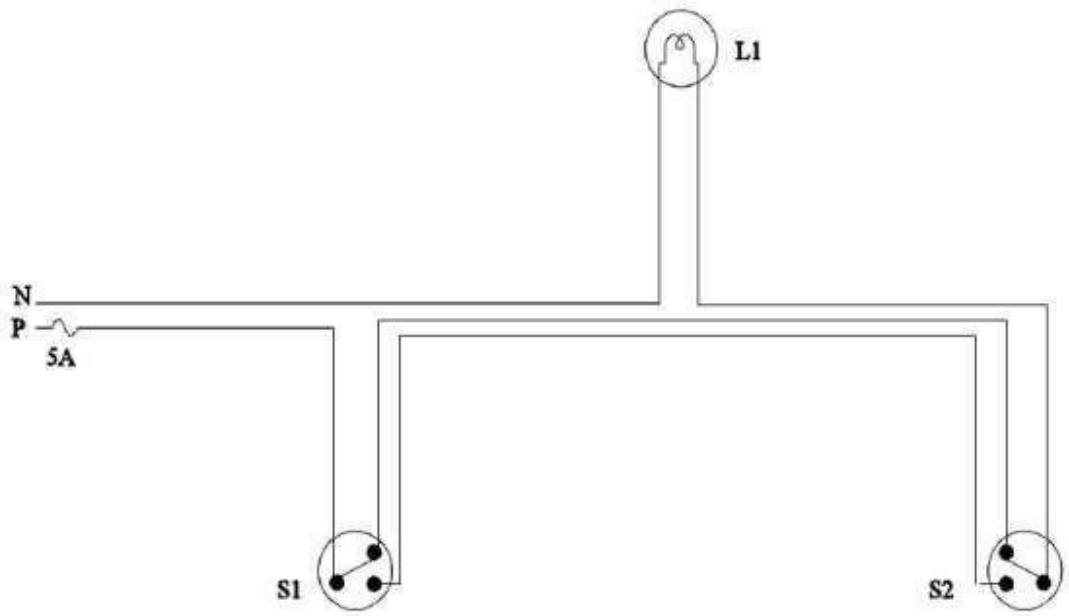
Precautions

1) Tools should be used carefully
2) All connections should be tight
3) All fittings should be proper
4) Wires should not be seen loose at ends

LAY OUT



CIRCUIT DIAGRAM



Estimate

Sl.No	Particulars	Specification	Quantity
1	Wire	1.5 mm^2 PVC insulated flexible Cu wire	320 cm
2	Conduit	20mmPVC	115 cm
3	Round Block	Teak Wooden	1 nos
4	Switches	Two way, piano type240 V, 6A	2 nos
5	Lamp Holder	Straight Batten, 6 A,240 V	1 nos
6	Fuse unit	6 A, 240 V, Kit Kat	1 nos
7	Incandescen tlamp	60 W, 240 V	1 nos
8	Junction Box	3 Way, PVC	2 nos
9	Saddle clips	20mm GI	11 nos
10	Screws	½” 1.5”	25nos 5 nos
11	Elbow	20mmPVC	1 nos

Result

The circuit for controlling one lamp by two switches is set up and the conditions were satisfied.

Experiment No. 4

WIRING OF FLUORESCENT LAMP AND POWER SOCKET

Aim:

To wire up a fluorescent lamp and light sockets (6A) with a power circuit for controlling power device (16A socket).

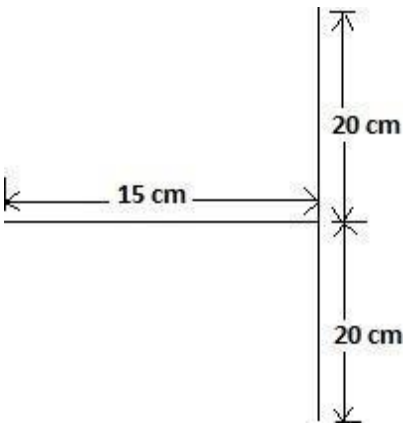
Conditions:

