University Of Engineering & Technology, Lahore
University Workshops (MED)

Reg. NO: _____

ELECTRIC WORKSHOP MANUAL

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Subject: _____

Teacher: _____

Student's Signature

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ELECTRICAL LAB PRECAUTIONS

1. Use power supply merely to test the Circuit. Switch off and take the Plug out immediately after checking the Circuit.

2. Use one hand instead of two. This will save you from fatal Electric shock.

3. Protect your body from coming into contact with live Conductors/ wires.

4. Perform practical with utmost care and attention. Mental absence may cause severe electric shock.

5. Take care while removing plug from shocks as your fingers may touch the energized pins.

6. Rubber shoes should wear during lab work.

7. Ask the Lab Instructor to check the Circuit before energizing.

8. If a person experiences an electric shock, shut the power off immediately or push him away from source using Insulators like clothes, wood etc.

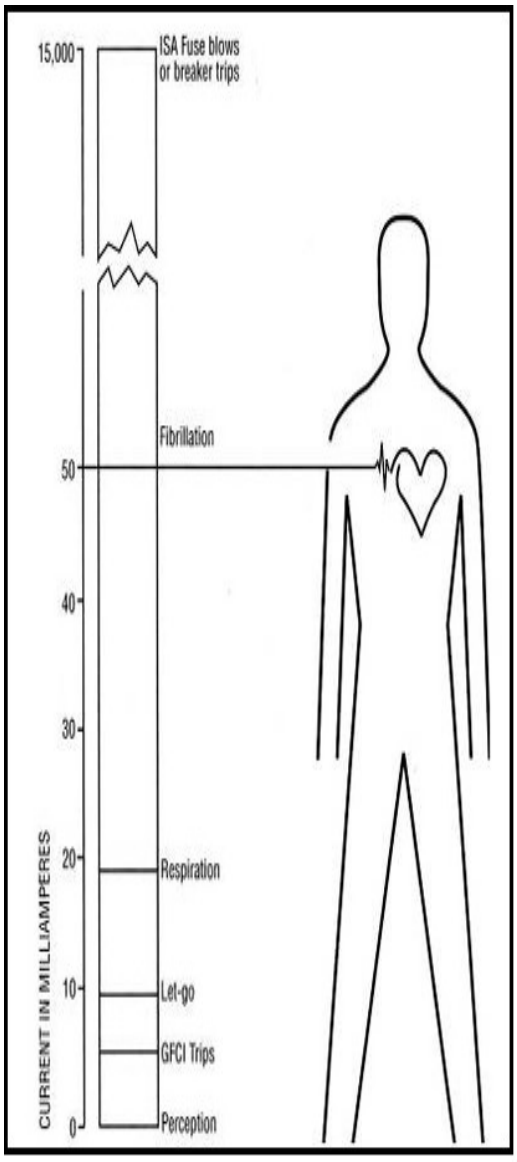
9. Hourseplay running or practical jokes are strictly prohibited in the Laboratory.

10. Avoid bringing all kind of eatables and drinks in lab.

11. Keep your work area neat and clean.

EFFECTS OF ELECTROCUTION

The primary variable for the determining the severity of Electric shock is Electric current which passes through the body. The fault current passing through the body depends on the voltage and resistance of the path it flows through the body. An approximate general frame work for electric shock as follows:



Readings		Effects
Safe Current Values	1 mA or less	Causes no sensation - not felt.
	1 mA to 8 mA	Sensation of shock, not painful; Individual can let go at will since muscular control is not lost.
Unsafe current values	8 mA to 15 mA	Painful shock; individual can let go at will since muscular control is not lost.
	15 mA to 20 mA	Painful shock; control of adjacent muscles lost; victim can not let go.
	50 mA to 100 mA	Ventricular fibrillation - a heart condition that can result in death - is possible.
	100 mA to 200 mA	Ventricular fibrillation occurs.
	200 mA and over	Servere burns, severe muscular contractions - so severe that chest muscles clamp the heart and stop it for the duration of the shock. (This prevents ventricular fibrillation).

FIRST AID FOR VICTIM OF ELECTRIC SHOCK

1- **Separate the person from source of Electricity**

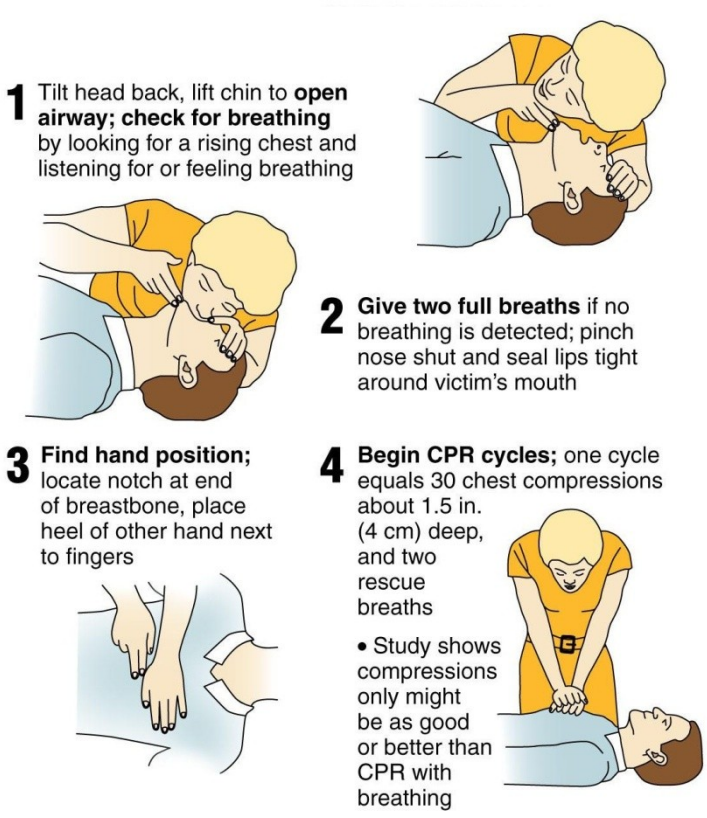
- Turn off the source preferably from circuit breakers or plug out the fuse.
- If you are not able to turn off supply, stand on dry and non conductive object such as dry wood or newspaper.
- Try to separate the person by using some kind of insulating material such as wooden or plastic broom handle or chair.
- Ensure none of your body part is in contact with the victim.

2- **Call 1122**

Electrocution often requires emergency medical assistance. Call 1122 help line so that victim may be hospitalized as early as possible.

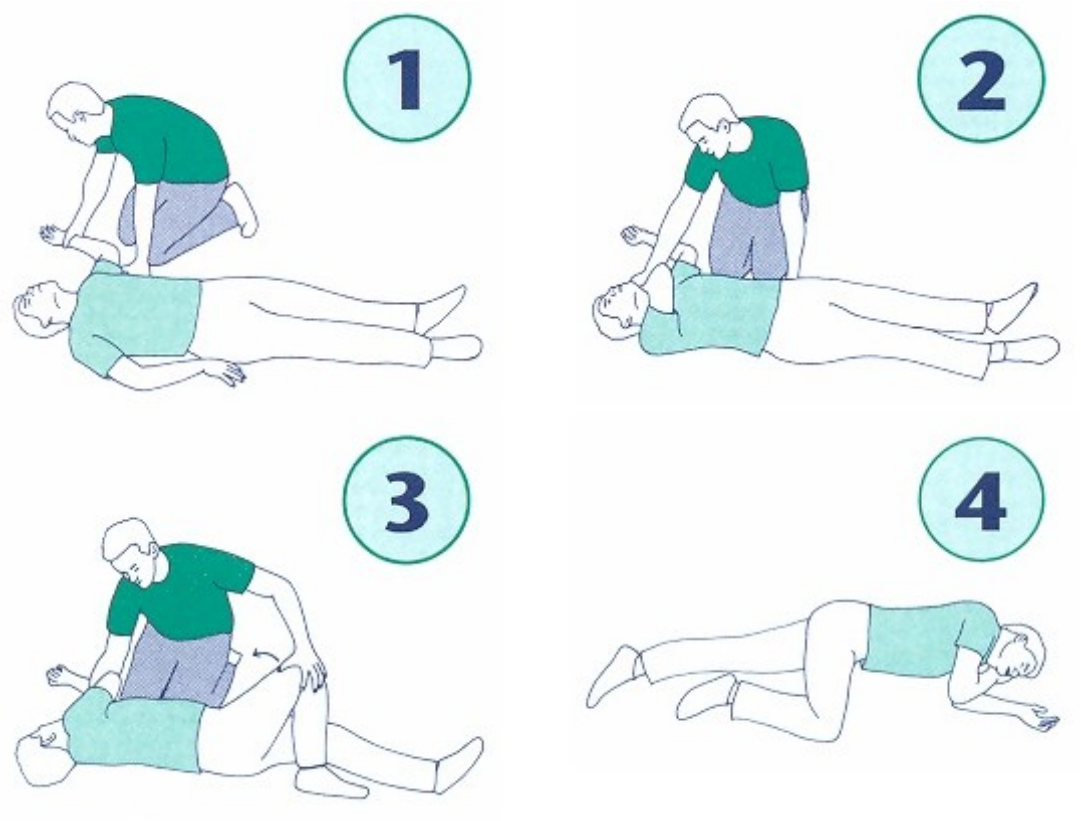
3- **Check for breathing**

If the victim is not breathing apply CPR for breath restoration as follows:+



4- **Place the victim in recovery position**

Place the victim in recovery position as described in following figure:



5- Cover the victim in a blanket

The victim will quickly cool down. You should try to wrap her in a thermal blanket to keep the body temperature regulated.

6- Check the body

Look for any burns or other injuries that are immediately noticeable. Report injuries to emergency responders when they arrive.

7- Control bleeding

If the victim is bleeding, try to stop or slow blood loss. Use a clean cloth to apply direct pressure**.**

8- Treating the Burns

- Identify burn area.
- Removing the clothes and jewelry to avoid further damage
- Covering the burn will help to protect the wound from further damage and lower the risk of infection.

