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 TEN of the following:** **20 Marks**

a) **Draw symbols of the following: (i) Exhaust fan (ii) Bell**

Ans: **i) Exhaust fan :** **ii) Bell** **(1 Mark each Symbols)**

b) **State any two difference between residential and commercial wiring.**

Ans: **(Any Two point expected Each points : 1 Mark, Total: 2 Marks)**

S.No	Basis	Residential Wiring	Commercial Wiring
1	Load capacity	Less	High
2	Type of Supply	Generally single phase	Generally 3 phase
3	Initial Cost	Less	High
4	Type of Load	Lighting load is more, power load is less.	Power load is more, lighting load is comparatively less.

c) **State IE rule 29.**

Ans: **Rule 29:-** **(2 Mark)**

Construction, Installation, protection, operation and maintenance of electrical supply lines and apparatus.

	All electric 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.
d)	**List two examples of commercial installation.**
Ans:	**(Any Two types are expected: 1 Mark each)** **Examples of commercial Installation: (Any Two examples expected)** 1) Hospital 2) Schools 3) Colleges 4) Banks 5) Shopping malls 6) Large temples 7) Auditorium 8) Cinema theaters 9) Show-rooms etc.
e)	**List the types of internal wiring.**
Ans:	**(Any four types are expected: 1/2 Mark each, Total : 2 Marks)** **List the types of Internal wiring in residential installations –** 1) Cleat wiring 2) Batten wiring 3) Wooden casing capping wiring 4) PVC conduit wiring 5) PVC casing capping wiring 6) Concealed wiring
f)	**State two factors deciding size of conduit**
Ans:	**Following factors deciding size of conduit:** **(2 Mark)** 1) Type of wiring method 2) No. of wires carried out through conduit 3) Size of wires required for sub circuits which is carried out through conduit 4) Future expansion

g)	**Define service connection.**
Ans:	**Service Connection:-** **(2 Marks)** It is the input conductor or wire which is carried out from supply company (authorities) pole to consumer's main board or premises.
h)	**State the functions of Bus-bar.**
Ans:	**Function of Bus-bar**: - **(2 Marks)** ➢ Distribute the load on 3-phase four wire systems. ➢ To provide number of connection of incoming line and to provide easy way to connect number of sub circuit. ➢ For better firm connection. ➢ To provide easy access during inspection & maintenance. ➢ To avoid unauthorized changes or connection OR Incoming and outgoing lines are connected to the element. This element means busbar
i)	**State the importance of electrical drawing.**
Ans:	**Importance of electrical drawing-** **(Any Two 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.
j)	**State the necessity of earthing.**
Ans:	**Necessity of earthing:** **(2 Marks)** 1. To provide an alternative path for the leakage current to flow towards earth. 2. To save human life from danger of electrical shock due to leakage current. 3. To protect high rise buildings structure against lightening stroke. 4. To provide safe path to dissipate lightning and short circuit currents. 5. To provide stable platform for operation of sensitive electronic equipment.

k) List the types of contract.

Ans: **Types of Engineering contract:-**

(Any Four types expected : 1/2-Mark each, Total: 2 Marks)

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
12) Cost plus(+) fix fee contract

l) Differentiate between wire and cable.

Ans: **(Any TWO Points expected: 1 Mark each, Total : 2 Marks)**

S.No	Wire	Cable
i)	It is generally single core	It may be single core, Two core, 2.5 core, 3 core, 3.5 core and 4 core
ii)	Wires are used for LT Supply	Cables are used for LT and HT supply
iii)	Current & Voltage capacity for wire is less	Current & Voltage capacity for cable is More
iv)	Cost of wire is less.	Cost of cable is more.
v)	There are following types of wires: VIR, PVC, TRS/CTS/flexible etc	There are following types of cables: armored and unarmored.

m) State the functions of following in motor wiring circuit: (i) Motor switch (ii) Main switch

Ans: **i) Function of Motor switch:** **(1 Mark)**

- To make ON/OFF the motor.

ii) Main switch: **(1 Mark)**

- To give the main supply to the motor with fuse protection inside.

