

Unit-5

Electrical Installation

wire: It is defined as thick flexible piece with insulation or without insulation carries the electrical current is known as wire.
eg: Aluminium, copper.

capable: It is defined as two or more insulated wire connected in a one part is known as capable.

classification of capable:
The classification of capable based on following groups

- i) Types of material used in capable
 - i) Aluminium conductor
 - ii) Copper conductor
- ii) The no. of core used in
 - i) Single core capable
 - ii) Double core capable
 - iii) Three core capable
 - iv) four core capable
 - v) Two core with capable continuity

- iii) Types of insulators used in
 - i) PVC
 - ii) Weather proof capable
 - iii) flexible cord

According to Voltage:

- i) No tension capable range is 1000 V
- ii) High tension capable range upto ~~or~~ 11K
- iii) Super-tension capable range 22-33 KV

i) Extra high tension capable 33-66 KV
ii) Extra Super-tension capable behind 132 KV

Fuse: It is defined as short piece of metal in circuit to operate protection of over current is known as fuse to prevent

The classification of fuse:

The classification of fuse are classified into two type

- i) Low voltage fuse
- ii) High voltage fuse

Low voltage fuse are also classified into two types

- i) Semi enclosed fuse
- ii) full enclosed fuse

The full enclosed fuse are also classified into two types.

- i) D-type
- ii) Link type

The link type are also classified into two types

- i) knife blade
- ii) Bolt fuse.

High voltage fuse also classified into three types

- i) liquid type
- ii) explosion type
- iii) cartridge type

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capacity of Battery: It is defined as the product of current and time is known as capacity of battery. It is measured in Ampere-Hours.

$$\text{capacity of Battery} = I \times T$$

UPS: It is defined as a part of continuous power supply without interruption is known as UPS. UPS stands for uninterruptible power supply. The classification of UPS are divide into two types:

- i) static UPS
- ii) Hybride UPS.

The static UPS divided into two types:

- i) Online UPS
- ii) offline UPS

Application of UPS:

It is used in computers

It is used in hospitals

It is used in Automobiles and Telephones

exchanges

Battery: It is defined as electrochemical Power source which converts chemical energy into electrical energy is known as battery.

This classified into two types

- i) primary
- ii) Secondary

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The application of battery classified into 2 types
i) Primary
ii) Secondary

Application of Battery

- i) It is used in industrial
- ii) It is used in motor cars, Bikes
- iii) It is used in phones, electronic devices.

factors of wiring system classified into

i) Types of material

ii) Types of load

iii) Quality of wiring system

iv) cost

v) further extension

vi) Safety

Advantages of power-factor improvement

i) Reduce the voltage drop

ii) Increase the percentage of Voltage Regulation

iii) Efficiency of the system will be measured

iv) Reduce the unit cost

Electrical energy Consumption: It is defined as utilizing of electrical energy is known as electrical energy consumption. It is measured in watt-hour

Bare conductor: It is defined as an electric conductor without any insulation is known as Bare conductor.

Bare conductor: It is an electric conductor which has no insulation

Types of Earthing

The classification of Earthing divided

into 4 types

i) plate earthing

ii) pipe earthing

iii) strip earthing

iv) rock earthing

Batteries:

Batteries are electrochemical power source which converts chemical energy into electrical energy is known as batteries.

The classification of batteries divided into

two types

i) primary batteries

ii) Secondary batteries

i) Primary batteries: It is defined as free energy into electrical energy is known as primary

battery

⇒ The primary batteries are not rechargeable and it is irreversible condition

⇒ In this type other batteries are most economically light weight and small size

⇒ The primary batteries low cost, low efficiency, low power output and less maintenance

The several types of Primary batteries.

i) carbon zinc

ii) zinc chloride

iii) Mercury cell

iv) lithium cell

v) silver oxide

vi) Alkane

Secondary battery: It is defined as storage of electrical energy or electrical current is known as secondary battery or Galvanic battery or storage battery.

The secondary batteries are fully rechargeable and reversible condition.

In this type of batteries most often used Ni-Cd & large size, heavy weight & high efficiency.

secondary batteries are high cost, high maintenance, high power output and high efficiency.

The several types of secondary batteries are:

i) Lead-acid cell

ii) Nickel cadmium cell

iii) Nickel iron

iv) Nickel metal hydrate

v) fuel cell

vi) lithium iron battery

vii) Stobu cell.

features of primary battery:

It is used for

→ Primary batteries are most economically

→ Primary batteries generate the

→ In this type of batteries, generate the

electrical current and high energy density

Features of secondary battery:

The secondary batteries are fully rechargeable
 If the current discharging can be recharged
 → In this type of battery storage capacitance high.

