Important Instruction 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.

NOTE: This is a practical oriented subject depends upon assumptions answer may vary. So do not stickups with model answers give marks for correct steps and equivalent diagrams?

Q.1. A) Attempt any Six of the following **12 Marks**

i) List types of electrical installation **(2 Marks for any two types)**

Types of Electrical Installation:

i) Internal Electrical Installation : (Indoor Installation)

ii) External Electrical Installation: (Outdoor Installation)

As per application their three types

a) Residential Electrical Installation

b) Commercial Electrical Installation

c) Industrial Electrical Installation

ii) Define service connection **(2 Mark)**

Service Connection:-

It is the input conductor or wire which is carried out from supply company (authorities) pole to consumers' main board or premises.

iii) List types of internal wiring. **(1/2 marks for any four types)**

Types of Internal wiring –

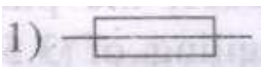
1) Cleat wiring
2) Batten wiring
3) Wooden casing capping wiring
4) PVC conduit wiring
5) PVC casing capping wiring
6) Concealed wiring

iv) List out four examples of commercial unit. **(1/2 marks for any four types)**

Examples of commercial unit:

1) Hospital
2) Schools
3) Colleges
4) Banks
5) Shopping malls
6) Large temples
7) Auditorium
8) Cinema theaters
9) Showrooms etc.

v) State the meaning of following IS symbols: **(1 Mark for each)**

1)  **: Fuse**

2)  **: 5A Socket**

vi) State the principle of circuit design in lighting circuit. **(2 Marks)**

The lighting sub circuit may be designed by the following rule:

Lighting Circuit (load):-

- Each sub circuit should not have more than a total 10 points (including lights, fans and 5A socket outlet)
- Each sub circuit should not exceed 800 watts.

vii) Define the term tender. **(2 Marks)**

Tender:-

Tender is offer or invitation of the work between any two parties. This offer may be written or non written. This offer is given by party no.1 (owner) to party no.2 (contractor- who have to complete the project work).

viii) State the permissible limit for earth resistance and insulation resistance between conductors.

Permissible limit: **(Each limit 1 Mark)**

1) **Earth Resistance :** should be very low for domestic installation it should be equal to or less than 5 ohm to 8 ohm
2) **Insulation Resistance between conductor :** should be very high for domestic installation it should be equal to or more than 1 mega ohm or

it should be not be less than $\frac{50\ M\Omega}{Number\ of\ outlet}$

Q.1. B) Attempt any Two of the following **08 Marks**

i) **State the importance of electrical drawing.**

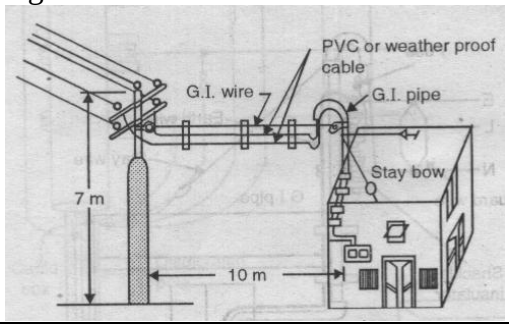
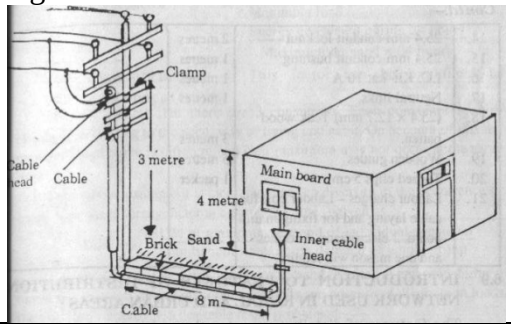
Importance of electrical drawing- **(Any four point expected 1 Mark each)**

By the electrical drawing following advantages in electrical installation are obtained.

1) Simplicity of installation increases.
2) Uniqueness also increases.
3) Better understanding at the time of installation, repairing and maintenance of the work is possible.
4) Time required for installation will be less.
5) Space required will be also less if the drawings are correct.

ii) **Compare overhead and underground service connection on any four points.**

(Any four points expected 1 Mark each)

S.No	Overhead service connection	Underground service connection
1	It is economical.	Cost is more
2	It is open to sky so repairing and Maintenance is more	Repairing and maintenance is less
3	Appearance is poor.	Appearance is good
4	Normally it is preferred for consumers.	Normally it is preferred for Residential commercial And Industrial consumers
5	PVC or weather proof cable or conductors are preferred	Armored cables are preferred
6	Less safety	More safety
7	Fig: 	Fig: 

iii) **State the IE rules related to residential installation.**

(Note: Similar to following rules any four expected 1 Mark each point)

1) All electrics supply lines and apparatus shall be of sufficient in mechanical strength and size for the work they may be required to do and shall be conducted, install and protected in accordance with I.S.I,s specifications.
2) The electrical wire or conductor which is used for residential installation should not be over heated at its rated load.
3) The permissible voltage drop in the wire should be proper (+ or – 5%)
4) The every metal point of the electrical device must be earthed.
5) The earth resistance should be maintained it should be very low or in between 5 to 8 ohm.
6) The switch board should be installed at the height of 1.2 meter to 1.3m from ground surface.
7) The main board should be installed at the height of 1.5m to 1.75 m from the ground surface.

OR (Expected any four points)

1. Every installation is to be properly protected near the point of entry of supply cables by a two-pole linked main switch and a fuse unit. In a two wire installation if one pole is permanently earthed, no fuse, switch or circuit breaker is to be inserted in this pole. A 3-pole switch and fuse unit is to be used in 3-ph supply.
2. The conductors used are to be such a size that it may carry load current safely.
3. The conductors installed are to be safe in all respects.
4. Every sub-circuit is to be connected to a distribution fuse board.
5. Every line (phase or positive) is to protected by a fuse of suitable rating as per requirements.
6. A switch board is to be installed so that its bottom lies 1.25 meters above the floor.
7. A plugs and socket-outlets are to be of 3-pin type, the appropriate pin of socket being connected permanently to the earthing system.
8. All incandescent lamps, unless otherwise required, are to be hung at a height of 2.5 meters above the floor level. And ceiling fans are to be hung 2.75 meters above the floor.

