SYLLABUS

UNIT III WIRING, GROUNDING AND SAFETY

Wiring: General Rules, materials and accessories,Types of wiring - Conduit wiring – Wiring layout of Residential building, Grounding: Importance of grounding, Types of grounding -Safety: Causes of accidents, Accident prevention.Design of residential wiring using DT concept.

WIRING:GENERAL RULES

The general wiring rules were given by BIS mark(Bureau of Indian standards) – IS 4648.

- AC and DC circuits should be separated for efficient power distribution, compatibility with different devices and ability to regulate voltage effectively based on the requirements of specific applications.
- In AC, 3 phases are indicated in Red, Yellow and Blue, Neutral in black.
- Total load in a circuit should not exceed 750W. Number of points should not exceed 10.
- For lighting loads, fuse wire should not exceed 5A capacity and for power loads it should be 10A.
- In domestic wiring 3 pin plug should be used.
- All switches should be connected through line wire only and never on the neutral.
- All the switch boards should be fixed at a height of 1.5 meter.
- All the fans should be fixed at a height of 2.5m from ground.
- The load on each power circuit is restricted to 3000W
- All live conductors should be insulated
- Each sub-circuit is protected against excessive current by a fuse or Automatic circuit breaker.
- Before doing any electrical work, make sure the power is off at the breaker
- Always replace wires that show signs of deteriorations.
- You should never touch any plumbing or gas pipes while working with electricity and its because they may be used to ground electrical systems.
- If you overload outlets or extension cords it's going to create a fire hazard.

Wiring: Materials(Tools) and accessories

Electrical tools are used to do the electrical works like electrical wiring and installations. Few electrical tools are discussed below.

TOOLS(MATERIALS) USED FOR WIRING

Screw Drivers: Screwdrivers can be used to loosen or tighten screws with slotted heads, screwdrivers are in various size and shape. Screwdrivers are made up of steel and they are tempered at the tip. According to the size and shape of screw different types of screwdrivers are used.They are Thin blade Type and Square blade Type

Hammer : Hammers are tools which are used for pounding and pulling out of nails, there are soft and hard-faced hammers. Hard faced hammer can be used to strike hard objects and they have a cylindrical-shaped head. The soft-faced hammer is used for the rewinding process. Mostly soft-faced hammers are made up of rubber or plastic. There are different types of hammers like a claw hammer, ball peen hammer and mallet.

Pliers : Pliers can be used for cutting, twisting, bending, holding, and gripping of wires and cables. The handles of the pliers will be insulated and it can't be considered as sufficient protection. There are different types of pliers : Side cutting plier , Diagonal cutting plier, Long nose , Slip joint

Drill : These devices are used to drill holes in metal sheets and concrete walls, they can be used to make holes in building structures for the passage of wires and conduit. They can be useful for indoor and outdoor wiring.

Chisel : This hand-held tool features a distinctive cutting edge which is purpose-made for carving and cutting hard materials such as wood, stone, and metal.

Wooden saw :A saw is a tool that's used to cut wood. It can be a hand tool or a power tool, and it usually has either a blade or a disk with a jagged cutting edge.

Hack saw : Hacksaws can be used to cut metal conduit and armored cable, it can also be used to cut the small and medium-sized metals.

Center punch: It is used to mark the center of a point. It is usually used to mark the center of a hole when drilling holes. A drill has the tendency to "wander" if it does not start in a recess. A center punch forms a large enough dimple to "guide" the tip of the drill.

Pocket knife :It is used to cut various objects, such as wires, cords, tapes and so on

Wrenches: Wrenches are instruments that can be used to turn nuts or hold the piece of stock when tightening screws, nuts, and bolts. There are different types of wrenches like adjustable wrenches, pipe wrench, vise grip wrench.

Wire Strippers: Wire strippers are used to remove the insulation of wires, mostly medium-sized wires ranging from gauge 10 to gauge 16. Wire strippers are also used to remove the insulation of rubber covered wires from gauge 26 to gauge 10.

A scratch awl: It is a woodworking layout and point-making tool. It is used to scribe a line to be followed by a hand saw or chisel when making woodworking.

Pipe Vice: A vice allows workpieces to be quickly and easily clamped - in a vertical plane for the vice pictured - others may hold items horizontally. Some vices are quite small and portable. Vices are ideal for tasks such as sawing, drilling and filing. The vice jaws can be adjusted to securely hold the object into place.

Soldering or Desoldering Iron: It is used to embed/ remove the components on/from the panel.

						
Hammer	Pliers	Pocket knife	Chisel	Hack saw	Centre punch	Drilling machine

						
Wooden saw	Wrenches	Wire Strippers	Pipe vice	Scratch awl	Screw Drivers	Soldering Iron

ACCESSORIES USED FOR WIRING

- Switches
- Lamp holders
- Socket outlets
- Ceiling roses
- Plugs
- Mounting blocks
- Main Switch
- Flexible cords
- Distribution board
- Fuse
- Cables

Switches: Used to make or break a circuit

Types of Switches

(i)Tumbler Switch or Surface switch

These switches are mounted on the mounting block directly fixed over the surface of the wall. Such types of switches project out of the surface of the wall. These switches can be classified into single way and two-way switches.

