

UNIT-V			
ELECTRICAL INSTALLATIONS			
(1 Marks)			
1	Taxonomy Level: Remember	CO: C114.6	PI:2.2.2
	What is Switchgear?		
	The device used for switching, controlling and protecting the electrical equipment.		
2	Taxonomy Level: Remember	CO: C114.6	PI:2.2.2
	What are different components of Switchgear?		
	The main components of switchgear are switch, fuse, circuit breaker and relays .		
3	Taxonomy Level: Remember	CO: C114.6	PI:2.2.2
	Define Fuse.		
	A fuse is a small wire or strip which is inserted in series to the circuit, when fault current flowing through the fuse, it gets hot and melted, then the fuse is disconnects the load from the supply.		
4	Taxonomy Level: Remember	CO: C114.5	PI:2.2.2
	What is bare conductor?		
	A conductor doesn't have any insulation over which is called bare conductor. For example: - Overhead lines.		
5	Taxonomy Level: Remember	CO: C114.5	PI:2.2.2
	Define wire and cable?		
	Wire is defined as a single conductor . Cable is defined as a group of wires enclosed in a jacket .		

(3 Marks)			
1	Taxonomy Level: Remember	CO: C114.6	PI:2.2.4
	What is the necessity of earthing?		
	Earthing It is the process of instant discharge of electrical energy into the earth through a low resistance wire. Necessity of earthing <ol style="list-style-type: none"> 1. Earthing protects the human lives and electrical equipment from fault current. 2. Maintain the voltage at a constant level even fault occurs. 3. Protect the buildings from over voltages due to lightning strokes. 4. Prevent the fire in electrical systems. 5. Provide a return path for the fault current. 		
2	Taxonomy Level: Remember	CO: C214.6	PI:2.1.1
	What are the advantages and disadvantages of fuse?		
	Advantages of Fuse <ol style="list-style-type: none"> 1. Cheapest form of protective device. 2. Requires no maintenance. 3. Replacement of fuse is very easy. 4. Suitable for overload protection 5. Requires very less time to act. Disadvantages of fuse <ol style="list-style-type: none"> 1. Rewiring or replacing a fuse takes a considerable time. 2. Breaking capacity is small. 		



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3	Taxonomy Level: Understand	CO: C114.5	PI: 2.2.4
Write down the advantages of lead acid batteries.			
Advantages of lead acid batteries <ol style="list-style-type: none"> 1. It provides very current. Therefore, used in high torque loads like, trains, cars, electric vehicles, bikes etc. 2. Less cost. 3. Efficiency of the battery is good (nearly 80%). 4. Provide good service for long duration. 5. Number of times the battery can be recharged is 300 to 1500. 			
4	Taxonomy Level: Understand	CO: C114.5	PI: 2.2.4
Write down the advantages of Lithium-ion batteries.			
<ol style="list-style-type: none"> 1. The weight of the Li-ion battery is less when compared to other batteries. So these batteries are used in military equipment, phones, watches and laptops 2. Has very low self-discharge per month (SDPM) (less than 3%) 3. High efficiency (around 99 %) 4. Li-ion batteries are available in different shapes. 5. Low toxicity (it is eco-friendly). 			
5	Taxonomy Level: Remember	CO: C114.5	PI: 2.2.4
What are the different types of batteries?			
<p>There are various types of batteries, each with its own characteristics and applications.</p> <ol style="list-style-type: none"> 1. Alkaline Batteries 2. Lithium-ion Batteries 3. Lead-Acid Batteries 4. Nickel-Cadmium (NiCd) Batteries 5. Nickel-Metal Hydride (NiMH) Batteries 6. Zinc-Carbon Batteries 7. Lithium Polymer Batteries 8. Silver Oxide Batteries 9. Zinc-Air Batteries 			

(5 Marks)

