Chapter no. 6 (12 marks)

PROTECTIVE DEVICES AND SWITCHGEAR

Unit-VI Protective Devices and Switchgear	6a. Describe the features of the given type of protective device. 6b. Select the relevant protective device for the given application with justification 6c. Select suitable switchgear for the given situation with justification. 6d. State the I.E. rule related to be applied for the given type of earthing with justification.	6.1 Fuse: Operation, types 6.2 Switch Fuse Unit and Fuse Switch Unit: Differences 6.3 MCB, MCCB and ELCB: Operation and general specifications 6.4 Earthing: Importance of earthing, factors affecting earthing 6.5 Methods of reducing earth resistance, I.E rules relevant to earthing

CO6 : Use relevant protecting devices/switchgear for different requirements

Fuse:

a **fuse** is an electrical safety device that operates to provide overcurrent protection of an electrical circuit. Its essential component is a metal wire or strip that melts when too much current flows through it, thereby interrupting the current.

Fuses have been used as essential safety devices from the early days of electrical engineering. Today there are thousands of different fuse designs which have specific current and voltage ratings, breaking capacity and response times, depending on the application. The time and current operating characteristics of fuses are chosen to provide adequate protection without needless interruption. Wiring regulations usually define a maximum fuse current rating for particular circuits. Short circuits, overloading, mismatched loads, or device failure are the prime reasons for fuse operation.

A fuse is an automatic means of removing power from a faulty system; often abbreviated to ADS (Automatic Disconnection of Supply). Circuit breakers can be used as an alternative to fuses, but have significantly different characteristics

fuse consists of a metal strip or wire fuse element, of small cross-section compared to the circuit conductors, mounted between a pair of electrical terminals, and (usually) enclosed by a non-combustible housing. The fuse is arranged in series to carry all the current passing through the protected circuit. The resistance of the element generates heat due to the current flow. The size and construction of the element is (empirically) determined so that the heat produced for a normal current does not cause the element to attain a high temperature. If too high a current flows, the element rises to a higher temperature and either directly melts, or else melts a soldered joint within the fuse, opening the circuit.

The fuse element is made of zinc, copper, silver, aluminum,[or alloys to provide stable and predictable characteristics. The fuse ideally would carry its rated current indefinitely, and melt quickly on a small excess. The element must not be damaged by minor harmless surges of current, and must not oxidize or change its behavior after possibly years of service.

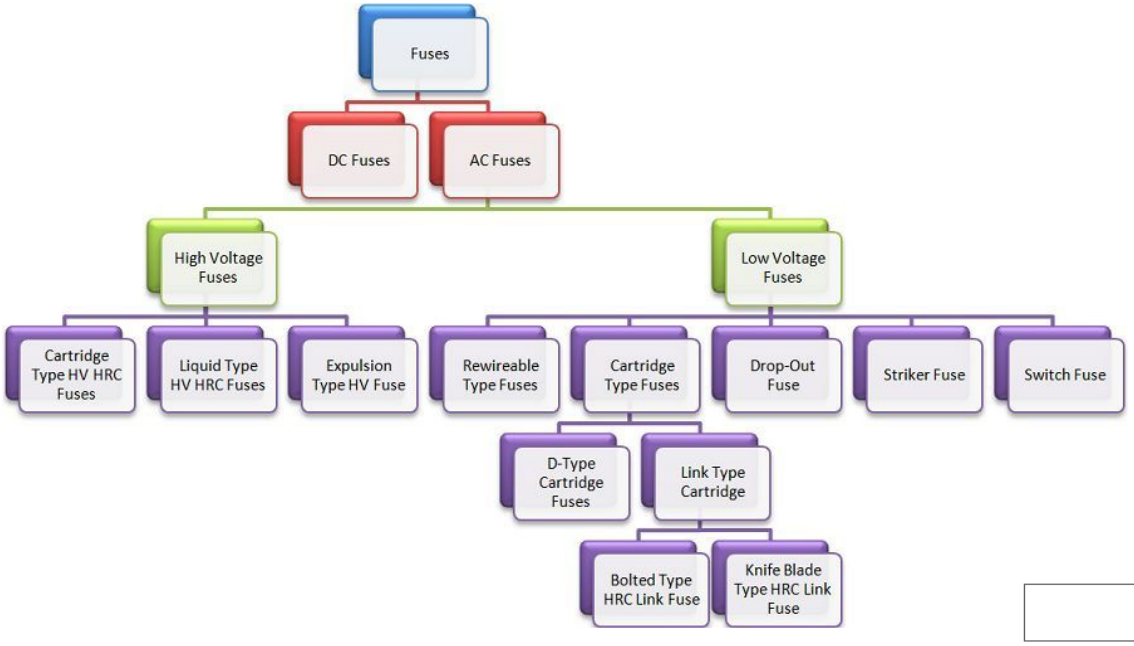
The fuse elements may be shaped to increase heating effect. In large fuses, current may be divided between multiple strips of metal. A dual-element fuse may contain a metal strip that melts instantly on a short-circuit, and also contain a low-melting solder joint that responds to long-term overload of low values compared to a short-circuit. Fuse elements may be supported by steel or nichrome wires, so that no strain is placed on the element, but a spring may be included to increase the speed of parting of the element fragments.