(ii)Flush switch

The flush switch is fixed in-fixed with the wall and it does not project out. These switches can also be classified into single-way and two-way switches.

(iii)Pull switch or ceiling switch

The pull switches are fixed on the ceiling and all the live parts are out of reach of the operator. The switch has a strong mechanical action and is usually operated with a single pull on the chord for on or off.

(iv)Rotary Switch

The rotary switch consists of an insulated handle to fix the blades. These blades move in steps by the movement of the handle and make contact with the terminals that connect the wires in the electric circuits .The movement of the handle is controlled by a cam or a spring. As the handle is moved by a quarter turn the blade is released and moves over quickly (with the help of spring) to make or break the circuit. These switches are available in single- or two-way patterns.

(v)Push button switch:This type of switch consists of one blade only. The blade is given a rocking action by press buttons and its movement is controlled by a cam and a spring. Thus, the blade opens or closes with quick motion.

(vi)Iron clad water tight switch:Such switches are of cast iron and have robust construction. A cook gasket is fitted between the case and the cover which makes it watertight.

(vii) Two way switch:The 2 way switch are generally used in staircase lightning systems where we want control of appliances from two different locations.

(viii) Knife switch:A knife switch is a type of switch used to control the flow of electricity in a circuit. It is composed of a hinge which allows a metal lever, or knife, to be lifted from or inserted into a slot or jaw.

Lamp Holders: Lampholders are mechanical devices that support lamps and connect them to electrical circuits. They hold light bulbs and make electrical contact to provide a bulb with power. Lampholders are used with most light sources for incandescent, fluorescent, and compact fluorescent lamps (CFL). It is made up of Bakelite exterior and porcelain interior

Types of Lamp holders

(i) Batten Holder

(ii)Pendent holder

(iii)Angle holder

(iv)Bracket holder

Socket outlets: The socket outlets have insulated base with moulded or socket base having three terminal sleeves. The cover is again moulded with corresponding three holes. The two thin terminal sleeves are meant for making connection to the load circuit wires and the third terminal sleeve, larger in cross-section, is Used for an earth connection.

Ceiling roses: Ceiling Roses are used to provide tapping to the lamp holder through the flexible wire or a connection to a fluorescent tube or a ceiling fan.

Plugs: These are used for tapping power from socket outlets.

Mounting Blocks: These are nothing but wooden round blocks. They are used in conjunction with ceiling roses, batten lamp holders, surface switches, ceiling switches, etc

Main Switch: This is used at the consumer's premises so that he may have self-control of the entire distribution circuit. The different classifications are double poled and triple poled.

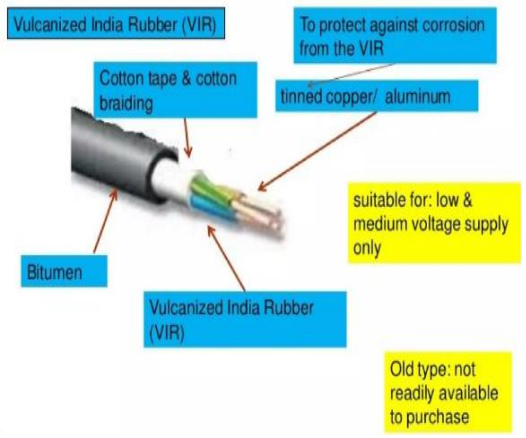
Distribution Fuse Boards :In industries or in very big buildings, where a number of circuits are to be wired,distribution fuse boards are used. They are usually iron clad and are designed with a large space for wiring and splitting the circuits. The fuse bank and in the distribution board can easily be removed.

Wiring Cables:

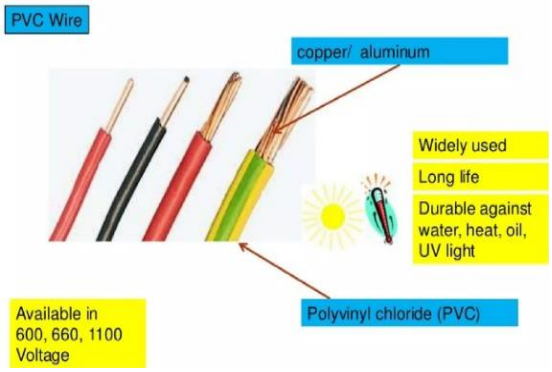
Based on the conductors Single core,Multi core,Single Strand,Multi Strand

Based on insulation:

- Vulcanized Indian Rubber(VIR) insulated Cables
- Poly-Vinyl Chloride(PVC)
- Tough Rubber Sheathed(TRS) Cables
- Cab Tyre Sheathed Cables
- Lead Sheathed Cables
- Weather Proof Cables

