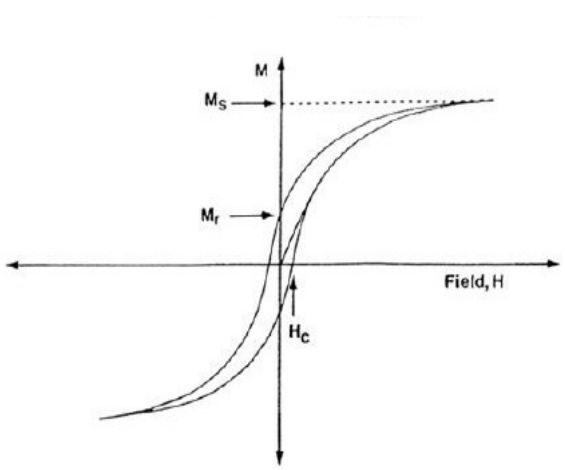
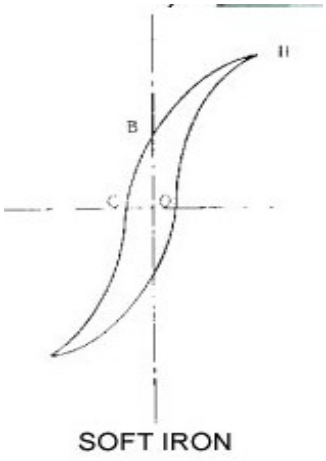
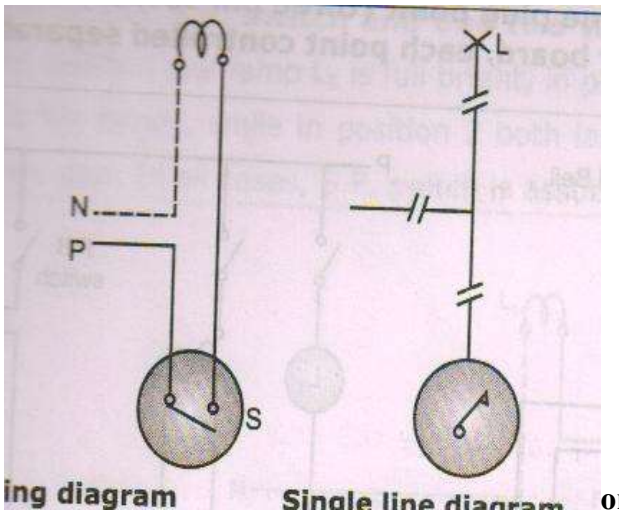
Important suggestions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more importance. (Not applicable for subject English and communication skills)
4) While assessing figures, examiner may give credit for principle components indicated in a figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case some questions credit may be given by judgment on part of examiner of relevant answer based on candidate understands.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q.1	**Attempt any FIVE of the following :** **10 Marks**
a)	**State the need for strictly following safety rules while working in electrical installations.**
Ans	**Need for strictly following safety rules while working in electrical installations:** **(2 Marks)** 1. To avoid the electrical shock to the human being and to provide safe guard. 2. To minimize the chances of fire hazard in the consumer premises or in installation network. 3. To get uniformness to everybody in our country. 4. For the better control simple and smooth operation of the electrical devices. 5. To minimize the chances of mechanical and electrical accidents.
b)	**Write any two properties of good electrical insulation material.**
Ans	**Electrical Properties of insulating material:-** **(Any TWO expected: 1 Mark each)** 1. It should have high resistance. 2. It should have high breakdown voltage. 3. It should have high dielectric strength. 4. It should have low dielectric loss. 5. It should have low dielectric constant.

c)	**Draw the labeled hysteresis loop for an electromagnetic material.**
Ans	**labeled hysteresis loop for an electromagnetic material:** **(2 Mark)**  **or**  **or equivalent figure**
d)	**Define dielectric failure of electrical insulating material.**
Ans	**Definition of dielectric failure of electrical insulating material.** **(2 Marks)** In the insulating material if the applied voltage is increased gradually then for certain value insulation will break down, which is known as dielectric failure **OR** Insulating material vanishes its insulating properties and starts conducting, also known as dielectric failure.
e)	**Name one gaseous and one liquid electrical insulation material.**
Ans	**i) Gaseous insulating material :** **(Anyone expected : 1 Mark)** 1. Air 2. Nitrogen 3. Hydrogen 4. SF6 **ii) liquid insulating material:** **(Anyone expected : 1 Mark)** 1. Transformer oil 2. Capacitor oil 3. Cable oil 4. Pyranol 5. Savotal 6. Savol 7. Vegetable oil 8. Silicon liquids

f)	**Draw a labeled circuit diagram of a one lamp control circuit using one switch.**
Ans	**Circuit diagram for one lamp controlled with one switch:** **(2 Marks)**  ing diagram Single line diagram **or equivalent figure**
g)	**Define earthing related to electrical wiring system.**
Ans	**Definition of earthing:** **(2 Mark)** ➢ Earthing means connecting the metal body of electrical device to the general mass of earth by a wire of negligible resistance. **OR** ➢ Earthing means connecting the metal body of electrical device to the earthing pit. **OR** ➢ Earthing is the processes of connection to the specific part of installation with earth conductive surface.
Q.2	**Attempt any THREE of the following :** **12 Marks**
a)	**Write any four of the IE rules to be followed in respect of safety while working in an electrical installation system.**
Ans:	**While working in an electrical installation following safety IE rules regarding with safety:** **(Any Four expected : 1 Mark each: Total : 4 Marks)** 1. IE Rule 3 : Authorization 2. IE Rule 29 : Construction and maintenance of electrical supply line and apparatus 3. IE Rule 30: Service line and apparatus on consumers premises. 4. IE Rule 31: IE Rule 30: Cut out on consumer premises. 5. IE Rule 32: Identification of earthed and earthed neutral conductor and position of switches and cut outs therein