The fuse element may be surrounded by air, or by materials intended to speed the quenching of the arc. Silica sand or non-conducting liquids may be used.

How Fuses Work

Fuses function as a protective agent for electrical circuits. Passing high electrical currents through a wire that isn't rated to handle such a high current can lead to heat, melting, or burning. Fuses help maintain a healthy electrical current that is bellow the rated level of the fuse. This melt can cause a break in the circuit and stops the circuit flow. Fuses have been an essential piece of safety equipment in electrical wiring since the early days of electricity. A fuse is essentially a means of using or controlling the electrical current within electrical wiring.

Types of Fuses



Circuit Specialists is introducing a variety of types of fuses from our prevailing fuse line Optifuse, Most fuses are either in stock or available for shipping within 1-2 days. When you combine low-cost fuses and fuse accessories sold here with our low-cost shipping options you'll see that we offer the lowest cost fuses in the industry. Most of our fuse selection has the possibility to display cross-reference information from other major fuse manufacturers like Littelfuse and Bussman. This technology makes it easy to ensure you are getting the same parts that will match bigger retailers available from Circuit for a better price. Below we'll break down some of the major types of fuses that we now offer

Automotive (Car) Fuses


Automotive (Car) Fuses

The most popular types of fuses we offer to the automotive industry are Car and Automobile Fuses. These fuses are necessary and ensure proper circuit wiring and electrical protection. Our featured blade fuse above is the part of the APR-K-160 REGULAR AUTOMOTIVE BLADE FUSES – 32VDC KITS.

Glass & Ceramic Fuses


Glass, Ceramic And Micro Fuses

Featured Item: FSA-K-1601

Electronic Fuses can be split into Glass and Ceramic Fuses. There are many types of fuses but only Glass and Ceramic Fuses are capable of providing fast-acting and time-delay in a variety of sizes. These fuses are used as over-current protection in electronic devices.

Fuse Holders and Accessories

With many types of fuses come many accessories. These Fuse clips and holders can help save space, add extra protection or ensure tight enclosure between the clip and actual fuse.

Circuit breakers are used to automatically to switch and operate electrical currents. Most people will be familiar with circuit breakers since they are commonly found in residential settings. Circuit breakers are a vital part of the electrical wiring process. Circuit breakers offer over-current protection and can help prevent electrical fires when a device has short circuited.

Fuse Blocks

Fuse blocks are essentially protected and consolidated blocks of fuses. These Blocks have an added level of security and protection. Fuse blocks are commonly used in automotive applications sharing multiple circuits.

Industrial Fuses

Industrial Fuses are used to protect motors and branch circuits where higher amps or volt ratings are required. Wiring regulations usually define a maximum fuse current rating for particular circuits in (volts).

Kits

TSA-K-160 FUSE (3AG) GLASS BODY TIME-DELAY KIT

In addition to the vast selection of fuses are pre-assebled kits. These service kits are filled with the more common types of fuses for the most common applications. Most include an organized case to assure the fuses needed are kept at hand.