n)	**Define service Board.**
Ans:	**Service Board:** **(2 Marks)** Service board is one type of distribution board which serves the purpose of electrical supply extension for emergency remote applications. It is similar to Flex box.
Q.2	**Attempt any FOUR of the following:** **16 Marks**
a)	**Prepare schedule of materials for underground service connection.**
Ans:	**Following schedule of materials for underground service connection:** **(Any Four point expected: 1 Mark each point, Total : 4 Marks)** 1. 2.5 Sqmm, 4 core Armored cable: (**Size of cable depends on load & length of cable 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 per required size. 5. Cable Gland as per 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 set, nut, screws, and wooden board. etc
b)	**List general requirements of electrical installation (any eight).**
Ans:	General requirements of electrical Installation: **(1/2 Mark for any four requirement)** 1) Safety (Electrical & Mechanical) 2) life 3) Appearance 4) cost 5) Maintenance & Repairing 6) Future expansion 7) Type of wires, wiring accessories and wiring methods

Explanation: **(2 Marks for any One requirement explanation)**

1) Electrical installation should be electrically and Mechanically safe. All precautions should be taken.
2) Life of installation should be long.
3) Appearance should be good and decorative.
4) It should be economical
5) Maintenance & repairing should be simple and less.
6) Future expansion can be easily done.
7) for the better requirement the selection of wires, wiring method and wiring accessories with our economy is also very important
8) Precautions should be taken to prevent leakage of water into installation rooms.
9) Provide proper clearance for cable and Follow minimum wire bending

OR

Following requirements of Electrical installation:-

(Any eight point expected: 1/2 mark each point: total 4 Marks)

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 that size of conductor should carry rated current and partial over 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 be 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 to 1.5 meters above the ground 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 ten points of lights, fans and socket-outlets. The load on each sub-circuit is to be restricted to 800 watts.
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 not be less than $= \frac{50\ M\Omega}{Number\ of\ outlet}$

c)	**State the principles in design of lighting and power sub circuits.**
Ans:	**Following principles in design of lighting and power sub circuits:** **Lighting Circuit :-** **(2 Mark)** ➢ Each sub circuit should have 8 to 10 points (including lights, fans and 5A socket outlet) ➢ Each sub circuit should not exceed 800 watts. ➢ Make the no. of lighting sub circuit for lighting load. $No.\ of\ \ Lighting\ \ Sub\ circuits = \frac{Total\ \ Electrical\ lighting\ \ load}{800\ W}$ **OR** $No.\ of\ \ Lighting\ Sub\ circuits = \frac{Total\ No.of\ \ lighting\ \ point}{10}$ **Power Circuit :-** **(2 Mark)** ➢ 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) ➢ Make the no. of power sub circuits for power load. $No.\ of\ \ power\ Sub\ circuits = \frac{Total\ electrical\ \ power\ load}{1000\ W\ \ or\ 2000\ W}$
d)	**Explain the procedure for submission of tender.**
Ans:	**Procedure of submission of Tender:-** **(4 Marks)** ➢ The tender is submitted from party No.2 (Bidder) to party No.1 (Owner) in sealed envelopes within the specification date & time period. ➢ It is submitted in envelopes titled by envelop No.1 & envelop No.2. ➢ The content in every envelope is given as below . **OR** ➢ The system of submitting tender documents is also called as two envelope system. ➢ The treasury challan, deposit, call receipt, forwarding letter the copies of registration certificate, income tax clearance certificate, and list of machinery to be used to be sealed in one envelope. ➢ The tender set itself with quoted value should be sealed in another envelope: these two sealed envelopes should be put in one cover and sealed. On the top of this cover, the name of the work, address of the receiving authority should be written.