1	Taxonomy Level: Understand	CO: C114.5	PI: 2.2.4
Explain the construction and working of Battery? List the advantages of Battery over other energy sources.			
<p>Battery A Battery is a device consisting of one or more electrical cells that convert chemical energy into electrical energy. The basis of an electrochemical cell is an oxidation-reduction reaction</p> <p>It has three main components:</p> <ol style="list-style-type: none"> 1. Anode (-ve electrode) ---- releases electrons----- zinc, lithium ect. 2. Cathode (+ve electrode) -----collects electrons ----- metallic oxides 3. Electrolyte (liquid form) 			

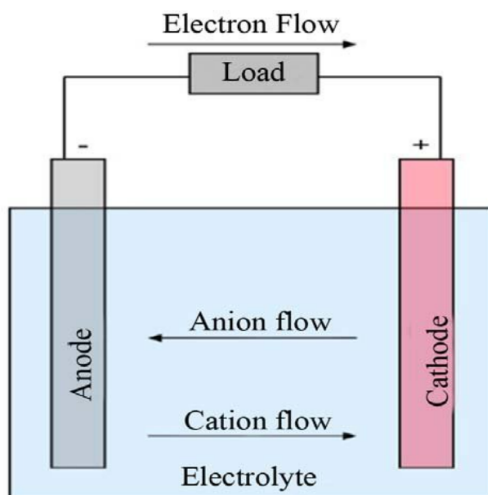
These are batteries that can be recharged after use by passing current through the electrodes in the opposite direction, i.e. from the negative terminal to the positive terminal.

Working:

When load is connected between anode and cathode, due to chemical action the electrons get transferred between anode to cathode. In order to recharge these batteries, the charge is transferred in the opposite direction and the reaction is reversed.

Advantages of Battery over other energy sources

1. Energy can be stored for long duration of time.
2. Delivers the energy effectively when compared to fossil fuels.
3. Can handle light and heavy loads.
4. Eco friendly.
5. More efficient.
6. Maintenance cost low.
7. Good tolerance to shock and vibrations.



2	Taxonomy Level: Understand	CO: C114.5	PI: 2.2.4
Define cell and battery? Classify various types of batteries.			
<p>➤ Cell is a device that consists of single unit having two electrodes and one electrolyte.</p> <p>➤ A battery is a collection of two or more cells connected in series, parallel, or a combination of both to provide a higher voltage, longer life, or increased capacity</p> <p>Types of Batteries:</p> <ol style="list-style-type: none"> 1. Primary Batteries/ Cells 2. Secondary Batteries/ Cells 			

Primary Batteries/ Cells	Secondary Batteries/ Cells
Once discharge, cannot be recharged	Can be recharged
Chemical energy into Electrical Energy only.	Chemical energy into Electrical Energy. Electrical energy into Chemical energy.
Examples: Leclanché cell, Alkaline cell etc.	Examples: Ni-CAD, Ni-MH, Lead acid, Lithium ion ect.
Applications: wrist watches, remote controls, flash lights etc.	Applications: Ni-CAD --- Flashlights Lead acid --- High current applications Lithium ion ---- applications require less space.

3 Taxonomy Level: Understand CO: C114.5 PI: 2.2.4

Define wire? What are the factors affecting the choice of wire? List the types of wires.

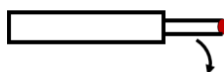
Wire is a single, usually cylindrical, metallic conductor that may be solid or stranded.

Factors affecting the choice of wire

1. Ampere rating (depends upon the load)
2. Colour code (live wire, neutral wire, earth wire etc.)

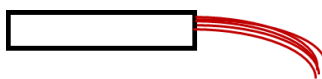
Types of wires

1. **Solid wire**: - Consists of a single solid conductor without any strands and used in high frequency application - difficult to bend.



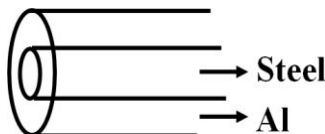
Solid conductor

2. **Stranded wire**: - Consist of multiple thin strands and these number of stands are depends on the voltage rating.