	6. IE Rule 33: Earthed termination consumers premises. 7. IE Rule 34: Accessibility of bare conductors 8. IE Rule 35: Danger boards notices 9. IE Rule 36: Handling of electrical supply line and apparatus. 10. IE Rule 37: Supply to vehicles, cranes etc. 11. IE Rule 38: Cable for portable or transportable apparatus. 12. IE Rule 41: Distinction of different circuits. 13. IE Rule 41A: Distinction of the installations having more than one feed 14. IE Rule 42: Accidental charges 15. IE Rule 43: Provision applicable to protective equipment's. 16. IE Rule 44: Instruction for restoration of persons suffering from electrical shock. 17. IE Rule 44A: Intimation of accidents 18. IE Rule 45: Precautions to be adopted by consumers, owners, occupiers, electrical contractors, electrical workman and suppliers. 19. IE Rule 46: Periodical inspection and testing of consumers installation. 20. IE Rule 48: Precaution against leakage before connection. 21. IE Rule 49: Leakage on consumers premises 22. IE Rule 50: Supply and use of energy. 23. IE Rule 54: Declared voltage of supply to consumers 24. IE Rule 55: Declared frequency of supply to consumer 25. IE Rule 56: Sealing of meters and cutouts 26. IE Rule 60: Test for resistance of insulation 27. IE Rule 61: Connection with earth
b)	**Explain the suitability of copper as an electrical conductor with reference to its mechanical and electrical properties.**
Ans:	**Following are properties of conductor:-** **(Any Four expected : 1 Mark each: Total : 4 Marks)** **i) High conductivity :-** Material should have high conductivity, So that ➢ Cross section of conductor (size) reduces, ➢ Copper losses reduces,

- So Efficiency increases,
- Voltage drop reduces,
- So, Regulation gets improved.

ii) High mechanical strength:-

Material should have sufficiently high mechanical strength to with stand against

- Rough handling of conductor during transportation & Stringing,
- Wind Pressure,
- Ice loading and
- Severe climatic condition

iii) **Flexibility:-**

Material should be flexible for

- Easy handling and
- Storage

iv) **Weight:-**

Material should be light in weight to reduce transportation & handling cost.

v) **High resistance to corrosion:-**

Material should have high resistance to corrosion

- To avoid rusting

vi) **Brittleness:-**

Material should not be brittle.

- So that it will not easily cut after twisting.

vii) **Temperature coefficient of resistance:-**

Material should have low temperature coefficient of resistance.

viii) **Availability & cost:-**

Material should be easily available & less costly.

ix) **Scrap Value:-**

Material should have high scrap value.

OR

Properties of Copper: **(Any Four expected : 1 Mark each: Total : 4 Marks)**

1. **Conductivity :** High (1.6 times more than Aluminum)

2. **Resistivity :** $\rho = 1.68 \times 10^{-8}$ ohm m / 0.01786 ohm m /mm^2 at 20^0 C

	3. **Mechanical Strength:** High, Tensile strength = 40 kg/mm^2 4. **Weight:** High, specific gravity = 8900 kg/mm^2 5. **Flexibility :** Less flexibility 6. **Temperature coefficient of resistance :** α = 0.0038/^{0}C at 20^0 C 7. **Soldering & Welding :** It can be welded & solder easily 8. **Melting point :** 1083 ^{0}C 9. **Thermal conductivity :** Thermal conductivity of copper is about twice 10. **Young modulus :** 13000 kg/mm^2
c)	**Explain the electrical and thermal properties of transformer oil those make it suitable as an electrical insulating medium.**
Ans:	**(Any four properties are expected from following or equivalent 1 Mark each ,Total 4 Marks)** **Following are the electrical and thermal properties of transformer oil:-** 1. Dielectric strength :- It should be have a high dielectric strength 2. Specific resistance:- It should be have a high Specific resistance. 3. Dielectric dissipation factor (DDF) (tanδ):- It should be as low as possible. 4. Relative permittivity (Dielectric constant):- It should be 2.2 5.Flash Point :- Oil should have very high flash point. (160^{0}c minimum, or greater than 140^{0}c) 4. Fire point - It should have high fire temperature (not less than 200°C) it should be 25% greater than flash point. 5. Pour Point: - (Indicates the lowest temperature at which the insulating oil will flow.)