Switch (S1)	**Lamp (L1)**
ON	ON
OFF	OFF
Switch (S2)	**Socket (P1)**
ON	ON
OFF	OFF

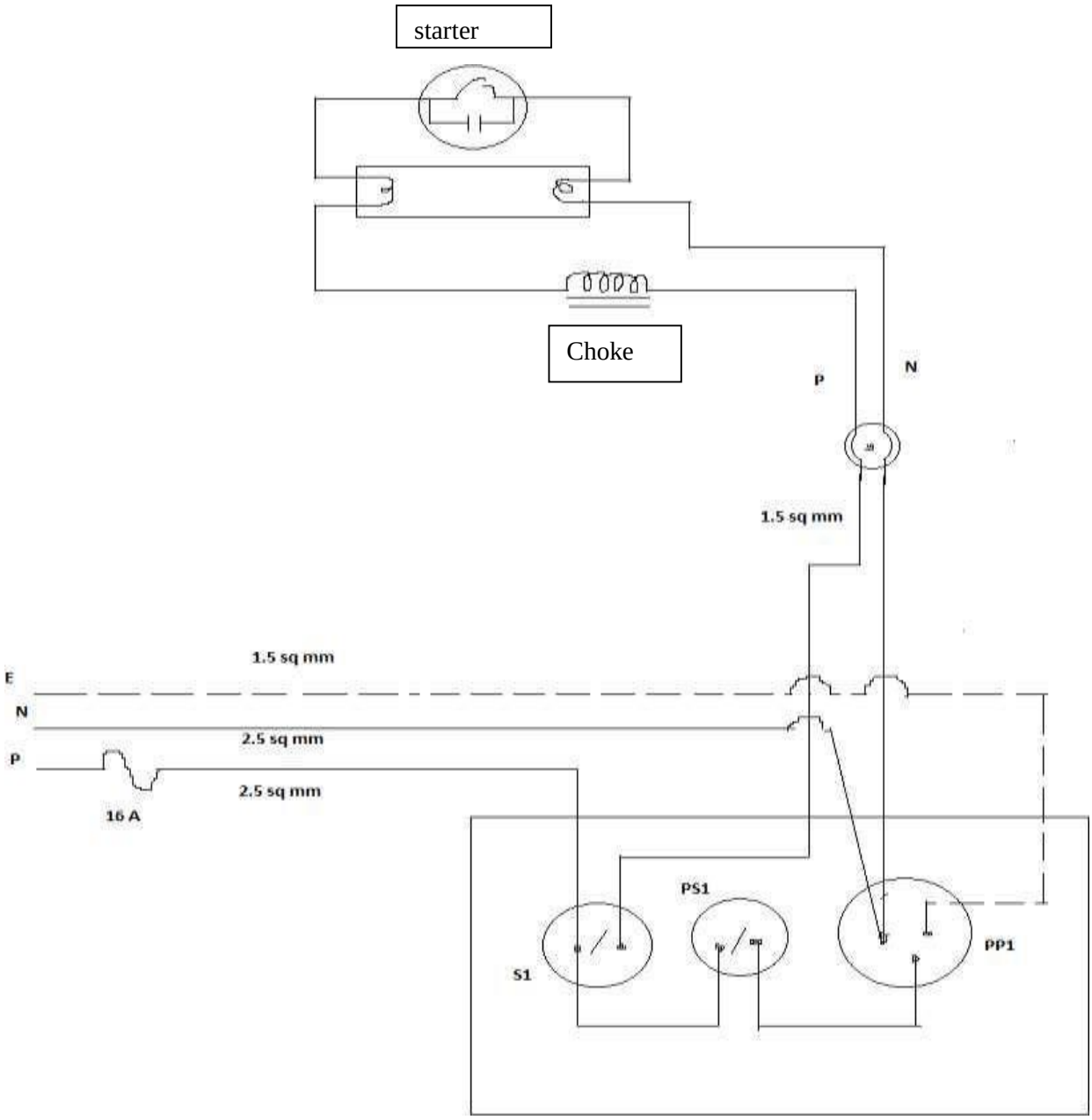
Tools Required:

1. Steel Ruler
2. Poker
3. Setting hammer
4. Wire Stripper
5. Screw Driver
6. Claw Hammer
7. Combination Plier
8. Nose Plier
9. Line Tester

LAY OUT



CIRCUIT DIAGRAM



Principle :

The supply is given through a choke and starter. The starter consists of a bimetallic strip kept in an enclosure which is filled with argon or neon gas. The capacitor inside the starter is to protect from radio interference. The bimetallic strip will be in normally open position, with close proximity. When

supply voltage is given, there will be a glow produced in the enclosure which heats up the bimetallic strip and one of the strip bends towards the other. When the contacts touch, the two filaments of the fluorescent lamp and the ballast (choke) will be switched in series to the supply voltage. The current through the filament causes them to heat up and emit electrons in the tube by thermionic emission. In the starter, the touching contact short out the voltage sustaining the glow discharge, extinguishing it, so the gas cool down and no longer heats the bimetallic strip, which opens within a second or two. This causes a sudden change in the current passing through the circuit, thus inducing a high voltage in the choke. This high voltage appears across the filaments of the tube and is enough to start the discharge in the tube.

Estimate:

Sl.No	Components	Specifications	Quantity
1	Wire	1.5 mm^2,PVC insulated flexible Cu wire 2.5 mm^2,PVC insulated flexible Cu wire	440 cm 100 cm
2	Starter	Glow type	1 no
3	Choke	40 W, 240 V	1 no
4	Fluorescent Lamp	40 W, 240 V	1 no
5	Tube Holder	6A, 240 V	1 no
6	Conduit	20mmPVC	55 cm
7	Saddle clips	20mm GI	5 no
8	Screws	½" ¾"	24 no 2 no
9	Switch	One way, piano type 16 A, 240 V One way, piano type 6 A, 240 V	1 no 1 no
10	Round Block	Wooden	1 no
11	Socket	16 A, 240 V,3 Pin(2 in one)	1 no
12	Fuse Unit	Kit Kat 6 A, 240 V	1 no
13	Ceiling rose	6A, 240 V	1 no
14	PVC gang box	5"x 4"	1 no.

Procedure:

Conduits are cut in proper dimensions. They are fixed by screwing them on the working board, with the help of 1/2‖ screws. Wire is cut out & is drawn through the conduits. Holes are made on the wooden board block & they are fixed on wooden board. Some extra wire is taken for connection. Necessary connections are made with the socket & piano switch and they are fixed on the wooden board. The phase wire is connected through the switch to one terminal of the socket. The neutral wire is connected to the other terminal of the socket. The middle terminal of the socket is connected to the Earth wire. The circuit is now checked using supply.

Precautions

1) Tools should be used carefully
2) All connections should be tight
3) All fittings should be proper
4) Wires should not be seen loose.

Result

Wired and tested a fluorescent lamp along with a power socket .

Experiment No.5

WIRING OF POWER DISTRIBUTION BOARD WITH ELCB, MAIN SWITCH AND ENERGY METER

Aim

To do wiring of single phase MCB distribution board with ELCB, Main switch and Energy meter.

Principle

The most commonly adopted system for distribution of electrical energy in a building is distribution board system. Supplier‘s service Mains will be connected to the energy meter located at consumer premises. From the energy meter, the connection is given to the cut out (fuse unit) for saving the energy meter if the consumer draws heavier current than the rating of the meter. The cut out also serves the purpose of enabling the supply authority to discontinue the supply in case the customer fails to pay the bill. The consumer‘s distribution starts after the energy meter and the supply authority‘s cut out. From the energy meter, connection is given to the distribution board through main switch. The main switch for single phase installations will be a double pole isolator or ICDP switch. Distribution board contains an ELCB at the input side and outgoing MCBs (fuse units in earlier Fuse DB system) meant for each sub circuit. One light sub circuit can have a maximum of ten light points or a maximum of 800 watts connected load whereas a power sub circuit can have a maximum of two power point or a maximum of 3000 watts connected load