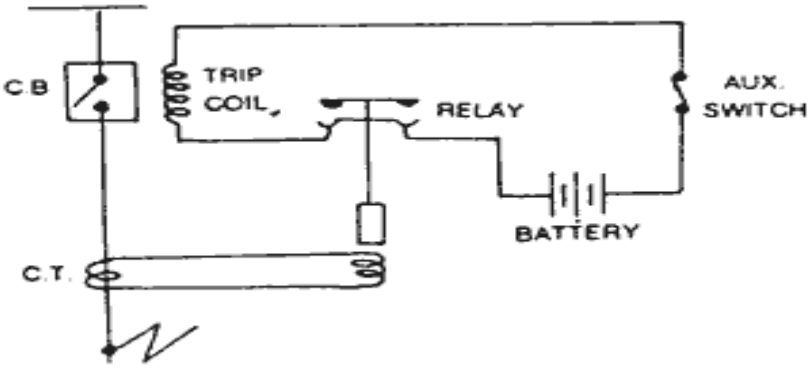
The safety measure and precautions that are taken while handling electrical equipment.

- ✔ Beware of live wires or conductors, bare or without insulations.
- ✔ Never tamper unnecessary with any electrical apparatus.
- ✔ Before switching ON any device, make sure that is properly insulated and proper earthing.
- ✔ Always maintain the earthing connection in satisfactory manner
- ✔ Do not throw water in case of fire due to electric short circuit.
- ✔ Disconnect the supply first when there is fire.
- ✔ Before use see the condition of electric equipment.
- ✔ Before inspection of electric equipment switch off supply first.
- ✔ Use suitable equipment as per working condition of workplace to avoid hazardous condition.

safety tools used in electric workshop.

The safety tools used are rubber,gloves,rubber shoes, safety goggles etc.

CIRCUIT BREAKER:



MCB-Miniature Circuit Breaker

MCB is an electromechanical device which guards an electrical circuit from an over current, that may effect from short circuit, overload or imperfect design. This is a better option to a Fuse since it doesn't require alternate once an overload is identified. An MCB can be simply rearranged and thus gives a better operational protection and greater handiness without incurring huge operating cost. The operating principle of MCB is simple.

n MCB function by interrupting the stability of electrical flow through the circuit once an error is detected. In simple conditions this circuit breaker is a switch which routinely turns off when the current flows through it and passes the maximum acceptable limit. Generally, these are designed to guard against over current and overheating.

MCB is substituting the rewirable switch-fuse units for low power domestic and industrial applications in a very quick manner. In wiring system, the MCB is a blend of all three functions such as protection of short circuit, overload and switching. Protection of overload by using a bimetallic strip & short circuit protection by used solenoid.

These are obtainable in different pole versions like single, double, triple pole & four poles with neutral poles if necessary. The normal current rating is ranges from 0.5-63 A with a symmetrical short circuit breaking capacity of 3-10 KA, at a voltage level of 230 or 440V.

Characteristics of MCB

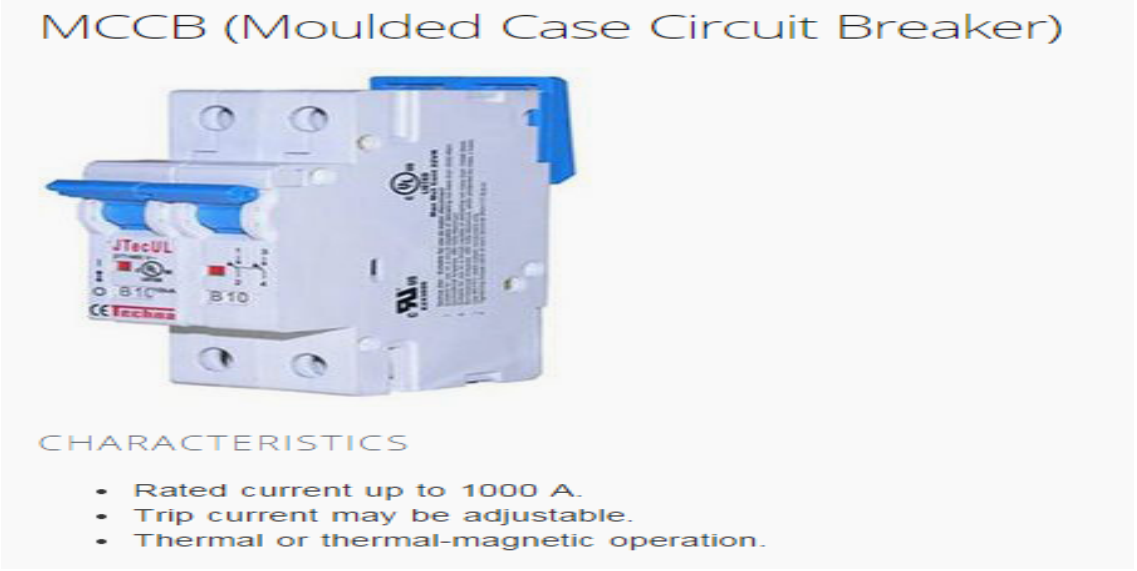
The characteristics of an MCB mainly include the following