	It should be low (Pour point of transformer oil is an important property mainly at the places where climate is extremely cold.)(- 6^0c to – 40^0c) 6. Viscosity:- Oil should have low viscosity at 100^0c . 7. Density:- Oil should have low density. Density of oil at 20^0C should be 0.89 gm/cm^3. 8. Moisture content:- Oil should be free from moisture (moisture content should be less than 10 ppm (Parts per million) Water content in oil is allowed up to 50 ppm 9. Dissolved gas:- Oil should be free from dissolved gas. 10. Acidity content:- Oil should be chemically stable. Acidity content should be very low. (0.03mg KOH/mg Maximum) 11. The oil should be clear & plane in colour, transparent & free from suspended matter. 12. For mineral oil, the power factor of new oil should not exceed 0.05 percent at 25^0c. 13. It should not contain impurities such as sulpher & its compounds to avoid rusting & sludge formation.
d)	**Explain the process and need of crimping of cable joints.**
Ans:	**The process of crimping of cable joints:** **(2 Marks)** **Measure the dimensions of cable and lug , select proper lug size.** 1. Remove the insulation of the cable as per the measured dimension. 2. Remove armouring and mechanical sheath on cable if present OR if required. 3. Both cable conductor and compression crimp should be cleaned down using cable cleaning wipes. 4. Select the proper lug size and die for crimping of core 5. Check cable conductor is be fully inserted into the crimp connector. 6. The correct compression or crimping sequence must be followed and the full compression pressure applied.

	Need of crimping of cable joints : **(2 Marks)** 1. Proper connection of the cable 2. To avoid the loose connection 3. To Minimize contact resistance 4. When permanent or direct fastening methods are not feasible then crimping procedure is followed, then cables are connected to bus bars.
Q.3	**Attempt any THREE of the following :** **12 Marks**
a)	**Explain the use of following tools in carrying out electrical wiring installation:** **(i) Nose pliers (ii) Test lamps (iii) Crimping tools (iv) Cutter.**
Ans:	**(Use of each tools : 1 Mark each)** **(i) Nose pliers :** To hold and tight the wires **(ii) Test lamps:** Verification of voltage & current in the system and also check the open circuit **(iii) Crimping tools:** for crimping of the lugs for wires and cables **(iv) Cutter:** To cut the wire and remove the insulation
b)	**Describe with reasons the failure of porcelain insulators.**
Ans:	**The reasons the failure of porcelain insulators: - (Any Four point expected: 1 Mark each)** **1. Manufacturing Defect:-** Insulator may fail due to manufacturing defect. So, it must be tested before use. **2. Uneven Expansion and Contraction:-** Insulator is manufactured by using combination of material. For.eg: porcelain, glass, cements and also attachment steel is used. Co-efficient of expansion and contraction of each material is different. So, there is possibility of cracking of insulator, so it may fail. **3. Mechanical Stress:-** Due to mechanical stress of wind insulator may fail. **4. Porous:-** Porcelain is porous material. So, if insulator is not glazed properly then direct dust will accumulate on insulator and It will absorb moisture from air, so reduces resistance of insulation. Hence leakage current increase which increases temperature of insulator. It may cause failure of insulator.

5. Flashover due to lightning stroke:-

If lightning stroke directly attacks on insulator than there is flash over and causes failure of insulator**.**

6. Flash over due to large birds or similar objects:-

Large birds or similar objects causes short circuit resulting in flash over and causes of failure insulator.

7. Flash over caused due to dust deposition:-

Transmission line running over/near dusty area for eg: coal mine, large stone crusher, cement factory etc.

Dust will deposit on insulator which reduces clearance between two conductors. So, there is possibility of flash over and causes failure of insulator.

8. Wrong Selection:-

If 11 KV insulators are used for 22 KV, then it causes failure of insulator.

9. Rough Handing:-

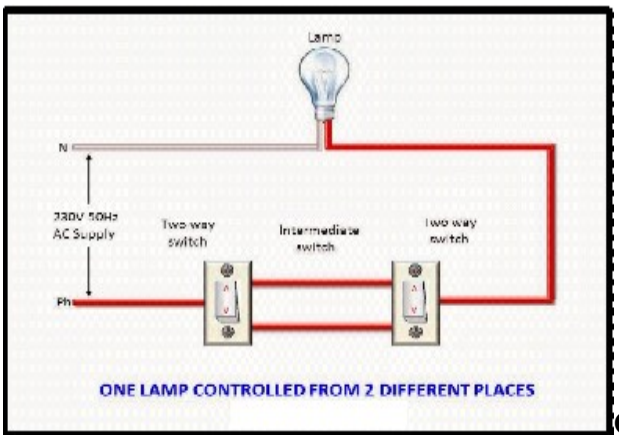
Due to rough handling of insulator during transportation, construction of line work etc causes failure of insulator.

10. Ageing Effect:-

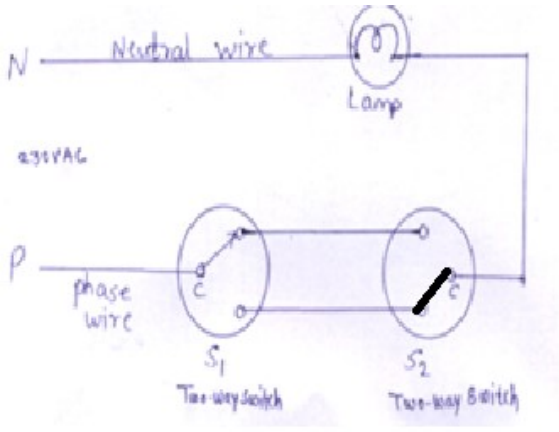
Due to continuous use of insulator for a long period, its dielectric strength reduces. So, it may fail insulator.

c) Explain with neat labeled circuit diagram the staircase wiring in which a lamp is controlled from two different locations.