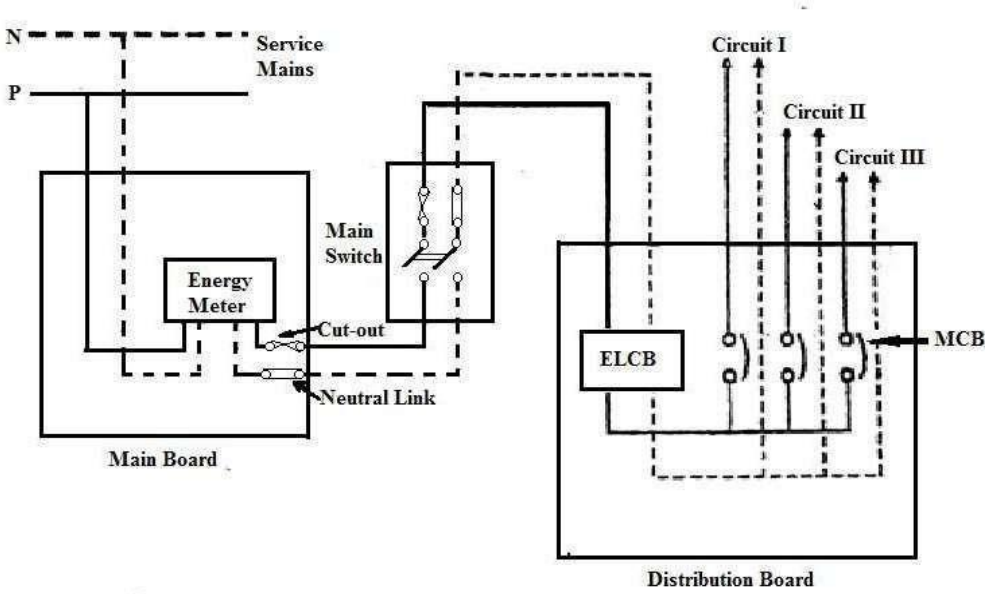
Tools Required

1. Steel Rule
2. Poker
3. Setting hammer
4. Wire Stripper
5. Screw Driver
6. Claw Hammer
7. Combination Plier
8. Nose Plier
9. Line Tester

Precautions

1) Tools should be used carefully
2) All connections should be tight
3) All fittings should be proper
4) Wires should not be seen loose.

CIRCUIT DIAGRAM



Procedure

Energy meter and Distribution Board are fixed. Conduits are cut in proper dimensions to give interconnection from meter to DB. They are fixed by screwing them on the working board, with the help of ½" screws. Wire is cut out & is drawn through the conduits. The Service Mains (phase and neutral wires) are connected to energy meter and from the energy meter through cut out and Neutral Link supply is given to the Isolator in the DB, then to ELCB. Outgoing circuits are taken through MCBs. The circuit is now checked using supply.

Estimate

Sl.No	Components	Specifications	Quantity
1	Single phase energy meter	250V, 20A, Induction type	1 no
2	Distribution board	SPDB,4 way, with 1 ELCB & 1 DP Isolator with Neutral Link & Earth Link	1 no
3	Fuse Unit	Kit Kat,16 A, 250 V	1 no
4	MCB	6A,250V	4 nos
5	ELCB	16A, 30mA	1 No.
6	DP Isolator	16A, DP	1 No.
7	Wire	2.5 mm^2,PVC insulated flexible Cu wire	200cm
8	Wire	1.5 mm^2,PVC insulated flexible Cu wire	100cm

9	Conduit	20mmPVC	45 cm
10	Saddle clips	20mm GI	5 no
11	Screws	½ “ 1”	12 no 2 no

Result

Power distribution arrangement using single phase distribution board with ELCB, MCB, Main switch and Energy meter has been wired and tested.