Strands

3. **Aluminum Conductor steel reinforced (ACSR)**: It consist of a core made of aluminum strands and surrounding by a layer of steel wires. This is used in overhead power lines



Aluminum -----> Good conductor ---> less weight, low cost.
Steel-----> To improve strength of the conductor

	<p>4. All Aluminum Alloy conductors (AAAC):- It consists of aluminum alloy strands to provides a good balance between electrical conductivity and mechanical strength. This is used in overhead power transmission and distribution lines</p> <p>Outer and inner layer -----> Aluminum</p> <p>Alloy -----> Aluminum (Al), Magnesium (Mg) & Silicon (Si)</p>		
4	Taxonomy Level: Understand	CO: C114.6	PI: 2.2.4
	What are the essential features of Switchgear?		
	<p>Switchgear is a crucial component in electrical power systems, serving to control, protect, and isolate electrical equipment. It consists of various devices that enable the safe operation of electrical circuits. The essential features of switchgear include:</p> <ol style="list-style-type: none"> 1. Complete reliability (minimum repair time) 2. Absolute discrimination (discrimination between fault section and healthy section) 3. Quick operation 4. Provision for manual control 5. Environmental Considerations 6. Compatibility 7. Earthing System 8. Control Devices 		
5	Taxonomy Level: Understand	CO: C114.5	PI: 2.2.4
	What are the characteristics of batteries for long life?		
	<p>Several characteristics contribute to the long life of batteries. Maximizing the lifespan of a battery involves factors related to design, usage, and maintenance. Here are key characteristics associated with batteries for long life:</p> <ol style="list-style-type: none"> 1. Type (Primary/secondary) 2. Voltage (1.2 V - 7.2V) 3. Discharge curve (Discharge vs. Voltage) 4. Capacity (Amp hr/kg) 5. Energy density (energy per unit volume) 6. Specific energy density (energy per unit weight) 7. Specific power density (power per unit weight) 8. Temperature dependency 9. Service Life (Life cycles) 10. Cost 		

(10 Marks)

1 Taxonomy Level: Understand CO: C114.6 PI: 2.2.4

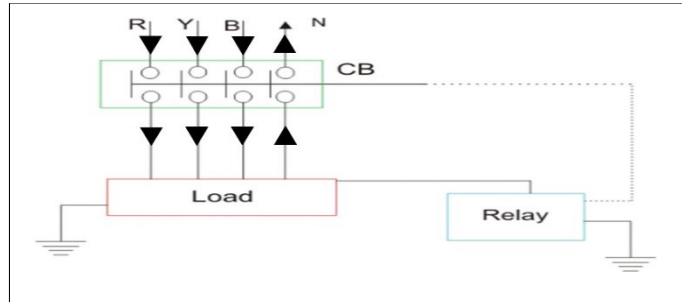
What is ELCB? Briefly explain the two different types of ELCB.

Earth leakage circuit breaker (ELCB)

Safety device used in electrical machines to avoid electrical shocks and protect humans.

When current leaks, circuit open, therefore no current. They are two Types.

1. Voltage operated ELCB



Normal condition:

Neutral current (say 10 A) is equals to sum of three phase currents (10 A). Leakage current is at the load is zero.

When Leakage current at the load:

When current leaked at the load (say 1 A), So neutral current (say 9 A) is less than the sum of three phase currents (say 10 A).

Then the Relay takes care of the following three things:

- Takes the Leakage current from the load
- Send the same current to the ground.
- Send the information to the CB; and finally CB trips the main supply.