	These envelopes are then handed over in person or send by post to the address mentioned before the specified time and date **OR** ➢ According to old procedure three envelopes are there and in third envelope rate offered by the tenderer is given and it is mention as **" Envelop No.3"**
e)	**State any four IE rules used in residential wiring installation.**
Ans:	**(Note: Similar to following IE rules any eight expected 1/2 Mark each point)** **Following IE rules used in residential wiring installation:-** 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 that size of conductor should carry rated current and partial over 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 be 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 to 1.5 meters above the ground 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 ten points of lights, fans and socket-outlets. The load on each sub-circuit is to be restricted to 800 watts. 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 not be less than $= \frac{50\ M\Omega}{Number\ of\ outlet}$
f)	**Predict the types of starters required for following motors:** **(i)I.M of fractional K.W rating. (ii) I.M of medium rating (up to 15 KW) (iii) I.M with high rating. (iv) Slip ring I.M of high rating.**
Ans:	**Name the starters used for following motors : (Each Name of Starter : 1 Mark)** **i) Induction motor of fractional K.W rating:** a) Direct On Line starter **ii) Induction Motor of medium rating (up to 15 KW):** a) Star-Delta Starter or b) Auto transformer starter

iii) Induction motor with high rating:

a) Star-Delta Starter

b) Auto transformer starter

c) Soft start starter.

iv) Slip ring Induction motor of high rating.

a) Rotor Resistance starter

Q.3 **Attempt any FOUR of the following:** **16 Marks**

a) **Compare overhead and underground service connection.**

Ans: **(Any Four point expected: 1 Mark each, Total : 4 Marks)**

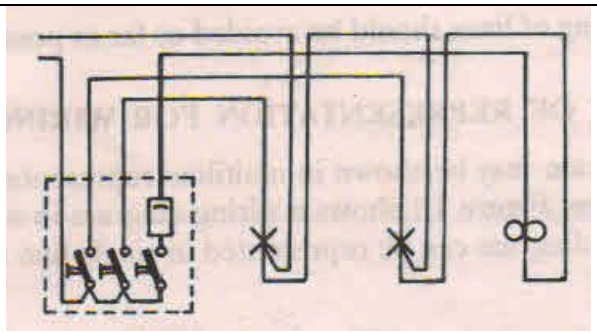
S.No	Basis	Overhead service connection	Underground service connection
1	**Initial cost**	Less	More
2	**Identification of fault**	Easy	Difficult
3	**Appearance**	Appearance is poor. OR not so good	Appearance is good.
4	**Safety**	Less safety	More safety
5	**Maintenance**	Easily possible	difficult
6	**Maintenance cost**	less	More
7	**Use**	For general premises	For thickly populated area or industrial purpose.

b) **Define the following terms as per IS: (i) Wiring diagram(ii) Schematic diagram**

Ans: **(i) Wiring diagram :** **(2 Marks)**

A wiring diagram shows the connection of an installation or part of installation. It shows how the connections are actually made and also gives layout of wiring.

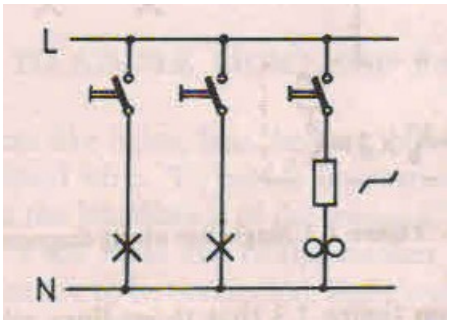
For example:



(ii) Schematic diagram: **(2 Marks)**

This is an explanatory diagram meant for easy understanding of the operation of an electrical circuit. It shows by symbols on an installation for the electrical connection.

For example:



c) State the sequence followed to prepare the estimate for commercial electrical installation.

Ans: **(Minimum Eight point expected: 1/2 each point: Total 4 Marks)**

The following sequence to be followed for the preparation of estimate of 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.

$$No.\ of\ \ Lighting\ \ Sub\ circuits = \frac{Total\ \ Electrical\ lighting\ \ load}{800\ W}$$

OR

$$No.\ of\ \ Lighting\ \ Sub\ circuits = \frac{Total\ \ No.of\ \ lighting\ \ po\,\text{int}}{10}$$

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

$$No.\ of\ \ power\ Sub\ circuits = \frac{Total\ \ electrical\ \ power\ load}{2000\,W\ \ or\ 3000\,W}$$

OR

$$No.\ of\ \ power\ Sub\ circuits = \frac{Total\ \ No.of\ \ power\ \ po\,\text{int}\,s}{2\ \ or\ 3\ \ po\,\text{int}\,s}$$

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.