HOW TO EXTINGUISH THE ELECTRICAL FIRE

- When an appliance, outlet, cable, or Switch sparks shut the power Supply with immediate effect.
- Call 1122 or fire fighters for the help.
- Avoid poring water or any kind of liquid over the electrical fire.
- Cover the small electrical fire with blanket to cut the supply of oxygen and allow smoothing the flam.
- Use only class C or ABC type fire extinguisher to extinguish the fire. If type of fire extinguisher is not listed don't use it at all. Liquid fire extinguisher may cause fatal electric shock.
- If class C or ABC type fire extinguisher is not available u may pore sand over it.
- If none of the above mentioned objects are available you may use water if and if you are 100% sure that power supply completely shut down.
- If fire is spreading and it is beyond your control then you should leave the area surrounded by the fire and stay at safe distance.

ASSIGNMENT No.1

Draw/sketch the listed tools and wiring accessories in the spaces given below and explain their working and uses as well.

Screw Driver

Description

_____

_____

_____

_____

Phase Tester

Description

_____

_____

_____

_____

Bradawl

Description

Pair of pliers

Description

Wire Cutter

Description

_____

_____

_____

_____

PVC Saddle

Description

_____

_____

_____

_____

PVC Conduit

Description

_____

_____

_____

_____

PVC Tee

Description

_____

_____

_____

_____

PVC Bend

Description

Three way PVC Inspection

Description

PVC Round Block

Description

Kit Kat Fuse

Description

Ceiling Rose

Description

_____

_____

_____

_____

Batten Type Lamp Holder

Description

_____

_____

_____

_____

Pendant Type Lamp Holder

Description

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Bracket Holder

Description

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_____

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Two Pin Socket

Description

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_____

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Three Pin Socket

Description

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_____

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Two Pin Plug

Description

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_____

Three Pin Plug

Description

_____

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_____

One way Switch (SPST):

Description

_____

_____

_____

_____

Two way Switch (SPDT)

Description

_____

_____

_____

_____

Two Pole Main Switch

Description

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_____

_____

Two Pole Changeover switch

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Description

_____

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_____

Single Pole circuit breaker

Description

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_____

_____

Two Pole circuit breaker

Description

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_____

_____

_____

Earth leakage circuit breaker

Description

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_____

_____

_____

Single Core Cable

Description

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Two Core Cable

Description

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_____

Three Core Cable

Description

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_____

_____

Four Core Cable

Description

INTRODUCTION TO BASIC ELECTRICAL CONCEPTS

Voltage

Voltage is the pressure, which drives the electric current in a specific direction in the circuit. It is denoted by the symbol "**V**" and is measured in volt (v).

Voltage/Potential Difference is divided into Alternating Voltage (AV) and Direct Voltage (DV). AV is voltage whose polarity changes contentious with the passage of time and DV does not change its polarity with the passage of time.

Electric Current

The rate of flow of charges through the circuit or any material in a specific direction is known as Electric current. It is denoted by the symbol "I" and is measured in Ampere (A).

Current may flow due to flow of positively charged particles, e.g. holes or positive ions, and negatively charged particles e.g. electrons or negative ions. There are two conditions, which must be fulfilled for the smooth flow of Electric Current through any material. These conditions are as follows:

- Potential difference across the terminal of component must be established.
- Path of flow of current must be completed.

Electric current is divided into Alternating Current (AC) and Direct Current (DC). AC is one whose direction of flow is changing contentious with the passage of time and DC does not change the direction of its flow with the passage of time.

Ohm's Law

This law describes the relationship b/w current **I** flowing through any component and voltage **V** across that component. It states that voltage **V** across any component is directly proportional to current **I** flowing through that component and mathematically it is expressed as follows:

$$V = I*R$$

Here **V** is the Voltage across the component, **I** is Current flowing through the same Component and **R** is the Resistance offered by the same Component which is measured in ohm (Ω).

Power

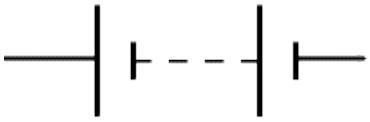
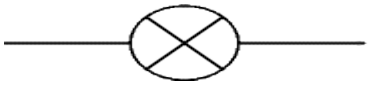
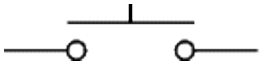
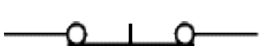
Power is product of voltage or potential difference **V** across any circuit components and current **I** flowing through that component. It is denoted as **P** is measured in Watt (**W**)

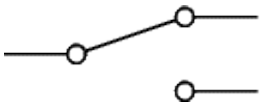
$$P = V*I$$

Electric Circuit

The path through which Electric Current flows is called Electric Circuit. The devices connected in the path of Electric Current is said to be Circuit Components. These Components are generally divided into two categories known as Passive Circuit Components and Active Circuit Components. Passive Components are those which dissipate the Electrical Energy such as Electric Lamp, Resistors, and Electric Motors

etc. Active Components generate Electrical Energy in the electric Circuit. Battery and Generator are the examples of Active Circuit Components. Some of Circuit Components and their brief descriptions are given in the following table.

Components	Circuit Symbols	Description
Battery		Supplies electrical energy. It provides Direct Current. The larger terminal (on the left) is positive (+).
DC supply		Supplies electrical energy. It provides Direct Current.
AC supply		Supplies electrical energy. It provides Alternating Current.
Fuse		A safety device which will 'blow' (melt) if the current flowing through it exceeds a specified value.
Earth (Ground)		A connection to earth. For many electronic circuits this is the 0V (zero volts) of the power supply.
Lamp (lighting)		A transducer which converts electrical energy to light.
Lamp (indicator)		A transducer which converts electrical energy to light.
Heater		A transducer which converts electrical energy to heat.
Motor		A transducer which converts electrical energy to mechanical energy.
Push Switch (push-to-make)		A push switch allows current to flow only when the button is pressed. This is the switch used to operate a doorbell.
Push-to-Break Switch		This type of push switch is normally closed (on), it is open (off) only when the button is pressed.

On-Off Switch (SPST)		SPST = Single Pole, Single Throw. An on-off switch allows current to flow only when it is in the closed (on) position.
2-way Switch (SPDT)		SPDT = Single Pole, Double Throw. A 2-way changeover switch directs the flow of current to one of two routes according to its position.
Voltmeter		A voltmeter is used to measure voltage across circuit component and required to connect in parallel fashion.
Ammeter		An ammeter is used to measure current and required to connect in series fashion.
Galvanometer		A galvanometer is a very sensitive meter which is used to detect tiny amount of current and required to connect in series fashion.
Ohmmeter		An ohmmeter is used to measure resistance of passive device and required to connect in parallel fashion.

MEASURING INSTRUMENTS

The devices that are used for the measurement of electrical parameters are referred as measuring instruments. Such as Voltmeter is used to measure voltage across any Component, ammter is used to measure Current flowing through a Component and Ohm meter is used to measure the resistance offered by any Components..

- **Voltmeter** is used to measure the Voltage across any Circuit Component. It is connected in parallel with the Circuit Component across which Voltage has to be determined.

- **Ammeter** is used to measure the current flowing through any Circuit Component. It is connected in Series with the Component. For that purpose first we have to open the component from its either side and then connect Am meter in series of that Component.

- **Ohm meter** is used to measure the Resistance offered by any passive Component in the Circuit. To measure the resistance of any passive component connected in the circuit first of all we have to cut off power supply from circuit and all the passive devices connected with that particular component then we have to connect ohm meter in parallel with it.

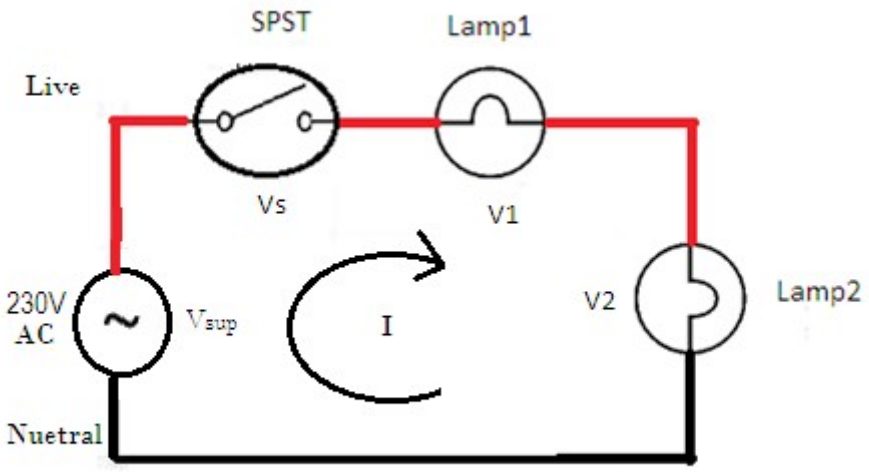
- **Multi meter** contains multiple measuring devices in single package. It is used to measure Resistance, Alternating and Direct Currents and Voltages etc.

Fig 4.3: Digital Multi Meter

BASIC ELECTRICAL WIRING CIRCUITS

1- Series Lamps controlled by single 1-way switch

This Circuit contains two Lamps labeled as L1, L2 and a 1-way Switch. Switch is connected in Series of AC Voltage Source and Lamps are also in Series with each other and with Switch as well. In Series connection of Circuit Components only one terminal of each Component is connected directly with each other and rest of terminals are connected with other Components. In Series connection same amount of Current flows through each of the Component but applied Voltage is divided with respect to their resistances, offered by them in flow of Current. When switch in open (Off) state both Lamps will remains off and at close (On) state both Lamps will glow with lesser brightness.



