1. **Explain different types of wires and cables?**

According to types of insulation, the cables are of the following types:

i. Vulcanized Indian Rubber (VIR) Cables:

VIR cable consists of either tinned copper conductor covered with a layer of vulcanized Indian rubber insulation. Over the rubber insulation cotton tape sheathed covering is provided with moisture resistant compound b1tumen wax or some other insulating material for making the cables moisture proof. The thickness of rubber insulation depends upon the voltage grade for which the cable is required.

The copper conductor is tinned to provide protection against corrosion due to presence of traces of sulphur, zinc oxide and other mineral ingredients in the VIR.

ii. Tough Rubber Sheathed (TRS) or Cab Tyre Sheathed (CTS) Cables:

These cables are available in 250/440 volt and 650/l, 100 volt grades and used in CTS (0r TRS) wiring. TRS cable is nothing but a vulcanized rubber insulated conductor with an outer protective covering of tough rubber, which provides additional insulation and protection against wear and tear. These cables are waterproof, hence can be used in wet conditions. These cables are available as single core, circular twin core, circular three core, flat three core, twin or three core with an earth continuity conductor (ECC). The cores are insulated from each other and covered with a common sheathing.

iii. Lead Sheathed Cables:

These cables are available in 240/415 volt grade. The lead sheathed cable is a vulcanized rubber insulated conductor covered with a continuous sheath of lead. The lead sheath provides very good protection against the absorption of moisture and sufficient protection against mechanical injury and so can be used without casing or conduit system. It is available as a single core, flat twin core, flat three core and flat twin or three cone with an earth continuity conductor.

iv. Polyvinyl Chloride (PVC) Insulated Cables:

These cables are available in 250/440 volt and 650/ 1.100 volt grades and are used in casing-capping, batten and conduit wiring system. In this type of cable conductor is insulated with PVC insulation. Since PVC is harder than rubber, PVC cable does not require cotton taping and braiding over it for mechanical and moisture protection.

v. Weather Proof Cables:

These cables are used for outdoor wiring and for power supply or industrial supply. These cables are either PVC insulated or vulcanized rubber insulated conductors being suitably taped (only in case of vulcanized rubber insulated cable) braided and then compounded with weather resisting material. These cables are available in 240/415 volt and 650/1,100 volt grades.

vi. Flexible Cords and Cables:

The flexible cords consist of wires silk/cotton/plastic covered. Plastic cover is popular as it is available in different pleasing colours. Flexible cords have tinned copper conductors. Flexibility and strength is obtained by using conductors having larger number of strands. These wires or cables are used as connecting wires for such purposes as from ceiling rose to lamp holder, socket outlet to portable apparatus such as radios, fans, lamps, heaters etc. The flexibility of such wires facilitates in handling the appliances and prevents the wires from breakage. These must not be used in fixed wiring.

vii. XLPE Cables:

PVC and XLPE cables are built of insulation made of polymers. Polymers are substances consisting of long macromolecules built up of small molecules or groups of molecules as repeated units. These are divided into homopolymers and copolymers. Homopolymers are built by reactions of identical monomers. Copolymers are built up of at least two different kinds of monomers.

The mechanical properties of the polymers e.g. tensile strength, elongation elasticity and resistance against cold depend upon chemical structure. Their resistance against external chemical influences, acids, bases or oils together with their electrical and thermal characteristics are the decisive factors for the usefulness of cables insulated and sheathed with these materials.

2. What is need of earthing. Explain different types of earthing method.

Earthing means connections of the neutral point of a supply system or the non-current carrying parts of electrical apparatus, such as metallic framework, metallic covering of cables, earth terminal of socket outlet, stay wires etc., to the general mass of earth in such a manner that at all times an immediate discharge of electrical energy takes place without danger.

Earthing is provided

1. to ensure that no current carrying conductor rises to a potential with respect to general mass of earth than its designed insulation.
2. to avoid electric shock to the human beings, and
3. to avoid risk of fire due to earth leakage current through unwanted path.

