AKTU

B. Tech I-Year

Gateway Classes

Semester -I & II

Common to All Branches

BEE101/201: FUNDAMENTALS OF ELECTRICAL ENGG.

UNIT-5 ONE SHOT : Electrical Installations

Gateway Series for Engineering

- Topic Wise Entire Syllabus
- Long - Short Questions Covered
- AKTU PYQs Covered
- DPP
- Result Oriented Content

Download App

For Full Courses including Video Lectures

AKTU

B. Tech I-Year

Gateway Classes

BEE101 / BEE201: FUNDAMENTALS OF ELECTRICAL ENGINEERING

Unit-5

Introduction to : Electrical Installations

Syallbus

Introduction of Switch Fuse Unit (SFU), MCB, ELCB, MCCB, ACB. Types of Wires, Cables and Bus-bars. Fundamentals of earthing and lightning protection. Types of Batteries .

Download App

For Full Courses including Video Lectures

AKTU

GATEWAY CLASSES

Electrical Engg

One Shot

UNIT - V

Syllabus BEE-201/101

7 X 3 = 21 + 2 marks

Sec-B ① →

Sec ② — ①

- **Unit-4 : (Electrical Installations)**
  - Introduction of Switch Fuse Unit (SFU), MCB, ELCB, MCCB, ACB.
  - Types of Wires, Cables and Bus-bars.
  - Fundamentals of earthing and lightning protection.
  - Types of Batteries

Switch Fuse Unit (SFU)

Q.1 Define Switchgears with Examples? (2 marks)

Sol. Switchgear: The apparatus used for switching, controlling and protecting the electrical circuits and equipment is known as switchgear. The term 'switchgear' is a generic term encompassing a wide range of products like circuit breakers, switches, switch fuse units, off-load isolators, HRC fuses, contactors, earth leakage circuit breaker, etc.

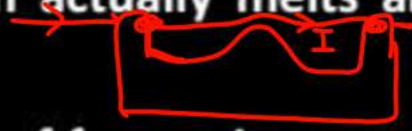
Switch Fuse Unit (SFU)

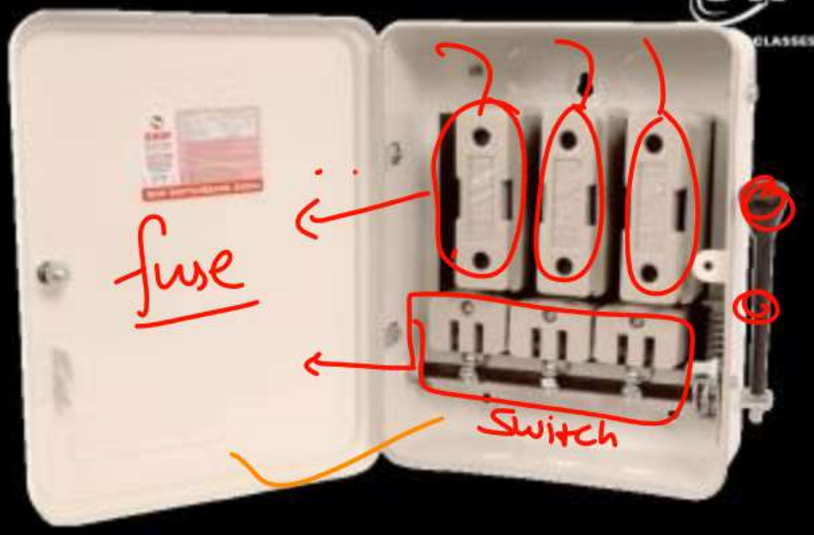
Protection

Q.2 Explain Switch Fuse Unit.

Sol. A switch is used to isolate the circuit from the supply purposely for repair and maintenance. Generally it is manually operated.

Fuse is perhaps the simplest and cheapest device used for interrupting an electrical circuit under short circuit, or excessive overload, current magnitudes. The action of a fuse is based upon the heating effect of the electric circuit. The part which actually melts and opens the circuit is known as the fuse element.





FUSE UNITS: The various types of fuse units, most commonly available are: Round type fuse unit, Kit-kat type fuse unit, Cartridge type fuse unit , HRC (High Rupturing Capacity) fuse units

A unit which consists of the combination of fuse and switch together is called switch fuse unit as shown in figure. Switch is used for the distribution of power and Fuse is used for the protection of the device from short circuit and overload. It is very widely used for low and medium voltages.

The advantages of such switch fuse unit are,

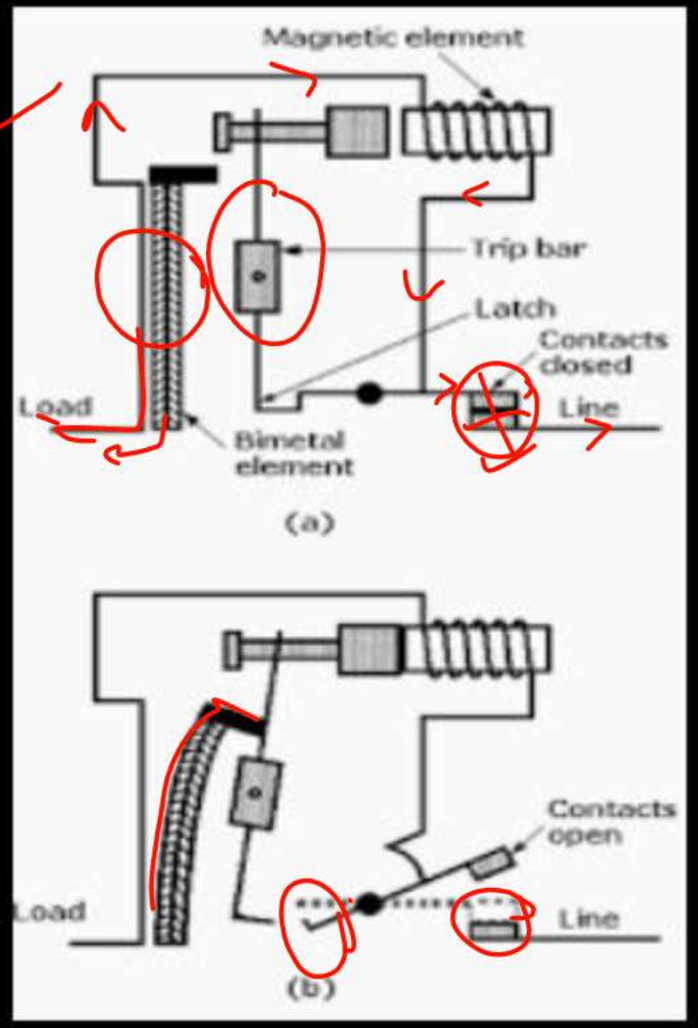
a. The number of joints in the circuit gets reduced.
b. Due to compact construction, less space is required.
c. Easy from handling point of view.

Q.3 Explain Short Notes on (i) MCB (ii) MCCB and (iii) ELCB . (AKTU) 7

Sol. **A miniature circuit breaker (MCB)** is an Electrical Switch that automatically switches off the electrical circuit during an abnormal condition of the network means an overload condition as well as a faulty condition. A Miniature Circuit Breaker (MCB) typically consists of the following components:

Main contacts: These are the contacts that carry the load current and are connected to the incoming and outgoing wires of the circuit.