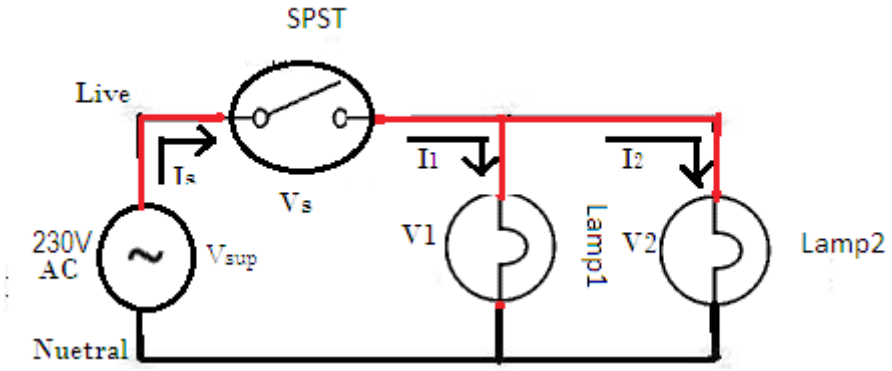
Two Series Lamps controlled by 1-way Switch

Switch(s) State	Voltage (V)			Current (A)	Power (W)		
	V_{Sup}	V_1	V_2	I	Source	P_1	P_2
Switch opened							
Switch closed							

Observations/ Findings:

2- Parallel Lamps controlled by single 1-way switch.

This Circuit contains two Lamps labeled as L1, L2 and a 1-way Switch. Switch is connected in Series of AC Voltage Source but Lamps are connected in parallel with each other. In parallel connection of Circuit Components both terminals of each Component is connected directly with each other. In parallel connection Voltage across each Component will be same but current divides in these Components. When Switch in open (Off) state both Lamps will remains off and at close (On) state of Switch both Lamps will glow with their full brightness.



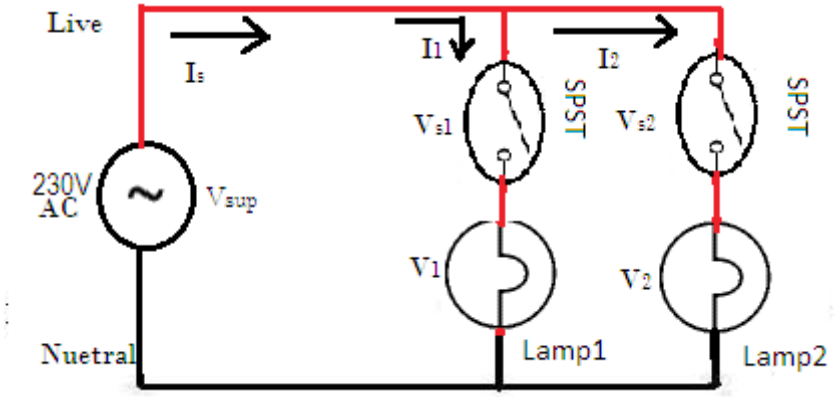
Parallel Lamps controlled by single Switch

Switch(s) State	Voltage (V)			Current (A)			Power (W)		
	V_{Sup}	V_1	V_2	I_s	I_1	I_2	Source Power	P_1	P_2
Switch opened									
Switch closed									

Observations/ Findings:

3- Parallel Lamps having separate control

This Circuit contains two Lamps labeled as L1, L2 and two 1-way Switches S1, S2. S1 is connected in Series of L1 and S2 is connected in Series of L2. When both of Switches are closed (On) both of Lamps become in parallel with each other and glow with their full brightness. In case of S1 is closed (On) and S2 is open (Off) L1 will glow and L2 remains Off and vice versa for S1 is open (Off) and S2 is closed (On).



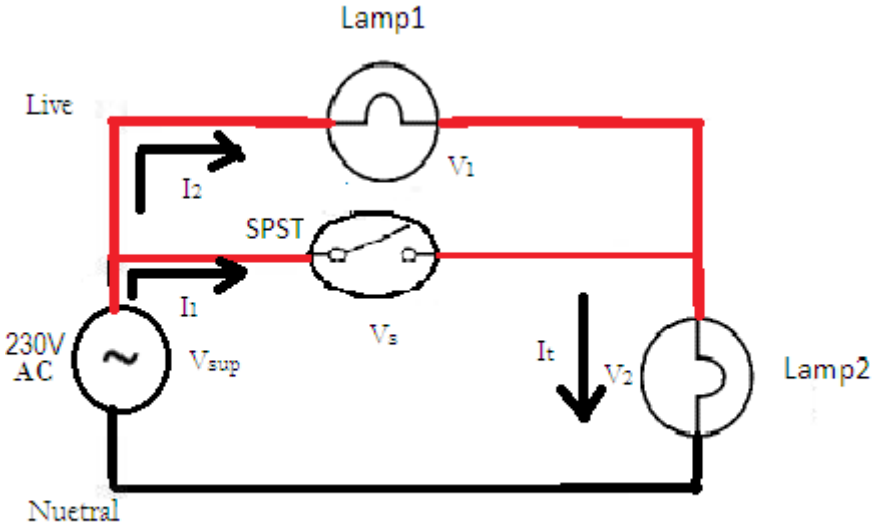
Two Lamps having Separate Control

Switch(s) State	Voltage (V)			Current (A)			Power (W)		
	V_{Sup}	V_1	V_2	I_s	I_1	I_2	Source	P_1	P_2
Both Sw open									
Sw1 open Sw2 close									
Sw1 close Sw2 open									
Both Sw close									

Observations/ Findings:

4- Test Board Circuit with 1-way switch

In this Circuit two Lamps labeled as L1, L2 and one 1-way Switch is connected with AC Voltage Source in such a way that Sw is in parallel with L1. When Sw is at open (Off) state L1 and L2 become in Series and both of them ill glow with their lesser brightness. When Sw is at close (On) state L1 becomes short and only L2 will glow.



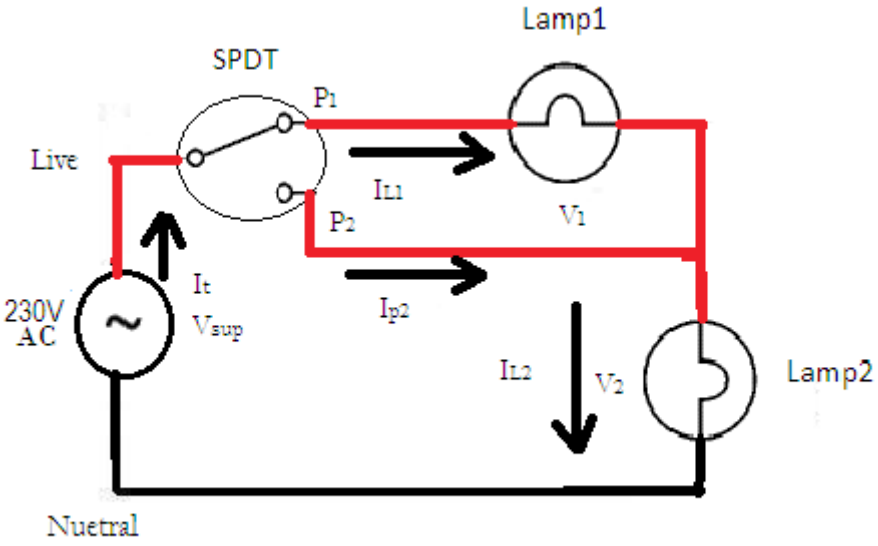
Test Board Circuit with 1-way Switch

Switch(s) State	Voltage (V)			Current (A)			Power (W)		
	V_{Sup}	V_1	V_2	I_1	I_2	It	Source	P_1	P_2
Switch opened									
Switch closed									

Observations/ Findings:

5- Test Board Circuit with 2-way switch

In this Circuit two Lamps labeled as L1, L2 and one 2-way Switch is connected with AC Voltage Source in such a way that P1 is connect with L1 and P2 is connected with common terminal of L1 and L2. When Sw is at P1 state L1 and L2 become in Series and both of them ill glow with their lesser brightness. When Sw is at P2 state L1 becomes open and only L2 will glow.



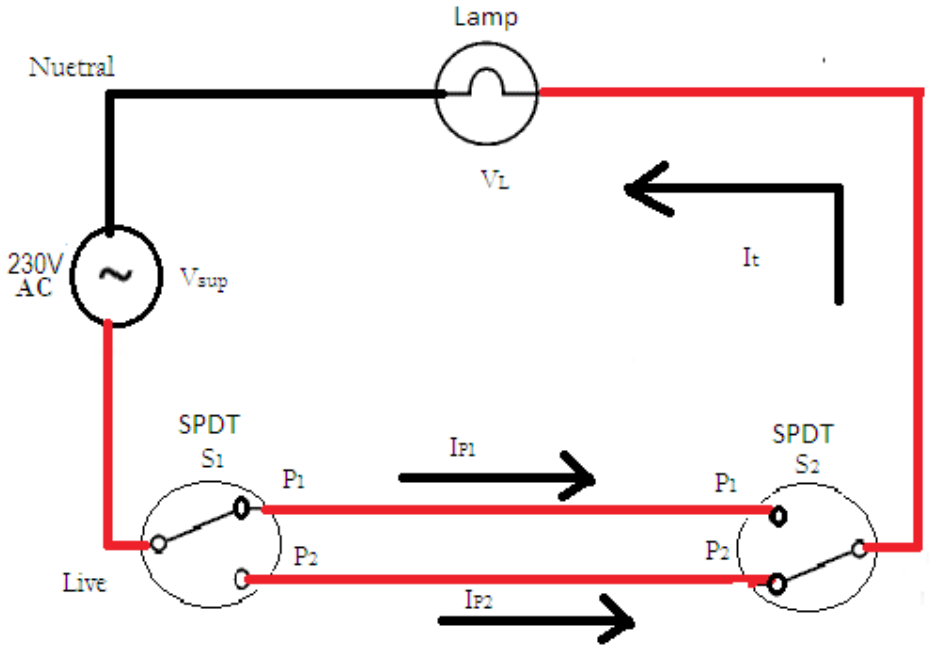
Test Bard with 2-way Switch

Switch(s) State	Voltage (V)			Current (A)			Power (W)		
	V_{Sup}	V_1	V_2	I_1	I_2	It	Source	P_1	P_2
P1 close									
P2 close									

Observations/ Findings:

6- Stair case Circuit

In this Circuit a Lamp and two 2-way Switches are connected with AC Voltage Source. When both of Switches are at P1 or P2 States Circuit will conduct and Lamp will glow. When these Lamps are in their alternate states means S1 is at P1 and S2 is at P2 then Circuit does not conduct and Lamp remains off in that case. This Circuit is known as Stair Case Circuit because it is implemented in the stairs of houses and buildings.