The various methods of earthing are

i. Strip or Wire Earthing:

In this system of earthing, strip electrodes of cross section not less than 25 mm 1.6 mm if of copper and 25 mm x 4 mm if of galvanised iron or steel are buried in horizontal trenches of minimum depth 0.5 metre. If round conductors are used, their cross-sectional area shall not be smaller than $3.0mm^2$ if of copper and $6mm^2$ if of galvanised iron or steel. The length of buried conductor shall be sufficient to give the required earth resistance. It shall, however be not less than 15 metres. The electrodes shall be as widely distributed as possible preferably in a single straight or circular trench or in a number of trenches radiating from a point. If conditions require use of more than one strip, they shall be laid either in parallel trenches or in radial trenches.

This type of earthing is used at places which have rocky soil earth bed because at such places excavation work of plate earthing is difficult.

ii. Rod Earthing:

In this system of earthing, 12.5 mm diameter solid rods of copper or 16 mm diameter solid rods of galvanised 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.
This system of earthing is suitable for areas which are sandy in character. This system of earthing is very cheap as no excavation work is involved.

iii. Pipe Earthing:
This is the most common and best system of earthing as compared to other systems suitable for the same earth and moisture conditions.
In this method of earthing, a galvanised steel and perforated pipe of approved length and diameter is placed upright in a permanently wet soil.
The size of the pipe depends upon the current to be carried and type of soil. Usually the pipe used for this purpose is of diameter 40 mm and 2.5 metres in length for ordinary soil or of greater length in case of dry and rocky soil. The depth at which the pipe must be buried depends upon the moisture of the ground. The pipe is placed at a depth of 3.75 metres (minimum). The pipe is provided with a tapered casting at the lower end in Order to facilitate the driving. The pipe at the bottom is surrounded by broken pieces of coke or charcoal for a distance of about 15 cm around the pipe. Generally alternate layers of coke and salt are used to increase the effective area of the earth and to decrease the earth resistance respectively. Another pipe of 19 mm diameter and minimum length 1.25 metres is connected at the top of GI pipe through reducing socket.

iv. Plate Earthing:
This is another common system of earthing. In plate earthing an earthing plate either of copper of dimensions 60 cm X 60 cm X 3 mm or of galvanised iron of dimensions 6o cm X 60 cm X 6 mm is buried into the ground with its face vertical at a depth of not less than 3 metres from ground level.

3. What is the effect of electric shock on human body?

Bruner (1967) states that the threshold of perception of electric shock is about 1 mA. At this level u tingling sensation is felt by the subject when there is a contact with an electrified object through intact skin. With the increase in magnitude of ac. the sensation of tingling gives way to contraction of muscles. The muscular contractions increase as the current is increased and finally a value of current is reached at which the subject cannot release his grip on the current carrying conductor. The maximum current at which the subject is still capable of releasing a conductor by using muscles directly stimulated by the current is called "let go current". The value of this current is significant because an individual can withstand, without serious after effects, repeated exposures to his 'let go current' for at least the time required for him to release the conductor. Also currents slightly in excess of 'let go current' would not permit the individual to release his grip from the conductor supplying current.
Based on the experiments conducted on males and females, it is generally accepted that the safe 'let go current' could be taken approximately 9 mA and 6 mA for men and women respectively.

At current levels higher than the 'let go current' the subject loses ability to control his (m n muscle actions and he is unable to release his grip on the electrical conductor. Such currents are very painful and hard to bear. This type of accident is called 'hold-on-type' accident, and is caused by currents in the range 20-100 mA. These currents may also cause physical injury due to powerful contraction of the skeletal muscles. However, the heart and respiratory function usually continue because of uniform spread of current through the trunk of the body.

If current contacts contact skin and passed through the trunk, at about 100 mA and above, there is a likelihood of pulling the heart into ventricular fibrillation. In this condition, the rhythmic action of the heart ceases, pumping action stops and the pulse disappears. Ventricular fibrillation is a serious cardiac emergency because once it starts, it practically never stops spontaneously. It proves fatal unless corrected within minutes, since the brain begins to die 2 to 4 minutes after it is robbed of its supply of oxygenated blood.
At very high currents of the order of 6A and above, there is a danger of temporary respiratory paralysis and also of serious burns. However, if the shock duration is of only a very few seconds, there is a possibility of heart reverting to the normal rhythmic action.