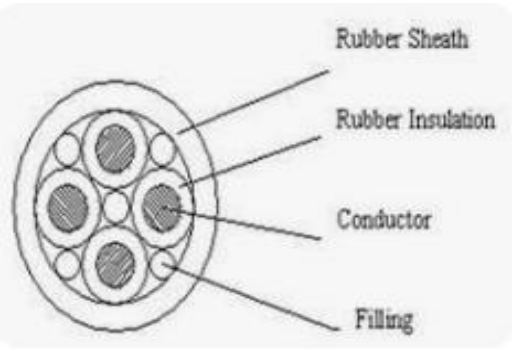
<table>
<tr><td colspan="2"><u>Vulcanized Indian Rubber(VIR) insulated Cables</u></td></tr>
<tr><td>➢ A VIR wire mainly consists of a tinned conductor having rubber coating.
➢ Tinning of conductor prevents the sticking of rubber to the conductor.
➢ Thickness of rubber mainly depends on the operating voltage to which wire is designed.
➢ A cotton bradding is done over the rubber insulations to protect the conductor against the moisture.
➢ Finally the wire is finished with wax for cleanliness.
➢ Nowadays these wires are not used since a better quality wires are available at a cheaper rate.</td><td> 
</td></tr>
<tr><td colspan="2"><u>Poly-Vinyl Chloride Cables</u></td></tr>
</table>

- This is the most commonly used wire for wiring purpose.
- Conductor is insulated by poly vinyl chloride (insulating material).
- It has following properties:
- 1. Moisture proof.
- 2.Tough.
- 3.Durable.
- 4.Chemically inert.
- But it softens at high temperatures therefore not suitable for connection to heating appliances.



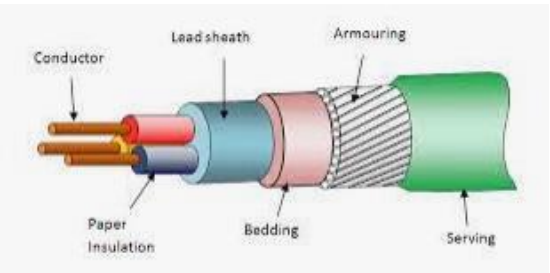
Tough Rubber Sheathed(TRS) Cables

- This type of wire is a modification of V.I.R. wire. It consist of the ordinary rubber coated conductors with an additional sheath of tough rubber.
- This layer provides better protection against moisture and wear and tear. Also it provides an extra insulation.
- These wires are generally available in single conductor, two conductors or three conductors.



Lead Sheathed Cables

- The ordinary wires can be used only at dry places but for damp places these wires are covered with continuous lead sheaths.
- The layer of lead covering is very thin like 0.12 cm thick.
- These wires provides little mechanical protections to the wires.



Weather Proof Cables

- These types of wires are used outdoor i.e. providing a service connection from overhead line to building etc.
- In this type of wire the conductor is not tinned and the conductor is covered with three braids of fibrous yarn and saturated with water proof compound.

TYPES OF WIRING

- Cleat Wiring System
- Wooden casing – caping wiring system
- Tough Rubber sheath wiring system
- Lead sheathed wiring system
- Conduit wiring system

Cleat Wiring:In this system, the VR. conductors are supported in porcelain cleats (vulcanised India rubber wire in porcelain cleats). Distance between cleats should be 30 cms to 60 cms. Wires should not run near water and gas pipelines. Used in industries and workshops for temporary wiring.

✓ Conductors are supported by porcelain cleats.
✓ Very cheap and can be done easily
✓ It has base and a cap.
✓ Life is very less so not suggested for permanent wiring.

Wooden Casing-capping wiring system

The system of wiring is most commonly adopted for residential buildings. It consists of rectangular wooden blocks, called casting, made from first class seasoned teak wood or any other wood free from any defect. It usually has two grooves into which the wires are laid. The casing at the top is covered by means of capping which is a rectangular strip of wood of the same width as that of casing and is screwed to it.Two or three wires of the same polarity may run in one groove. But wires of opposite polarity nced not be run in one groove.

Tough Rubber Sheath (TRS)Wiring:

The TRS cables are available in single, twin or three cores with circular or oval shape. The cable is quite flexible and has an insulation which resists rough usage, moisture, climate variations, acids and alkalies but is slightly affected by lubricating oils. So TRS cables may be run on the surface of the walls or buried in plaster.

Lead sheathed wiring system:

In lead sheathed wiring the cables used are insulated wires, TRS or PVC, with metal outer covering of about 1 mm. thick. The metal covering is known as sheathing and is made of lead – aluminum alloy containing about 95% of lead.It has longer life but is costly.

Conduit Wiring:

In this system of wiring, the conductors run in metallic tubes called conduits. It is the best system of wiring which provides mechanical protection, safety against fire and shock if bonding and earthing are well done. This is most desirable for workshops and public buildings.