- Rated current is not more than 100 amperes
- Normally, trip characteristics are not adjustable
- Thermal/thermal magnetic operation

MCCB : Moulded Case Circuit Breaker.

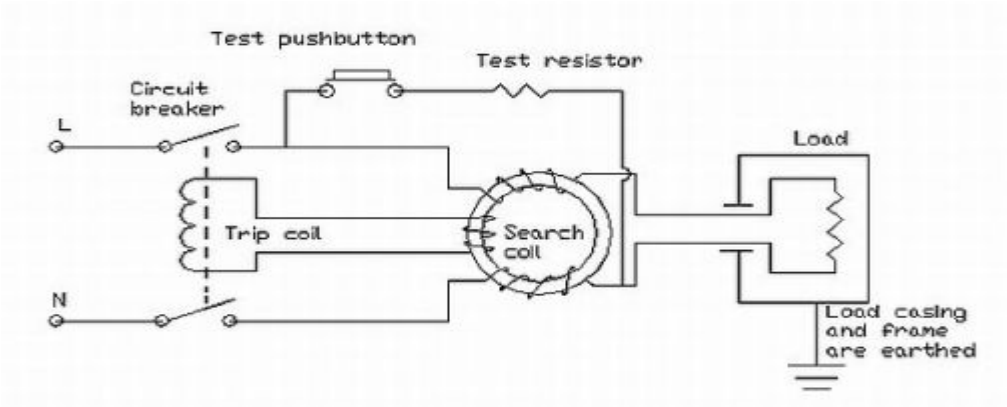
Moulded Case Circuit Breaker is a compact type air circuit breaker enclosed in a moulded (insulating body) case.

- ❖ MCCB is an operating switch used manually for making ON and OFF, their circuit under normal operating conditions.
- ❖ Under Faulty conditions ,it automatically trips the circuit by tripping mechanism is actuated by magnetic and thermal sensing device.
- ❖ When contact of MCCB are opened ,under abnormal and normal condition it produce arc between two contact.



ELCB : Earth Leakage Circuit Breaker

Earth Leakage Circuit Breaker gives protection against direct or indirect contacts with the live circuit under fault condition.



ELCB (Earth Leakage Circuit Breaker)

CHARACTERISTICS

- Phase (line), Neutral and Earth wire connected through ELCB.
- ELCB is working based on Earth leakage current.
- ***Operating Time of ELCB:***
  - The safest limit of Current which Human Body can withstand is 30ma sec.
  - Suppose Human Body Resistance is 500Ω and Voltage to ground is 230 Volt.
  - The Body current will be 500/230=460mA.
  - Hence ELCB must be operated in 30maSec/460mA = 0.65msec

Earthing.

circuitry which connects parts of the electric circuit with the ground in order to ensure safety in electrical connections. It is necessary to connect a conductor with all metal wires in circuit to provide zero potential with negligible resistance. Here a metal is dipped under the ground which provides zero potential i.e reference voltage to all points.

Necessity of Earthing :-- In an electrical appliances if the line wires come in contact with the metallic frame then frame also become live.