Ans: **one lamp controlled from two places:** **(Figure: 2 Mark & Explanation: 2 Mark)**



OR



or equivalent figure

	Explanation: 1. The switch S1 (two way switch is located at bottom position of the staircase. 2. The switch S2 is located at top position of the staircase. 3. Initially the lamp is 'OFF' by changing the position of S1 or S2 the lamp will become 'ON' or 'OFF' as per our requirement. 4. The staircase wiring is also used in hospitals. 5. The operation steps for the staircase wiring are as below: ➢ Initially lamp is OFF ➢ Change the position of S1 lamp will become ON due to current flow ➢ Change the position of S2 lamp will become OFF due to current discontinuity ➢ This process remains continuously
d)	**Explain the uses of safety rubber hand gloves and rubber mats in electrical engineering.**
Ans:	**Uses of safety rubber hand gloves in electrical engineering:** **(2 Marks)** ➢ The safety rubber hand gloves are always used for online work to insulate the human body or operator from the electrical supply. ➢ The danger of electrical shocks from leakage current is also avoided from rubber hand gloves, the hand gloves manufactured for various operating voltages for LT line upto 600V it is differently manufactured and for 11KV and 33KV etc it is differently designed and manufactured. **Uses of safety rubber mats in electrical engineering:** **(2 Marks)** ➢ The Rubber mats are always used in the front of all control panels and if required switch boards. ➢ The main purpose of rubber mat is at the time of earth fault or earth leakage current operators (human body) is isolated from ground or earth i.e. why danger of electrical shock is avoided.
Q.4	**Attempt any THREE of the following :** **12 Marks**
a)	**Explain the use of the following components in electrical wiring system and give specification of each: (i) MCB (ii) ELCB**
Ans:	**Explanation:** **i) MCB (Miniature Circuit Breaker)** **(1 Mark)** ➢ MCB provides short circuit protection.

- MCB provides overload protection
- ELCB provides earth fault protection.
- MCB is in series with load and ELCB is across the supply.

The standard specifications of MCB available in the market: **(1 Mark)**

1. Single pole
2. Two pole
3. Three pole
4. Four pole
5. For available current rating : 0.5A, 1A, 1.6A,2A,5A, 6A, 10A,16A,20A, 25A, 30A, 32A, 40A, 50A, 60A and 63A 250V and 450 v

ii) ELCB- (Earth Leakage Circuit Breaker) **(1 Mark)**

An Earth Leakage Circuit Breaker (ELCB) is a device used to directly detect currents leaking to earth from an installation and cut the power and avoid the person from getting shock.

There are two types of ELCBs:

1. Voltage Earth Leakage Circuit Breaker (voltage-ELCB)
2. Current Earth Leakage Circuit Breaker (Current-ELCB).

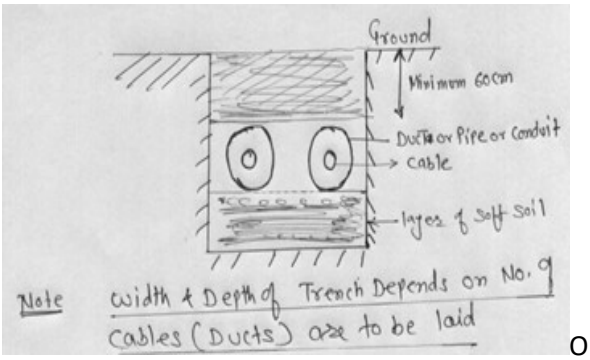
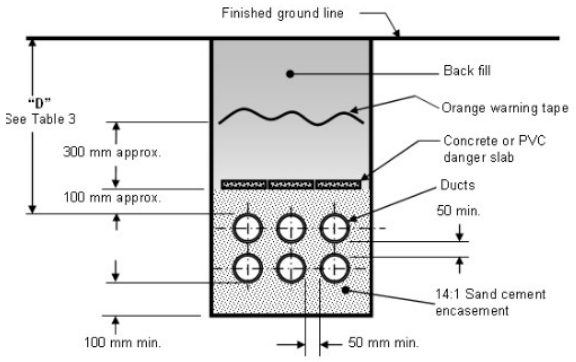
OR