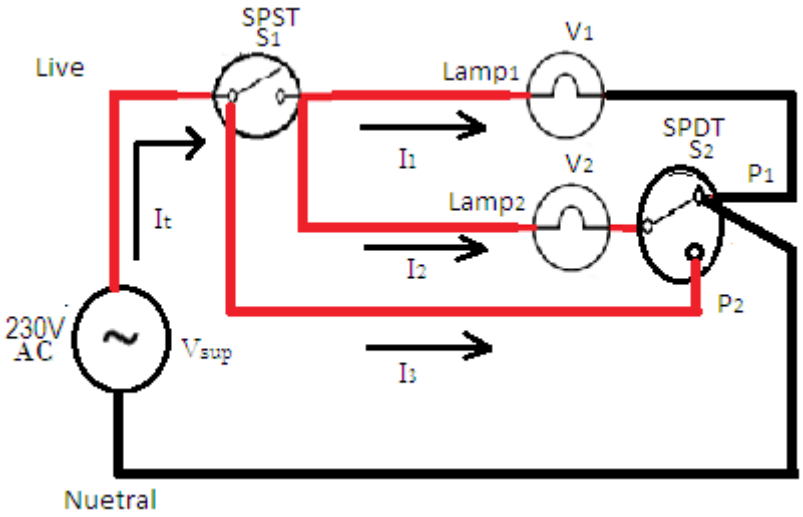
Stair Case Circuit

Switch(s) State	Voltage (V)		Current (A)			Power (W)	
	V_{Sup}	V_L	I_{p1}	I_{p2}	I_t	Source	PL
Both Sw closed with P1							
Sw1 closed with P1 & Sw2 closed with P2							
Sw1 closed with P2 & Sw2 closed with P1							
Both Sw closed with P2							

Observations/ Findings:

7- Three Operation Circuit

In this Circuit two Lamps labeled as L1, L2, one 1-way and one 2-way Switch is connected with AC Voltage Source in such a way that P1 of 2-way Switch and 1-way switch is directly connected with voltage source. P2 is connected with neutral of voltage source and L2. L1 and L2 are also having direct connection with each other as shown in following figure. Four different cases may be possible in this Circuit described as follows.



Three Operation Circuit

- **Case 1:** let S1 is open and S2 is connected to P1none of lamp may glow as live is disconnected with both of them.
- **Case 2:** let S1 is open and S2 is connected to P2 both of lamps glow with lesser brightness as both of them are connected in series fashion.
- **Case 3:** let S1 is closed and S2 is connected to P1 both of lamps glow with full brightness as they are parallel to the source.
- **Case 4:** let S1 is closed and S2 is connected to P2 only lamp1 will glow lamp2 gets short.

Switch(s) State	Voltage (V)			Current (A)				Power (W)		
	V_{Sup}	V1	V2	I1	I2	I3	It	Source	P1	P2
Sw1 open & Sw2 close with p1										
Sw1 open & Sw2 close with p2										
Sw1 closed & Sw2 close with p1										
Sw1 closed & Sw2 close with p2										

Observations/ Findings:

ASSIGNMENT No.2

Q1. Draw the schematic diagram of seven Electric lamps controlled by single 1-way switch in such a way that whenever:

- **Switch is open** none of Electric lamp should glow
- **Switch is close** three of them should glow in series fashion whereas four should glow in parallel fashion

Q2. Draw the schematic diagram of seven Electric lamps controlled by single 1-way switch in such a way that whenever:

- **Switch is open** two of Electric lamps should glow in parallel fashion
- **Switch is close** three of them should glow in series fashion whereas four should glow in parallel fashion

Q3. Draw the schematic diagram of seven Electric lamps controlled by four switches in such a way that:

- Three of electric lamps should control separately
- Rest of them should control from 4th switch in parallel fashion

Q4. Draw the schematic diagram of seven Electric lamps controlled by two switches in such a way that whenever:

- **Switch S1 & switch S2 are upward** three of the electric lamps should glow in series fashion
- **Switch S1 & switch S2 are downward** four of the electric lamps should glow in parallel fashion
- **Switch S1 & switch S2 are at alternate state** none of lamp should glow

Q5. Draw the schematic diagram of seven Electric lamps controlled by two switches in such a way that whenever:

- **Switch S1 is upward & switch S2 is downward** three of the electric lamps should glow in series fashion and two of them should glow in parallel fashion
- **Switch S1 is downward & switch S2 are upward** four of the electric lamps should glow in parallel fashion
- **Switch S1 & switch S2 are at same** two of them should glow in parallel fashion

CABLES AND ITS CLASSIFICATION

Metallic conductors are used as medium of electrical energy to transfer it from source of electricity to the point where it is to be used. These metallic conductors are categories as wires and cables.

Wires are the conductors which do not contain protective insulation but it may contain thin layer of insulation to protect the leakage of current.

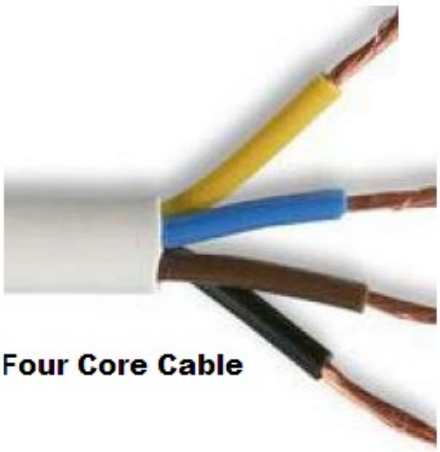
Whereas cables are conductors covered with protective insulation. Same insulation protects cable from leakage of current and mechanical damage as well.

Cables are classified on the basis of their Cores, and insulated materials. Single or a group of multiple conductors covered under single protective insulation is referred as a **core**. On the basis of Core, Cables are divided into **Single Core** and **Multi Core Cables**. In Single Core Cable a Conductor or a group of Conductors is insulated and covered with single Protective Covering Whereas Multi Core Cable Contains more than one insulated Conductors or group of Conductors under a common Covering. Twin/ two Core, Three Core and Four Core Cables are commonly used in domestic and Industrial wirings.

Single Core Cable

Three Core Cable

Two Core Cable



Four Core Cable

A Varity of different Insulating materials is used in the manufacturing of Cables. Some commonly used Cables, classified on the basis of Insulating Material, are described as follows:

- **Vulcanised Rubber Insulated Cable (VRI)**
- **Poly-Vinyl-Chloride Cable (PVC)**
- **Tough Rubber Seath Cable (TRS)**

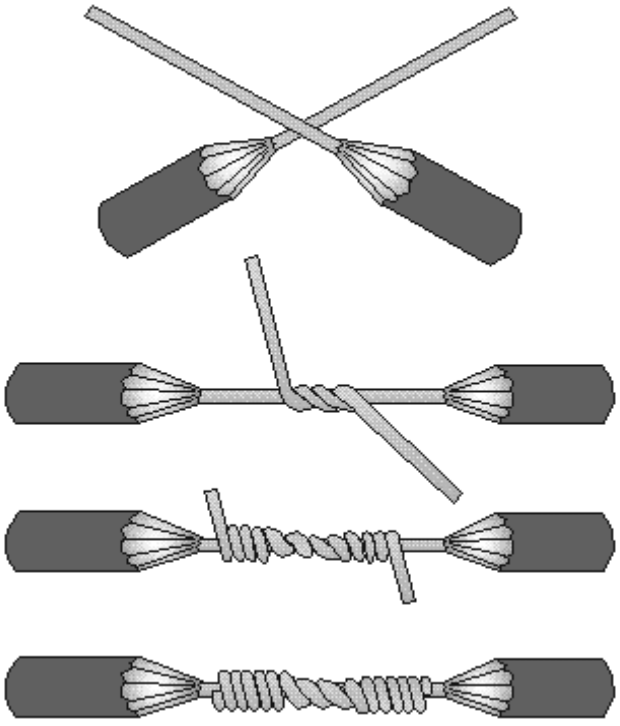
- **Impregnated Paper Insulated Cable**
- **Varnished Cambric Insulated Cable.**
- **Mineral Insulated/ Fire Retarded Cable**.

ELECTRICAL JOINTS & SPLICES

Interconnection of multiple electrical conductors with each other in such a way that it is mechanical sound and may conduct electricity efficiently is known as Electrical Joint or Splice. Splices may be divided into two categories known as butted and tap splices. Splice made by joining the free ends of conductors with each other is known as butted whereas Tap joint is made by joining the a branched conductor with a contentious wire. Five different types of splices are used commonly. Each has its own advantages and disadvantages. Other than knotted tap splice all the splices are butted joints.

1- Western Union Splice

The Western Union splice joins small, solid conductors. Following figure shows the steps in making a Western Union splice.



Western Union splice.