Trip Unit: This is the core component of an MCB, which monitors the current flowing through the circuit and trips the breaker in case of an over-current or short-circuit. The trip unit consists of a bimetallic strip, a magnetic actuator, and an operating mechanism.



Terminal: These are the connections for the incoming and outgoing wires.

Housing: The housing is the protective casing that houses the MCB components and provides insulation between live parts and other electrical components.

Trip Indicator: An MCB typically has a visual indicator that shows whether the breaker is in the "on" or "off" position.

Trip spring: This is the spring mechanism that holds the MCB contacts in the "on" position. When the trip unit operates, the trip spring releases, allowing the contacts to separate and break the circuit.

MCCB

Molded Case Circuit Breaker or MCCB is an automatic electrical device. It is a type of circuit breaker that protects the circuit from overloading, short circuit and current surges. It *offers extra features that make it a superior circuit breaker such as remote closing and adjustable trip settings,*

- Its working is based on thermal mechanism. It has a bimetallic contact which expands and contracts when there are changes in temperature. Under normal condition, the contacts are closed allowing current to pass. Under over load or short circuit condition, current exceeds its safe value. Due to this, heat is generated and the contacts are opened to interrupt the circuit.
- Due to the interruption of high current, there is arc formation. Hence in MCCB there are arc chutes which suppress the arc.

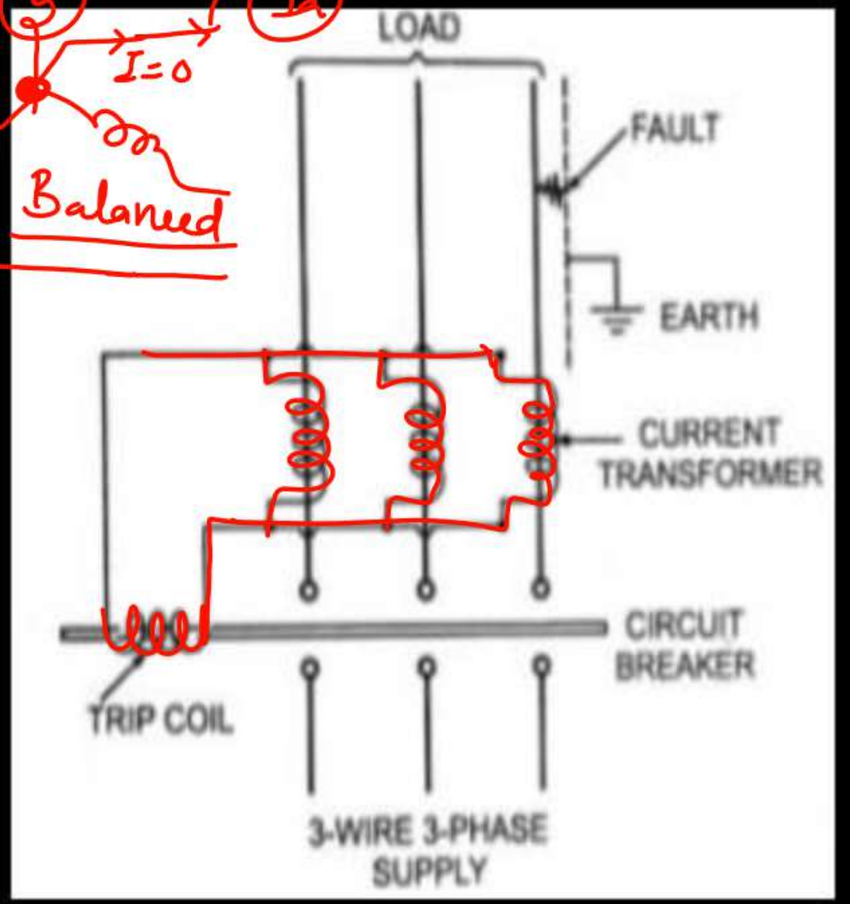
- There is a disconnection switch, with the help of which, the MCCB can be operated manually.
- its current settings and time settings can be adjusted according to our needs.
- It can be easily reset after the fault rectification. Thus it provides operational safely and convenience.
- All the operating parts of MCCB are covered within a plastic moulded housing made in two halves. The two halves are joined together to form the whole structure.
- The basic difference between MCB and MCCB is the current rating. Hence MCCBs are used for industrial and commercial applications such as main feeder protection, generator and motor protection, capacitor bank protection, welding applications and applications which require adjustable trip setting.

ELCB (Earth Leakage Circuit Breaker)

It is a device that provides protection against earth leakage. These are of two types.

1. Current operated earth leakage circuit breaker:

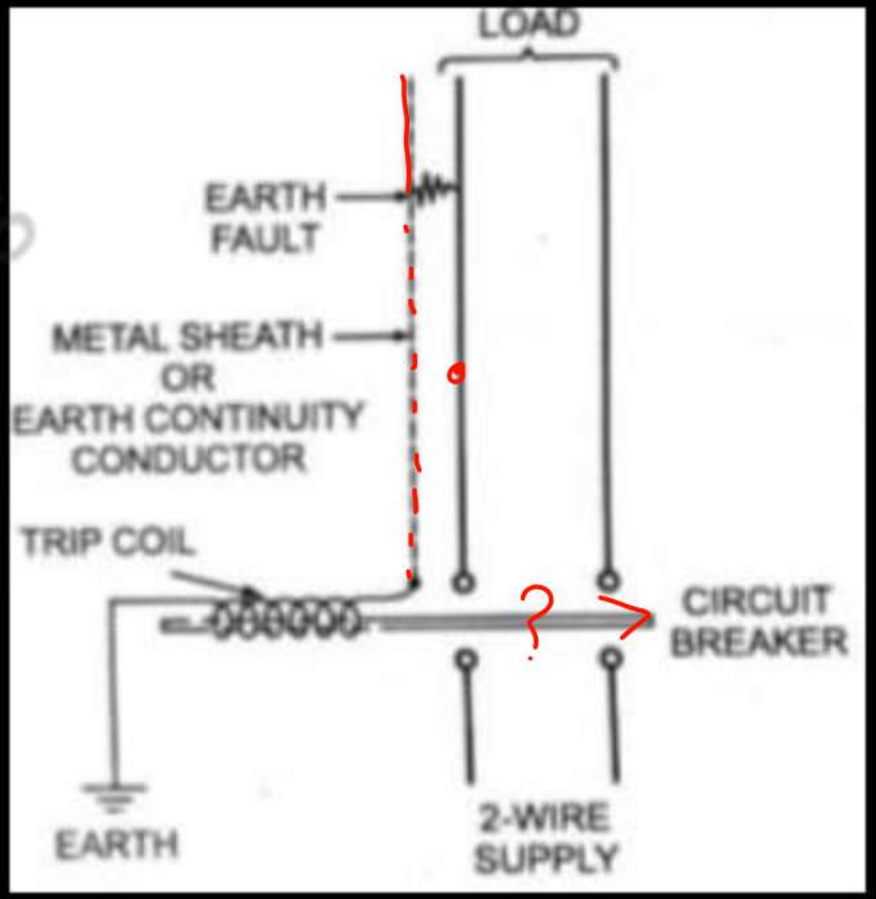
- It is used when the product of the operating current in amperes and the earth-loop impedance in ohms does not exceed 40.
- such circuit breakers is used where consumer's earthing terminal is connected to a suitable earth electrode.
- A current-operated earth leakage circuit breaker is applied to a 3-phase, 3-wire circuit.
- when there is no earth leakage, the algebraic sum of the currents in the three coils of the current transformers is zero, and no current flows through the trip coil.
- In case of any earth leakage, the currents are unbalanced and the trip coil is energized and thus the circuit breaker is tripped.