Experiment No: 6

STUDY OF BATTERIES

A battery is a collection of one or more cells that go under chemical reactions to create the flow of electrons within a circuit. Battery cells are usually made up of three main components;

1. The Anode (Positive Electrode)
2. The Cathode (Negative Electrode)
3. The Electrolyte

Types of Batteries

Batteries can be classified into different categories and types, ranging from chemical composition, size, form factor and use cases, but in general there are two major battery types;

1. Primary Batteries
2. Secondary Batteries

1. Primary Batteries

Primary batteries are batteries that cannot be recharged once depleted. Primary batteries are made of electrochemical cells whose electrochemical reaction cannot be reversed. Primary batteries exist in different forms ranging from coin cells to AA batteries. They are commonly used in standalone applications where charging is impractical or impossible. The most popular type of primary batteries is alkaline battery. These batteries are characterized by high specific energy and are environmentally friendly, cost-effective and do not leak even when fully discharged. The only down side to alkaline batteries is the low load current, which limits its use to devices with low current requirements like remote controls, flashlights and portable entertainment devices.

2. Secondary Batteries

Secondary batteries are batteries with electrochemical cells whose chemical reactions can be reversed by applying a certain voltage to the battery. Also referred to as rechargeable batteries, secondary cells can be recharged after the energy on the battery has been used up.

They are typically used in high drain applications and other scenarios where it will be either too expensive or impracticable to use primary batteries. Small capacity secondary batteries are used to power portable electronic devices like mobile phones, and other gadgets and

appliances while heavy-duty batteries are used in powering diverse electric vehicles and other high drain applications like load leveling in electricity generation. They are also used as standalone power sources alongside inverters to supply electricity. Although the initial cost of acquiring rechargeable batteries is always a whole lot higher than that of primary batteries but they are the most cost-effective ones over the long-term.

Secondary batteries can be further classified into several other types based on their chemistry**.** This is very important because the chemistry determines some of the attributes of the battery including its specific energy, cycle life, shelf life, and price to mention a few.

There are basically four major chemistries for rechargeable batteries;

1. Lithium-ion(Li-ion)
2. Nickel Cadmium(Ni-Cd)
3. Nickel-Metal Hydride(Ni-MH)
4. Lead-Acid

1. Nickel-Cadmium Batteries

The nickel–cadmium battery(NiCd battery or NiCad battery) is a type of rechargeable battery which is developed using nickel oxide hydroxide and metallic cadmium as electrodes. Ni-Cd batteries excel at maintaining voltage and holding charge when not in use. However, NI-Cd batteries easily fall a victim of the dreaded “memory” effect when a partially charged battery is recharged, lowering the future capacity of the battery.

In comparison with other types of rechargeable cells, Ni-Cd batteries offer good life cycle and performance at low temperatures with a fair capacity but their most significant advantage will be their ability to deliver their full rated capacity at high discharge rates. They are available in different sizes and terminal voltages with individual cells or assembled in packs of two or more cells. The small packs are used in portable devices, electronics and toys while the bigger ones find application in aircraft starting batteries, electric vehicles and standby power supply.

Some of the properties of Nickel-Cadmium batteries are listed below.

- SpecificEnergy:40-60W-h/kg
- EnergyDensity:50-150W-h/L
- SpecificPower:150W/kg
- Charge/dischargeefficiency:70-90%
- Self-discharge rate: 10%/month
- Cycle durability/life:2000cycles

2. Nickel-Metal Hydride Batteries

Nickel metal hydride(Ni-MH) is another type of chemical configuration used for rechargeable batteries. The chemical reaction at the positive electrode of batteries is similar to that of the nickel–cadmium cell(NiCd), with both battery type using the same nickel oxide hydroxide (NiOOH). However, the negative electrodes in Nickel-Metal Hydride uses a hydrogen-absorbing alloy instead of cadmium which is used in NiCd batteries

NiMH batteries find application in high drain devices because of their high capacity and energy density. A NiMH battery can possess two to three times the capacity of a NiCd battery of the same size, and its energy density can approach that of a lithium-ion battery. Unlike the NiCd chemistry, batteries based on the NiMH chemistry are not susceptible to the “memory” effect that NiCads experience.