There are two types of conduit wiring:

- Surface Conduit Wiring
- Concealed Conduit wiring

Surface Conduit Wiring: PVC or GI conduits are laid on the surface of the wall or ceiling. These conduits are attached to the walls with a 2-hole strap and base clip at a regular certain distances. Electrical wires are laid inside the conduits.

Concealed Conduit wiring: PVC conduit pipes are placed inside the chiseled brick/block wall before plaster. The wall is later completely plastered and painted. Electrical wires are laid inside the conduits. This type of wiring is aesthetically appealing since there are no electrical wires/conduits seen on the top of the wall.

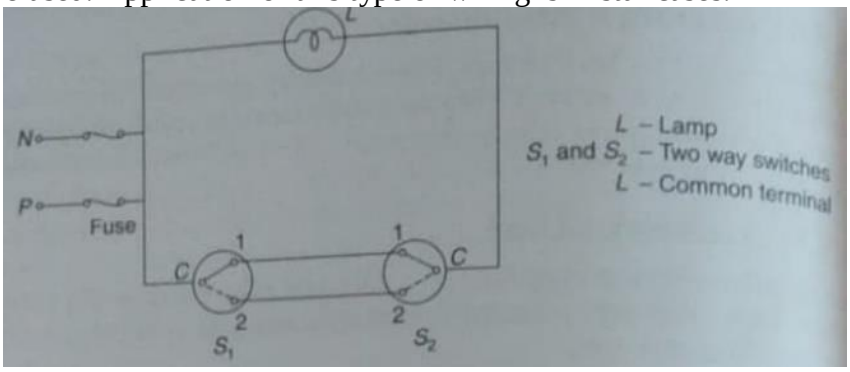
Wiring Circuits:

Staircase Wiring

Fluorescent Tube wiring

Staircase Wiring:

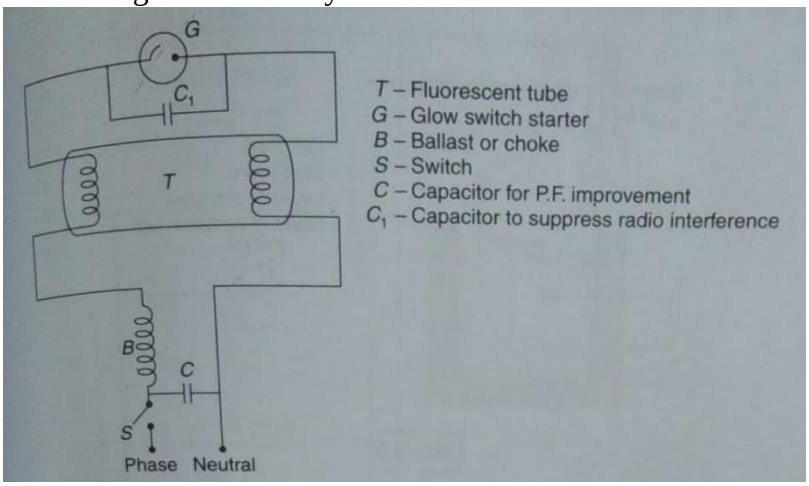
In this wiring a single lamp is controlled from two places. For this purpose two numbers of two-way switches are used. Application of this type of wiring is in staircases.



Fluorescent Tube wiring

Fluorescent tube (T) has filaments on either end. They are coated with electron emitting material. The inside of the tube has a phosphorous coating which is used to convert ultraviolet radiation into visible light and to give the required color sensation. A ballast (B) is used to give a transient high voltage so as to initiate the electron movement. It is an iron cored coil having high inductance. G is a glow starter. A capacitance (Cis used for improving the power factor of the circuit.Another capacitor (C) is used to suppress radio interference.

With the switch "S" closed, the circuit gets closed. The current flows through the ballast and the starter. The glow switch suddenly breaks thereby breaking the circuit. Due to the high inductive property of the ballast, a transient voltage is available across the filaments. Hence electrons are emitted and travel through the tube. Such a continuous flow of electrons produces the sensation of light to human eyes.



GROUNDING

"Grounding" means a low-resistance path has been made for electricity to flow into the ground.

IMPORTANCE OF GROUNDING

- Eliminates shock hazard.
- Protects equipment from voltage Unbalance.
- Prevents electrical fires.
- Reduces equipment repair cost and downtime.

- Lowers levels of electrical noise
  (fluctuations in an electrical signal)

Earthing and its Necessity

Earthing means generally connected to the mass of the earth.It shall be in such a manner as to ensure at all times an immediate and safe discharge of electric current due to leakages, faults, etc.