ELCB

2. Voltage operated earth leakage circuit breaker:-

- It is suitable for use when the earth–loop impedance exceeds the values applicable to fuses or excess-current circuit breaker or to current operated earth leakage circuit breaker.
- When the voltage between the earth continuity conductor (ECC) and earth electrode rises to sufficient value, the trip coil will carry the required current to trip the circuit breaker.
- With such a circuit breaker the earthing lead between the trip coil and the earth electrode must be insulated



Advantages of ELCB:-

i. Provide protection to a human against the electric shock.
ii. Detects very small leakage currents.
iii. Reduces the risk of fire due to hot spots.
iv. Saves electrical energy due to leakage.
v. Energy conservation can be achieved.

Ques.:- Give the difference between MCB and MCCB

2 marks

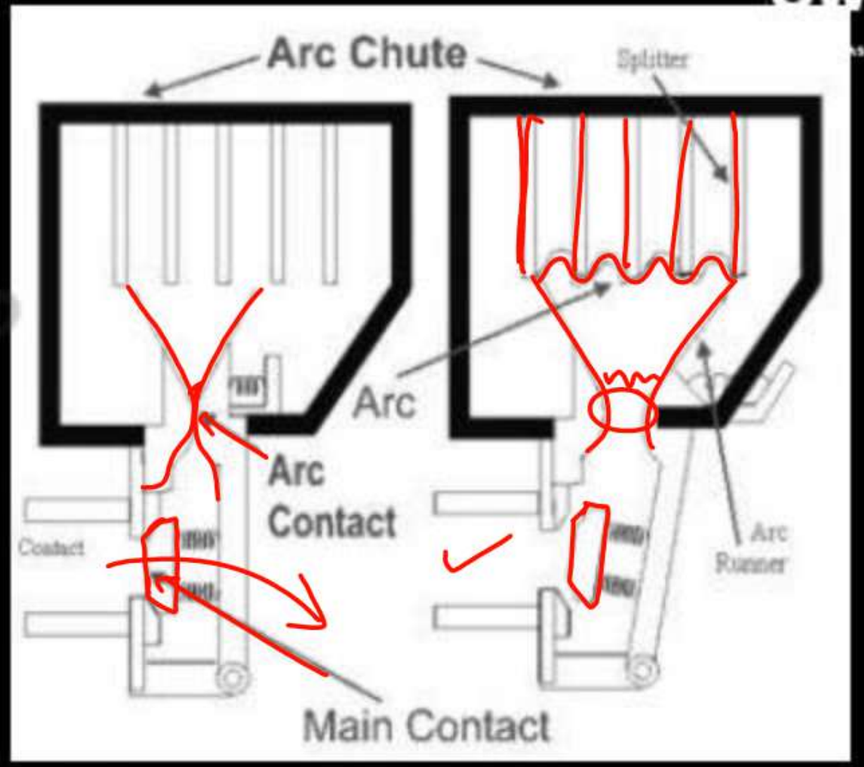
fuse Vs MCB

MCB	MCCB
Type of switch which protects the system from overloaded current.	Protects the equipment from over temperature and fault current.
Miniature Circuit Breaker	Moulded case circuit breaker.
Remotely on/off is not Possible	Remotely on/off is Possible
Current rating is upto 100 amps	Current rating is from 10 - 200 amps
Can be used in lightning circuit and for low loads.	Can be used in heavy current circuit
For domestic purpose.	For commercial and industrial use.

Ques. Explain Air circuit breaker and its working.

Sol. **An Air Circuit Breaker is an automatically operated electrical switch that uses air to protect an electrical circuit from damage caused by excess current from an overload or short circuit**

- **Air circuit breakers operate with their contacts in free air.**
- **The main pair of contacts (1) carries the current at normal load and these contacts are made of copper metal. The second pair is the arcing contact (2) and is made of carbon. When the circuit breaker is being opened, the main contacts open first. When the main contacts opened the arcing contacts are still in touch with each other.**



- As the current gets a parallel low resistive path through the arcing contact. During the opening of the main contacts, there will not be any arcing in the main contact. The arcing is only initiated when finally the arcing contacts are separated.
- As the arc is driven upward it enters the arc chute, consisting of splatters. The arc in the chute will become colder, lengthen, and split hence arc voltage becomes much larger than the system voltage at the time of operation of an air circuit breaker, and therefore the arc is extinguished finally during the current zero.

TYPE OF WIRES AND CABLES

Q.1 Explain Different types of cables. (AKTU)

Sol.:- **1. Conductor Used:** According to conductor material used in the cables, these may be divided into two classes known as copper conductor cables and aluminum conductor cables.

2. Number of Cores Used: It may be divided into different classes known as: single core cables, twin core cables, three core cables, four core cables etc

3. Voltage Grading:

1. **Low tension cables:** Used for the voltage levels upto 6.6.kV.
2. **Medium tension cables:** Used for 11kV level and are called belted cable.
3. **High tension cables:** Used for 22kV and 33kV levels.
4. **Extra high tension cables:** Used for voltage levels more than 33kV.
   - → gas filled
   - → oil filled.

4. Types of Insulation Used: According to type of insulation the cables are of following types:

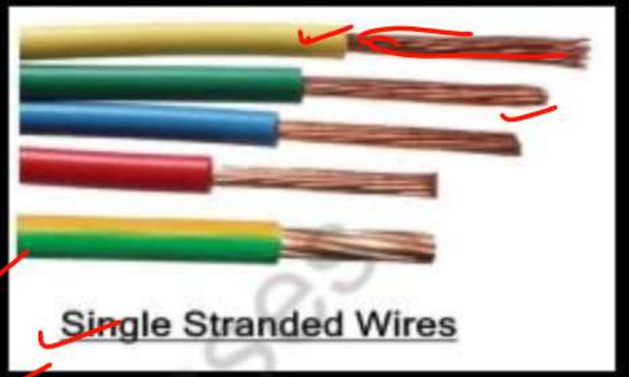
- Vulcanized Indian Rubber (VIR)
- Tough Rubber Sheathed (TRS)
- Lead Sheathed Cables.
- Polyvinyl Chloride (PVC) Cables.
- Flexible cords and cables.
- XLPE cables.