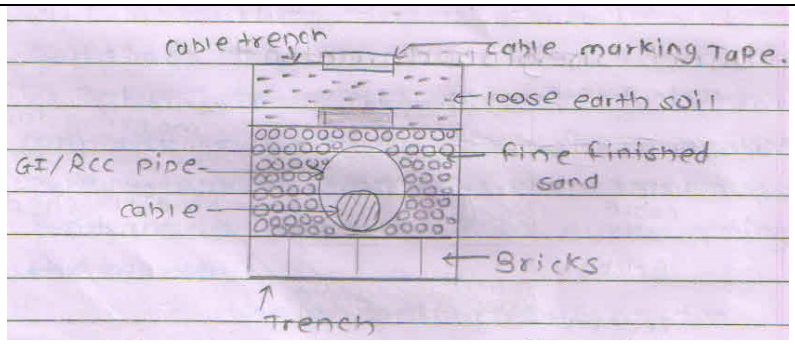
Earth leakage circuit breaker is a safety device used in electrical installations with high earth impedance to prevent shocks and disconnect power under earth fault conditions. Works on principle of relaying when the current in the earth path exceeds a set value. ELCB is used for protection against electric leakage in the circuit of 50 Hz or 60 Hz , rated voltage single phase 230 V, 3 ph. 400 v. Rated current up to 60 Amp. When the earth fault occurs, the ELCB cuts off the power within 0.1 sec. automatically to protect the personnel.

The standard specifications of ELCB available in the market: **(1 Mark)**

1. There are three categories as per the sensitivity :' B' class ELCB for residential, 'C' Class ELCB for commercial and 'D' class ELCB for industrial.
2. The ELCB are available in 100 mA, 300 mA, 500 mA and 1000 mA
3. The low sensitivity ELCB are used for electrical machine the rating is in between the 3A to 10 A

b)	**Explain with justification two uses of each of two following as an electrical conductor: (i) Brass (ii) Silver**
Ans:	**(i) Brass:** **(1 Marks)** **Brass** is an alloy of copper (60%) and zinc (40%) ; the proportions of zinc and copper can be varied to create a range of brasses with varying properties. Brasses set the standard by which the machinability of other materials is judged and do not become brittle at low temperatures like mild steel. Brass has excellent thermal conductivity and is a first choice for heat exchangers. The following properties of brass: ➢ Resistivity : 7.5 x 10^{-8} ohm m ➢ Tensile strength is high ➢ Soldering and welding is simple. ➢ It has high resistance to corrosion. ➢ Specific gravity 8.5 ➢ Melting point is 890^0C **Uses of Brass as an electrical conductor:** **(1 Marks)** 1. The brass is generally used for nut bolts 2. It is also used for current carrying rods. 3. Electrical plugs and outlets use brass connections. **(ii) Silver:** **(1 Marks)** Silver is the best conductor of electricity because it contains a higher number of movable atoms (free electrons). For a material to be a good conductor, the electricity passed through it must be able to move the electrons; the more free electrons in a metal, the greater its conductivity. However, silver is more expensive than other materials and is not normally used unless it is required for specialized equipment like satellites or circuit boards. ➢ It is a best conductor of electrical current and heat due to vary high cost it is rarely used for conducting material ➢ Properties are as below: ➢ Electrical resistivity is equal to 1.65x10^{-8} ohm m ➢ Melting point is equal to 960^0C ➢ Ducting and malleability property is very good

	➢ It is a well resistance to corrosion. ➢ The cost is very high **Uses of Silver as an electrical conductor:** **(1 Marks)** 1) In switches to minimize contact resistance 2) In measuring instruments 3) In relays
c)	**Explain the phenomenon of loss of magnetism.**
Ans:	**Phenomenon of loss of magnetism:** **(2 Mark)** It is the process in which permanent magnetic material completely demagnetize Due to following factors is called as a loss of magnetism. **Following factors for loss of magnetism.** **(2 Mark)** 1. Ageing: Due to ageing or completion of life of the magnetic material loss of magnetism is possible. 2. Heat: If the magnetic material is heated more than its curie temperature then loss of magnetism is possible. 3. Due to mechanical process: If the number of mechanical process like punching, cutting, drilling, machining are carried out then loss of magnetism is possible. 4. Improper storage of magnetic field: If the magnetic material is not magnetized properly with high efficiency then loss of magnetism is possible
d)	**Describe with sketches the process of laying of underground cables by the drawing in method.**
Ans:	**Drawing in cable laying System:** **(Figure: 2 Mark & Explanation: 2 Marks)**  OR 



Procedure:

- A trench of minimum 60cm deep is made along with cable route.
- Width of trench depends on number of conduits to be laid.
- Separate pipes are provided for each cable.
- Spacing between 2 cables (conduit) is between 25 cm to 75 cm.
- Diameter of pipe is **2 to 3 cm**, greater than cable diameter for easy handling of cable.
- Pipe used may be cement pipe, DWC pipe or ducts of **glad** stone are used.
- For Maintenance and other cable work, man-holes are provided at suitable distance.
- Size of man-holes should be large enough to allow a person to enter into duct without difficulty.
- Unarmored cables are used in this type.