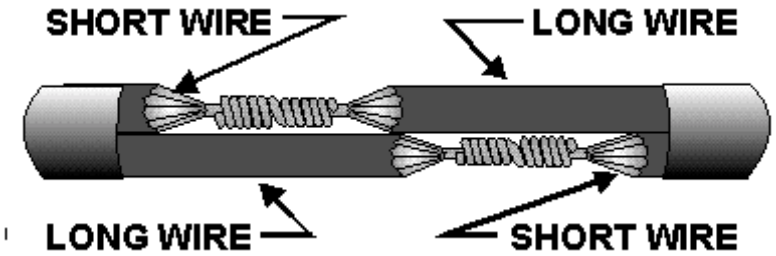
- Prepare the wires for splicing. Enough insulation is removed to make the splice. The conductor is cleaned.
- Bring the wires to a crossed position and make a long twist or bend in each wire.

- Wrap one end of the wire and then the other end four or five times around the straight portion of each wire.

- Press the ends of the wires down as close as possible to the straight portion of the wire. This prevents the sharp ends from puncturing the tape covering that is wrapped over the splice.

2- Staggering Splices

Joining small multiconductor cables often presents a problem. Each conductor must be spliced and taped. If the splices are directly opposite each other, the overall size of the joint becomes large and bulky. A smoother and less bulky joint can be made by staggering the splices.

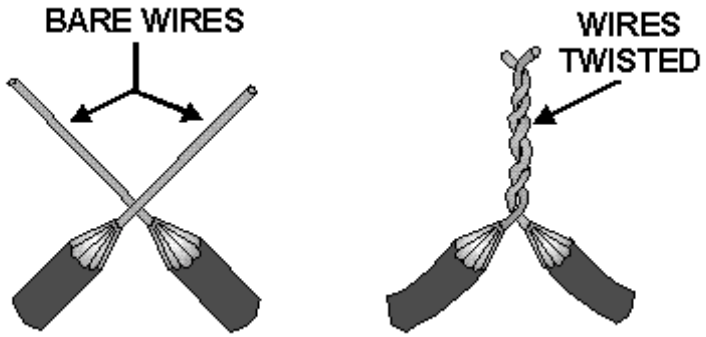


Staggering splices.

Figure shows how a two-conductor cable is joined to a similar size cable by using a Western Union splice and by staggering the splices. Care should be taken to ensure that a short wire from one side of the cable is spliced to a long wire, from the other side of the cable. The sharp ends are then clamped firmly down on the conductor.

3- Rattail Splice

A splice that is used in a junction box and for connecting branch circuits is the rattail joint.

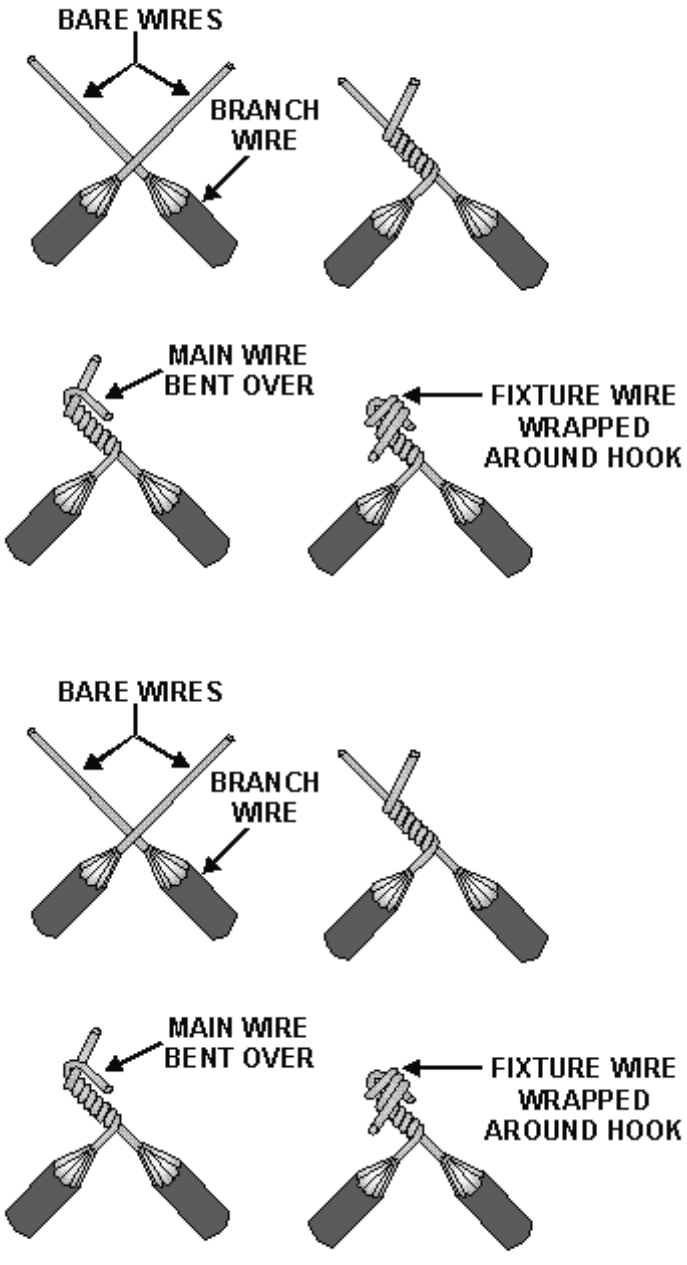


Rattail joint.

To create a rattail joint, first strip the insulation off the ends of the conductors to be joined. You then twist the wires to form the rattail effect. This type of splice will not stand much stress.

4- Fixture Splice

The fixture joint is used to connect a small-diameter wire, such as in a lighting fixture, to a larger diameter wire used in a branch circuit. Like the rattail joint, the fixture joint will not stand much strain.
Following figure shows the steps in making a fixture joint. The first step is to remove the insulation and clean the wires to be joined. After the wires are prepared, the fixture wire is wrapped a few times around the branch wire. The end of the branch wire is then bent over the completed turns. The remainder of the bare fixture wire is then wrapped over the bent branch wire.



Fixture joint.

5- Knotted Tap Joint

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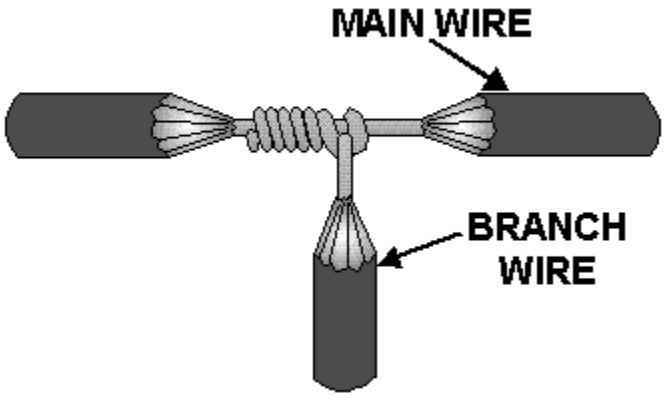
- Remove the insulation of main cable upto one inch whereas branch cable should be stripped of about three inches.



Knotted tap joint.

- The branch wire is laid behind the main wire. The branch wire is brought under the main wire, around itself and then over the main wire to form a knot as shown in above figure.

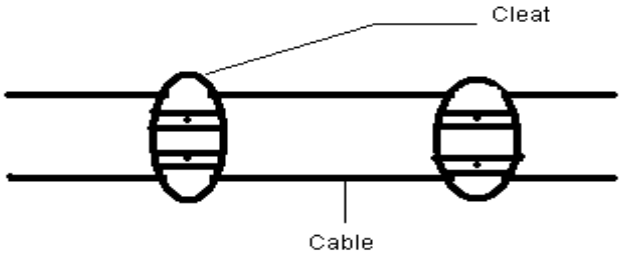
- The branch wire is then wrapped around the main conductor in short, tight turns and the end is trimmed off.

The knotted tap is used where the splice is subject to strain or slippage. When there is no strain, the knot may be eliminated.

ELECTRICAL WIRING SYSTEMS

1- Cleat Wiring System

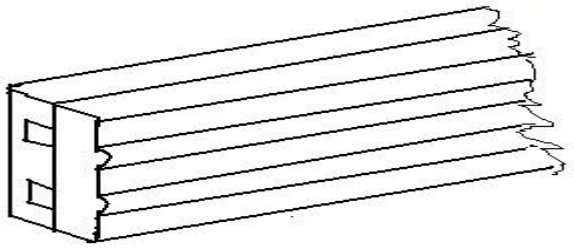
This Wiring System consists of VIR or PVC cables layed down with the help of Cleats. It may be used in dry conditions, where Wiring runs, are unlikely to sustain mechanical damage. The commonly used Cleat is made up of Wood or Porcelain (China Clay), consisting of a base with groves to hold the Cable and a top without grove, which are fastened together and to the wall by one or more screws. It is cheapest Wiring System and has nearly 10 years estimated life.



Cleat Wiring

2- Casing and Capping Wiring System

This type of Wiring is used for indoor Electrification only. It consists of a strip of wood with parallel groves cut length ways to accommodate Cables. Teak wood is strongly recommended for this System. It is fixed flat on the wall or ceiling by rawal plugs which are placed not more than 3fts along with round porcelain cleats are fixed under the casing to prevent the moisture and direct contact with wall. Its estimated life is nearly 50 years and it is expansive than that of Cleat Wiring System.