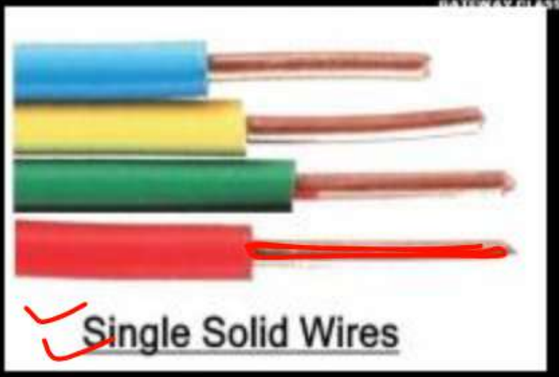
Ques. Explain different types of wires. (AKTU)

Sol.:- 1. Single Conductor Wire:-

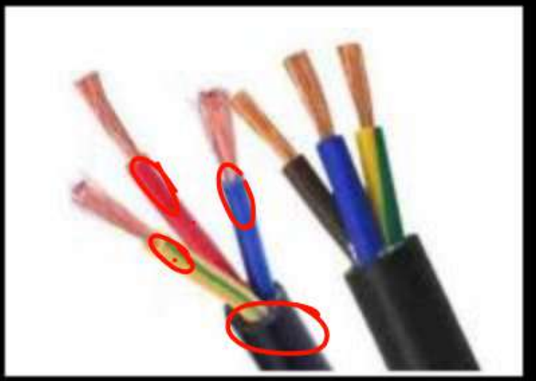
Single Stranded Wire

Single Solid Wire (> 15A)





2. Poly Vinyl Chloride Wire



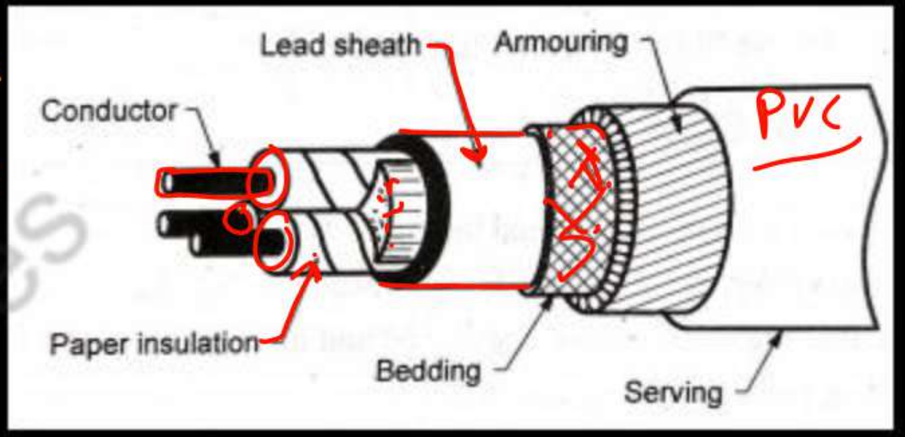
3. VIR wire

3. Flexible Wire

Types of cables

Ques. Explain construction of cable.

- **Sol.:-**



- **Conductor of Core:** This section consists of single conductor or more than one conductor. The conductors are also called cores. Cables with three conductors used are aluminium or annealed copper. The conductors are stranded conductors in order to provide flexibility to the cable.

Insulation: Each conductor or core is covered by insulation of proper thickness. The commonly used insulating materials are varnished cambric, vulcanized bitumen and impregnated paper.

Metallic Sheath: The insulated conductors are covered by lead sheath or aluminium sheath. This provides the mechanical protection but mainly restricts moisture and other gases to reach to the insulation.

Bedding: The metallic sheath is covered by another layer called bedding. The bedding consists of paper type compounded with a fibrous material like jute strands or hessian tape. The purpose of bedding is to protect the metallic sheath from corrosion and from mechanical injury resulting due to armouring.

Armouring: This layer consists of the layers of galvanized steel wires which provide protection to the cable from the mechanical injury.

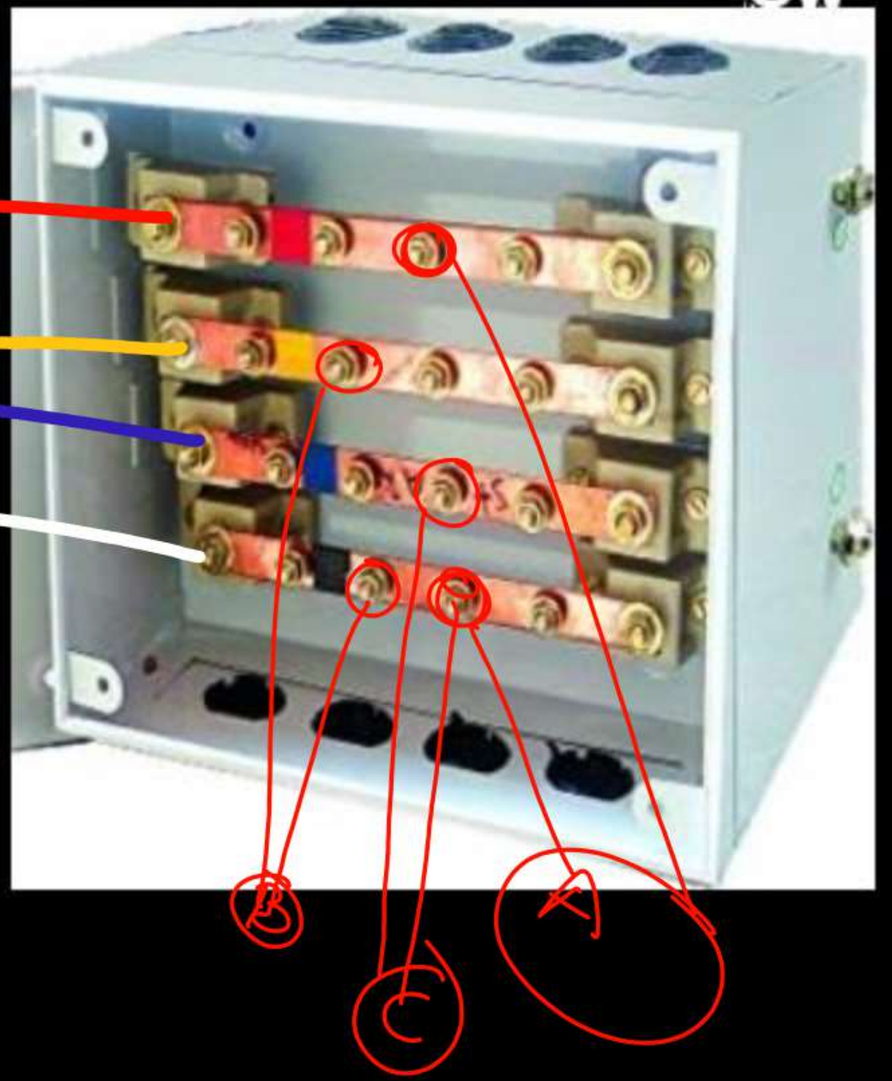
Serving: The last layer above the armouring is serving. It is a layer of fibrous material like jute cloth which protects the armouring from the atmospheric conditions.

Bus Bar

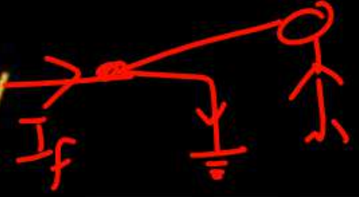
Ques. Write a short Note on Bus Bar. (AKTU) 2 marks

Sol.

- An electrical bus bar is defined as a conductor or a group of conductor used for collecting electric power from the incoming feeders and distributes them to the outgoing feeders. In other words, it is a type of electrical junction in which all the incoming and outgoing electrical current meets. Thus, the electrical bus bar collects the electric power at one location.
- The bus bar system consists the isolator and the circuit breaker. On the occurrence of a fault, the circuit breaker is tripped off and the faulty section of the busbar is easily disconnected from the circuit.
- There are many factors to consider when selecting a busbar, such as reliability, flexibility, and cost.