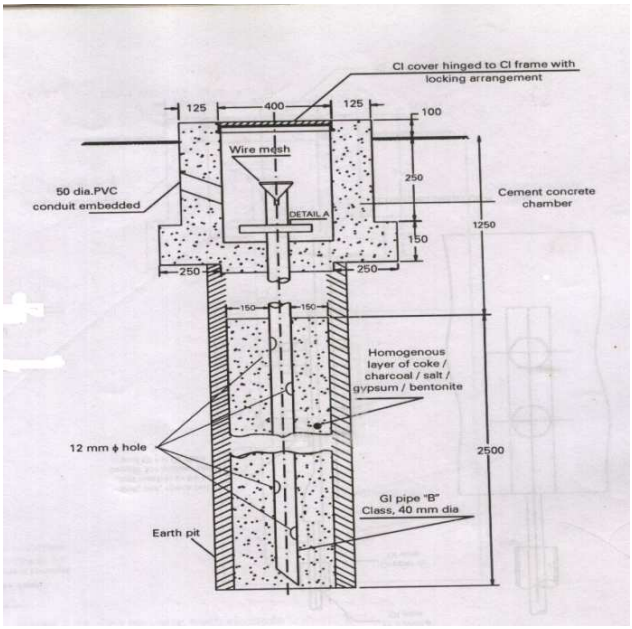
9. Lights and fans may be wired on a common circuit. Each sub-circuit is not to have more than a total of ten points of lights, fans and socket-outlets. The load on each sub-circuit is to be restricted to 800 watts. If a separate circuit is installed for fans only.
10. No fuse and switch is to be provided in earthed conductor.
11. Every circuit or apparatus is to be provided with a separate means of isolation such as a switch.
12. All circuit or apparatus requiring attention are to be provided with means of access to it.
13. In any building, light and fan wiring and power wiring are to be kept separate.
14. In 3-Phase, 4-wire installation the load is to be distributed equally on all phases.
15. No additional load is to be connected to an existing installation unless it has been ascertained that the installation can safely carry the additional load and that the earthing arrangements are adequate.
16. Lamp holders used in bath rooms are to be constructed or shrouded in insulating materials and fitted with protective shield and earth continuity conductor is not to be size less than 7/0.915 mm.
17. The metal sheaths or conduits for all wiring and metal coverings of all consuming apparatus or applications is to be properly earthed in order to avoid danger from electrical shock due to leakage or failure of insulation.
18. Each sub-circuit is to be protected against excessive current (that may occur either due to over load or due to failure of insulation) by fuse or automatic circuit breaker.
19. All light conductors are to be insulated or otherwise safe guarded to avoid danger.

    After completion of work the installations are to be tested (the test are to be carried out as described) before energisation.
20. Earth Resistance : should be very low for domestic installation it should be equal to or less than 5 ohm to 8 ohm
21. Insulation Resistance between conductor : should be very high for domestic installation it should be equal to or more than 1 mega ohm or it should be not be less than

$$= \frac{50\ M\Omega}{Number\ of\ outlet}$$

Q.2 Attempt any Four of the following **16 Marks**

a) Draw a neat labelled sketch of pipe earthing. **(4 Marks)**



OR

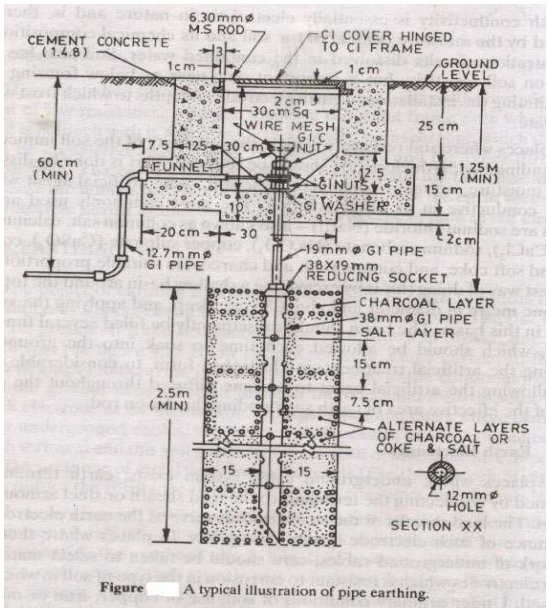


Figure A typical illustration of pipe earthing.

Or equivalent ckt dia.

b) Compare residential and commercial electrical installation on any four points.

(Any four points expected 1 Mark each)

S.No	Basis	Residential installation	Commercial installation
1	Load capacity	Less	High
2	Input Supply	Generally single phase	Generally 3 phase
3	Purpose	Domestic purpose	Commercial purpose
4	Type of Load	Lighting load is more, power load is less.	Power load is more, lighting load is less.
5	Distribution	Bus bar chamber is not required	Bus bar chamber is required
6	Safety precautions	It is not public place so as per our convenience fuse MCB can be used.	It is public place so fuse MCB, MCCB should be compulsory used.
7	Sub-circuit	The lighting sub-circuit and power sub-circuit are separated	The lighting sub-circuit and power sub-circuit are separated

8	Power factor improvement	There is no need of power factor improvement device	If the power factor is poor then there is need of power factor improving device
9	Caution	There is no need of caution notice for residential installation	If supply voltage is equal to or more then 400V then there is need of caution notice

c) State the factors governing number of lighting sub circuit and power sub circuits in commercial installation. **(Lighting sub Ckt-2 Marks & Power Sub Ckt-2 Marks)**

Lighting Sub-Circuit (load):-

- Each sub circuit should not have more than a total 10 points (including lights, fans and 5A socket outlet)
- Each sub circuit should not exceed 800 watts.

Power Sub-Circuit (load):-

- For power load there should be maximum 3000W for 2 to 3 points.
- For power load there should be maximum 1000W for total 1 to 2 points. (old rule)

d) State any four rules for motor wiring.

Following rules for Motor Wiring:- **(Any four points expected 1 Mark each)**

i) Each motor should be provided with separate cable for distribution board or main board.
ii) Each motor should be individually controlled
iii) Rating of fuse, ICTP or ITDP, & starter should be based on starting current which is assumed two times rated input current.
iv) The motor should be earthed at two distinct terminals by 8 SWG copper wires.
iv) The voltage drop in the cable should be with the tolerance limit + or – 5 %
v) All protective measures should be installed for each motor.
vi) Control unit should be near to motor as far as possible.
vii) Suitable KVAr rating of capacitor should be installed near to motor.

e) State various tests of wiring installation and explain any one in detail.