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

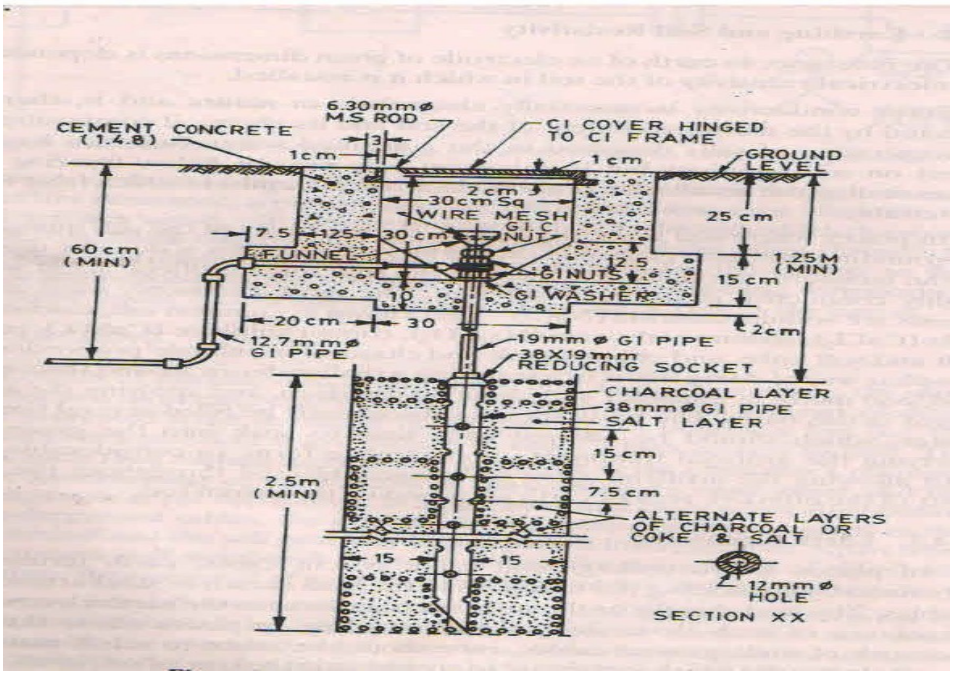
V = voltage = 230 V , I = Input current for every sub circuit

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 of 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 need of earthing and draw neat labeled sketch of pipe earthing.

Ans: **Need of earthing:** **(2 Marks)**

1. To provide an alternative path for the leakage current to flow towards earth.
2. To save human life from danger of electrical shock due to leakage current.
3. To protect high rise buildings structure against lightening stroke.
4. To provide safe path to dissipate lightning and short circuit currents.
5. To provide stable platform for operation of sensitive electronic equipment.

	Diagram for pipe earthing : **(2 Marks)**  **or equivalent figure**
e)	**State the meaning of:(i) Earnest Money deposit (ii) Security Deposit.**
Ans:	**i) Earnest Money deposit (EMD) :-** **(2 Marks)** EMD is a deposit taken as a guaranty from the bidder if the tender is accepted by the owner and if the contractor (bidder) refuses to accept that work in that case the EMD is not returned to that party it is generally 2 to 5 percent estimated cost. It is refundable to every unsuccessful (not considered) bidder. **ii) Security Deposit (SD):-** **(2 Marks)** Security deposit is amount or deposit given by the contractor to the owner till satisfactory completion of the project work. Generally it is a 5 to 10 % of the total estimated cost.
f)	**Write complete procedure of submission and opening of tender.**
Ans:	**Procedure of submission of Tender:-** **(2 Marks)** ➢ The tender is submitted from party No.2 (Bidder) to party No.1 (Owner) in sealed envelopes within the specification date & time period. ➢ The is submitted in envelops No.2 titled by envelop No.1 & envelop No.2. ➢ The content in every envelope is given an above.