Characteristic of battery:

i) Capacity of battery

ii) Rate of discharge

iii) Temperature

iv) Density of electrolyte

v) Watt-hour efficiency

vi) Amp-hour efficiency

vii) Battery life

i) Capacity of Battery: It is defined as the product of current and time is known as capacity of battery

$$\text{Capacity of battery} = I \times T$$

It is measured in Ampere-hour

ii) Rate of discharge: It is defined as the current discharge from the battery is known as rate of discharge

The capacity of battery is inversely proportional to the rate of discharge. If the capacity of battery decreases and rate of discharge will be increases

$$\text{Capacity of battery} \propto \frac{1}{\text{Rate of discharge}}$$

(iii) Temperature: In these characteristics are completely depends upon capacitor of battery. The capacity of battery is directly proportional to temperature if the capacity of battery increases and temp also increases.

$$T \propto CB$$

(iv) Density of electrolyte: This condition also capacity of battery is directly proportional to density of electrolyte.

If the capacity of battery increases and density of electrolyte increases.

(v) Watt-hour efficiency: It is defined as the ratio of output energy to input energy known as watt-hours efficiency.

The mathematical expression of watt-hour efficiency

$$\eta = \frac{O/P \text{ energy}}{I/P \text{ energy}} \times 100$$

O/P = electrical energy discharging

I/P = electrical energy in charge

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

Based on the above equation the percentage of watt-hour efficiency is

where V_d = discharging voltage

I_d = discharging current

T_d = discharging Time

and that V_c = charging voltage

I_c = charging current

T_c = charging Time

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vii) Amp-hour efficiency: It is defined as ratio of output amp hour to input amp hour is known as Amp-hour efficiency.

$$\% \eta = \frac{\text{output Amp-hour}}{\text{Input Amp-hour}} \times 100$$

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

viii) Battery Life: The life of battery the storage of electrical current for many years stills out any discharging current mainly depends on the material like Nickel iron, Dead acid cell, Nickel cadmium etc. Now-a-days used in quality of battery.

in industries and Domestic purpose.

Problems:

- Q) A house has the following load
- 5 lamps, 60W, each working per 8 hours a day.
 - 4 lamps, 100W each working per 8 hours a day.
 - 2 heaters of 1000W each working per 3 hours a day
 - 5 fans of 80W each working per 12 hours a day

Calculate the January bill, if the rate of charge is Rs 0.50 per unit, add Rs. 10 as meter rent per month

S.No	Loads	watts (W)	Quantity	Total watt (W)	Working hours (T)	Total Energy
1	Lamp	60W	5	300W	8	2400 W/h
2	Lamp	100W	4	400W	8	3200 W/h
3	Heaters	1000W	2	2000W	3	6000 W/h
4	fans	80W	5	400W	12	4800 W/h

$$\text{Total Energy} = 15200 \text{ W/h}$$

$$15.2 \text{ Kw/h}$$

Total energy consumed in month January

$$= 15.2 \times 31$$

$$= 471.2 \text{ Kwh}$$

Given data:

Unit last = 0.50 Paisa

Rent per month for monthly charge = 10 RS

Total bill of January:

= Total energy consumed in Jan x per unit cost + Monthly rate

$$= 471.2 \text{ Kwh} \times 0.50 + 10$$

$$= 245.6 \text{ RS}$$

∴ Total Bill of January = 245.6 RS

- Q) Lead-Acid cell is charged at rate of 18 amps for 10 hours an average voltage 2.26 volts it is discharged in the same time at rate of 17.2 A the average voltage during discharge 1.98 V. calculate i) Amp-hour efficiency
ii) Watt-hour efficiency

Given data:

$$I_c = 18 \text{ A}$$

$$T_c = 10 \text{ h}$$

$$V_c = 2.26$$

$$T_d = 10 \text{ h}$$

$$I_d = 17.2 \text{ A}$$

$$V_d = 1.98 \text{ V}$$

i) Amp-hour efficiency

$$\frac{I_d \times T_d}{I_c \times T_c} \times 100$$

$$= \frac{17.2 \times 10}{18 \times 10} \times 100$$

$$= \frac{172}{18} \times \frac{1}{18} \times 100$$

$$= \frac{1720}{18} \times 100$$

$$= 95.5 \%$$

ii) Watt-hour efficiency

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

$$= \frac{17.2 \times 10 \times 1.98}{18 \times 10 \times 2.26} \times 100$$

$$= \frac{172}{10} \times \frac{198}{100} \times \frac{1}{18} \times \frac{100}{226}$$

$$= \frac{34056}{40680} \times 100$$

$$= 0.837 \times 100$$

$$= 83.71 \%$$

Note: The watt-hour efficiency is the product of amp-hour efficiency and voltage utilization.