Below are some of the properties of batteries based on the Nickel-metal hydride chemistry;

- SpecificEnergy:60-120h/kg
- EnergyDensity:140-300Wh/L
- Specific Power:250-1000W/kg

- Charge/dischargeefficiency:66%- 92%
- Self-dischargerate:1.3-2.9%/monthat20^{o}C
- Cycle Durability/life:180 -2000

3. Lithium-ion Batteries

Lithium ion batteries are one of the most popular types of rechargeable batteries. They are found in different portable appliances including mobile phones, smart devices and several other battery appliances used at home. They also find applications in aerospace and military applications due to their lightweight nature.

Lithium-ion batteries are a type of rechargeable battery in which lithium ions from the negative electrode migrate to the positive electrode during discharge and migrate back to the negative electrode when the battery is being charged. Li-ion batteries use an intercalated lithium compound as one electrode material, compared to the metallic lithium used in non-rechargeable lithium batteries.

Lithium ion batteries generally possess high energy density, little or no memory effect and low self-discharge compared to other battery types. Their chemistry alongwith performance and cost vary across different use cases for example, Li-ion batteries used in handheld electronic devices are usually based on lithium cobalt oxide ($LiCoO_2$) which provides high energy density and low safety risks when damaged while Li-ion batteries based on Lithium iron phosphate which offer a lower energy density are safer due to a reduced likelihood of unfortunate events happening are widely used in powering electric tools and medical equipment. Lithium ion batteries offer the best performance to weight ratio with the lithium sulphur battery offering the highest ratio.

Some of the attributes of lithium ion batteries are listed below;

- SpecificEnergy:100:265W-h/kg
- Energy Density: 250: 693W-h/L

- SpecificPower:250: 340W/kg
- Charge/dischargepercentage:80-90%
- CycleDurability:400:1200 cycles
- Nominal cell voltage: NMC3.6/3.85V

4. Lead-Acid Batteries

Lead acid batteries are a low-cost reliable power workhorse used in heavy duty applications. They are usually very large and because of their weight, they are always used in non-portable applications such as solar-panel energy storage, vehicle ignition and lights, back up power and load leveling in power generation/distribution. The lead-acid battery is the oldest type of rechargeable battery and still very relevant and important in today's world. Lead acid batteries have very low energy to volume and energy to weight ratios but it has a relatively large power to weight ratio and as a result can supply huge surge currents when needed. These attributes along with its low cost makes these batteries attractive for use in several high current applications like powering automobile starter motors and for storage in backup power supplies.

Experiment No: 7

STUDY OF EARTHING SCHEMES

To connect the metallic parts of electric machinery and devices to the earth plate or earth electrode (which is buried in the moisture earth) through a thick conductor wire (which has very low resistance) for safety purpose is known as *Earthing or grounding*.

When the metallic part of electrical appliances (parts that can conduct or allow passage of electric current) comes in contact with a live wire, maybe due to failure of installations or failure in cable insulation, the metal become charged and if a person touches such a charged metal, which in turn results in a severe shock. To avoid such instances, the power supply systems and parts of appliances have to be earthed so as to transfer the charge directly to the earth.

Components of an Earthing System

A complete electrical earthing system consists of the following basic components.

- Earth Continuity Conductor
- Earthing Lead
- Earth Electrode

Earth Continuity Conductor or Earth Wire

The part of an earthing system which interconnects the overall metallic parts of electrical installation to ground is known as earth wire or earth continuity conductor. The resistance of the earth continuity conductor is kept very low. Resistance of earth wire should be less than 1Ω in practice. The cross sectional area of the Earth Continuity Conductor should not be less than half of the cross sectional area of the thickest wire used in the electrical wiring installation. Generally, the size of the bare copper wire used as earth continuity conductoris 3SWG.