OR

- The system of submitting tender documents is also called as two envelope system.
- The treasury challan, deposit, call receipt, forwarding letter the copies of registration certificate, income tax clearance certificate, and list of machinery to be used to be sealed in one envelope.
- The tender set itself with quoted value should be sealed in another envelope: these two sealed envelopes should again be put in one coverer and sealed. On the top of this cover, the name of the work, address of the receiving authority should be written. These envelopes are then handed over in person or send by post to the address mentioned before the specified time and date

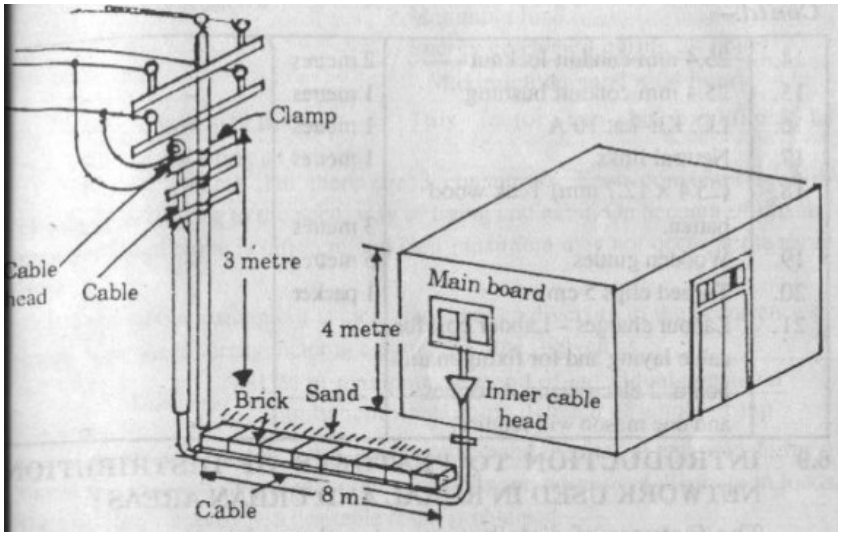
OR

- According to old procedure three envelopes are there and in third envelope rate offered by the tenderer is given and it is mention as **" Envelop No.3"**

Procedure of Opening of Tender:- **(2 Marks)**

The sealed envelopes are opened in presence of representative of bidders. The procedure is as below

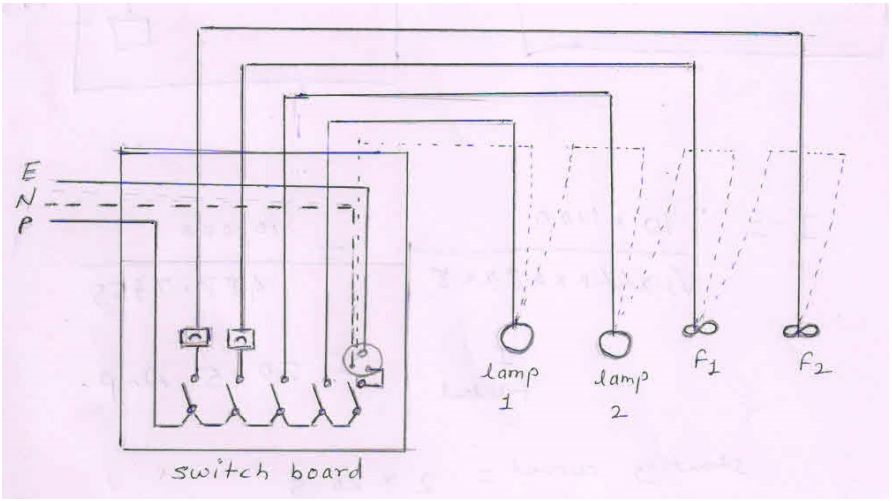
- The tenders are always opened at specified date & time in front of representative of every bidder.
- Initially envelop No.1 of every party is opened. The all documents which are given as above are checked if found O.K. then envelope No.2 of those parties is opened.
- If one of the party having the any short coming in envelop No.1 then the envelop No.2 of that party is not opened.
- The all contents in envelop No.1 are checked. It is as above & after opening the all envelops of all parties the comparative statement is done and for suitable company the contract is handed over.
- If one of the company having quotation of lowest price can be rejected by party No.1 (Owner) due to poor reputation, large works in hand, unsuitable drawing or without any reason.
- At first envelop No.1 of all parties are opened and comparative statement of all parties done.
- The rejected party of whose envelope No.1 is invalid there envelope No.2 are not opened it is freezed.