Q) find the energy consumed in a house for a month of june if the load

a) 4 lamps, 100W each working per 6 hours a day

b) $\frac{1}{2}$ HP single pump motor used per 4 hours

a days

c) 2 heaters of 100W each working one for 2 hours

and another used for 1 hour a day.

calculate the amount of bill cost of energy

65 paise

Note: $\frac{1}{2}$ HP Single pump motor used in 373W

and 1 HP single pump motor 746 W.

S.No	Loads	watts (W)	Quantity	Total Watts	Working Hours	Total Energy
1	Lamps	100W	4	400W	6	2400
2	HP	373W	1	373 W	4	1492 W
3	Heaters	1000W	1	1000W	2	2000 W
4	Heater	100W	1	1000W	1	1000 W

$$\text{Total energy} = 6892 \text{ W/h}$$

$$= 6.892 \text{ Kwh}$$

Total energy consumed in month of June

$$= 6.892 \times 30$$

$$= 205.860 \text{ Kwh}$$

given data :

$$\text{Unit lost} = 0.65 \text{ Paise}$$

$$\text{Total bill of June} = 205.860 \times 0.65$$

$$= 134.394 \text{ RS.}$$

Q) Lead-acid cell maintains constant current 1.5A of 20 hours before its terminals voltage 1.8V calculate the capacity of cell given data

$$I = 1.5 \text{ A}$$

$$T = 20 \text{ hours}$$

$$\text{capacity of cell} = I \times T$$

$$= 1.5 \times 20$$

$$= \frac{15}{10} \times 20$$

$$= 30 \text{ Amp-hour}$$

Q) Lead-acid cell has 13 plates, each one 25cm x 20cm the clearance between the length of the plates 1.2mm. If the resistivity of the acid 1.6 Ω/cm find the internal resistance.

Given data:

$$\text{No. of plates} = 13$$

$$\text{Area of cross section (A)} = \frac{25\text{cm} \times 20\text{cm}}{13} \\ = 500 \text{ cm}^2$$

$$\text{Length of plate (l)} = \frac{1.2\text{mm}}{13} = 0.12\text{cm}$$

$$\text{Resistivity } (\rho) = 1.6 \Omega\text{-m}$$

$$R = \rho \frac{l}{a}$$

$$\frac{1.6 \times 0.12}{500}$$

$$R = 3.84 \times 10^{-4} \Omega$$

Opposite plates to adjacent plates
Opposite plates to adjacent plates

$$0.08 \times 9$$

$$0.81 \times 9$$

Opposite plates to adjacent plates

* Q) The battery of 40 cells is to charge from supply the internal resistance of each cell 0.05Ω and charging current $4A$ with average emf and each cell during $2.5V$. calculate the value of series resistance

Given data:

$$\text{No. of cells} = 40$$

$$\text{Supply voltage} = 180V$$

$$\text{internal resistance} (r) = 0.05\Omega \Rightarrow 40 \times 0.05 \Rightarrow 2\Omega$$

$$\text{current } (I) = 4A$$

$$\text{average emf} = 40 \times 2.5$$

$$= 100V$$

$$I = \frac{V - E_a}{R + r}$$

$$I(R + r) = V - E_a$$

$$R + r = \frac{V - E_a}{I} = (A)$$

$$R + r = \frac{180 - 100}{4} = 20\Omega$$

$$R + r = \frac{80}{4}$$

$$R = 20 - 2$$

$$\boxed{R = 18\Omega}$$

Q) Three lamps of rating $100W$, $200W$, $300W$ and rated voltage $230V$ are connected in parallel across $200V$ supply. calculate the power flowing in each lamp

Given data

Three lamps rating = 100W, 200W, 300W

Rate of Voltage = 230V

Supply Voltage = 200V

Power (P) = $V \times I$

$$P_1 = 100W$$

$$P_2 = 200W$$

$$P_3 = 300W$$

$$V_s = 200V$$

$$P_1 = \frac{V_s^2}{R_1}$$

$$P_2 = \frac{V_s^2}{R_2}$$

$$P_3 = \frac{V_s^2}{R_3}$$

calculating the resistance in each lamp

$$R_1 = \frac{V_s^2}{P_1}$$

$$P_1 = \frac{(230)^2}{100} = 529\Omega$$

$$P_2 = \frac{(230)^2}{200} = 264.5\Omega$$

$$P_3 = \frac{(230)^2}{300} = 176.3\Omega$$

Power blowing each lamp

$$P'_1 = \frac{(200)^2}{529} = 15.6W$$

$$P'_2 = \frac{(200)^2}{264.5} = 151.22W$$

$$P'_3 = \frac{(200)^2}{176.3} = 226.84W$$

SFU (Switch fuse Unit)