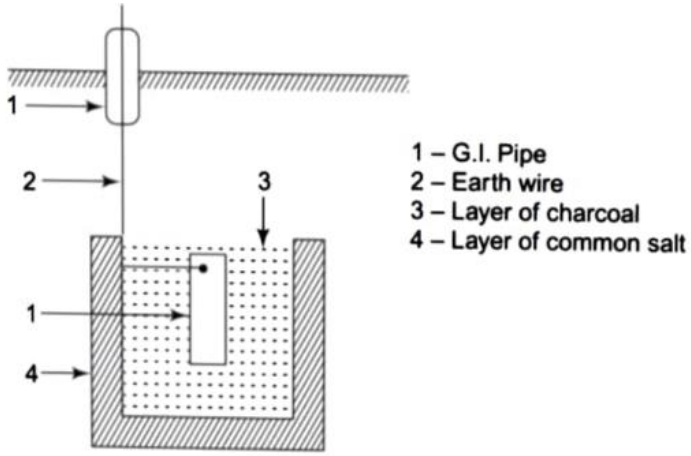
All metallic parts of every electrical installation such as conduit, metallic sheathing, armouring of cables, metallic panels, frames, iron clad switches, instrument frames, household appliances, motors, starting gears, transformers, regulators etc,shall be earthed using one continuous bus (barewire). If one earth bus for the entire installation is found impracticable, more than one earthing system shall be introduced. Then, the equipment and appliances shall be divided into sub-groups and connected to the different earth buses.The earthing conductors, when taken out doors to the earthing point, shall be encased in pipe securely supported and continued up to a point not less than 0.3 more below ground Level. No joints are permitted in an earth bus. Whenever there is a lightning conductor system installed in a building, its earthing shall not be bonded to the earthing of the electrical installation.

Before electric supply lines or apparatus are energized, all earthing systems shall be tested for electrical resistance to ensure efficient earthing. It shall not be more than two ohms including the ohmic value of earth electrode.

METHODS OF EARTHING/ELECTRICAL GROUNDING

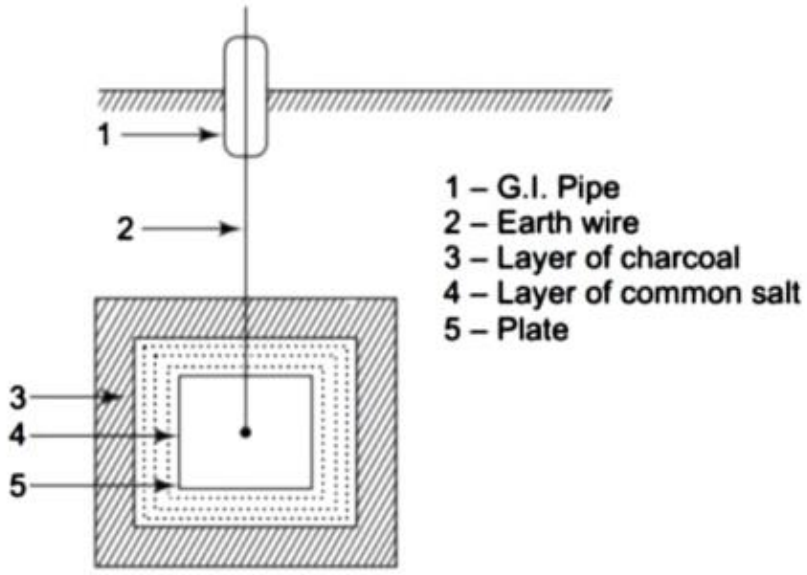
Earthing through a G.I. Pipe

In this method a G.I. pipe used as an earth electrode. The size of the pipe depends upon the current to be carried and type of soil in which the earth electrode is buried. For ordinary soils the length of the G.l. pipe used as an earth electrode is 2 m long and 38 mm in diameter or 1.37 m long and 51 mm in diameter. For dry and rocky soils the length may be increased to about 2.75 metres and 1.85 metres respectively. The pipe is placed vertically, burying to a depth not less than 2 metres in as moist place as possible, preferably in close proximity of water tap, water pipe or water drain and at least 0.6 metre away from all building foundations, etc as shown in Figure. The pipe shall be completely covered by 80 mm of Charcoal with the layer of common salt 30 mm all around it. The charcoal and salt decreases the earth's resistance.



Earthing through a Plate

A G.I. or copper plate is used as an earth electrode. If a G.I. plate is used it shall be of dimensions 0.3 m x 0.3 m and 6.35 mm thick and ifa copper plate is used it shall be of dimensions 0.3 mx 0.3 m and 3.2 mm thick. The plate is buried to a depth of not less than 2 m in as moist a place as possible preferably in close proximity of water tap, water pipe or water drain and at least 0.6 m away from all building foundations, etc. The plate shall be completely covered by 80 mm of charcoal with a layer of common salt of 30 mm all around it, keeping the faces of the vertical as shown in Figure.