(Types of tests 2-Mark for any two point & Explanation-2 Marks)

i) Insulation resistance test between conductors.

ii) Insulation resistance test between conductor and earth.

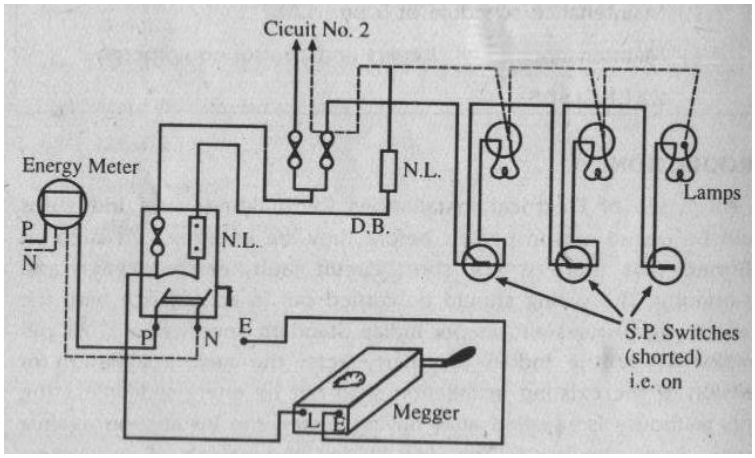
iii) Earth resistance test

iv) Short circuit test

v) Polarity test

vi) Earth continuity test

1) Installation resistance test:



Or equivalent ckt dia.

Installation resistance test procedure is as follows,-

1) First make off the main switch.
2) Short the both outgoing terminals of main switch phase and neutral by external link.
3) Insert all loads and lamps in their sockets and holders.
4) Make 'ON' all the switches in the installation.
5) Make the connection of Megger as follows,-

   L – Line terminal is connected to outgoing shorted link of main switch.

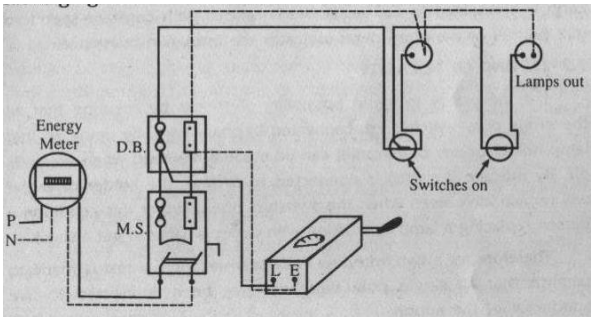
   E – Earth terminal of Megger is connected of metal body of main switch which is connected to earth.
6) Rotate the handle of Megger at near about 100 to 120 rpm measure the insulation resistance.

Conclusion:-

If the measured insulation resistance is more than 1 M Ω or insulation resistance is equal to or more than 50 M Ω ⁄ no. of outlets then wiring quality is good. If it is less than that value then wiring quality is poor.

OR

2) Procedure verification of current and circuit continuity Figure:-



Or equivalent ckt dia.

Installation continuity test procedure is as follows:-

1) First make off the main switch.
2) Insert all loads and lamps in their sockets and holders.
3) Make 'ON' one by one switch in the installation.
4) Make the connection of Megger as follows,-
   L – Line terminal is connected to outgoing phase terminal of main switch.
   E – Earth terminal of Megger is connected to neutral terminal of main switch .
5) Rotate the handle of Megger at near about 100 to 120 rpm measure the insulation resistance.

Conclusion: -

If the measured resistance is zero Ω then there is circuit continuity if this resistance indicates more than zero ohms then there may be loose connection or open.

Verification of current in the installation:-

It is a ON-line test after switched ON the main switch one by one circuit switch is operated and if the lamp glows then circuit is OK and current is verified

f) What are the factors to be considered while deciding the distribution board and main switch for electrical motor in industrial installation?

(1 Mark each point or similar point)

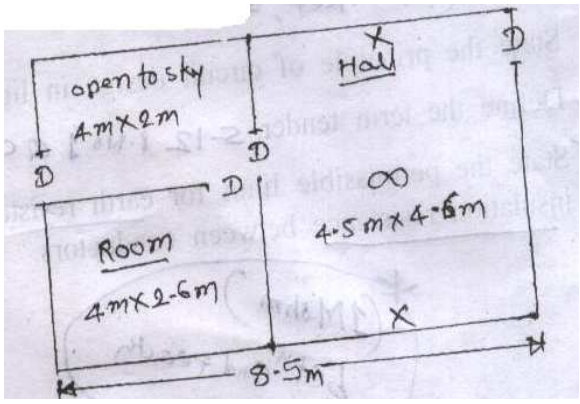
The factors to be considered while deciding the distribution board and main switch for electrical motor in industrial installation are as below:

1. The voltage rating and current is decided by the number of circuit to be connected.
2. The current rating of the main switch is decided by the its rated current and its starting current which is assumed two times at its rated current for starting surge, momentary short circuit, over load and future expansions.
3. The size of the main switch also depends upon the current rating and type of motor and its number of phases.
4. For deciding the distribution board and main switch the regular selection factor for eg. Life, economy, maintenance etc are also to be considered..

Q.3 Attempt any Two of the following **16 Marks**

a) Estimate of material and their complete cost required for casing capping wiring system used in a house, the plan of which is shown in fig. Assume height of ceiling of 3.5m and one plug point is to be provided in each room

Note: 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.