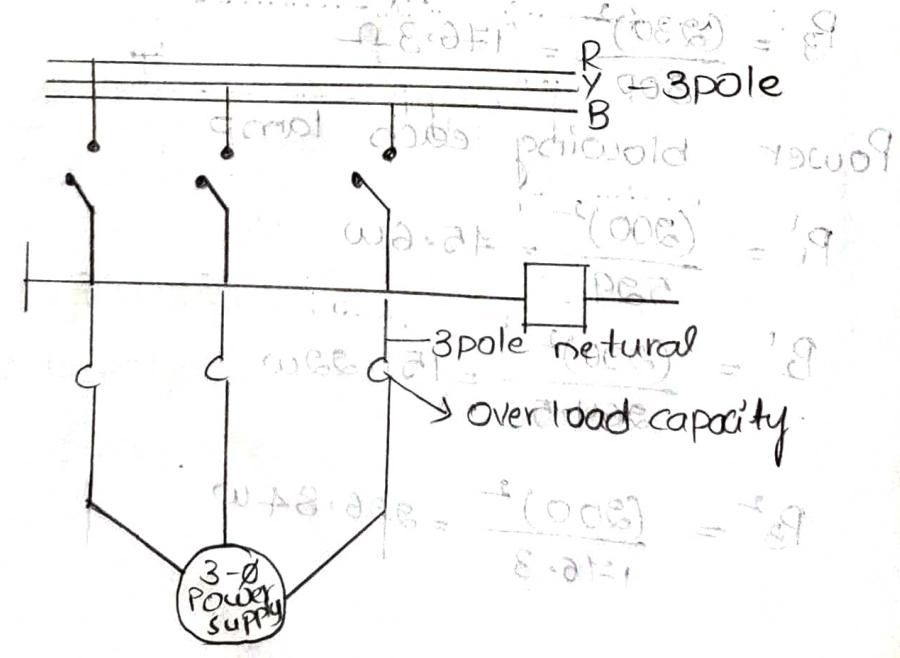
- ⇒ This type of fuse form of integrated switch, two units are available.
- ⇒ This type of switch in the circuit are 3 pole and 3-pole unit in circuit with rating of SFU thousand amperes.
- ⇒ The rated voltage 440V with breaking capacity of the circuit with 50KA.
- ⇒ This type of switch used in 3-phase Supply only.

The SFU classified into two types:

- i) SFU when the ~~force~~^{fuse} is constant
- ii) SFU when the ~~force~~^{fuse} is movable condition

Both units are uses the Unit with force fuse stationary is more reliable and unit with fuse movable condition less of electrical connection.

- ⇒ The 3-φ power motor used in SFU as show in fig.



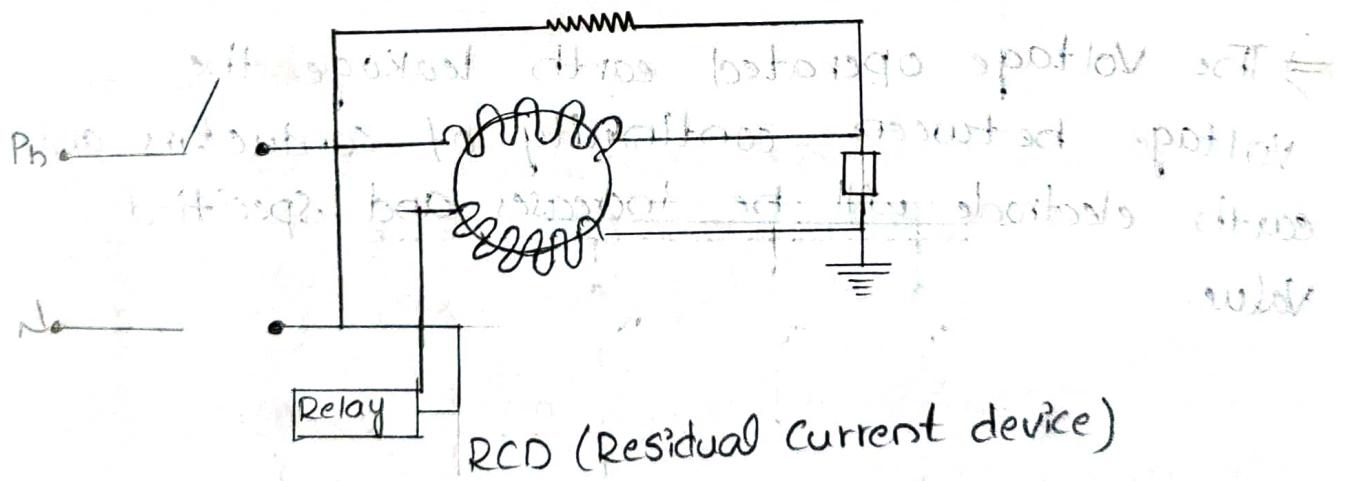
Application of SFU: It is technique used during self test for fault detection and isolation for protection against short circuit and over current faults of both system faults like lightning strikes and also ground faults.