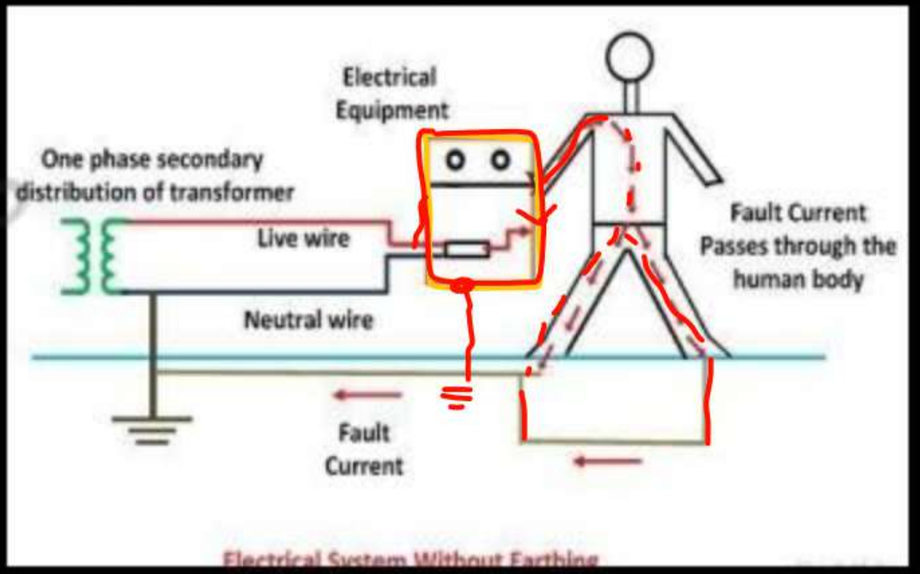
Earthing and its necessity



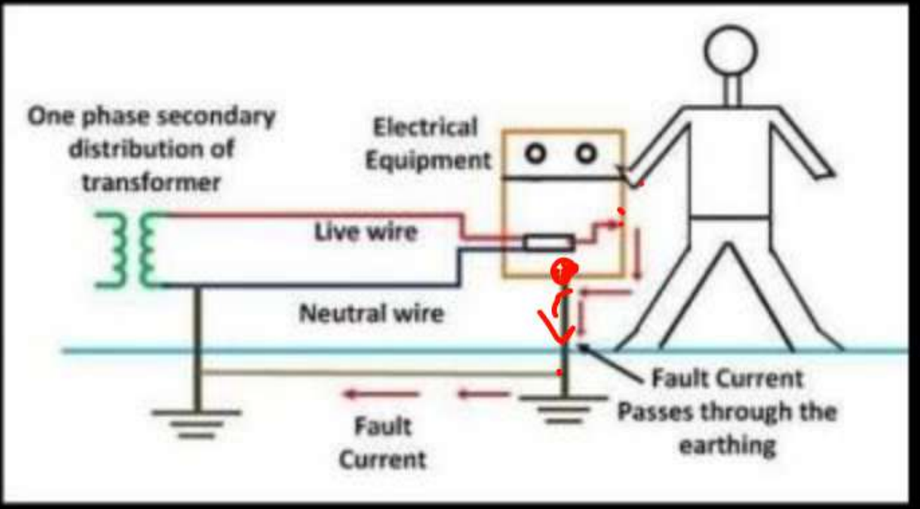
Ques:- What do you mean by Earthing? Why it is required?

Sol.- The process of transferring the immediate discharge of the electrical energy directly to the earth by the help of the low resistance wire is known as the electrical earthing.

- Earthing is used to protect you from an electric shock. It does this by providing a path for a fault current to flow to earth.
- As earthing resistance is very small than the resistance of the body, hence almost entire current flows through earthing connection.
- Earthing is used to protect human beings as well as provide safety to electrical appliances and appliances from leakage current.
- Earthing system is used to keep the voltage as constant (If a fault occurs on any one phase).
- To protect the Electric system and buildings from lighting.
- To provide the ground connections for the ground neutral system.
- To provide a means of positively discharged and de-energizing feeders or equipment before proceeding maintenance on them.



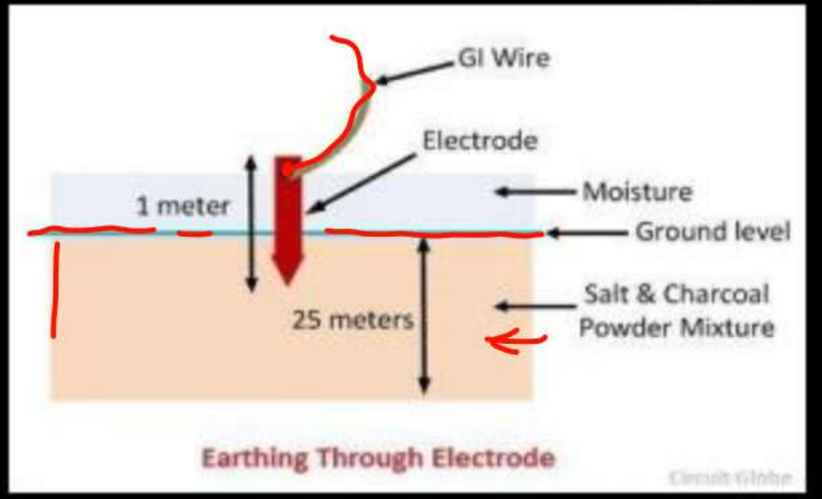
Electrical System Without Earthing



Types of Earthing

Ques. Explain different types of Earting. (AKTU)

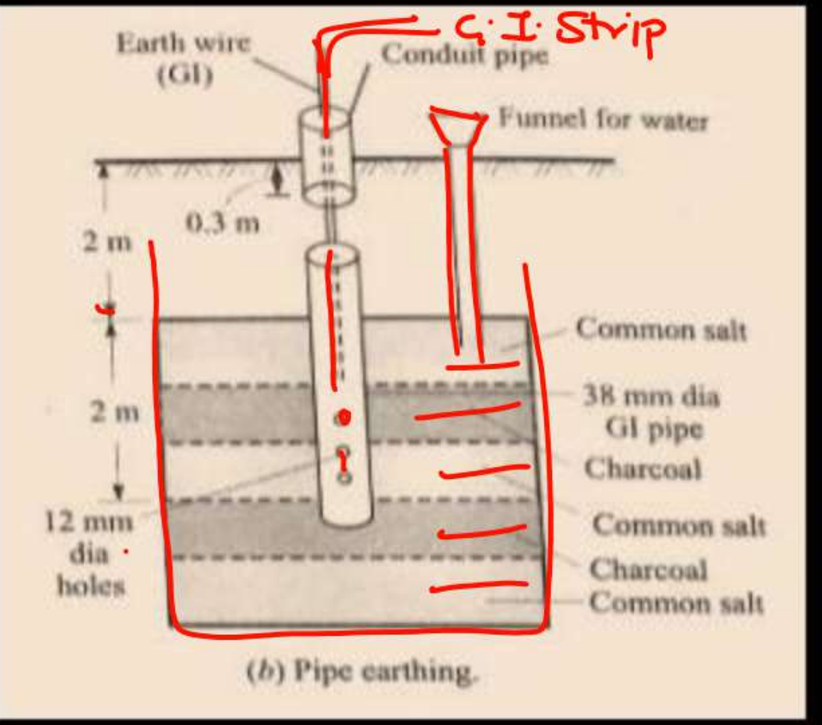
Sol. Rod Earthing: In this type of earthing, 12.5 mm diameter solid rods of copper or 16 mm diameter solid rods of galvanized iron or steel or hollow section 25 mm GI pipes of length not less than 2.5 metres are driven vertically into the earth either manually or by pneumatic hammer. In order to increase the embedded length of electrodes under the ground, which is sometimes necessary to reduce the earth resistance to desired value, more than one rod sections are hammered one above the other.