Q.5	**Attempt any TWO of the following :**	**12 Marks**
(a)	**State the properties of copper and aluminium which make them good conductors of electricity.**	
Ans:	**i) Following properties of copper: (Any three point expected: 1 Mark each, Total 3 Marks)** 1. **Conductivity :** High (1.6 times more than Aluminum) 2. **Resistivity :** $\rho = 1.68 \times 10^{-8}$ ohm m / 0.01786 ohm m /mm^2 at 20^0 C 3. **Mechanical Strength:** High, Tensile strength = 40 kg/mm^2 4. **Weight:** High, specific gravity = 8900 kg/mm^2 5. **Flexibility :** Less flexibility	

	6. **Temperature coefficient of resistance :** $\alpha = 0.0038/^0C$ at 20^0 C 7. **Soldering & Welding :** It can be welded & solder easily 8. **Melting point :** 1083 ^{0}C 9. **Thermal conductivity :** Thermal conductivity of copper is about twice 10. **Young modulus :** 13000 kg/mm^2 **ii) Following properties of Aluminium:** **(Any three point expected: 1 Mark each, Total 3 Marks)** 1**. Conductivity :** Less, (1.6 times lesser than copper) 2. **Resistivity :** More, $\rho = 2.8 \times 10^{-8}$ ohm m / 0.0287 ohm m/ mm^2 at 20^0 C 3. **Mechanical Strength:** Less, Tensile strength = 18 kg/mm^2 4. **Weight:** Low, specific gravity = 2700 kg/mm^2 5. **Flexibility :** More flexibility 6**. Temperature coefficient of resistance :** $\alpha = 0.004/^0C$ at 20^0 C 7. **Soldering & Welding :** Pure aluminum can't be welded or soldered 8. **Melting point :** 655/658 ^{0}C 9. **Thermal conductivity :** Thermal conductivity of aluminum is about twice times less 10. **Young modulus:** 5600 kg/mm^2
b)	**Explain the reasons for failure of gaseous and solid dielectric materials used in electrical engineering application.**
Ans:	**Reasons for failure of gaseous and solid dielectric materials used in electrical engineering application.** **(6 Marks)** 1. If the system voltage increases more than breakdown voltage for some interval then there

are chances of dielectric failure

2. Long time partial discharge in solid insulator will create dielectric failure.
3. Due to super heating of dielectric material i.e. due to heavy load or over load temperature increases and dielectric failure occurs.
4. Due to lighting surge there may be possibility of dielectric failure.
5. Due to short circuit or ground fault there may be possibility of dielectric failure.
6. Due to poor maintenance of insulating material there may be possibility dielectric failure

OR

Failure of gaseous dielectric or Breakdown of gaseous dielectric depends on following factors: **(Any Three point expected: 1 Mark each, 3 Mark)**

1. Breakdown voltage depends on the frequency of the applied voltage.
   When frequency is increased breakdown voltage decreases.
2. It depends on distance between the electrodes & the chemical composition of the gas.
3. It also depends on shape & size of electrodes.
4. It also depends on uniformity of the applied electric field.
5. It also depends on pressure.

Failure in solid dielectric or Breakdown in solid dielectric depends on :

(Any Three point expected: 1 Mark each, 3 Mark)

Three types breakdown.

i)Electro-thermal ii) purely Electrical iii) Electro – chemical

1. Electro-thermal breakdown is due to the heat produced by the dielectric loss which is due to the heat produced by the dielectric loss which is proportional to the intensity of the electrostatic field &frequency.
2. Purely electrical breakdown is due to collision ionization by electrons. When the free electrons in the crystals are accelerated by the strong electric field K.E. increases and collision occurs.
3. Electro chemical breakdown usually occurs at very high temperature and high humidity of the surrounding air

c)	**Describe with neat circuit diagram the measurement procedure of earth resistance for an installation.**

Ans:

(Any one method of laying of underground cable expected: Figure: 3 Mark & Explanation: 3 Mark, Total 6 Marks)

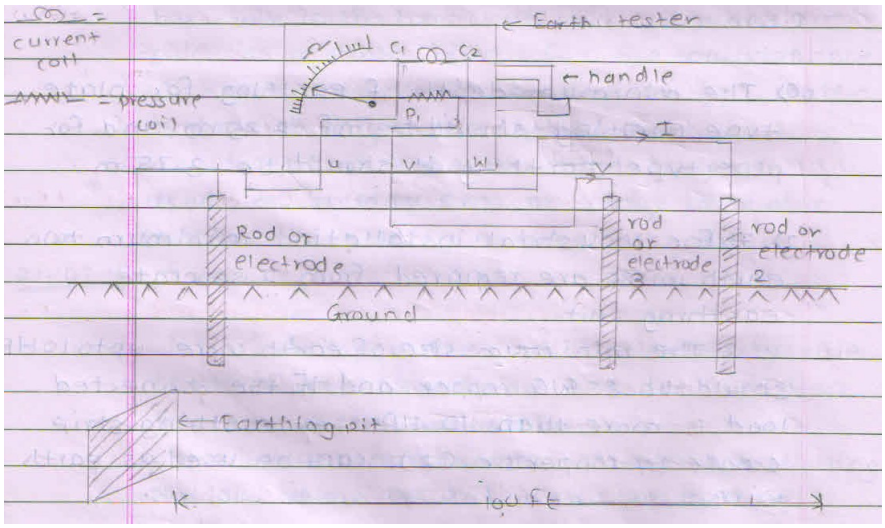
Following procedure (Method) for testing of earth pit resistance with necessary diagrams.