Advantages of SFU: It has following advantages, i.e.

- It is less maintenance
- Required space is less
- Short time for fault detection and clearance

ELCB [Earth Leakage circuit Breaker] (or) Residual Current Circuit Breaker: It is a device which detects the residual current.

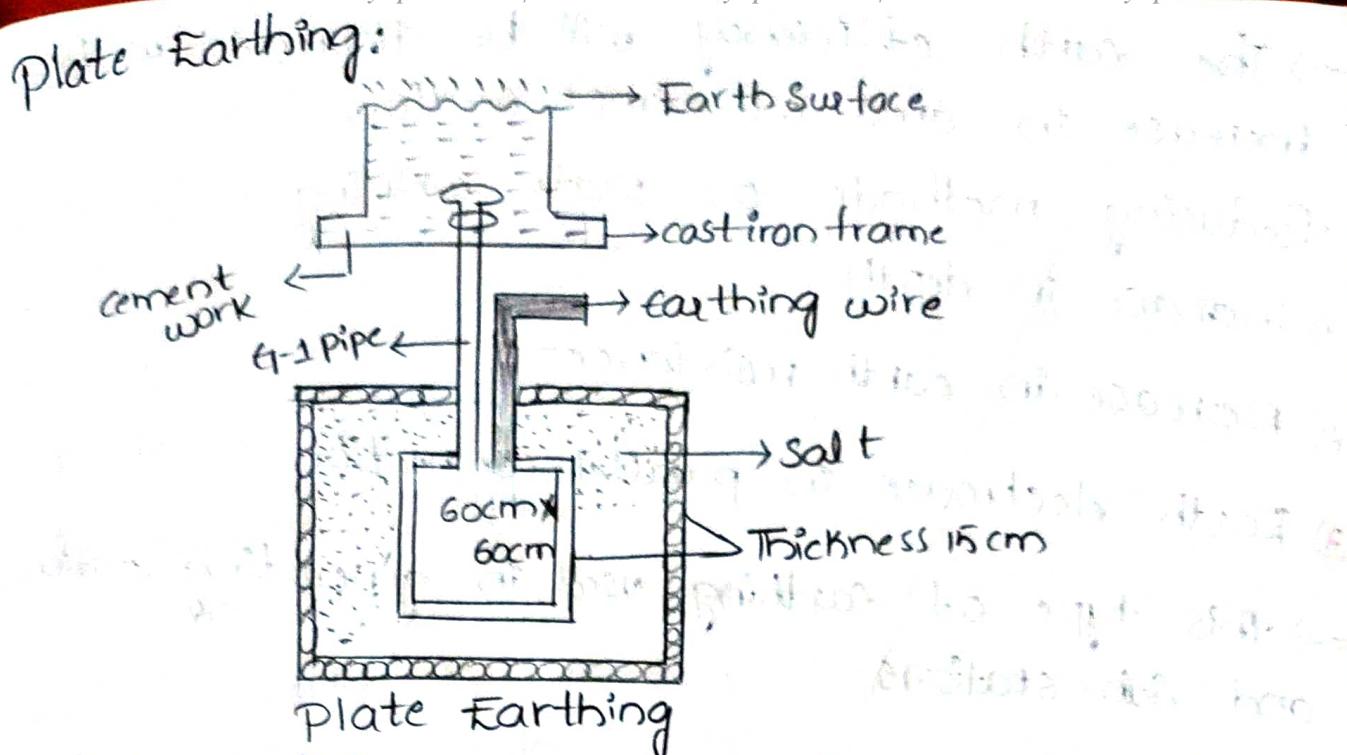
- It is residue current device.
- It is circuit breaker design to provide protection of earth leakage (or) electrical shock.
- It goes off condition when it is sense large leakage current in the circuit.
- ELCB operating principle can be explained shown in fig.