TYPES OF GROUNDING

- Ungrounded Systems
- Resistance Grounded Systems
- Solidly Grounded Systems
- Neutral Grounding

Ungrounded Systems

- It is used back in the ’40s and ’50s
- No intentional connection to ground was given
- Capacitance-grounded system
- Capacitance between the lines and the earth is considered
- The ground-fault current is negligible and can be utilized to reduce the risk of shock to people

Advantages

- Negligible ground-fault current
- Low probability of line-to-ground acting faults escalating to a phase-to-phase or 3-phase fault.
- Assure a continuous operation of processes on the first occurrence of a lint-to-ground fault
- Minimize shock risks to people.

Disadvantages

- Difficult and time-consuming to locate any faults
- All lines need to be individually tested.
- High operational and maintenance costs

Resistance Grounded Systems

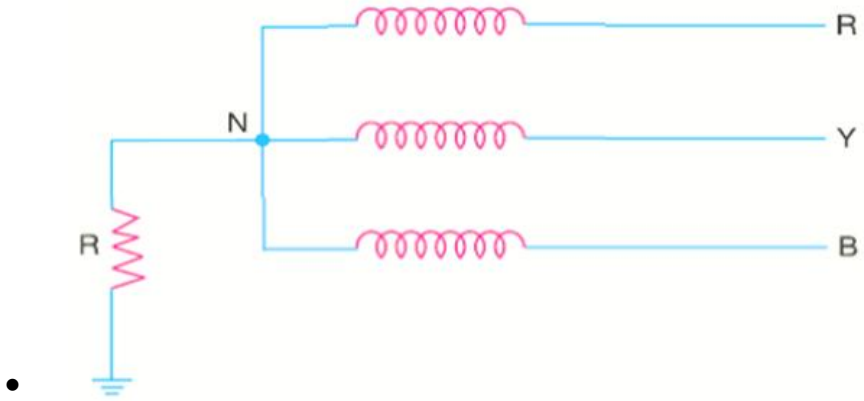
- Electrical power system has a connection between neutral line and the ground through resistor
- Resistor is used to limit the fault current through a neutral line.

High Resistance Grounding

- Limit ground fault current to < 10 amps
- Commonly utilized in plants and mills wherever ongoing operation of processes is intervening within the event of a fault.

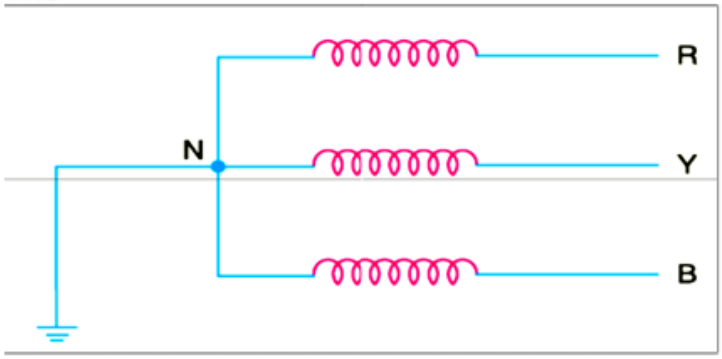
Low Resistance Grounding

- Limits ground fault current to between 100 and 1000 amps.
- Used in medium voltage systems of 15kV or less and tripping protective devices once there's a fault.



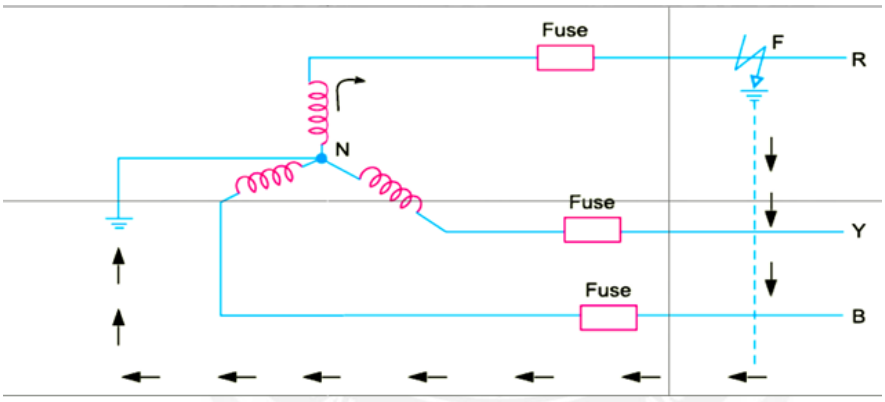
Solidly Grounded Systems

- Electrical power system is directly connected to the ground
- No intentional added impedance in the circuit
- Own large amounts of ground-fault current, thus faults are easily located.
- Commonly used in industrial and commercial power systems.
- There are backup generators in case when a fault shuts down a production method.



Neutral Grounding

The process of connecting the neutral point of 3-phase system to earth (i.e. soil) either directly or through some circuit element is called neutral grounding. Neutral grounding provides protection to personal and equipment. It is because during earth fault, the current path is completed through the earthed neutral and the protective devices (e.g. a fuse etc.) operate to isolate the faulty conductor from the rest of the system.