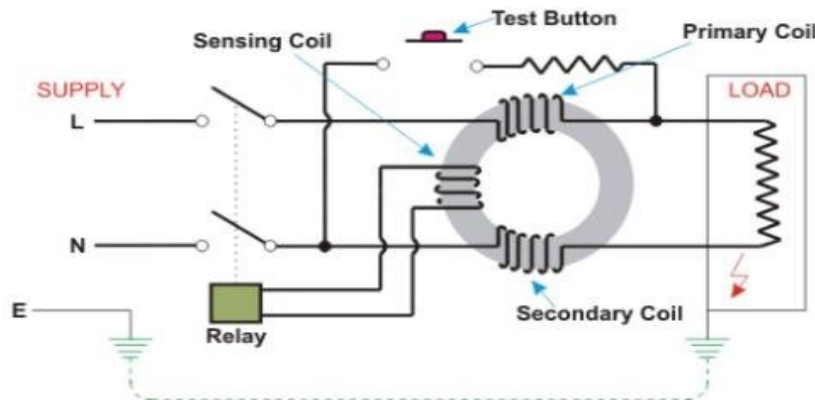
2. Current operated ELCB (RCCB)

Normal condition:

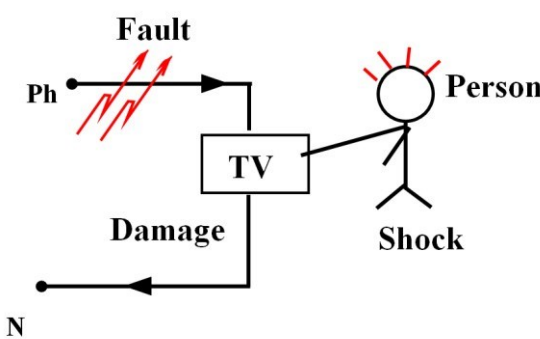
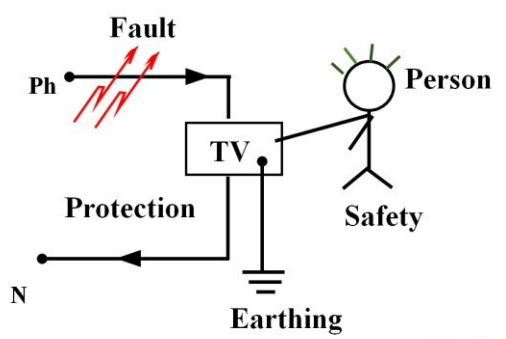
Current in the live wire and the neutral wire is same. No leakage current is zero. Switch is closed.

When Leakage current at the load:

Current in the neutral wire is less than the live wire. Whenever there is a difference in current in the live wire (primary coil) and neutral wire (secondary coil), sensing coil send the signal to the relay and relay trips the supply.



2	Taxonomy Level: Analyze	CO: C114.5	PI: 2.2.4
	Define Cable? List the factors which affecting the selection of the cable? Explain different types of Cables?		
	<p>Cable When two or more wires combined to form a group of multiple wires inside a common sheathing. Cables are used for transmitting electric power or telecommunication signals from one place to another.</p> <p>Factors Affecting the Choice of Cables</p> <ol style="list-style-type: none"> 1. Cable cost and safety 2. Life Time 3. Permanency 4. Accessibility 5. Appearance 6. Mechanical protection 7. Maintenance cost <p>Types of Cables Cables are classified based on the</p> <ol style="list-style-type: none"> 1. Type of conductor used <ul style="list-style-type: none"> ➤ Aluminum conductor cable ➤ Copper conductor cable ➤ Silver conductor cable ➤ Gold conductor cable 2. Number of cores <ul style="list-style-type: none"> ➤ Single core cable ➤ Two core cable ➤ Three core cable and ➤ Four core cable etc. 3. Voltage rating <ul style="list-style-type: none"> ➤ LV cables and ➤ HV cables. 4. Type of insulation material used in the cables <ul style="list-style-type: none"> ➤ Vulcanized Indian Rubber (VIR) cables ➤ Tough rubber sheathed (TRS) cables ➤ Lead sheathed cables ➤ Polyvinyl chloride (PVC) cables. ➤ XLPE cables (cross linked poly ethylene insulated) ➤ Waterproof cables ➤ Multi strand cables 5. Application <ul style="list-style-type: none"> ➤ Power cables (VIR cables, TRS cables, PVC cables etc.) ➤ Telecommunication cables ➤ (Optical fiber cables, twisted pair cables and coaxial cables). 		