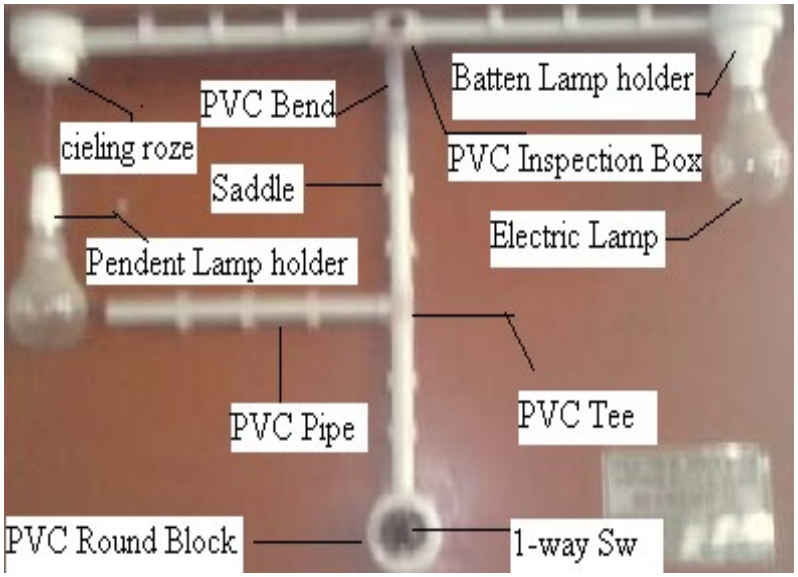
Casing Capping Wring

3- Conduit Wiring System

Wiring System where Cables run in protective light weight and thin pipes/ tubes from Supply to Load is known as Conduit Wiring System. The standard size of Conduits, used in this System is ½, ¾, 1, 1½, inches of their external length. This System normally includes PVC Conduits, PVC Bend, PVC Tee, and PVC Round Block as accessories which are described in above section. This System gives the Cable good mechanical protection, reduces the fire risk and permits easy to reinstall. Conduit Wiring is installed in two ways.

3.1- Surface Conduit Wiring System

The Conduits are fixed on the surface of walls, ceilings, and girders to run the Cables from Supply to Load. Various types of Saddles are used for this purpose. These Saddles provide good secure fixing to the Conduits and other Wiring fittings. Normally these Saddles are placed at about 3fts distance along the Conduit. The Conduit run should be continuous and as straight as possible. It should be placed either horizontal or vertical. This System is used in factories, houses, and commercial buildings where sight of exposed running conduit is not important.



Surface Conduit Wiring

3.2- Concealed Conduit Wiring System

In this System no other than fittings are exposed on the surface of the walls, or ceilings. With good Concealed Wiring it should not be possible to see where the Conduits have been run. It is the most suitable in excessive moisture and chemical environment and is widely used in modern houses and commercial building.

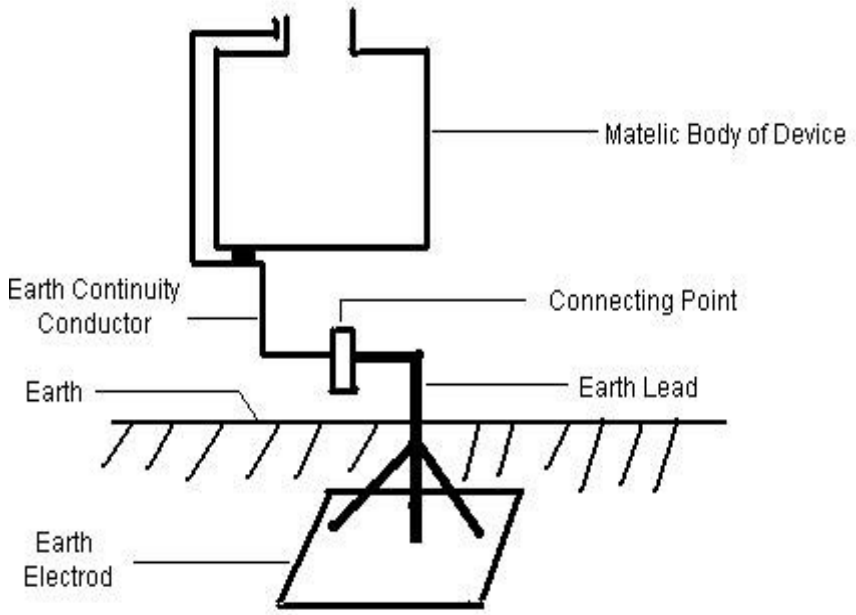
SYSTEM EARTH

Earthing is the process of connecting the metallic body of a device or instrument with the particular layer of earth. The purpose of earthing is to provide the low resistance path for the flow of current from the metallic body of the device to earth so that human being may be protected from the Electric shock in case of contact of human body with the body of device. According to IEE rules resistance of this System must not exceeds from one ohm. Earthing System has following three parts:

- **Earth Continuity Conductor** is low resistance Conductor that connects the metallic body of device with Earthing Lead. It is the connection between Socket and Main Switch.

- **Earth Lead** connects the Earth Continuity Conductor with Earth Electrode. It is flexible Cable has greater diameter as compared to Earth Continuity Conductor and the Main Switch with Earth Electrode.

- **Earth Electrode** is a metallic plate, Rod, or Pipe, which is buried one ft below of moisture layer inside the earth some noncreative absorbent is also added in that place. It's the last part of Earthing System. Earthing Lead is normally connected with it at more than one point. Earth plate is made up of Copper or Ferrous where as Galvanized Iron is used in Earth Pipe making.



System Earth

ELECTRICAL WIRING LAB WORK

In Electrical wiring lab work we have to implement single phase wiring by using PVC surface conduit wiring system. In this wiring system we have to install conduits on the surface of wooden board. In single phase wiring red and black cables is used. Red cables are used as phase cables where as black cables are used as neutral cables. All switches should be connected with the phase of power supply.

Apparatus

List all the tools & wiring accessories, required to perform the lab work.

Procedure

Draw the labeled conduit layout used in lab work

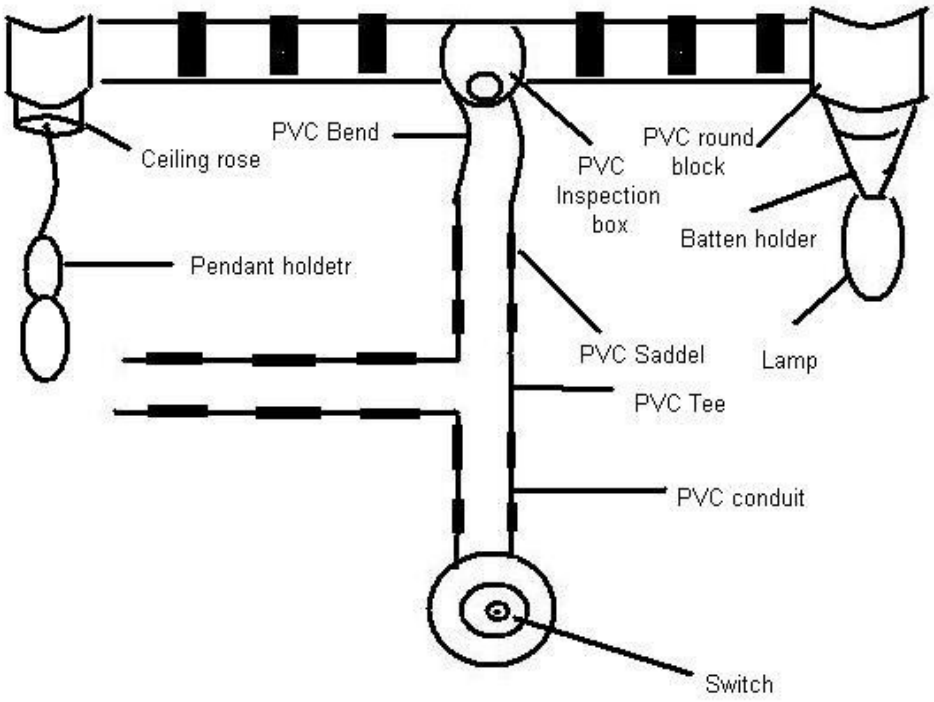
Draw the Circuit diagram
(Use red ink for live connections and black for neutral connections)

Draw wiring diagram in accordance with circuit and conduit layout
(Use red ink for live connections and black for neutral connections)

Conclusions/findings

ASSIGNMENT No.3

Draw the circuit and wiring diagram of series, parallel circuits using SPST switch and Test board circuits in accordance with following conduit layout.
(Use red ink for live connections and black for neutral connections)



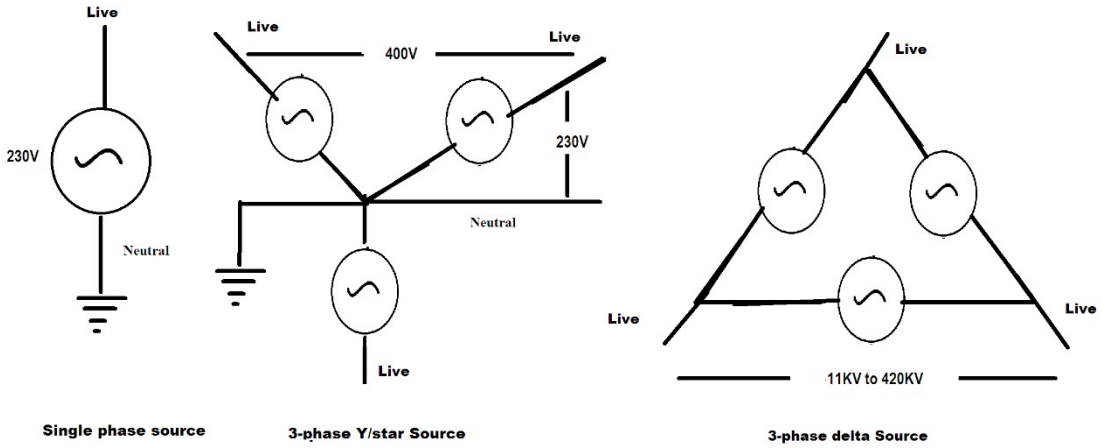
Piping layout No. 1

SOURCES OF ELECTRICAL ENERGY USED IN ELECTRICAL WIRING SYSTEM

Electrical wiring system is responsible for transfer, distribution and consumption of electrical energy within single assembly/structure. On the basis of types of assembly it is divided into auto wiring and building wiring. But we will discuss only building wiring in this section.