Advantages of Neutral Grounding:

(i) Voltages of the healthy phases do not exceed line to ground voltages i.e. they remain nearly constant.

(ii) The high voltages due to arcing grounds are eliminated.

(iii) The protective relays can be used to provide protection against earth faults. In case earth fault occurs on any line, the protective relay will operate to isolate the faulty line.

(iv) The overvoltages due to lightning are discharged to earth.

(v) It provides greater safety to personnel and equipment.

(vi) It provides improved service reliability. (vii) Operating and maintenance expenditures are reduced.

Difference between Earth and Ground

S.No	Earthing	Grounding

1	Earth is used for the protection of the human body in faulty conditions.	Grounding is utilized for the protection of electrical equipment.
2	Earthing is done to ensure the safety of electrical equipment and humans by ejecting the electrical energy to the earth.	Grounding is done to provide an effective return path from the machine to the power source.
3	Earthing is achieved through the connection of a metallic system to earth. It is normally achieved by inserting ground rods or other electrodes deep inside the earth.	Grounding ensures a safe, alternate path around the electrical system of your house by protecting it from high voltage produced in the lines due to lightning.
4	Earthing is a preventive measure.	Grounding is a backup pathway.
5	Green wire is used in this as a classification.	The black wire is used in this as a classification.

ELECTRICAL SAFETY AND PRECAUTIONS

A man who works in the electrical department must carefully handle the work without any damage to the equipment and also workers. Because accidents may cause heavy loss. He must know all the operations of electrical equipment. Otherwise wrongly handled equipment will cause heavy loss. Electrical accidents may occur only due to carelessness. Due to this, workers will get injured,damaged equipment will cause loss, because the work was stopped. To avoid this, electrical workers must follow the rules and regulations when working.

SAFETY: CAUSES OF ACCIDENTS:

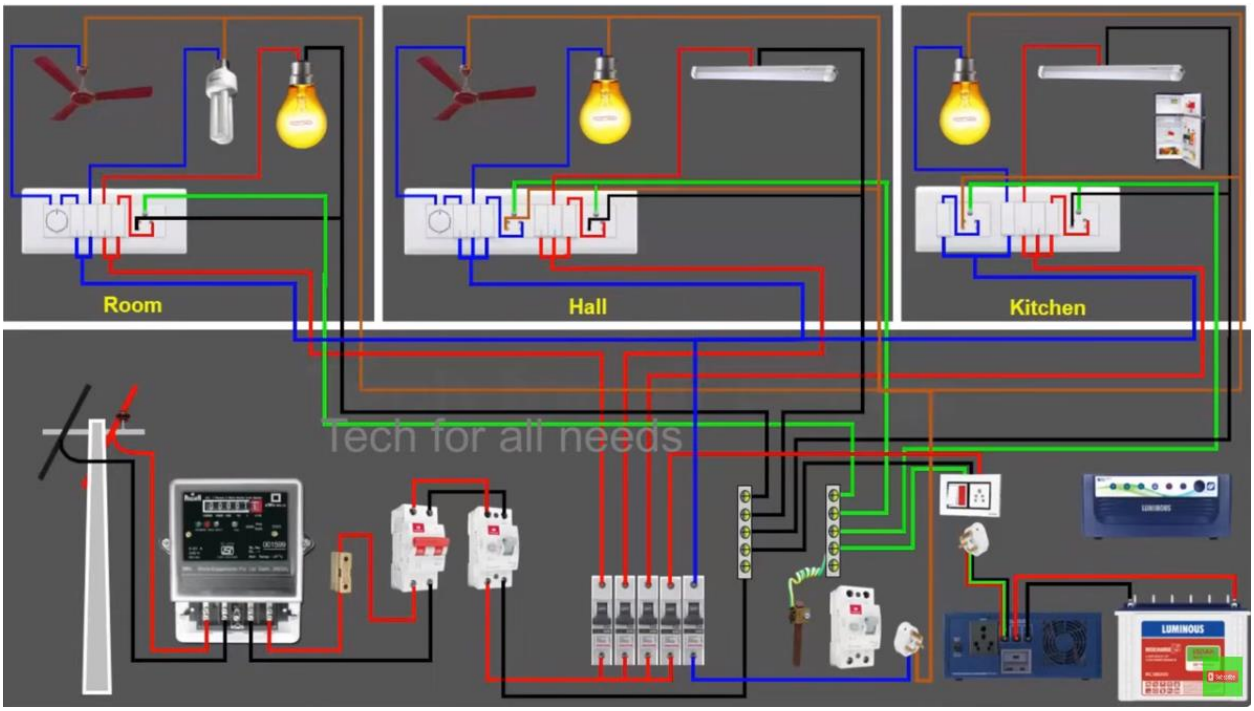
1. Unsafe system of work
2. Inadequate information
3. No training
4. Inadequate isolation
5. Unsafe rules
6. Poor control of work activities
7. Live working
8. Unsuitable test equipment
9. Poor maintenance
10. Failure to manage work
11. Person not competent
12. Uninsulated electrical wiring