3	Taxonomy Level: Understand	CO: C114.6	PI: 2.2.4
What is Earthing and it needs? Explain different types of earthing?			
<p>Earthing</p> <ul style="list-style-type: none"> ➤ To connect the metallic (conductive) Parts of an Electric appliance or installations to the earth (ground) is called Earthing or Grounding. ➤ The process in which the instantaneous discharge of the electrical energy takes place by transferring charges directly to the earth through low resistance wire. Low resistance earthing wire is chosen to provide the least resistance path for leakage of fault current. ➤ When the overload current is passed through the equipment or when the fault occurs in the system due to the current, the fault current from the equipment flows through the earthing system. 			
<div style="display: flex; justify-content: space-around; align-items: flex-end;"> <div style="text-align: center;">  <p>a. No earthing situation</p> </div> <div style="text-align: center;">  <p>b. Earthing situation</p> </div> </div>			
<p>Need of earthing</p> <ul style="list-style-type: none"> ➤ During the occurrence of any fault in the system, the potential of the non-current part of the equipment raises. And, if anyone touches the body of the equipment, then they may get shocked. This earthing discharges the leakage of the current to the earth. In this way, we may avoid electric shock. It also protects our home appliances from lightning strokes. ➤ To achieve the earthing, we need to connect the parts of the installation (TV, AC etc) to the earth by using the earth electrode (It is being placed in the soil at some distance below the ground level). ➤ Finally, the need for earthing is fundamental to maintaining a secure, reliable, and safe electrical infrastructure. 			

Types of Earthing

There are several types of earthing systems used in electrical installations, each designed to meet specific requirements and conditions. Here are some common types of earthing:

- 1. Plate Earthing:** In this type of earthing, a metal plate is buried vertically in the ground. It provides a low-resistance path for fault currents. It is filled with alternate layers of charcoal and salt to enhance conductivity.
- 2. Pipe Earthing:** In this type of earthing, a metal pipe, usually made of copper or galvanized iron, is driven vertically into the ground to achieve earthing. It is filled with alternate layers of charcoal and salt to enhance conductivity.
- 3. Rod Earthing:** In this type of earthing, a metal rod, often made of copper or galvanized iron, is driven into the ground to establish a connection with the earth. It is a common method for earthing in residential and small commercial installations.
- 4. Strip Earthing:** In this type of earthing, a metal strips are buried horizontally in trenches filled with charcoal and salt. This method is suitable for locations with limited space.

Comparison of types of earthing

Type of Earthing	Plate type	Pipe type	Rod Type	Strip type
				
Earth Electrode	Cu or GI plate	Cu or GI plate	Cu or GI plate rod	Cu or GI strip
Earth wire	Cu wire	Cu wire	Cu wire	Cu wire
Dimensions	2 m X 2 m X 6 mm	2 m	2 m	25 mm X 4 mm
Depth	3mt	3mt	3mt	0.5 mt
Filling materials	Charcoal and salt	Charcoal and salt	Charcoal and salt	Charcoal and salt

4 Taxonomy Level: Understand

CO: C114.6

PI: 2.2.4

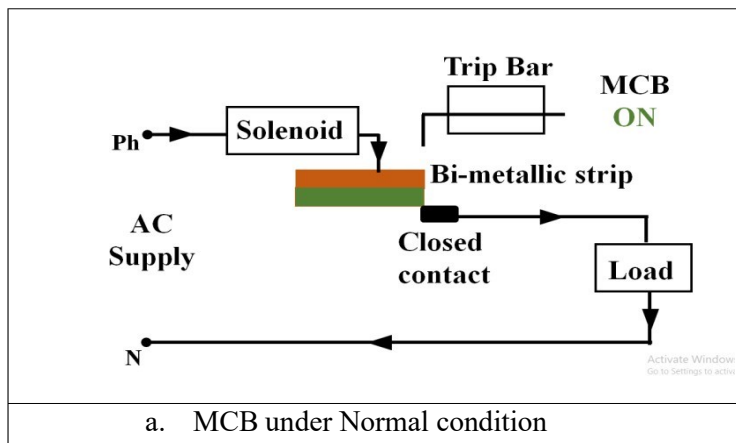
Explain the working of Miniature Circuit Breaker?