1) Total Lighting load = 02 plug point x 100 = 200 W

02 light point x 40 = 80 W

01 fan point x 60 = 60 W

Total load = 340 watt for 5 Points---------- (1 Mark)

Total load = 340 watt

$$I_L = \frac{P}{V_L Cos\phi} \qquad Assumention\ Cos\phi = 1$$

$$I_L = \frac{340}{230 \times 1}$$

$$I_L = 1.478\ Amp$$

No. of lights sub circuit $= \frac{340}{800} = 0.425 \cong 1\ Nos$ ---------- **(1Mark)**

No. of lighting sub circuit as per point $= \frac{5}{10} = 0.5 \cong 1\ Nos$

Sub circuit is suitable for lighting = 1

Procedure for determination of length of wire ---------- (2 Marks)

Schedule of material: - ---------- (4 Mark)

S.No	Material of Material	Quantity	Rate	Total Amount
1	ICDP 250V,5 A	01	250.00	250.00
2	Fuses 250V, 5A	02	45.00	90.00
3	Casing Capping (2meter)	10 Nos	22.00	220.00
4	Copper Earthing Plate	01	490.00	490.00
5	Earth Wire pvc 1.5 sq. mm	10 Mtr app.	07.00	70.00
6	PVC wires for wiring 1msq.m	30 Mtr	05.00/m	150.00
7	DP	01	80.00	80.00
8	Earthing Sundry	Lum sump	200.00	200.00
9	6A S.P.S.T.	05	10.00	50.00
10	6A Three point socket	02	12.00	24.00
11	Ceiling rose	01	08.00	8.00
12	Lamp holder	02	12.00	24.00
13	**Labour Charges**	**05**	**70.00**	**350.00**
		Total Amount :-		**2006.00**
13	Contingencies+ profit margin	10% Amount:-		206.00
		Total Amount:-		**2212.00**

b) State the sequence, to be followed to prepare estimate for a residential installation.

Sequence to be followed for estimation of Residential Installation:-

(Minimum eight point expected 1 each point)

1) Find out the type of load and total electrical load for the given residential installation.
2) Differentiate this total electrical load in lighting load and power load.
3) Make the no. of lighting sub circuit for lighting load.

$$\text{No. of lighting sub circuit} = \frac{\text{Total electrical lighting load}}{800 \text{ w}}$$

Or

$$\text{No. of lighting sub circuits} = \frac{\text{Total no. of lighting point}}{10}$$

4) Make the no. of power sub circuits for power load.

$$\text{No. of lighting sub circuits} = \frac{\text{Total electrical power load}}{1000 \text{ w or } 2000\text{w}}$$

Or

$$\text{No. of power sub circuits} = \frac{\text{Total no. of power points}}{1000\text{w or } 2000 \text{ w}}$$

5) Find out total power consumption of every lighting and power sub circuits.
6) Find out rated Input current for every lighting and power sub circuit.

$P = V1 \cos \phi$ P = Input power for every sub circuit

V = voltage = 230 V

I = Input current for every sub circuit

7) Determine the size of wire required for every sub circuit by considering overload starting surge and future expansion.
8) Draw the single line diagram.
9) Mark the batten on plan layout.
10) Find out the total length batten required for every sub circuit and whole residential installation.

11) Find out the total length and size of wire required for every sub circuit.

12) List out the material required for whole residential installation.

13) Find out cost of material and labour in estimation chart.

14) Find out the total cost of estimation with profit margin and contingencies charges.

15) Find out per point charges.

16) Draw the circuit diagram.

c) A hall whose dimensions are 18m x 12m is to be fitted with an electrical installation of following load i) Fluorescent lamps-14 No's, ii) ceiling fan-08 Nos. iii) Plug points -04 Nos.

1) Draw a layout and show the position of lamps, fans etc. Calculate the rating of equipments.

2) Prepare a schedule of material 3) Find out cost of work

Note: 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.

Given Data: (The Assumed data may be vary) (Give stepwise Marks as mention below)

$$Total\ load\ in\ \ Hall = tubes \times watt\ = 14 \times 40 = 560\,W$$

$$= Fans \times watt\ = 08 \times 60 = 480\,W$$

$$= Sockets \times watt = 04 \times 100 = 400W$$

$$Total\ load\ in\ \ Hall = tubes\ in Watt + Fans\ in\ Watt + Socket\ in\ watt$$

$$Total\ load\ in\ \ Hall = 560 + 480 + 400 = 1440\ watt$$ ---------- **(1 Mark)**

$$Total\ load\ in\ \ Amps = \frac{1440}{230} = 6.26 \cong 7\ Amp \quad assu\min g\ \ p.f. = 1$$

Rating main switch: - since more current is 7 A.

Assumed that Staring current = 1.5 times rated current

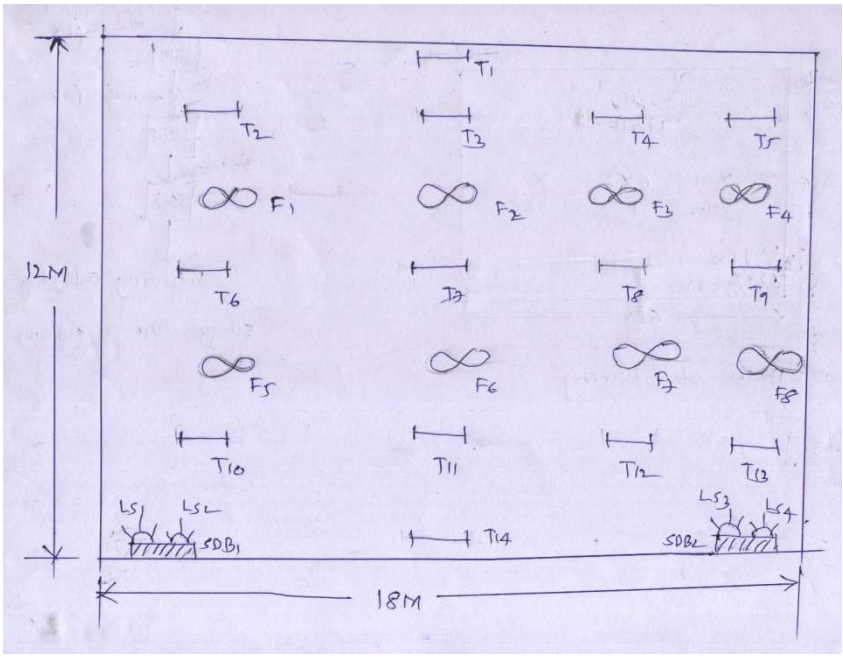
So starting current = 1.5x 7 = 10.5 A

So Use:-

240V, 16A, ISI mark Main switch of any company

$$No.\ of\ lighting\ sub\ circuit = \frac{1440}{800} = 1.80 \cong 2$$ ---------- **(1 Mark)**