- So when operator touches such electrical equipment ,current flows through operators body to ground and he experiences an electric shock.
- So to ovoid such hazardous situation if electric ground wire is connected to metal frame , as soon as metal frame becomes alive excessive current then flows through the wire(which has negligible resistance and zero voltage).
- As the wire has almost zero resistance , it carry excessive current and so as fuse connected between power supply and equipment gets fused off. It makes system safe and operator from experiencing an electric shock.

purpose of earthing:

- To save human life from danger of electrical shock or death by blowing a fuse i.e. To provide an alternative path for the fault current to flow so that it will not endanger the user
- To protect buildings, machinery & appliances under fault conditions ie. To ensure that all exposed conductive parts do not reach a dangerous potential.
- To provide safe path to dissipate lightning and short circuit currents.
- To provide stable platform for operation of sensitive electronic equipments i.e. To maintain the voltage at any part of an electrical system at a known value so as to prevent over current or excessive voltage on the appliances or equipment .

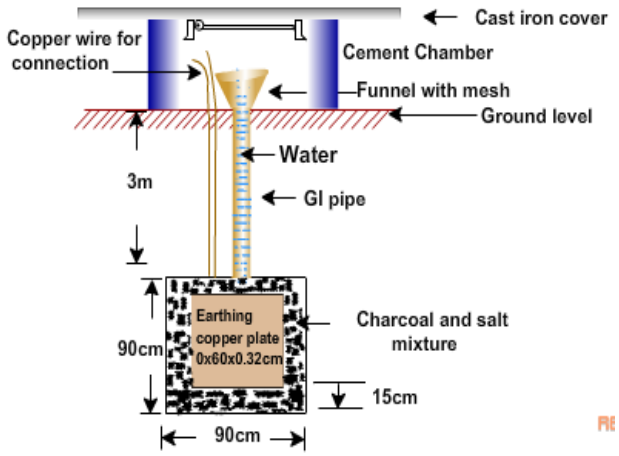
To provide protection against static electricity from friction

The different types of earthing

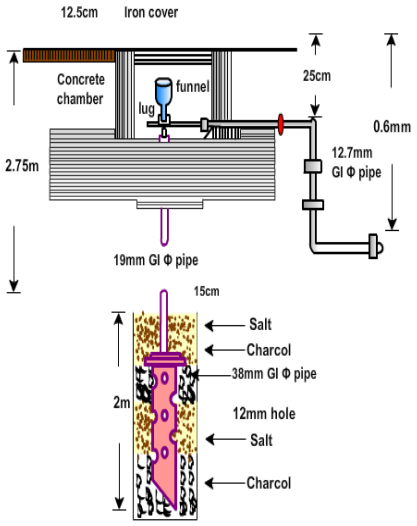
i) Plate earthing
ii) pipe earthing
iii) earthing through water main

i)Plate earthing:

In this method a copper plate of 60cm x 60cm x 3.18cm or a GI plate of the size 60cm x 60cm x 6.35cm is used for earthing. The plate is placed vertically down inside the ground at a depth of 3m and is embedded in alternate layers of coal and salt for a thickness of 15 cm. In addition, water is poured for keeping the earth electrode resistance value well below a maximum of 5 ohms. The earth wire is securely bolted to the earth plate. A cement masonry chamber is built with a cast iron cover for easy regular maintenance.



ii) Pipe earthing :

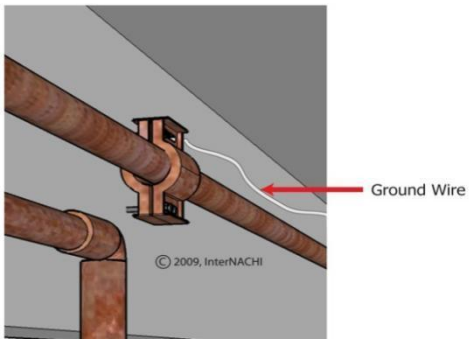


Pipe earthing is the best form of earthing and is very cheap in cost.
in this method a galvanized iron pipe of approved length and diameter is placed up right in a permanently wet soil. the size of the pipe depends upon the current to be carried and type of soil usually the pipe used for this purpose is of 38mm and 2.5m in length the depth at which the pipe must be buried depends upon the moisture of the ground. the pipe is placed at a depth of3.75m. the pipe is provided with a tapered casing at the lower end in order to facilitate the driving.