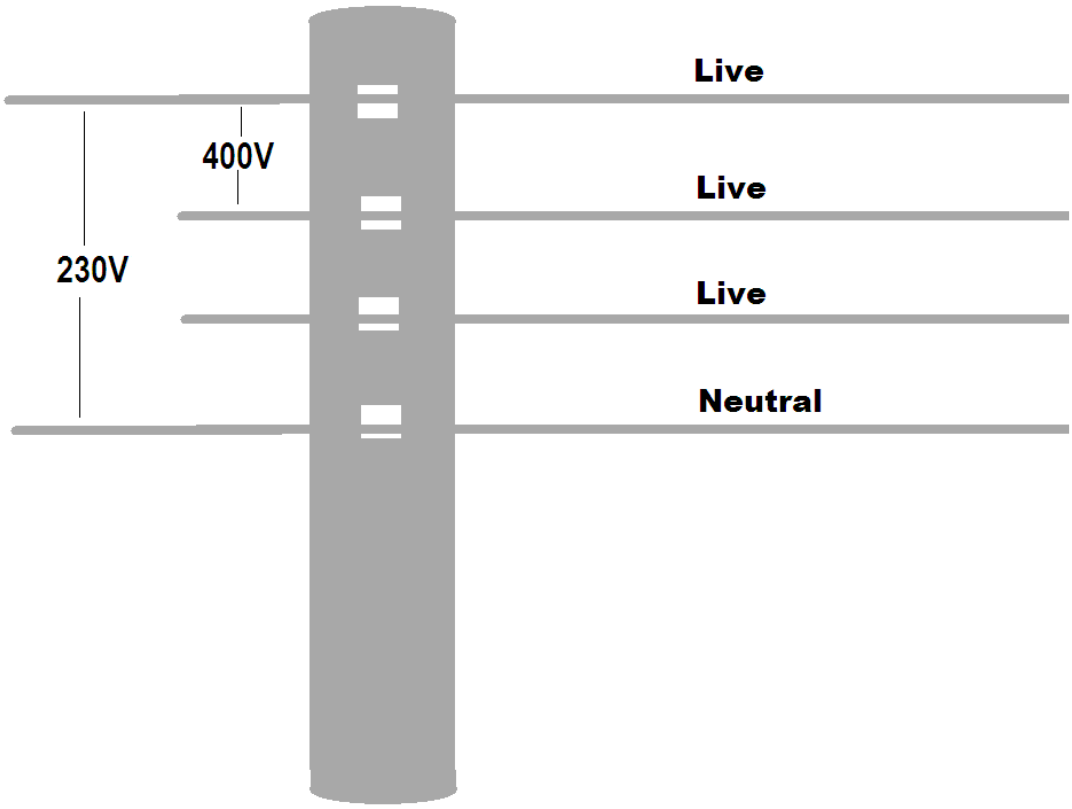
On the basis of source and load/appliances building wiring is further divided into single phase and 3-phase wiring systems. The load of residential building is normally single phase and 230V alternating voltage is required to operate same load and it will be 2 terminal devices whereas 3-phase load requires more than 230V alternating voltage for its operation and it contains 3 terminals.

Alternating voltage source provided by the electrical supply companies is categories as single phase, 3-phase Y/star and 3-phase delta sources. Single phase source consists on only 2 terminals. The terminal of single phase source which indicates flow of current is referred live/phase terminal whereas other terminal is grounded and is called as neutral. 3-phase source Y/star source is 4 terminals device containing 3 live terminals and one neutral terminal. Potential difference b/w 2 live terminal is 400V whereas in live and neutral is 230V. 3-phase delta source is 3 terminals devices with all the terminals are live. Potential difference in both live terminals may vary from 11KV to 420KV. Frequency of all the sources is 50Hz and phase shift b/w 2 live terminals in 3-phase will be 120°. Symbols of these sources are given below:



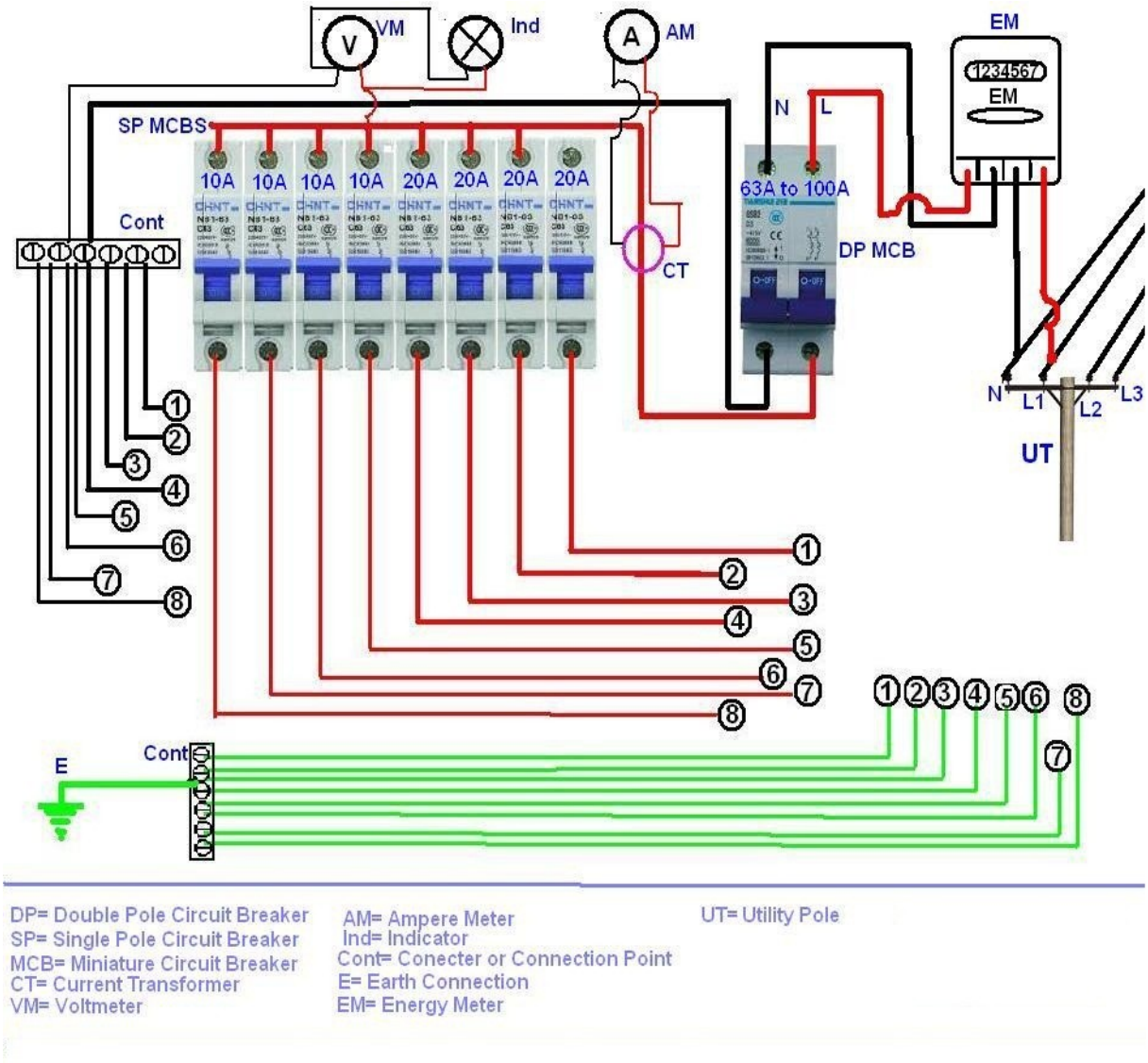
SINGLE PHASE ELECTRIFICATION OF RESIDENTIAL BUILDING

We need to connect whole load of our building with electrical supply system by means of service mains. These are 4 wires, consisting on 3 live and one neutral, running on electric poles along the streets. The group of same wire is referred as 3-phase Y/star source as well.