Miniature Circuit Breaker (MCB)

A Miniature Circuit Breaker is an electrical device designed to automatically switch off the electrical circuit when it detects excessive current flowing through it. MCBs are commonly used in residential and commercial electrical distribution panels for circuit protection.

An MCB consists of three main components: a bimetallic strip, an electromagnet, and a tripping mechanism.

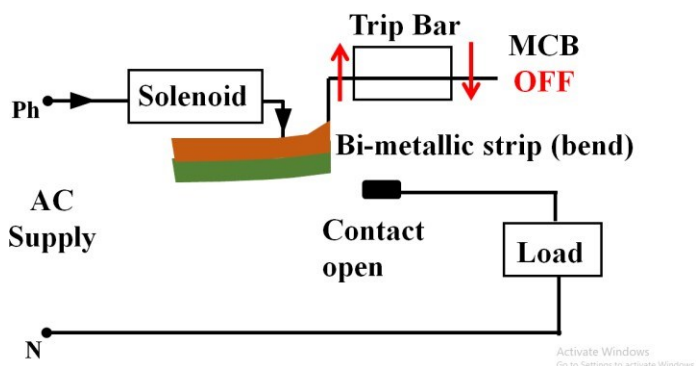
1. **Normal condition:** When the current flowing through the circuit is within the rated capacity of the MCB, the bimetallic strip remains in its normal position, and the electromagnet is not energized. Under normal condition, the current is passing from **Phase ---- > Solenoid ---- > Bimetallic strip ---- > closed contact ---- > load > Neutral. So, MCB is ON.**



2. **Thermal Tripping:** In the case of an overcurrent, caused by a **overload**, the current passing through the MCB exceeds its rated capacity. The increased current causes the bimetallic strip to heat up and leads to bend away from closed contact. Overload condition means applied load is greater than the rated value.

Phase ---- > Solenoid ---- > Bimetallic strip ---- > Bend ---- > open circuit --> Load safe.

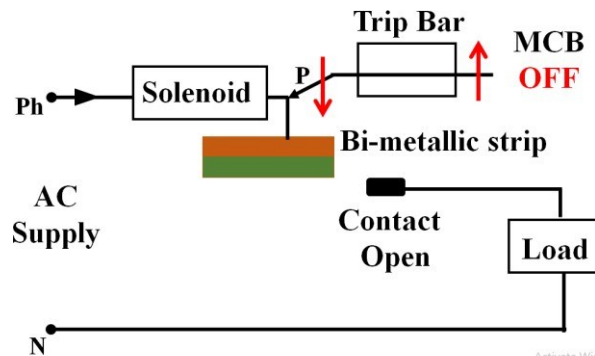
Bimetallic strip ----- > hits the trip bar ----- > MCB OFF.



3. Magnetic Tripping: In the case of an overcurrent, caused by a **short circuit**, the current passing through the MCB exceeds its rated capacity. A high current passing through the coil increases the strength of the magnetic field of the electromagnet. Then the trip bar is pulled toward the electromagnet, the contacts are opened and the current stops.

Excess current ---- > Phase ---- > Solenoid ---- > Magnetized ---- > attracts Plunger (P) ---- > open circuit ---- > Load safe.

Plunger ----- > hits the trip bar --> MCB OFF.



c. MCB protection under Short circuit condition (Magnetic trip mechanism)