When compared to the plate earth system the pipe earth system can carry larger leakage currents as a much larger surface area is in contact with the soil for a given electrode size. The system also enables easy maintenance as the earth wire connection is housed at the ground level.

iii) Earthing through water main:

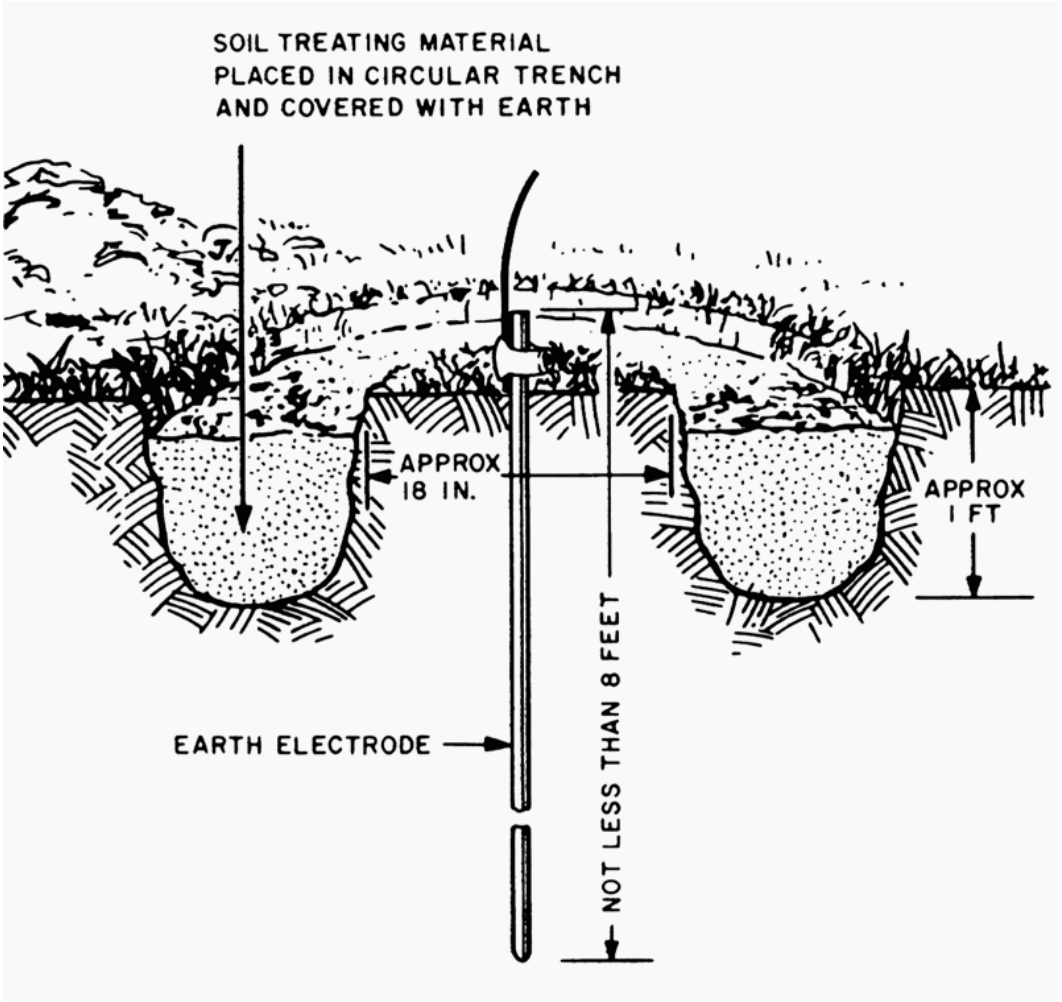
Grounded to Waterline



Reducing earth electrode resistance

Under certain circumstances the value of electrode resistance may be excessively high and steps must be taken to reduce its value. The following methods may be adopted:

- electrodes buried to a greater depth
- use of extendable rods
- use of additional rods
- soil conditioning agents (temporary measure)



Earthing in a EHV Substation I.E.Rules 1956

- Rule 92
  - **Every substation /generating station exposed to lightning shall adopt efficient means for diverting the electrical surges due to lightning to earth**
  - **Earth lead of any lightning arrestor shall not pass through any iron or steel pipe.**
  - **It shall be taken directly, as far as possible, to a separate earth electrode and/or junction of the earth mat.**
  - **Bends Shall be avoided where ever practicable**
  - **Earth screen if provided for lightning protection shall be connected to main earth grid.**