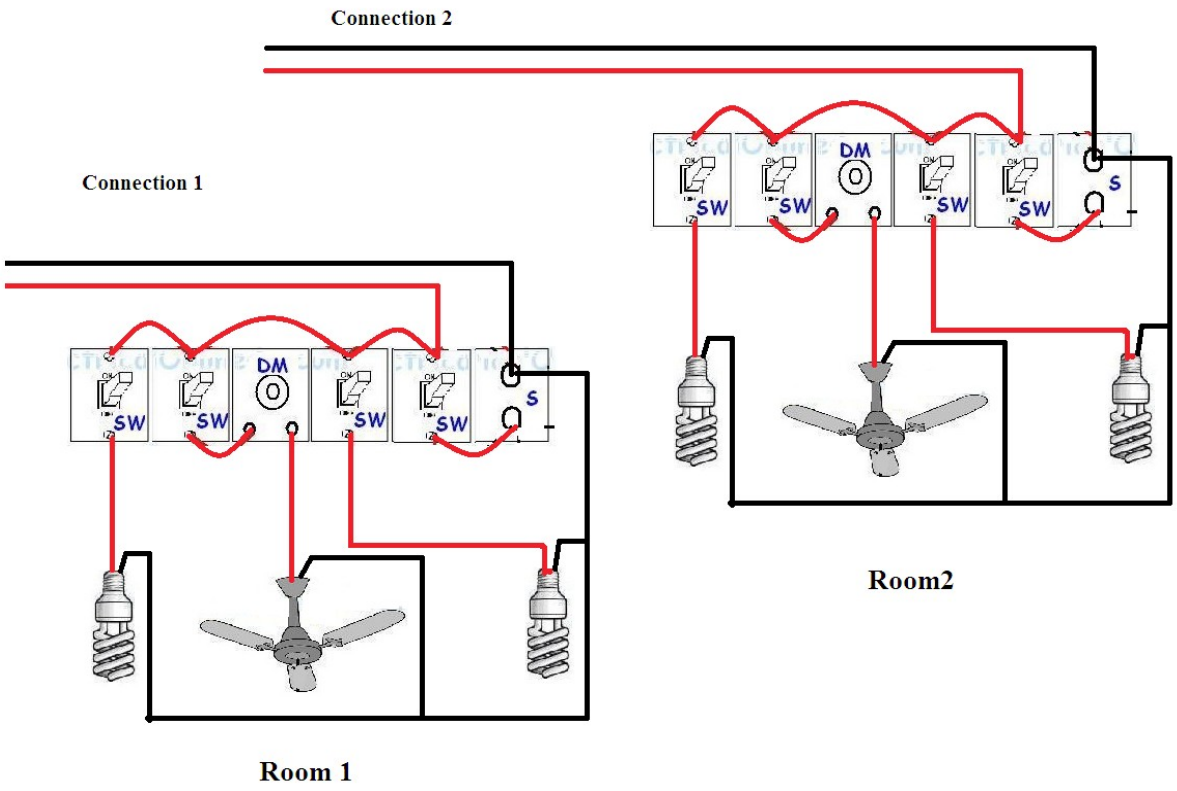


Service mains

If we intended to operate only single phase load/appliances with in a building and total power consumption capacity of same building is less than 4KW one single phase connection will be sufficient to operate whole load of same building. In single phase connection one live and neutral connection will be provided by the electric supply company from service mains. Same connection of live and neutral are connected with single phase energy meter which is 4 terminals device. 2 of the given terminals are reserved for the connection of service mains and rest of them is required to connect with load of building. The only purpose to install energy meter is to measure energy consumed by the customer in KWh throughout the month. Energy meter is further connected with 2-pole main switch/circuit breaker, installed in distribution board of building, which also 4 terminals device. It is first control of electricity installed in wiring system and we may control electricity within building by using same switch/circuit breaker. After the connection of main switch now we need to divide the building into multiple divisions and run live and neutral connection for each of the decided division separately by using single pole circuit protection device i.e. fuse/circuit breaker. Detailed wiring diagram from service mains to circuit breakers installed in distribution board is shown as follow:



After the installation of circuit breakers in distribution board now we are required to run live connection from circuit breaker and neutral connection from neutral link towards the switch board of divisions where switches and sockets are installed. All the single pole switches installed in switch board must be connected with live only and none of single pole switch may connect with neutral and each is required to connect in series of the appliance which is to be control from the switch. Neutral of source needs to connect with the appliance only as shown in following figure:

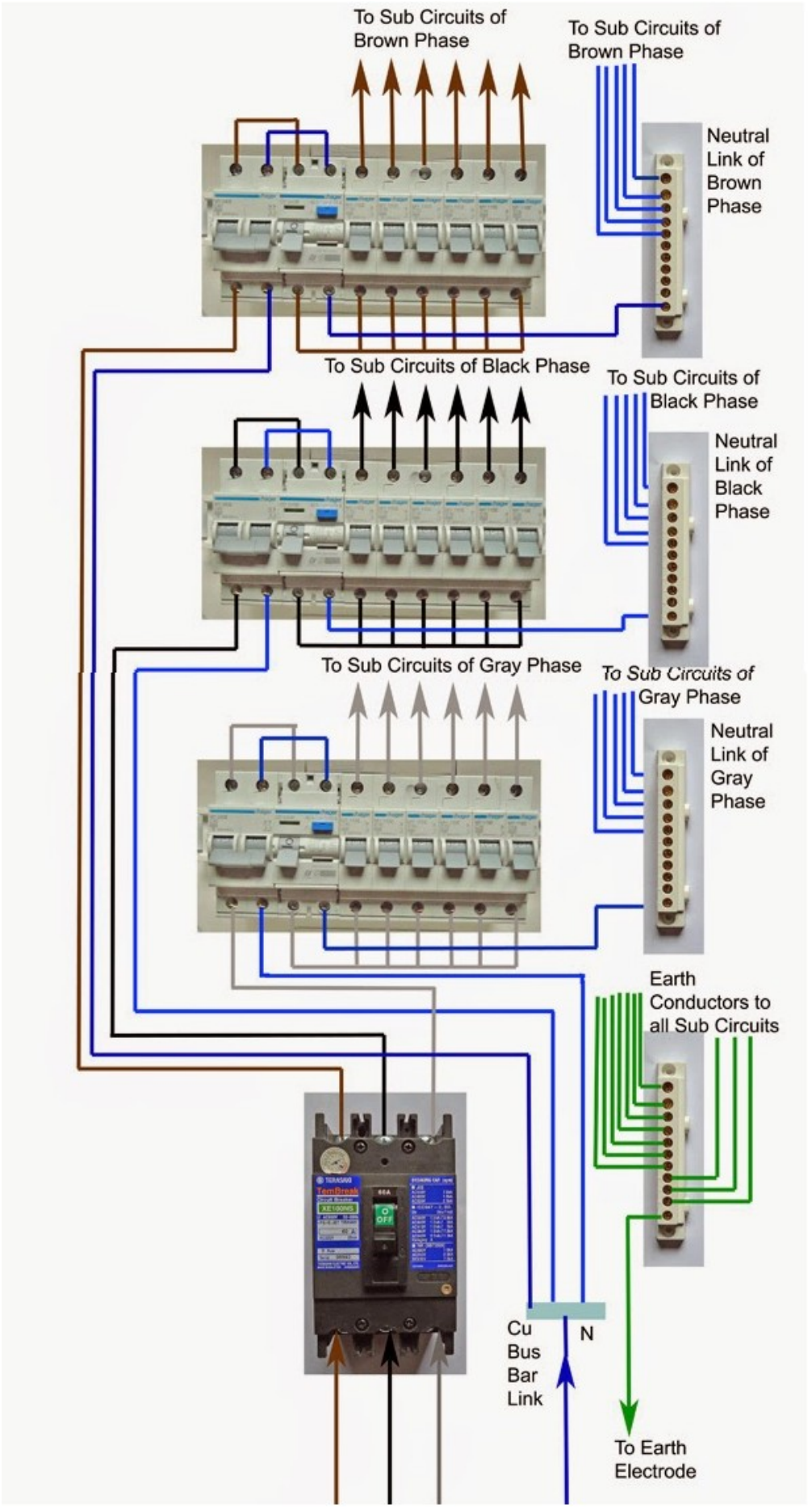


SW: Switch
DM: Dimmer
S: 2-pin Socket

Wiring of divisions

DISTRIBUTION BOARD WIRING FOR 3-PHASE CONNECTION

3-phase connection is required to operate load of residential building if total power consumption capacity is more than 4KW. 3 lives and a neutral are provided in 3-phase 400V connection. Same connections of lives and neutral are required to connect with 3-phase energy meter. It has 8 terminals 3 lives and a neutral are reserved for connection of service mains and rest of 4 terminals are reserved for the connection of load. Energy meter is further connected with 3-phase switch/circuit breaker (Molded case circuit breaker), consisting on 6 terminals, 3 for the connections of 3 lives of source and rest for connection of load. There is no provision to connect within 3-phase switch/circuit breaker. Now one live from 3-phase circuit breaker and a neutral cable from neutral link is required to run towards 1st sub distribution board, 2nd live from 3-phase circuit breaker and a neutral cable from neutral link need to be towards 2nd sub distribution board and same for the 3rd phase/live. Room wiring for single phase appliances/load is the same as discussed above.


To Sub Circuits of Brown Phase
To Sub Circuits of Brown Phase
Neutral Link of Brown Phase
To Sub Circuits of Black Phase
To Sub Circuits of Black Phase
Neutral Link of Black Phase
To Sub Circuits of Gray Phase
To Sub Circuits of Gray Phase
Neutral Link of Gray Phase
Earth Conductors to all Sub Circuits
Cu Bus Bar Link
N
To Earth Electrode

ASSIGNMENT No.4

Electrification is required to be done in an office having three rooms, two washrooms and a kitchen. Each room is required to furnish with two ceiling fans, five electric lights and an air conditioner whereas kitchen and wash rooms are required to furnish with three electric lights an exhaust and a bracket fan. Design the electrical wiring system for the given building.

Power rating of the appliances is as follows:

Sr.	Appliances	Power
1	Electric Light	25 W
2	Ceiling Fan	120 W
3	Bracket fan	60W
4	Exhaust fan	50W
5	Air conditioner	1.7kW

Your design must consist on detailed wiring diagram by ensuring proper safety and control measures from Service mains to appliance with complete connection.

(Note: Use red, yellow and blue ink for live and black for neutral & green for earth connections. Use proper symbols where applicable. You may use one page for single room wiring.)

SELF ASSESSMENT

Q1- What is difference b/w neutral and earth terminals?
Ans: _____

Q2- How does connections of 2 pin socket differ from that of 3 pin socket?
Ans: _____

Q3- - How does connections of 2 pin plug differ from that of 3 pin plug?
Ans: _____

Q4- Define Single Phase Alternating Voltage source and also describe the specifications of same source used in Pakistan.
Ans: _____

Q5- Differentiate SPST and SPDT Switch.
Ans: _____

Q6- How may we use an SPDT Switch as an SPST?
Ans: _____

Q7- Draw circuit diagram of staircase circuit in such a way that when both of the SPDT switches are at same states electric lamp must be off and it must glow only at alternate states of connected switches
Ans:

Q8- Why electric lamps glow with lesser brightness in series circuit?
Ans: _____

Q9- Explain the working of 2 lamps having different wattage in series and parallel connections.
Ans: _____

Q10- Explain the behavior of the circuit when one of lamp connected in parallel fashion gets short.
Ans: _____

Q11- Explain the behavior of the circuit when one of lamp connected in series fashion gets short.
Ans: _____

Q12- what is the condition which causes short-circuit?
Ans: _____

Q13- How may distinguish among single, double and three pole circuit breaker? Also explain their way of connections.
Ans: _____

Q14- what is recommendation of IEE for the connection single pole safety devices and control devices?
Ans: _____

Q15- How single phase alternating voltage source differs from three phase source?
Ans: _____

Q16- what is the purpose of earthling of electrical appliances?
Ans: _____

Q17- Explain safe method to extinguish an electrical fire.
Ans: _____