- It consisting of current transformer, relay and sensing coils

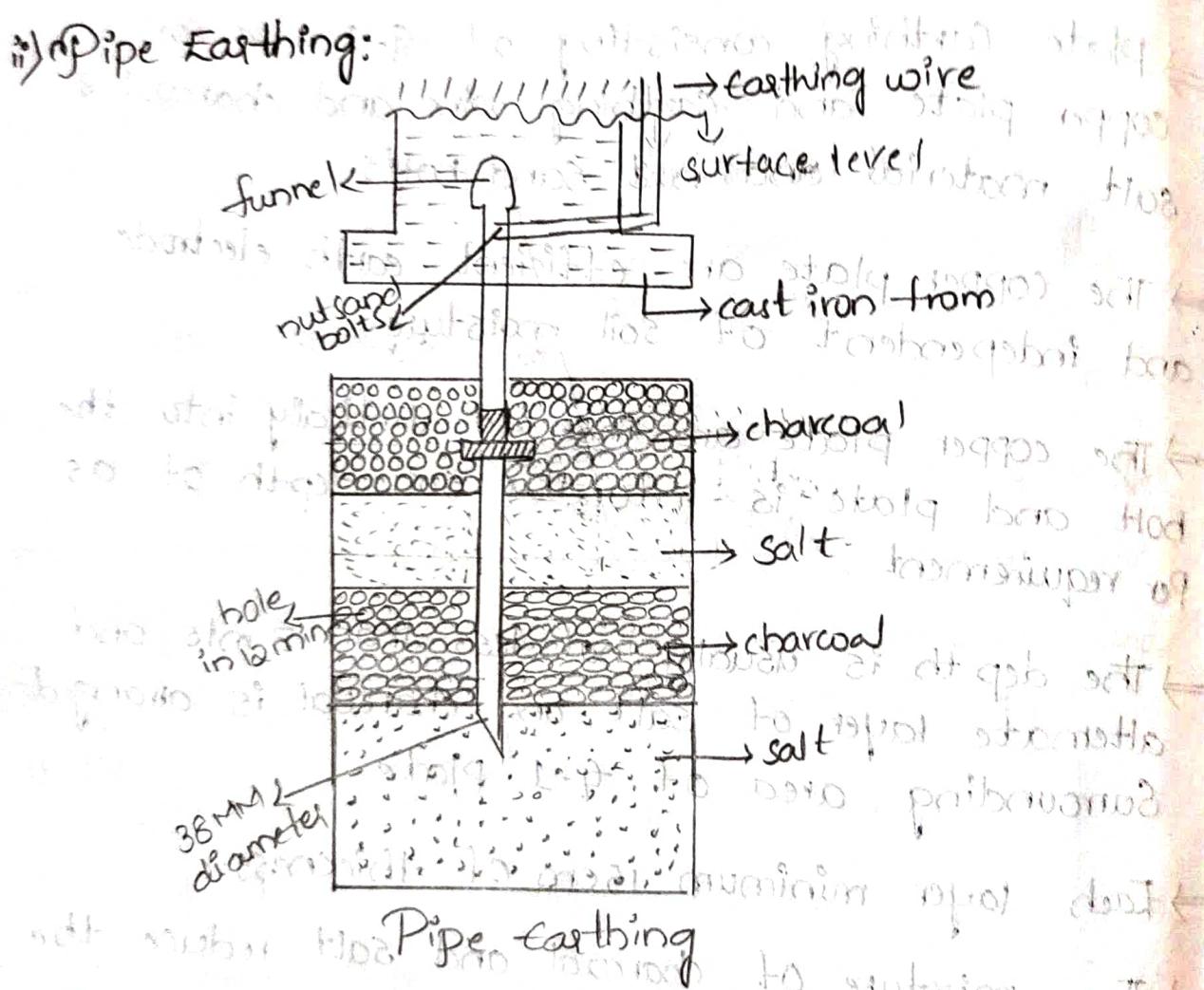
- When operated RCD connected to supply and load.

- The phase and neutral connected to load Primary winding of transformer and secondary winding connected to relay which is used Sensing coils.
- When phase & neutral current are equal and opposite direction then no generate current in sensing coils.
- When phase and neutral current are not equal then flux is produced if it should include current in secondary winding.
- ELCB classified into two types
 - i) Current operated earth leakage trip.
 - ii) Voltage operated earth leakage trip.
- The current operated in earth leakage used in 3-phase supply and three coils of current transformer is zero and no current flow in the trip coils.
- The voltage operated earth leakage the voltage between continuity of conductors and earth electrode will be increases and specified value.



- ⇒ Plate earthing consisting of G-1 pipe (or) copper plate and earthing wire and charcoal & salt material and nut sand bolts.
- ⇒ The copper plate are efficient earth electrode and independent of soil moisture.
- ⇒ The copper plate are inserted vertically into the bolt and plate is into the soil depth of as per requirement.
- ⇒ The depth is usually not less than 3 mts and alternate layer of salt and charcoal is arranged surrounding area of G-1 plate.
- ⇒ Each layer minimum 15cm of thickness.
- ⇒ The mixture of charcoal and salt reduce the earth resistance.
- ⇒ The earthing wire inserted into the soil through G-1 plate and it is arranged 19mm. diameter and 60 cm into the soil from other side.