Earthing Lead or Earthing Joint

The conductor wire connected between earth continuity conductor and earth electrode or earth plate is called earthing joint or “Earthing lead”. The point where earth continuity conductor and earth electrode meet is known as connecting point. Generally, copper wire can be used as earthing lead but, copper strip is also used for high end installations. The size or

area of earthing lead should not be less than the half of the thickest wire used in the installation. The largest size for earthing lead is 3SWG and the minimum size should not be less than 8SWG.

Earthing Electrode or EarthPlate

The underground metallic (plate) part of the earthing system which is connected with earthing lead is called earth plate or earth electrode.

Size of Earthing Electrode

Bothc opper and iron can be used as earthing electrode.
The size of earth electrode (In case of copper)
2×2(two foot wide as well as in length)and1/8inch thickness..I.e. 2'x2'x1/8″. (600x600x300 mm)
In case of Iron
2′x2′x¼" =600x600x6mm
It is recommended to bury the earth electrode in the moisture earth. If it is not possible, then put water in the GI (Galvanized Iron) pipe to make possible the moisture condition.

Methods and Types of Electrical Earthing

Earthing can be done in many ways.The various methods employed in earthing (in house Wiring or factory and other connected electrical equipments and machines)are given below.

Plate Earthing:

In plate earthing system, a plate made up of either copper with dimensions **6**0cmx60cmx 3.18mm**(i.e.** 2ftx 2ftx 1/8 in**)** or galvanized iron (GI) of dimensions 60cm x 60cm x 6.35 mm (2ft x 2ft x ¼ in) is buried vertical in the earth (earth pit) which should not be less than 3m (10ft) from the ground level. For proper earthing system, follow the above mentioned steps in the (Earth Plate introduction) to maintain the moisture condition around the earth electrode or earth plate.