Layout Drawing:- --------- **(2-Marks)**



or equivalent figure

Note:- Cost of material may vary so do not stick on final figures

ii) Schedule & cost of Material: - **(4-Marks)**

S.No	Material of Material	Quantity	Rate	Total Amount
1	ICDP 250V,16A	01	250.00	250.00
2	Fuses 250V, 16A	02	45.00	90.00
3	PVC conduit (3 Mtr pipe) 1.5mm thickness	20 pipe	15.00	300.00
4	Copper Earthing Plate	01	490.00	490.00
6	DP	01	150.00	150.00
7	Earthing Sundry	lumsump	200.00	200.00
8	6A S.P.S.T.	26	10.00	260.00
9	6A Three point socket	04	12.00	48.00
10	Ceiling rose	22	10.00	220.00
11	1.5 Sqmm PVC wire Runing earth	60 Mtr	7.00	420.00
11	1 Sqmm PVC wire (90 Mtr -1 bundle)	02 Bundle	550.00	1100.00

12	**Labour Charges**	**26**	**70.00**	**1820.00**
		Total Amount :-		**5348.00**
13	Contingencies+ profit margin	10% Amount:-		540.00
		Total Amount:-		**5888.00**
	iii) Cost of work:	Say Total Amount:		**6000.00**

Q.4. A) Attempt any Four of the following **16 Marks**

a) What is DP-MCB, state its advantages. (Meaning-2 Marks & Advanatges-2 Marks)

DP-MCB: - It is a Double pole miniature circuit breaker

Function: The function of DP- MCB is to isolate the circuit against over current due to over load or short circuit.

Advantages of DP-MCB: - (Any two points expected)

1. It operate the automatically whenever there is the fault.
2. High reliability.
3. Compact in size.
4. Long life.
5. Economical.

b) Explain the factors which decide selection of conductor size.

Following factors decided selection of conductor size: (Any four point expected 1 Mark each)

1. Its rated load current according to connected load.
2. The starting current which is assumed it may be 1.5 to 2 times rated input current for starting surge, momentary short circuit, overload and future expansion.
3. Cross section of conductor is also depends upon Permissible voltage drops in the conductor. (+ or – 5%),
4. Conductor should not over heated at its regular rated load.
5. The cross section of the conductor also depends upon the type material used for conductor for eg. Aluminum or copper.

c) State the procedure to prepare a design for commercial electrical installation

(Minimum eight point expected 1/2 each point)

The procedure to prepare design for commercial electrical installation -

1) Find out the type of load and total electrical load for the given commercial installation.
2) Differentiate this total electrical load in lighting load and power load.
3) Make the no. of lighting sub circuit for lighting load.

$$\text{No. of lighting sub circuit} = \frac{\text{Total electrical lighting load}}{800 \text{ w}}$$

Or

$$\text{No. of lighting sub circuits} = \frac{\text{Total no. of lighting point}}{10}$$

4) Make the no. of power sub circuits for power load.

$$\text{No. of lighting sub circuits} = \frac{\text{Total electrical power load}}{1000 \text{ w or } 2000\text{w}}$$

Or

$$\text{No. of power sub circuits} = \frac{\text{Total no. of power points}}{1000\text{w or } 2000 \text{ w}}$$

5) Find out total power consumption of every lighting and power sub circuits.
6) Find out rated Input current for every lighting and power sub circuit.

$P = V1 \cos\phi$ P = Input power for every sub circuit

V = voltage = 230 V

I = Input current for every sub circuit

7) Determine the size of wire required for every sub circuit by considering overload starting surge and future expansion.
8) Draw the single line diagram.
9) Mark the batten on plan layout.
10) Find out the total length batten required for every sub circuit and whole commercial installation.

11) Find out the total length and size of wire required for every sub circuit.

12) List out the material required for whole commercial installation.

13) Find out cost of material and labour in estimation chart.

14) Find out the total cost of estimation with profit margin and contingencies charges.

15) Find out per point charges.

16) Draw the circuit diagram.

d) State the sequence to be followed to prepare estimate for a factory installation.

(Minimum four point expected 1 each point)

Sequence to be followed for estimation of factory unit:-

1) Find out output power of every machine in watts.
   1) 1 HP = 735.5 w
   2) 1 BHP = 746 w
   3) 1 KVA = 1000 VA. Assume P.f.
2) Find out Input power of every machine by assuming the efficiency of every machine.

$$\text{Input power of machine} = \frac{\text{output power of machine}}{\text{Efficiency of machine}}$$

3) Find out Input current of every machine for 1-ph machine.

$$\text{Input power} = V I \cos\phi$$

V = Input voltage = 230V

$\cos\phi$ = P.f.

I = Input current

If the machine is 3-ph

$$\text{Input power} = \sqrt{3}\ V_L I_L \cos\phi$$

V_L = Line voltage = 400V

I_L = Line current or Input current

$\cos\phi$ = P.f.

4) Find out size and core of cable required for every machine size of cable is decided by starting current. Which is assumed two times Input current to sustend starting surge, overload momentary short circuit and future expansion.
5) Find out total Electrical load of given factory.

6) Determine the Input current required for whole factory.

$P = \sqrt{3}\ V_L\ I_L \cos \emptyset$

7) Determine the size & core of Input cable required for whole factory. To decide the size of current is assumed two times rated Input current for future expansion, overload starting surge and momentary short circuit.

8) List out the material required for factory electrification.

9) Make the estimation chart for material and labour also.

10) Find out total cost of estimation by assuming contingencies changes and profit margin.

e) Predict the types of starters required for following motors. (1 Mark Each)

i) I.M of fractional KW rating : No starter is required (in some of the applications DOL starter is used

ii) I.M of medium rating (up to 15KW) : Star-Delta Starter or Auto transformer starter

iii) I.M with high rating: Star-Delta Starter or Auto transformer starter and soft start starter

iv) Slip-ring I.M of high rating: Rotor Resistance starter

f) Discuss any four types of contracts. (Any four types expected 1-Mark each with their explanation)

Different types of contract:-

1) Lump sum contract
2) Item rate contract
3) Cost + % rate contract
4) Target rate contract
5) Material supply contract
6) Labour contract
7) Sub contract
8) All in one contract
9) D.G.S. of 'D' rate contract
10) Cost plus(+) percentage variable rate contract
11) Cost plus(+) fluctuating fees rate contract

Q.5 Attempt any Two of the following **16 Marks**

a) In a workshop one 15 metric HP, 400 volt, 50Hz, 3-ph motor is to be installed, prepare the estimate required for PVC surface conduit wiring. The plan of the workshop is shown in fig.

Note: 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.

Assuming height of Ceiling if 3 m from the floor.

Motor is installed 1 M away from the nearest wall.