→ The earth efficiency will be increased with increase in area of cross section
 Reducing methods of plate earthing
 i) Increase in depth
 ii) Decrease in earth resistance
 iii) Earth electrodes in parallel connection.
 ⇒ This type of earthing used in generating stations and sub-stations



⇒ Pipe earthing consisting of galvanic iron pipe in specified length and diameter
 ⇒ The mixture of charcoal and salt, nut sand bolts and earthing wire pipe acts as an earth electrode

→ Pipe is a cross sectional area and large leakage current can be carried out and same size of electrode:

→ And q-1 plate is inserted vertically into the hole and alternater layer of charcoal and salt

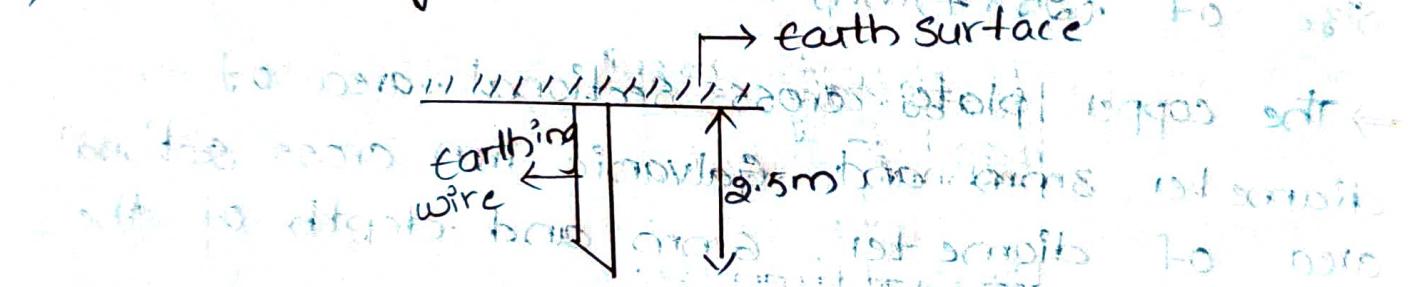
→ Depth in the hole 2.5 mts on earth surface.

→ The mixture of charcoal and salt improving earth efficiency and reducing the earth resistance.

→ The standard size of pipe 38mm diameter and hole in the standard size pipe 12mm.

→ The pipe earthing used in sand areas [outside building areas]

v) Rod Earthing



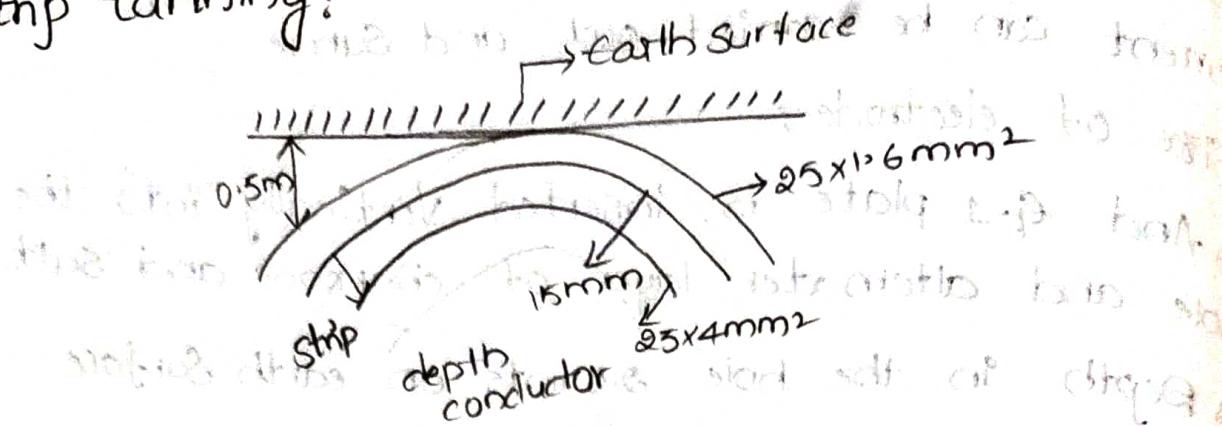
⇒ In this method of earthing, Solid rod 12.5mm and diameter of solid rod 16mm and the depth in the soil of earth electrode 2.5 mts.

⇒ Sometimes length rod will be increases and earth resistance decreases.

⇒ This type of earthing used in sand areas.

⇒ This type of earthing method increase in cross sectional area and efficiency of earthing also increase and q-1 plate inserted into the soil vertically 25mm

1) Strip earthing:



⇒ Strip earthing is done by an earthing wire, is inserted horizontally this type of earthing is complete opposite of plate and pipe earthing.

⇒ The minimum depth of the soil in electrode is 0.5m.

⇒ If the copper plate used in the size of $(25 \times 1.6)\text{mm}^2$ and galvanic iron used in the size of $(25 \times 4)\text{mm}^2$.

⇒ The copper plate cross sectional area of diameter 3mm and galvanic iron cross sectional area of diameter 6mm and depth of the conductor used is 15mm.