1) Earth Tester : i) Three point method ii) Four point method

2) By Potential drop method

3) Water tap method

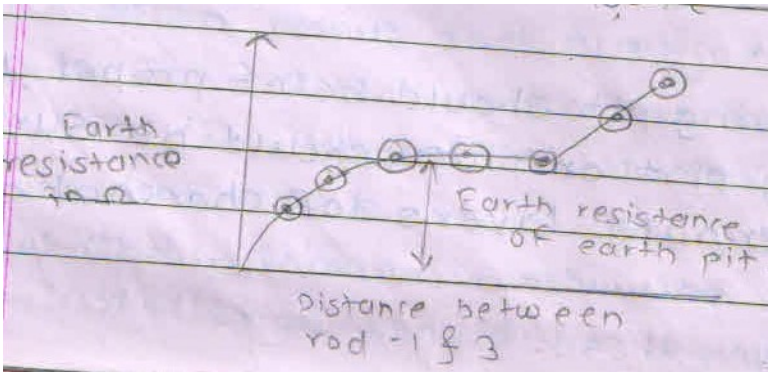
1) earth resistance measurement for Earth Tester



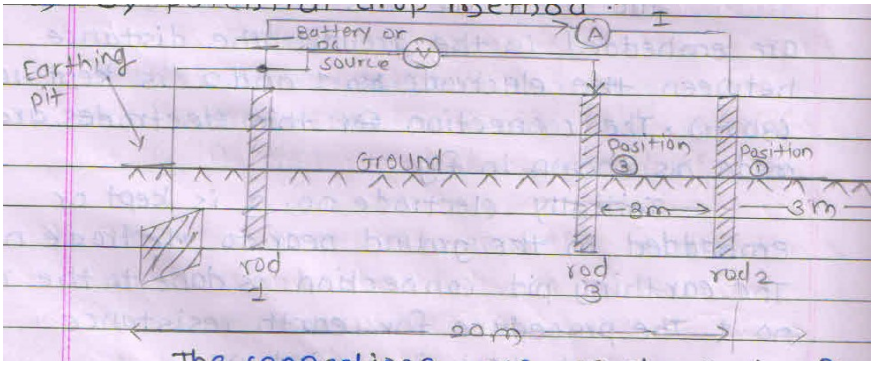
- The earth tester has two coils named current coil and pressure coil.
- The three GI rods or iron rods (electrode) are embedded in the ground. The distance between the electrode no.1 and no.2 is kept 100 ft (30m). The connections for this electrode are made as shown in figure.
- Initially electrode no.3 is kept or embedded in the ground near to electrode no.2.
- The earthing pit connection is done to the rod no.1. The procedure for earth resistance measurement test is as below.
- Make the connection as shown in figure.
- Rotate the handle of earth tester near to 100 to 120 RPM and measure the first reading of earth resistance.
- Remove the rod no.3 and place at the distance of 90 ft from the rod no.1 and embed in the ground. Rotate the handle of earth tester at 100 to 120 RPM and measure the earth

resistance.

- The same procedure is repeated and rod no.3 is kept at 80 ft., 70 ft,70ft,50 ft, 40 ft,30 ft ,2 0 ft, 10 ft and 0 ft, and by rotating handle of earth tester separate readings are taken.
- The graph is plotted between the earth resistance value and the distance between rod no.1 and rod no.3.
- The earth resistance of the earth pit should be which is specified by Indian electricity rule



2) By Potential Drop Method:

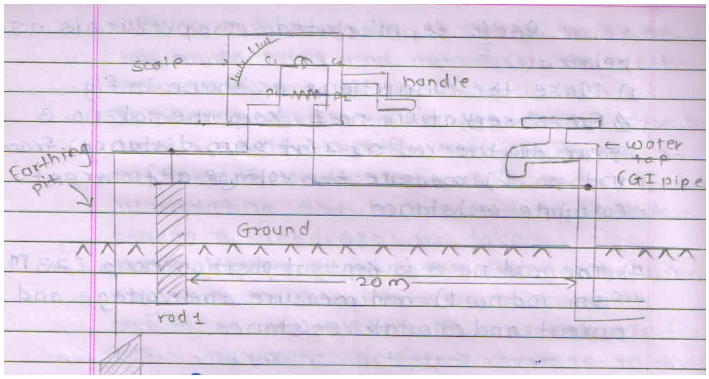


or equivalent figure

- The connection are as shown in figure.
- In potential drop method external DC source battery or handle driven generator is used as DC source.
- The current flowing through the rod no.1 and rod no.2 current electrodes is measured
- AT same time voltage across the rod No.1 and rod No.3 is measured by apply the ohms law. $R = \frac{V}{I}$ is calculated. The procedure is as below
- Make the connections as shown in figure for observation no.1. Keep the rod no.3 near to the rod no.2 (at 20m distance) from rod no.1 measure the voltage and current, calculate resistance.

- The rod no.3 is kept at position no.2 (23 m from rod no.1) and measure the voltage and current and calculate resistance.
- Keep the distance between rod no.1 and rod no.3 (17 m in the ground). Measure the voltage and current calculate the resistance.
- For the 3 observation 3 resistances are calculated the mean resistance of that is declared as earth resistance of that earthing pit.
- Due to external DC source there are chances of electrical shock so that skilled labours can be this test

3) By Water tap Method:



or equivalent figure

Earth resistance measurement test by water tap method is shown in figure.