Earthing Through Electrode

Pipe Earthing: In the given figure, a GI pipe with a few holes at its lower end is buried to a depth not less than 2 m and atleast 0.6 m away from the foundation of any building. Normally, the size of pipe is either 2m long and 38 mm diameter or 1.37 m long and 51 mm diameter. However, for dry and rocky soil, we use longer pipes. Alternate layers of common salt and charcoal have thickness of 30 mm and 80 mm, respectively.

To maintain good conductivity of the soil, an arrangement is made for pouring water into the earth pit surrounding the earth electrode. This is especially needed during summer. As the pipe has much larger contact area with soil, it can handle larger leakage currents than the plate earthing of same electrode size. The earth wire (made of copper) is tightly fastened to the earth electrode by means of nut and bolt.



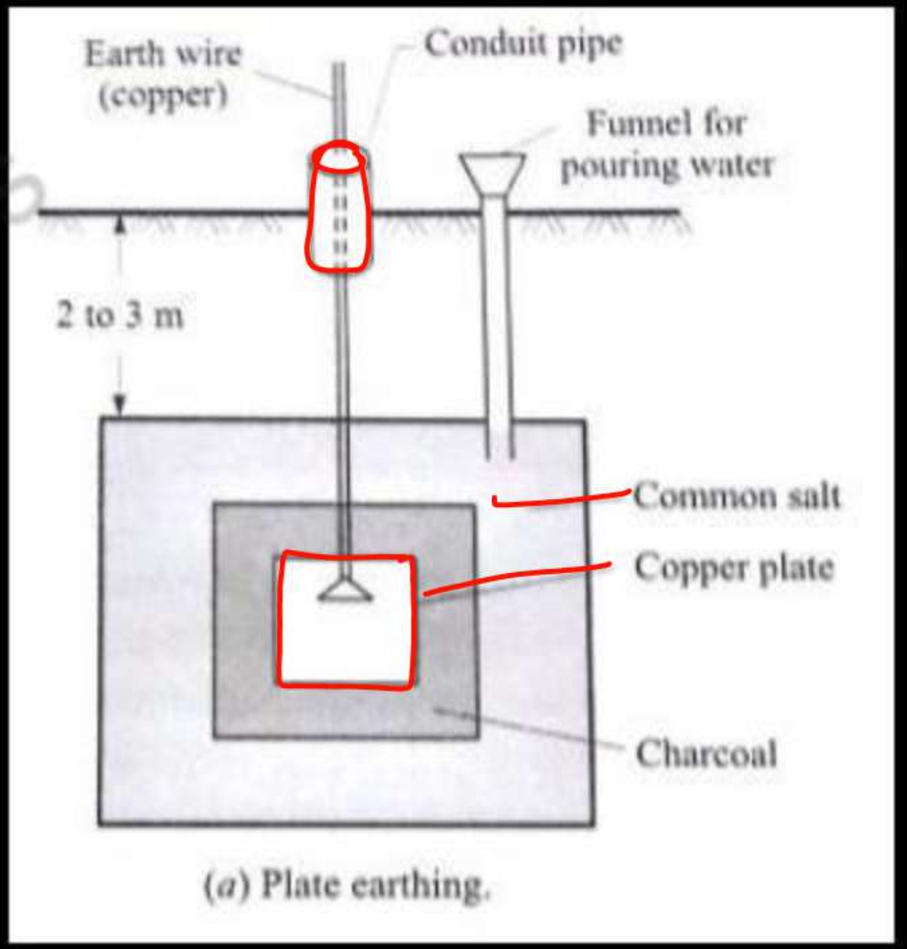
(b) Pipe earthing.

Types of Earthing

Plate Earthing:- In plate earthing an earthing plate either of copper of dimensions 60cm X 60cm X 3mm or of GI of dimensions 60cm X 60cm 6mm is buried into the ground with its face vertical at a depth of not less than 3 metres from ground level.

The earth plate is embedded in alternate layers of coke and salt for a minimum thickness of 15cm. The earth wire (GI wire for GI plate earthing and copper wire for copper plate earthing) is securely bolted to an earth plate with the help of a bolt, nut and washer made of material of that of earth plate.

A small masonry brick wall enclosure with a cast iron cover on top or an RCC pipe round the earth plate is provided to facilitate its identification and for carrying out periodical inspection and tests.



(a) Plate earthing.

Lightening Protection System

Ques. Explain Lightening Protection System and its elements.

Sol.:-

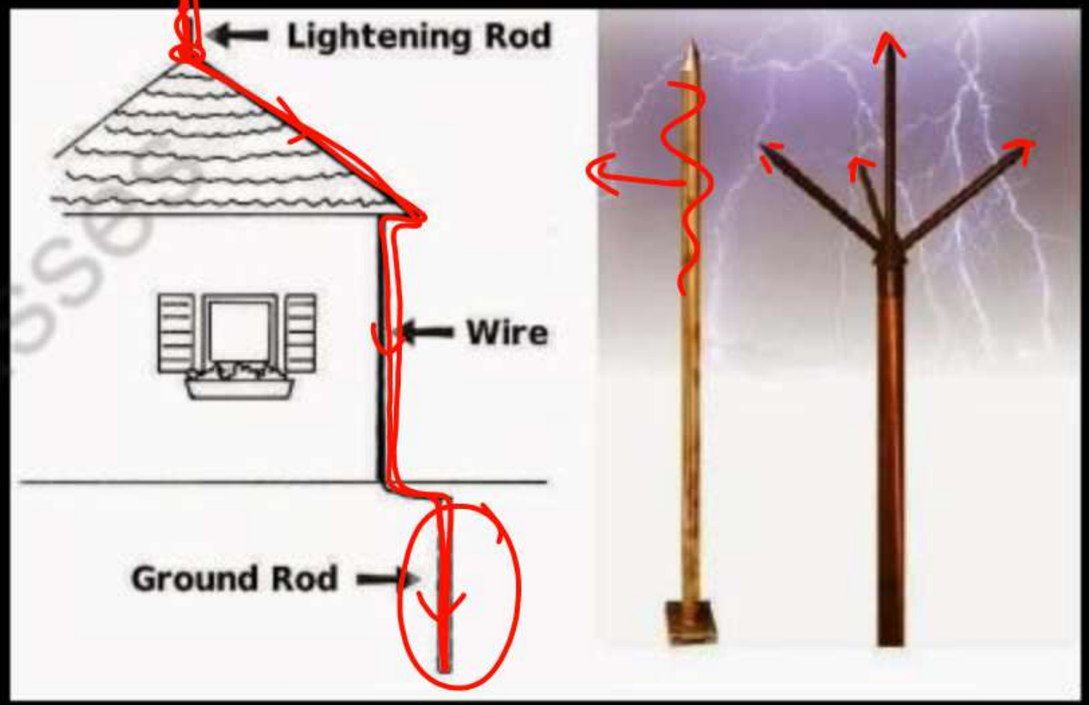
- A Lighting Protection System (LPS) is the system that provides a means by which a lightning discharge may enter or leave earth without passing through and damaging personnel, electrical equipment, and non-conducting structures such as buildings.
- So, A Lightning Protection System does not prevent lightning from striking; it provides a means for controlling it and prevents damage by providing a low resistance path for the discharge of the lightning energy.
- Lightning protection is essential for the protection of humans, structures, contents within structures, Transmission lines, and electrical equipment by controlling a variety of risks resulting from thermal, mechanical, and electrical hazards of the lightning flash current. These risks can be categorized as follows:

  Risk to persons (and animals),

  Risk to structures & internal equipment.

Components of lightning protection system

- The basic components of a lightning protection system includes;
- **Air terminals-** these are metal rods that serve as the first exposure point for lightning strike. These are set up on the top of a structure.
- **Main conductor cables-**heavy twisted or aluminum copper cable (or thicker) which is connected to the air terminal and/or runs near the ridge or other building high points, routed to the ground.
- **Ground rods** – composed of a corrosion-resistant alloy of copper and steel and are connected to the cables.
- **Bonding & Mounting hardware—**used to splice or connect between air terminals, cables, ground rods.
- **Lightning arresters/surge protection-** electrical devices installed in or on a building's electrical components and designed to protect electrical equipment from the electrical surge that occurs when lightning strikes a nearby power line.



Types of Batteries

Imp

Ques:-Give the Classification of Batteries (AKTU)

Sol. Types of Batteries: There are two types of batteries which are given below:

- **Primary Battery:**

  It is also called single-use or throw-away batteries as it cannot be recharged to reuse. It is discarded after complete depletion of charge in it. Examples of primary batteries are alkaline batteries, mercury batteries. silver-oxide batteries, and zinc carbon batteries.

- **Secondary Batteries**

- The batteries that can be electrically recharged again are called secondary batteries. By allowing the cur-rent in the opposite direction, these batteries can be recharged. Nickel Cadmium, Lead-Acid batteries and Lithium batteries fall into the secondary battery category.
- There are several types of secondary batteries are given below:
  - **Lead Acid Batteries**
  - **Nickel-Iron (OR Edison) Batteries**
  - **Nickel-Cadmium Accumulators**
  - **Nickel-Metal Hydride Cells**
  - **Lithium battery (Lithium Ion)**

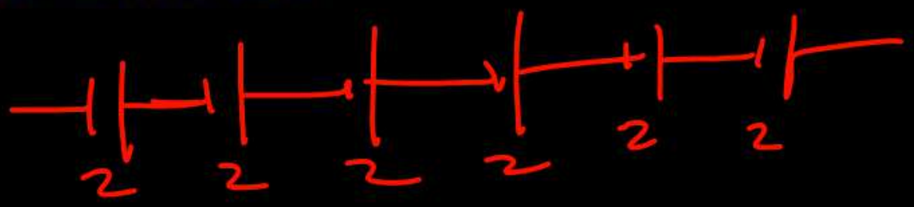
Important Characteristics of Batteries

ImP

Ques.- What are the important Characteristic of Battery?

Sol.

200A ⟶ 1h.
10A ⟶ 20h



1.Nominal voltage: It is indicated on a battery depending on the amount of cells connected in series. It is open circuit voltage of a battery.

AH

2. Battery capacity or battery life: It is specified in ampere-hours (AH). It indicates the amount of electricity which a battery can supply at the specified discharge rate till its voltage falls to a specified value. Mathematically product of discharge current (I_D)in amperes and the time for discharge (T_D) in hours till voltage falls to a specified value is the capacity of a battery.

Battery capacity = $I_D * T_D$ (AH)

⟶ 200H 20A →

3. Specific gravity of electrolyte: More the specific gravity of electrolyte, more is the battery capacity. It decides internal resistance of a battery.

4. Specific energy: The battery capacity expressed in watt-hour per kg weight is called specific energy. It is also called gravimetric energy density of a battery.

WH

Important Characteristics of Batteries

5. Electrical characteristics: These characteristics include the charging and discharging curves for a battery. It is the graph of terminal voltage against charging or discharging time in hours at normal rate. The fig shows such curves for a typical battery. From the given charging and discharging curves, the time of discharge for a specified voltage level can be obtained.

6. Battery efficiency: It is defined as the ratio of the output during discharging to the input required during charging, to regain the original state of the battery. It is commonly called ampere-hour efficiency or quantity efficiency and denoted as ηAh.

η_{Ah} = Amp-hour on discharge / Amp-hour on charge

- So

$$\%\eta_{Ah} = \frac{\text{Current} * \text{Time on discharge}}{\text{Current} * \text{Time on charge}} * 100$$

$$\eta_{AH} = \frac{I_d T_d}{I_c T_c}$$

- ***Energy or Watt – Hour (W-H) Efficiency:***

$$\eta_{WH} = \frac{V_d I_d T_d}{V_c I_c T_c}$$

Lead acid battery

Ques. Explain different types of battery and explain any one.

Sol. Lead acid battery is the most commonly used secondary battery. In general, a single Pb-acid battery can consist of 3, 6, or 12 lead acid cells.

The active components of lead acid battery are:

1. Cathode: Lead peroxide (PbO_2) and it is dark chocolate brown in colour when fully charged.

2. Anode: Sponge lead and is grey in colour when it is charged.

3. Electrode: Dilute Sulphuric acid, H_2SO_4, that contains 31 percent of concentrated H_2SO_4.

The advantages of Pb-acid battery are:

i. Efficiency of the battery is high, i.e., nearly 80 percent.

ii. Number of times the battery can be recharged is 300 to 1500

iii. It is environmental friendly.

iv. Cost of the battery is less.

The disadvantages of Pb-acid battery are:

i. Effectiveness if the battery gets reduced at low temperature

ii. Due to overcharging, corrosion of battery occurs.

iii. It is not possible to keep it in ideal position for long duration.

Ni-Cd Battery

The active components of Ni-Cd Battery are:

1. Anode: Cadmium , Cd **2. Cathode:** Nickel hydroxide, NiOH2 and

3. Electrolyte: Alkaline Potassium hydroxide, KOH.

The advantages of Ni-Cd Battery are:

- It can be recharged many times.
- During discharging, it maintains voltage at a constant level.
- At low temperature, the performance of the battery is good.
- It is available in different configurations like button, cylindrical and rectangular.

The disadvantages of Ni-Cd Battery are:

- Due to high toxicity level of cadmium, it creates environmental pollution.
- Since cadmium is a heavy metal, the weight of the batteries is high.
- The electrolyte used is in this battery is a corrosive hazardous chemical.