⇒ The strip earthing is used in rock areas.

⇒ Difference between MCB and MCCB

MCB stand for miniature circuit breaker	MCCB stand for moulded case circuit breaker.
2) The rating of current MCB are 1KA	2) The rating of current MCCB is 3KA
3) It is used in 3-Ø 1-Ø supply	3) It is used in only 3Ø supply

The application of MCB
domestic, lighting circuits.

The application of MCB DC
circuits, transformer
distributed system.

MCB

- It is electromechanical device and MCB stand for "miniature circuit Breaker."
- It is used in only low voltages and current in the form of determine the values when the switch is automatically off then the current that flow more than limited value
- The normal current rating are available from 0.5-63A short circuit breaking capacity 3-10KA, at a rated voltage 230/440V.
- MCB is designed to protect against overcurrent and over temperature fault.
- There are two contact one is fixed and other is moveable
- MCB turns off, thereby stopping the current from flowing in circuit
- It mainly consist of one bimetallic strip, one trip coil and one hand operated on-off lever
- Electric current carrying path of MCB is as follows.
 - first left hand side power terminal then bimetallic strip then current coil then moving contact then fixed contact

→ Lastly right hand side power terminal, and all arranged in series.

Diagram:

SM bus with load terminals and outgoing line connection.

In terms of protection coil goes of bus as it can create self voltages to melt coil.

→ Industries and with the protection of other residential loads from coil.

2) Residential

3) Computers

4) Power loads

5) Refrigerators

6) Lighting circuits

Advantages:

→ It is automatically switch off protecting overload (or) short circuit condition.

→ It is quick identification of faults in the circuit at any time.

→ No need of fuses and no serving.

Diagram:

SM bus with load terminals and outgoing line connection.

MCCB:

- ⇒ It is electro mechanical device, it stands for moulded case circuit breaker.
- ⇒ In this type of circuit breaker which protect the overload capacity and short circuit connection.
- ⇒ In this type of circuit breaker switch off automatically when the flow of current more than limited value.
- ⇒ MCCB is an alternative to fuses since it does not require replacement once an overload is detected.
- ⇒ MCCB can be easily reset after a fault and offers improved operational safety.
- ⇒ Molded case circuit Breakers generally have:
 - * Thermal element for over current protection.
 - * Magnetic element for short circuit release which has to operate faster.
- ⇒ The MCCB are five major components:
 - 1) Molded case (or) frame
 - 2) Operating mechanism
 - 3) Contacts
 - 4) Trip components
 - 5) Arc extinguishers

The range of circuit breakers are available from 63A up to 3000A and rating/pivoltage 440V with frequency 50Hz

Diagrams, 3) which illustrates the effect of short circuit on the system.

Teaching children about how to apply Ziegler-Nichols tuning rules to a P-I-D controller.

Information about how phasors help in solving AC circuit problems.

Application

1) to estimate required funds for project implementation.

2) capacitor switching

3) Transformer distributed system

4) Industries

Advantages:

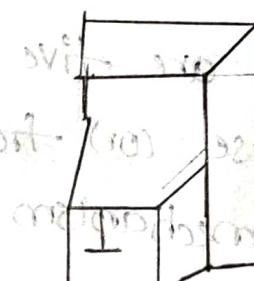
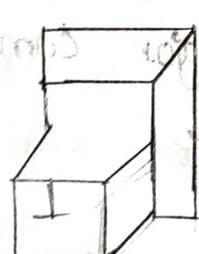
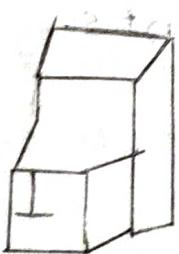
1) This MCCB's are current falls in 1- ϕ occur.

and remaining phases are disconnected.

2) This type of circuit breaker totally independent

commercial operation.

3) The switching life is more.



Advantages and Disadvantages of 3- ϕ transformer

Advantages:

1) Less cost

2) Less weight

3) Less Size

require to assembling

- 4) Less time require to assembling
- 5) Require less space
- 6) Delivers more power
- 7) Higher efficiency
- 8) Easier to install
- 9) Easy transportation and installation
- 10) Easy to repair
- 11) Easy to control with computer technology
- 12) Easy assembling

Disadvantages

- 1) Greater cost of stand by units
- 2) Increased cost and inconvenience of repairs
- 3) Transformer still supply the power, while it is not possible in case of failing a three phase transformer.

points of supplies, and off set ratio of each ratio must be avoided at same time.

ratio = $\frac{N_{11}}{N_{12}}$ = $\frac{N_{21}}{N_{22}}$

two groups with no brakets at ETC substation & M.G having unit to groups to substation to bus bar with two floors with two phases per branch to two substation connected to substation through switches