Height of Main Switch is 1.2 M from the floor

Step No. 1:- The out power of induction motor = 15 x 735.5 = 11032.5 W---------- **(1 Mark)**

Step No. 2:- Input power of I. M = output power of I M / efficiency of IM motor. ------ **(1 Mark)**

Assuming efficiency of I.M is 80 %

Input power of induction motor = 11032.5 / 0.8 = 13790.625 W

Step No. 3:- To determine the rated current for I.M ---------- **(1/2 Mark)**

$$P = \sqrt{3}\, V_L\, I_L Cos\phi \qquad V_L = 400\, V$$

$$I_L = \frac{P}{\sqrt{3}\, V_L Cos\phi}$$

$$I_L = \frac{13790.625}{\sqrt{3}\times 400\times 0.8} \qquad Cos\phi = 0.8\ assumption$$

$$I_L = 24.89\ Amp \qquad Rated\ current = 24.89\ Amps$$

Step No. 4:- To determine the size & core of cable:- ---------- **(1/2 Mark)**

Starting current is assumed two times rated input current for starting surge, momentary short circuit & overload. Starting current = 2 x 24.89 = 49.78 Amps

So use,

16 Sqmm 4 core cable for the I.M.

Step No. 5:- Determined the size length & dimensions of ICTP earth wire at input cable:-

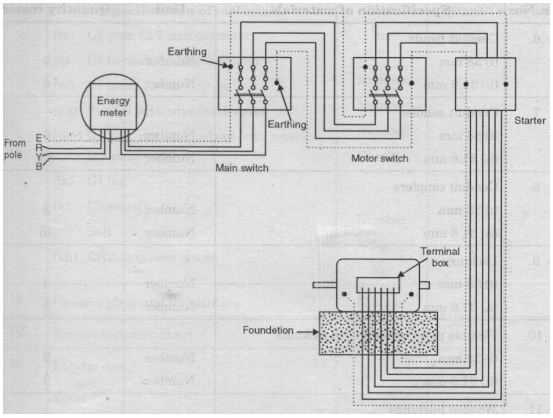
The rating of main switch is 450 V, 32 Amp ICTP ISI mark

Size of earth wire 8 SWG copper or 6 SWG GI

Length of earth wire = 2 times length of cable

Length of input cable for I .M at actual

Step No.6: Draw the circuit Diagram. ---------- **(1 Mark)**



or equivalent figure

Step No. 7:- Find out the estimation chart with material cost & labour cost: ---------- **(4 Mark)**

Length of cable - it should be calculated as per their assumed distances

Common Material: (Any eight points expected)

1. 4 core Armored cable: (Size of cable is depends on load. & length of cable is depends on service connection premises)
2. Brick, soft sand for protection of cable.
3. If cable is laid across the public road then Cement pipe, DWC pipe or GI pipe is required for better protection of cable
4. Cable lug as required size.
5. Cable Gland as required size
6. Feeder piller or cable box or bus bar and cable end box.
7. GI pipe as required size.
8. Cable bushing.
9. 8 SWG Wire
10. Clamps, saddles etc
11. As such all service connection material like main switch, MCB, Energy meter, Neutral link, IC cut out, earthing nut, screws, and wooden board. etc
12. 16 mm^2, 4 core cable having the length of 15 meter and 6 core 2 Mtr for starter.
13. RYB mains indication lamps.

14. 1m x 1m wooden board as main board.
15. Earthing plate 60cm x 60 cm x 3.18 mm – 1 Nos.
16. Earthing sundry char coal and salt.
17. 15 HP Star-delta starters.
18. 8 SWG copper or 6 SWG GI earthing wire, having the length of 40 Mtr.

b) Calculate the rating of cable, switches, conduit and prepare an estimate for a proposed workshop of 12m x10m equipped with 3 machines:

(The Assumed data may be vary) **(Give stepwise Marks as mention below)**

Note: 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.

i) 3-Ph, 400V, 5HP, P.f. of motor 0.8 & η = 0.85:

$$Total\ power = Total\ H.P \times 735.5$$

$$For\ Machine\ No.1\ Rated\ input\ current\ I_L = \frac{HP \times 735.5}{\sqrt{3}\, V_L \times \eta \times Cos\phi}$$

$$Rated\ input\ current\ I_L = \frac{5 \times 735.5}{\sqrt{3} \times 400 \times 0.8 \times 0.85}$$

Current in Motor No. 1:- = 7.806 Amp ---------- **(1 Marks)**

It is assumed that starting current is two times rated input current.

Starting current = 2 x 7.806 = 15.612 Amp

So use, 4 Sqmm , 31/2 core cable Aluminum 1/ 2.80 mm , 600V grade should be selected

rating of SFU, ICTP switch is 16A, 450V grade should be selected.

ii) 3-Ph, 400V, 3HP, P.f. of motor 0.8 & η = 0.8:

$$Total\ power = Total\ H.P \times 735.5$$

$$For\ Machine\ No.2: Rated\ input\ current\ I_L = \frac{HP \times 735.5}{\sqrt{3}\, V_L \times \eta \times Cos\phi}$$

$$Rated\ input\ current\ I_L = \frac{3\times 735.5}{\sqrt{3}\times 400\times 0.8\times 0.8}$$

Current in Motor No. 2:- = 4.976 Amp ---------- **(1 Marks)**

It is assumed that starting current is two times rated input current.

Starting current = 2 x 4.976 = 9.952 Amp

So use, 2.5 Sqmm , 3 ½ core cable Aluminum 1/ 2.80 mm , 600V grade should be selected rating of SFU, ICTP switch is 16A, 450V grade should be selected.

iii) 1-Ph, 230V, 0.75 HP, P.f. of motor 0.7 & η = 0.75 :

$$Total\ power = Total\ H.P \times 735.5$$

$$For\ Machine\ No.3: Rated\ input\ current\ I_L = \frac{HP\times 735.5}{V_L\times \eta\times Cos\phi}$$

$$Rated\ input\ current\ I_L = \frac{0.75\times 735.5}{230\times 0.75\times 0.7}$$

Current in Motor No. 3:- = 4.568 Amp ---------- **(1 Marks)**

It is assumed that starting current is two times rated input current.

Starting current = 2 x 4.568 = 9.136 Amp

So use, 1.5 Sqmm , 2 core cable Aluminum 1/ 2.80 mm , 600V grade should be selected rating of SFU, ICTP switch is 16A, 450V grade should be selected.