Lithium Ion Battery

The secondary battery that plays a major role in electric vehicles is Lithium Ion Battery or Li-ion battery. The active components of Li-ion battery are:

Anode: Lithium carbon **Cathode:** Lithium metal oxide, LiMOx where M is any metal, and

Electrolyte: Non-aqueous electrolyte like Ethylene carbonate or Diethyl carbonate.

The advantages of Li-ion Battery are:

- Weight of the battery is less when compared to other batteries.
- Li-ion Battery is available in different shapes.
- It posses very low self-discharging rate, i.e., 5-10 per cent per month.
- This battery does not pollute the environment, i.e. it is eco friendly.

The disadvantages of Li-ion Battery are:

- Flow of charge inside the battery gets affected due to deposition of ions.
- The internal resistance of the battery gets increases gradually and hence, the output decreases.
- It cannot be used to charge the normal charges.

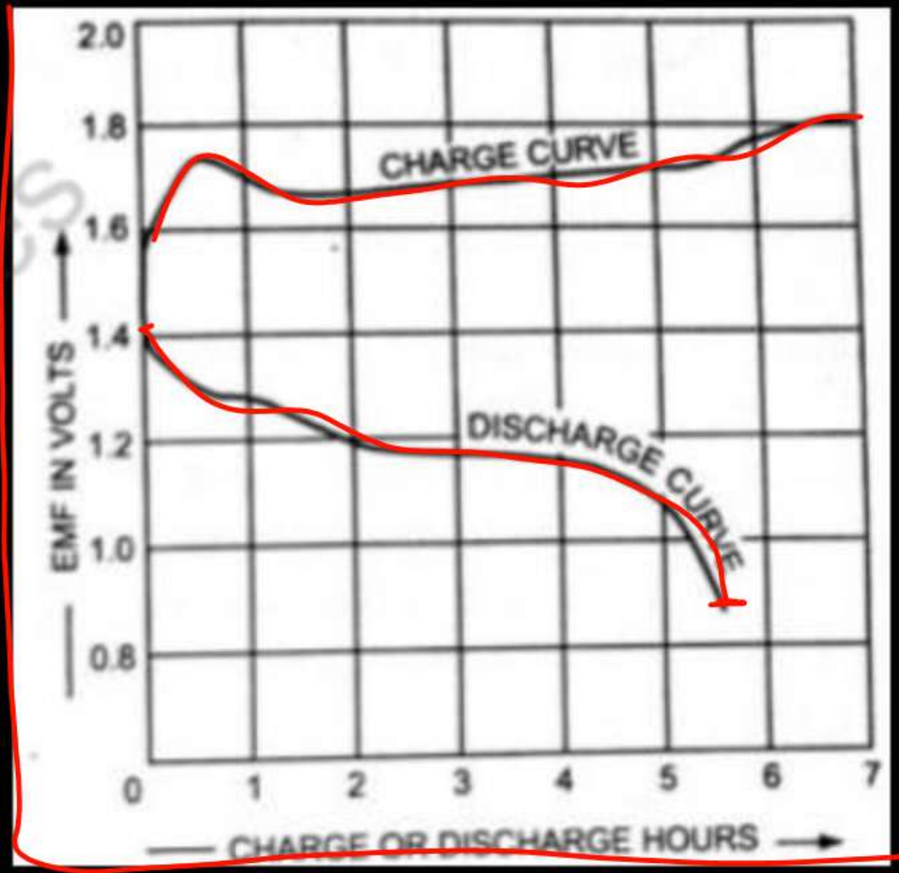
The major applications of Li-ion Battery are:

Used in the laptop, computers and advanced cellular phones.

Nickel-Iron (OR Edison) Batteries:

Charge and Discharge Curve: The given figure shows how the voltage of a nickel-iron cell varies during charging and discharging. The emf, when fully charged, is about 1.4V, decreases to 1.3V rapidly and then slowly to 1.1 or 1.0V of discharge. An average discharge voltage is about 1.2V. The average charging voltage is about 1.7V per cell. The voltage characteristics are similar to those of a lead-acid cell. There is no lower limit to the voltage of the Edition cell because in it there is nothing like sulphation, but discharge is not continued below a useful lower limit. The emf of the cell or battery increases slightly with the temperature. Due to comparatively high internal Resistance, the efficiency of the Edison batteries are lower than those of the lead-acid batteries.

The ampere-hour and watt-hour efficiencies of the Edison batteries are about 80 percent and 60 per cent respectively.



Battery Back Up

- A battery backup device is an electronic device that supplies secondary power in the absence of the main power. It can also protect electronic hardware from power spikes and fluctuations.
- The main battery backup device which is commonly used is called uninterruptible power supply [UPS].

2 marks

- Calculate the backup of battery of 100AH connected to load of 100 watts and supply voltage is 12V. AKTU (2018-19)

Battery Backup = $100\ AH \times 12\ V = WATT\text{-}HOUR^*/100\ WATT$

= 12 HOURS

$= \frac{\text{Watt hour}}{\text{Watt}} = AH \times V = \frac{100 \times 12}{100} = 12$ hours.

Battery Back Up

- **An alkaline cell is discharged at a steady current of 4 ampere for 12 hours, the average terminal voltage being 1.2 V. To restore it to original state of voltage , a steady current of 3 A for 20 hours is required, the average terminal voltage being 1.44 V. Calculate the ampere-hour and watt-hour efficiencies in this particular case.**

Id = 4A **Td = 12 Hrs** **Vd = 1.2 V** **Ic = 3A** **Tc = 20Hrs** **Vc = 1.44 V**

% η AH = Id × Td * 100 / Ic × Tc

% η AH = **4 × 12** * 100/ 3 × 20 = 80% **Ans.**

$$\frac{I_d \cdot T_d}{I_c \cdot T_c} \times 100 = 80\%$$

% η WH = **Id × Td × Vd** * 100 / Ic × Tc × Vc

% η WH = **4 × 12 × 1.2** * 100 /3 × 20 × 1.44 = 66.66% **Ans.**

$$\frac{V_d I_d T_d}{V_c I_c T_c} \times 100 = 66.6\%$$

Numericals

- **Q. Calculate the energy consumption per day in a house using 5 CFLs of 20 W each, 3fans of 60 W each for 3 hrs a day. AKTU (2018-19)**

4 fan 60 × 6 = 240 × 6 = 1440

3 Tube 20 × 12 = 60 × 12 = 720

1 AC 1500 × 6 → 9000 W

1 w/m 500 × 2 → 1000 W

1440

720

12180 W

$$KWh = (5\times20\times3) + (3\times60\times3)\,1000$$

= 0.84 KWH (Unit)

1 day

3 × 5 × 20 W → CFL

3 × 3 × 60 W → fan

= 300 W

= 540 W

for 1 day = 300 + 540

= 840 WH

= 0.84 KWH

12.16 KWH

30 ×

8

12.16 × 30 × 8

1 month

For more Subject/pdf Notes
Download Gateway Classes Application
From Google Play store

Link in Description

Thank You

AKTU

B. Tech I-Year

Gateway Classes

Full Courses Available in App

AKTU B.Tech I- Year : All Branches

AKTU B.Tech II- Year

Branches : 1. CS IT & Allied

2. EC & Allied

3. ME & Allied

4. EE & Allied

Downlod App Now

Download App

Full Courses

- V. Lectures
- Pdf Notes
- AKTU PYQs
- DPP