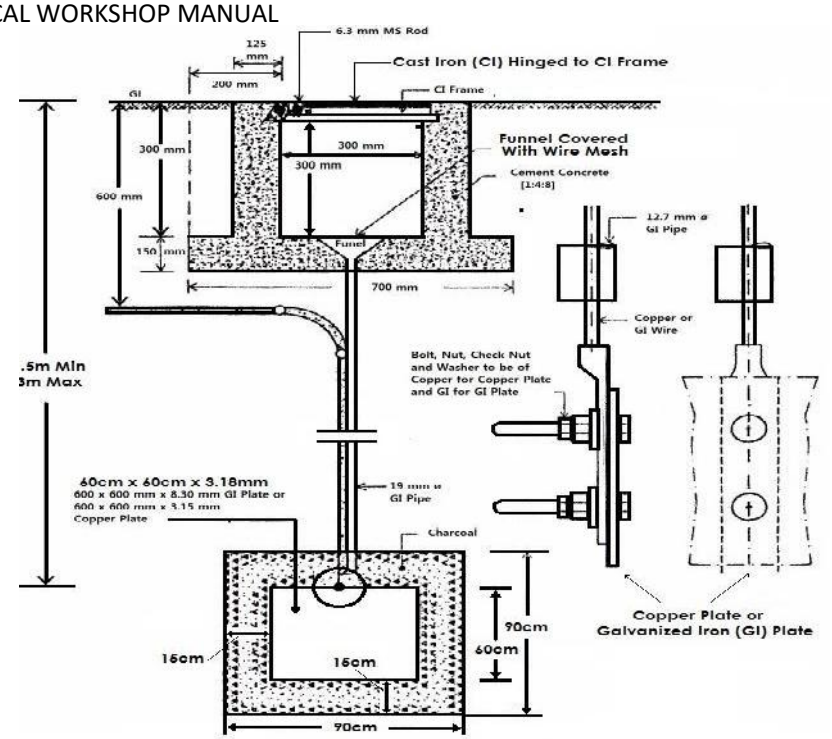
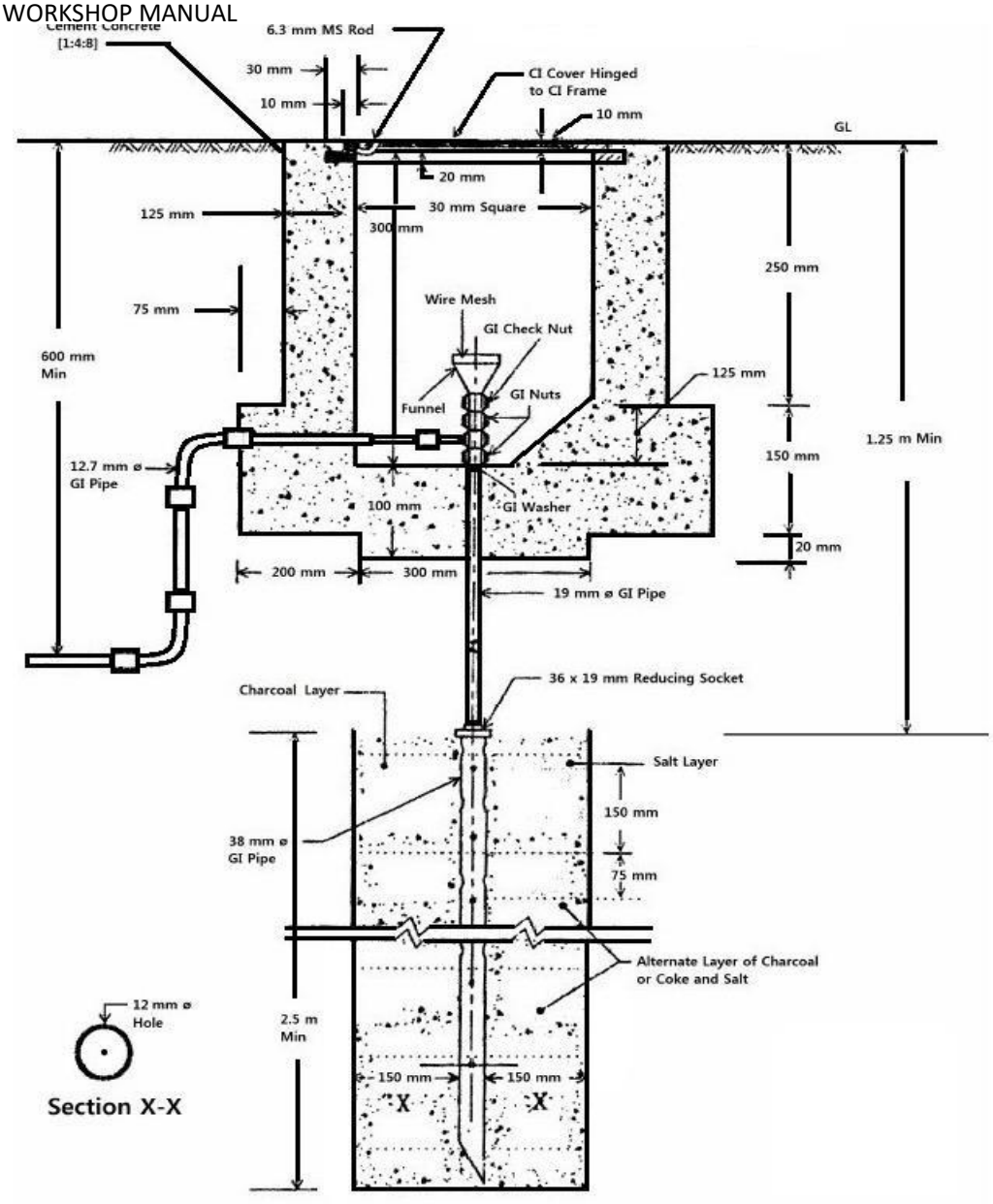


Plate Earthing

Pipe Earthing:

A galvanized steel and a perforated pipe of approved length and diameter is placed vertically in a wet soil in this kind of system of earthing. It is the most common system of earthing.

The size of pipe to use depends on the magnitude of current and the type of soil. The dimension of the pipe is usually 40mm (1.5in) in diameter and 2.75m (9ft) in length for ordinary soil or greater for dry and rocky soil. The moisture of the soil will determine the length of the pipe to be buried but usually it should be 4.75m (15.5ft).



Pipe Earthing