Rating of main switch for all motors:-

Rating of main switch for all motors = staring current of highest rated m/c + Full load current of all remaining machines

Rating of main switch for all motors = Staring current of 5 H.P + Full load current of 3 H.P & 0.75 H.P

= 15.612 + 4.976+4.568

Rating of main switch for all motors = **25.156 Amp**---------- **(1 Marks)**

Main switch for all Motors is selected 32A, 500V, ICTP used

Common Material: (Any eight points expected) **(4 Marks)**

1. 4 core Armored cable: (Size of cable is depends on load. & length of cable is depends on service connection premises)
2. Brick, soft sand for protection of cable.
3. If cable is laid across the public road then Cement pipe, DWC pipe or GI pipe is required for better protection of cable
4. Cable lug as required size.
5. Cable Gland as required size
6. Feeder piller or cable box or bus bar and cable end box.
7. GI pipe as required size.
8. Cable bushing.
9. 8 SWG Wire
10. Clamps, saddles etc
11. As such all service connection material like main switch, MCB, Energy meter, Neutral link, IC cut out, earthing nut, screws, and wooden board. etc
12. 4 or 6 mm^2, 4 core cable having the suitable length as per their assumption.
13. 2.5 mm^2, 4 core cable having the suitable length as per their assumption.
14. 1.5 mm^2, 2 core cable having the suitable length as per their assumption.
15. RYB mains indication lamps
16. 1m x 1m wooden board as main board.
17. Earthing plate 60cm x 60 cm x 3.18 mm – 1 Nos.
18. Earthing sundry char coal and salt.
19. 5HP DOL Starter, 3HP DOL Starter, 0.75 HP DOL Starter
20. 8 SWG copper or 6 SWG GI earthing wire, having the suitable length of their assumption.

c) i) What is meant by effective earthing? How the effectiveness of earthing is checked?

(Meaning of effective earthing-2 Mark & Earthing checked-2 Mark)

Effective Earthing:

The effective earthing is the proper earthing of which earth resistance is properly maintained. It is as below:

a) Major generating station below point 0.5 ohm

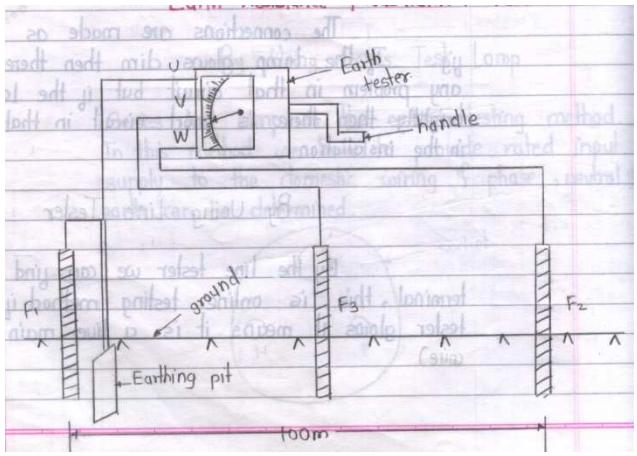
b) Minor generating station below 0.5 to 1 ohm

c) Major substations below 1 ohm to 1.5 ohm

d) Minor substation below 1.5 ohm to 2 ohm

e) For the installation below 5 to 8 ohm

The effectiveness of earthing is checked by: Earth resistance measurement test



Or equivalent ckt dia.

Earth resistance for domestic installation should be in between 5 to 8 ohm. This earth resistance is measure by: i) potential drop method and ii) Earth tester method

Earth resistance measurement by earth tester method:

It is as shown in figure. The F_1 and F_2 is fixed distance earthing rod & F_3 is a variable distance earth rod. The three terminals of the earth tester are connected to the earthing rod as shown in figure. Initially the F_3 rod is kept 100 meter away from the earthing pit by rotating the handle of earth tester near about 100 to 120 rpm the reading is taken the same procedure is repeated by varying the distance between F1 & F2 from 90m to 0m (gradually reduction) & number of reading are taken.

The distance between F1 & F3 & earth resistance measured, the graph is plotted it may be as shown in figure. The maximum uniform readings are declared as earth resistance of that earthing pit.

ii) State the criteria for selecting a contractor. (Any four points expected 1 Mark each)

i) Previous experience
ii) Financial position
iii) Machinery & man power
iv) Quoted Rates
v) Works in hand
vi) Reputation
vii) Valid Licenses
ix)Valid tax clearance certificate

Q.6 Attempt any Four of the following **16 Marks**

a) Prepare a schedule of material for underground service connection.

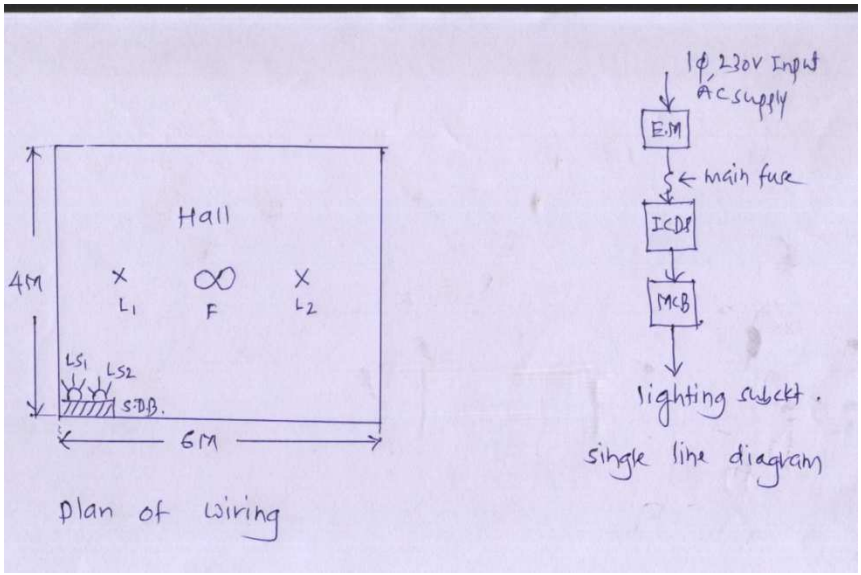
(Minimum eight point expected 1/2 each point)

Scheduled of material for underground service connection is as follows:

21. 4 core Armored cable: (Size of cable is depends on load. & length of cable is depends on service connection premises)
22. Brick, soft sand for protection of cable.
23. If cable is laid across the public road then Cement pipe, DWC pipe or GI pipe is required for better protection of cable
24. Cable lug as required size.
25. Cable Gland as required size
26. Feeder piller or cable box or bus bar and cable end box.
27. GI pipe as required size.
28. Cable bushing.
29. 8 SWG Wire
30. Clamps, saddles etc

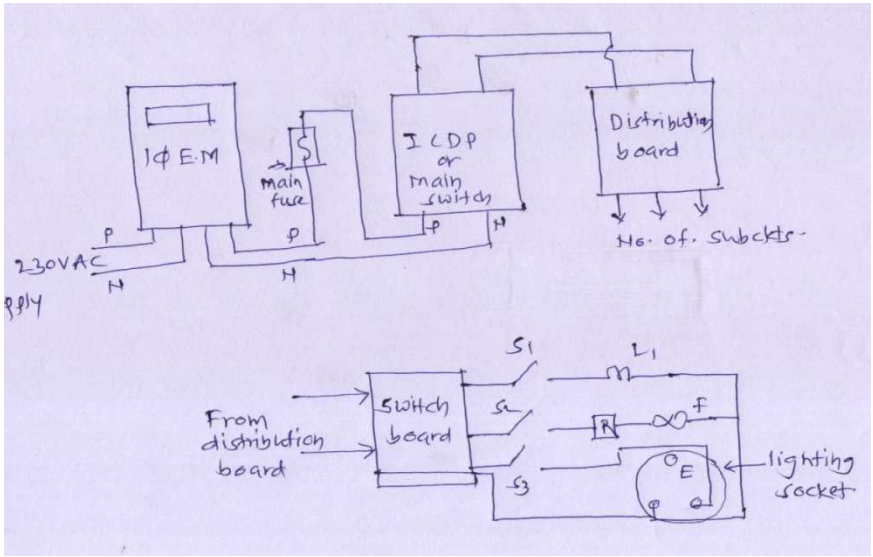
31. As such all service connection material like main switch, MCB, Energy meter, Neutral link, IC cut out, earthing nut, screws, and wooden board. etc

b) A hall 6m x 4m is to be provided with 2 lamp, 1 fan and two 5A socket outlet. Draw the plan of wiring with single line diagram showing position of switches and fitting. (4 Mark)



Or equivalent ckt dia.

c) Show the position of switch board, distribution board and main switch in a circuit diagram for commercial installation.



Or equivalent ckt dia.

d) State a procedure for estimating labour cost for commercial installation

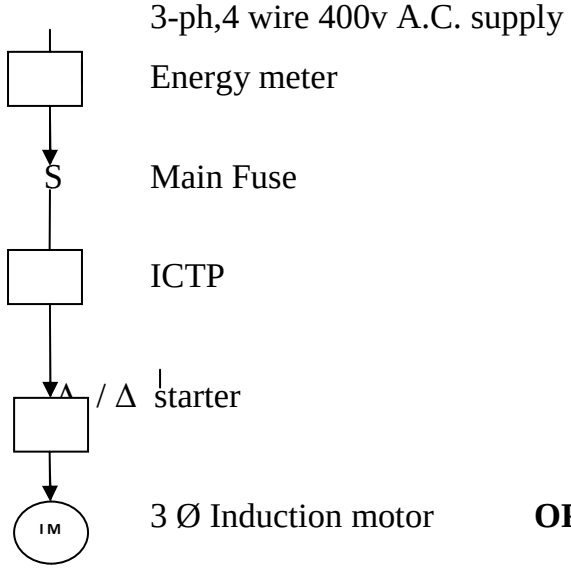
(Minimum eight point expected 1/2 each point)

Labour cost for commercial installation is estimated as below:

1) Cost of labour per full point
2) Cost of labour per separate plug
3) Cost of labour per half point
4) Cost of labour per power point
5) Cost of labour per two way point
6) Cost of labour per lighting circuit
7) Cost of labour per power circuit.
8) Cost of labour per distribution box fitting.
9) Cost of labour per mains running a) two wire b)three wire c) four wire
10) Cost of labour per fixture fitting e.g. tubes, fans etc.
11) Cost of labour for cable laying
12) Cost of labour for earthing per earthing point.
13) Cost of labour for fixing of main board
14) Cost of labour at actual for special work if any.

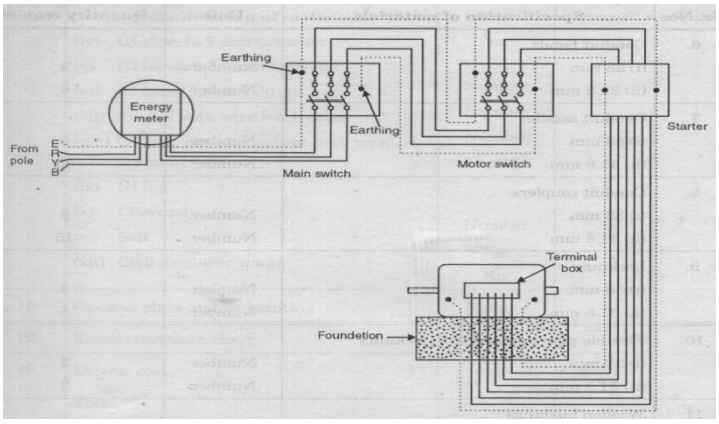
e) Draw and label single line diagram of 3 phase induction motor connected to supply with start-delta starter.

Single line diagram -



OR

Wiring diagram –



Or equivalent ckt dia

f) Describe the procedure for execution of work.

(Any four types expected 1-Mark each)

The following procedure for execution of work:

1. Electrical Installation plan can be approval for electrical inspector.
2. Work starting intimation should be given to electrical inspector office before starting the work.
3. Planning: The catalogues of different accessories used in electrical installation.
4. To complete the work within time limit
5. To ensure expenditure: If planning is done for finance the provision can be made for smooth flow of fund at proper time.
6. Determination of required quantity of material.
7. Determination of required for labour.
8. To ensure the availability: To ensure the availability of required special tools or machinery if any required, this avoids the delay in the work.
9. To ensure to proper design: If design is planned in advance and if technical sanction is taken, then there will not be confusion and the design will not be changed frequently.

----------**END**----------