13. Overloading of sockets

Electrical Precautions (ACCIDENT PREVENTION)

- Before using the equipment, the person must know the operation of that equipment. Electrical connections are made properly according to the definition.
- Only the trained and efficient person is allowed to operate, test and repair the machine.
- A person who works in the electric post and tower post must wear a safety belt and gloves.
- If a situation like working on a post happens, one man may work standing on the ladder and the other person should hold the ladder for safety. If it is essential, then the post and the ladder must be tied with a rope for safety purposes.
- After earthing the overhead lines by discharge rod, the works should be carried out.
- Check the condition of all the hand tools, supply wires operated in current and also check whether the earth wire is in good condition.
- Do not pull on the wire to unplug devices as this can damage the cable. Instead, remove the plug directly from the socket.
- After the main switch is off, the fuse wire must be changed. Depending upon the load, sufficient ampere fuse wire should be provided.
- All the hand tools used in electrical works must be insulated.
- While wiring, make sure the switch is always connected in phase line.
- If any fault occurs in an electrical equipment in the houses, it should be checked and repaired after the equipment is totally disconnected from the supply.Ex. Fan, Grinder, Mixie etc.
- Safety equipment existing in the electrical circuit should not be removed due to any reasons.
- If fire occurs in the electrical circuit, immediately the main switch should be turned off . For extinguishing the fire any one of the following i.s.carbon-dioxide extinguisher, dry powder extinguisher can be used. Soda acid extinguishers should not be used at any cost. Water is not used to extinguish the fire because it conducts electricity and causes severe accidents.
- If any person gets electric shock while touching the electric wire, immediately the supply should be disconnected. The person should be removed from the wire by the use of a dry stick, dry wooden plank , dry cloth etc.
- Sweating hands should not be used to switch ON or work on the electric supply. If the person is sweating continuously, he must wear gloves.
- The main switch should be in OFF position while doing electrical work. Before turning ON the switch, check if anybody is working in that electrical circuit.
- Damaged wire should not be used for wiring works or electrical connection.

RESIDENTIAL WIRING USING DT



Design thinking is a problem-solving methodology that emphasizes understanding the needs of users and creating innovative solutions to address those needs. Applying design thinking to residential house wiring involves considering the practical requirements of a house with a hall, kitchen, and bedroom while integrating safety, functionality, and efficiency into the wiring design.

Empathize: Understanding User Needs

The first step in the design thinking framework is to empathize with the users, in this case, the inhabitants of the house. Understanding their needs and preferences is crucial in designing an effective electrical wiring system. Each area - the hall, kitchen, and bedroom - has unique requirements. For instance, the kitchen might require more power outlets for various appliances, while the bedroom may need dedicated circuits for lighting and electronic devices.

Define: Problem Statement

Based on the gathered information, the next step is to define the problem. In this scenario, the problem could be defined as designing a safe and efficient electrical wiring system that meets the specific needs of each area in the house while adhering to safety standards and regulations.

Ideate: Generating Solutions

During this phase, brainstorming different solutions to address the defined problem is essential. Considering the layout of the house, the power requirements of each room, and the safety protocols, various wiring configurations and setups can be envisioned. For example, allocating separate circuits for high-power appliances in the kitchen to prevent overload or implementing ground fault circuit interrupters (GFCIs) in areas with water sources, like the kitchen and bathroom, to enhance safety.

Prototype: Creating a Wiring Plan

Creating a prototype involves developing a detailed wiring plan for the house. This plan should outline the placement of electrical outlets, switches, circuit breakers, and the routing of wires. For instance, strategically placing outlets in the hall for convenience and ensuring adequate lighting in the bedroom for comfort and functionality are key considerations.

Test: Evaluating the Design

Once the wiring plan is formulated, it's crucial to test its feasibility and effectiveness. This may involve consulting with electricians or experts in residential wiring to review the plan for compliance with safety codes and efficiency. Additionally, simulating usage scenarios can help identify any shortcomings or potential issues in the design.

Implement: Installation and Execution

Upon successful testing and refinement, the wiring plan can be implemented during the construction or renovation phase of the house. Skilled electricians would execute the plan, ensuring proper installation and adherence to safety standards.

Applying the design thinking framework to residential house wiring involves a user-centric approach that prioritizes understanding the needs of the inhabitants and designing a wiring system that caters to those needs while ensuring safety and functionality. By empathizing, defining the problem, ideating solutions, prototyping, testing, and finally implementing the design, a well-planned and efficient electrical wiring system can be achieved for a house comprising a hall, kitchen, and bedroom. This approach not only addresses the technical aspects of wiring but also considers the human experience within the space, ultimately enhancing the quality of living for the occupants.