As per this figure the water tap should be of GI pipe which is embedded in the ground. The rod no.1 is not essential. **The procedure is as below.**

- Make the connections as shown in figure
- The common link of C1-P1 is connected to the earthing pit and common link of C2-P2 is connected to the water tap.
- The distance between the water tap to earthing pit should be near to 20m.
- By rotating handle of earth tester at near about 100 to 120 rpm measure the earth resistance on that earth tester.
- That resistance is declared as earth resistance of that earthing pit. In this test the accuracy is less but electrical rods are not required.

Q.6	Attempt any TWO of the following : 12 Marks
a)	**Explain the criteria to be applied in deciding the earthing system for an electrical installation.**

Ans:

Following criteria (factors) to be applied in deciding the earthing system for an electrical installation: **(Any six point expected: 1 Mark each, Total 6 Marks)**

(1) Temperature of soil:

TABLE 11.4

Effects of Temperature on Soil Resistivity

Temperature		Resistivity (Ω-cm)
°C	°F	
20	68	7,200
10	50	9,900
0	32 (water)	13,800
0	32 (ice)	30,000
–5	23	79,000
–15	14	330,000

(2) Soil Condition:

- Different soil conditions give different soil resistivity. Most of the soils are very poor conductors of electricity when they are completely dry.(Soil resistivity is measured in ohm-meters or ohm-cm.)
- Soil with low resistivity is highly corrosive. If soil is dry then soil resistivity value will be very high.

(3) Moisture:

- Moisture has a great influence on resistivity value of soil. The resistance of soil drops quickly to a more or less steady minimum value of about 20% moisture content in soil.(A dry soil has high resistivity if it contains no soluble salts)

(4) Dissolved salts:

- Resistivity of soil depends on resistivity of water; Small quantity of salts in water reduces soil resistivity by 80%.

(5) Climate Condition:

- Increase or decrease of moisture content determines the increase or decrease of soil resistivity.

- Thus in dry whether resistivity will be very high and in monsoon months the resistivity will be low.

(6) Physical Composition:

- Different soil composition gives different average resistivity. Based on the type of soil, the resistivity of clay soil may be in the range of 4 – 150 ohm-meter, whereas for rocky or gravel soils, the same may be well above 1000 ohm-meter.

(7) Location of Earth Pit:

- The location also contributes to resistivity to a great extent. Therefore, choose a site of earth pit that is naturally not well drained.

(8) Effect of grain size and its distribution:

- Grain size, its distribution and closeness of packing are also contributory factors, since they control the manner in which the moisture is held in the soil.

(9) Area Available:

- Single electrode rod or strip or plate will not achieve the desired resistance alone.
- If a number of electrodes could be installed and interconnected the desired resistance could be achieved.

(10) Obstructions:

- The soil may look good on the surface but there may be obstructions below a few feet like virgin rock. In that event resistivity will be affected. Obstructions like concrete structure near about the pits will affect resistivity.

(11) Depth of electrode embedded in the earth. (*Depth:* As a ground rod is driven deeper into the earth, its resistance is substantially reduced. In general, doubling the rod length reduces the resistance by an additional 40%)

(12) Size and spacing of earth plate and size of conductor. (*Size:* Increasing the diameter of the rod does not materially reduce its resistance. Doubling the diameter of the ground rod reduces resistance by less than 10%)

(13) Metal of earth plate and earth wire.

(14) Quality of Coal / Charcoal used in the earth electrode pit.

(15) Leakage Current Magnitude:

- A current of significant magnitude and duration will cause significant drying condition in

soil and thus increase the soil resistivity.

16) The resistance of the grounding is made up of the following components:

- Resistance of the electrode itself and that of the connection to it
- Contact resistance of the surrounding earth to the electrode
- Resistance of the earth immediately surrounding the grounding electrode or resistivity of earth, which is often the most significant factor

17) Cost of the earthing pit

b) State two insulators of following types along with their areas of application: (i) Class A (ii) Class E (iii) Class H

Ans: Temperature class and withstand temperature ranges for them:

(Each type of insulation & their application: 2 Mark each , Total : 6 Marks)

S.No	Insulation Classes	Maximum permissible temperature (^{0}C)	Materials	Areas of application
1	Class- A	105^0	cotton, silk, or paper, press board, vulcanized fiber, wood, with impregnated varnish or insulation oil	winding of transformer, motors etc
2	Class- E	120^0	Superior wire enamels based on polyvinyl ferrul or epoxy resins, moudling with cellulose fibers, cotton fabric and paper laminates.	enameled coating for wires, spacers
3	Class- H	180^0	Combination of materials such as mica, glass, fiber, asbestos, with suitable high resistive bonding material like silicon	Heating devices such as oven. Iron, geyser etc

c) Compare the casing / capping system of electrical wiring to concealed system of electrical wiring. On the basis of look, cost, life, safety retentivity of material and suitability for locations.

Ans:

Compare casing capping wiring with concealed wiring:

(Each point 1 Mark : Total 6 Marks)

S.No	Point	Casing Capping	Concealed wiring
1	Look (Appearance)	Better	Best
2	Cost	High	Very High
3	Life	High	Very High
4	Safety	Medium	High
5	Retentivity of material	better	good
6	Suitability for location	for any location it is suitable	Suitable for only designed trenches in walls and ceiling.

---------- END----------