The threshold of perception depends largely on the current density in the body tissues. It may vary widely depending upon the size of the current contact. At very small point contact, it is probable that even 0.3 mA current may be felt whereas a current in excess of perhaps 1 mA may not produce sensation if the contacts are somewhat larger. Similarly, depending on the size of contact, the threshold of pain may also be considerably above 1 mA, probably 10 mA if the contacts are large enough.
Besides the magnitude of current, the current duration and the relationship of current flow resistance are also important. Duration of less than 10 ms typically does not produce fibrillation whereas duration of 0.1 s or longer does. It has been found experimentally that the safe value of current in amperes (rms) which a human body can tolerate is given as

$$I = \frac{0.165}{\sqrt{t}} \, for \; t < 3s \; and \; I = 9mA \; for \; t > 3s$$

where t is the time duration in seconds of the flow of current.

Que.4> Explain Different Component of LT Switch Gear.

Ans.> In an electric Power System Switchgear is the Combination of electrical Disconnect Switches, fuses or circuit breaker used to Control, Protect and Isolate electrical equipment. Following Component are used to perform above mentioned function.

(i) Fuses → Simplest and cheapest Device for break the electrical Connection under overload or short circuit Protection.
the action of Fuse is based on flow of current through fuse wire if current exceed beyond limit then heat develop in wire which is more then melting point of wire So Fuse break the electrical Connection. there are following types.
(i) Round type (ii) Kit Kat type fuse (iii) Cartridge type
(iv) HRC (v) Semi conductor Fuse unit.

(ii) Miniature Circuit Breaker (MCB) > It is used to Protect wiring Installations and Sophisticated equipment against overcurrent and short ckt Faults. The operation is based on bimetallic strip which deflects when heated by over current flowing through it hence release the electrical Connection. MCB are available with different current rating 0.5 to 160 A.

(iii) Earth leakage Circuit Breaker> [ELCB] > It is device that Provide Protection against earth leakage. there are of two types→
(i) Current operated earth leakage Circuit Breaker
(ii) Voltage operated earth leakage Circuit Breaker
- Current operated ELCB is used when the Product

of the operating current in ampere and the earth loop Impedance in ohms does not exceed 40. $I_m Z_s < 40$

* Voltage operated ELCB is used when earth-loop Impedance exceeds the value applicable to fuses or other circuit breaker.

(iv) Molded Case Circuit Breaker (MCCB) > It is used to wide range of Voltage and frequency and have current rating upto 2500 A also trip setting is adjustable, also MCCB is larger then MCB. operating principal is based on bimettalic strip contact which expand and contracts in response to change in temp.

Que.3 > What is the Difference b/w MCCB & MCB

MCB	MCCB
(i) Current rating up to 160A	(i) Current rating up to 2500 Amper
(ii) Size is Small	(ii) Size is large in Compare to MCB
(iii) trip setting is not adjustable	(iii) Tripping current is adjustable
(iv) Range of frequencies are Narrow	(iv) Range of Frequencies are wide.

Que. 5> Explain amper hour and Watt-hour efficiency.

Ans.> (i) Ampere-hour efficiency → ratio of Ampere hour of discharge to amper hour of charge.

$$\eta_{A-h} = \frac{I_d T_d}{I_c T_c} \times 100$$

(ii) Watt-hour efficiency → Ratio of energy delivered in Watt hour during Dis charge to energy Consume during charging.

$$\eta_{w-h} = \frac{V_d I_D T_d}{V_c I_c T_c} \times 100$$

V_d → Discharge Valtage
T_d → Dis charge time
I_d → Dis charge Current
V_c → Charging Voltage
T_c → charging time
I_c → charging current

Que 6> A battery has taken charging current of 5.2 A for 24 hour at a Voltage 2.25V while Discharging it gave a current of 4.5 A for 24 hour at an average Voltage of 1.85V Calculate amper-hour and Watt hour efficiency.

Ans.> Given →

$I_c = 5.2 A$
$V_c = 2.25V$
$T_c = 24$ hour
$I_D = 4.5 A$
$V_D = 1.85 V$
$T_D = 24$ hour

now

$$\eta_{A-h} = \frac{T_d I_D}{I_c T_c} \times 100 = \frac{4.5 \times 24}{5.2 \times 24} \times 100 = 86.54\%$$ Ans

$$\eta_{w-h} = \frac{V_d I_d T_d}{V_c I_c T_c} \times 100 = \frac{4.5 \times 1.85 \times 24}{5.2 \times 2.25 \times 24} \times 100 = 71.15\%$$ "

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