	➢ For all reaming parties envelope No.2 opened and detailed comparative statement is done. ➢ For lowest eligible bidders the contract is handed over.
Q.4	**Attempt any FOUR of the following: 16 Marks**
a)	**Draw a labeled diagram of underground service connection.**
Ans:	**Labeled diagram of underground service connection: (4 Marks)**  **OR equivalent figure**
b)	**State the purpose of maintenance of electrical installation.**
Ans:	Purpose of maintenance of electrical installation is as belows. **(4 Marks)** 1) To increase the life of installation. 2) To increase the efficiency of installation. 3) To avoid the interruption in work or system. 4) To minimize cost of repairing and routine work cost. 5) To increase the quality of work. **OR** **Purpose of maintenance of electrical installation:-** 1. To prevent minor faults from developing into major breakdown. 2. To reduce breakdown period. 3. To keep the electrical installation in good working condition. 4. To provide greater safety & protection to the workers. 5. To use less standby equipment's.

6. To increase life of electrical installation.
7. To avoid inconvenience.
8. To increase productivity
9. To determine the need for major & minor repairs.

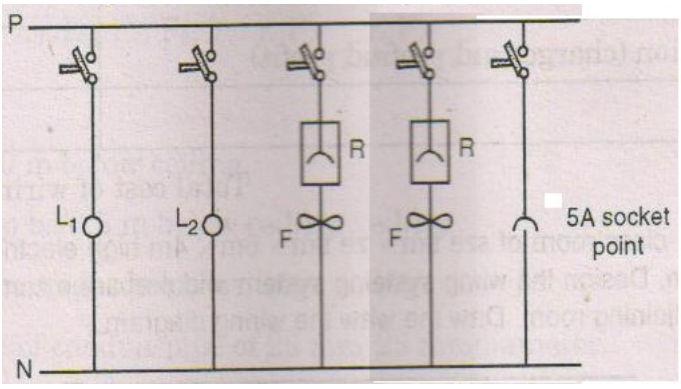
c) Draw and label multiline diagram and single line diagram for two lamps, two fans and 5 amp socket connected to single phase supply.

Ans: **i) Multiline diagram :** **(2 Marks)**



or equivalent figure

(ii) Single line diagram: **(2 Marks)**



or equivalent figure

d)	**State the criteria for selecting contractor.**
Ans:	**Following the criteria for selection of contractor:** **(Any Four points are expected: 1 Mark each)** 1. Contractor should be well reputed 2. Past experience of the Contractor 3. Contractor licenses should be valid 4. Works in hand of the Contractor. 5. Manpower, Machines, Material availability of the contractor. 6. Tax clearance certificate & financial power of contractor.
e)	**State the design considerations of commercial installation.**
Ans:	**(Minimum Eight point expected: 1/2 each point)** **The following design procedure for commercial 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. $No.\ of\ \ Lighting\ \ Sub\ circuits = \frac{Total\ \ Electrical\ \ lighting\ \ load}{800\ W}$ **OR** $No.\ of\ \ Lighting\ \ Sub\ circuits = \frac{Total\ \ No.of\ \ lighting\ \ po\,\text{int}}{10}$ 4) Make the no. of power sub circuits for power load. $No.\ of\ \ power\ Sub\ circuits = \frac{Total\ electrical\ \ power\ load}{2000\ W\ \ or\ 3000\ W}$ **OR** $No.\ of\ \ power\ Sub\ circuits = \frac{Total\ \ No.of\ \ power\ \ po\,\text{int}\,s}{2000\ W\ \ or\ 3000\ W}$ 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 of 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.

f) State the sequence to be followed to prepare estimate of factory unit.

Ans: **(Minimum Eight point expected 1/2 each point)**

Following the sequence to be followed to prepare estimate 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 ϕ = 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 sustain 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. **OR** **Following the sequence to be followed to prepare estimate of factory unit:-** i) Input current of the motor ii) Selection of size of cable and conduit iii) Determination of rating of fuse iv) Selection of rating of main switch v) Distance between Main board and control board vi) Type of supply for every machine vii) Earthing type and its size.
Q.5	**Attempt any FOUR of the following: 16 Marks**
a)	**What is MCB? Give any two functions of MCB.**
Ans:	**MCB: (2 Mark)** MCB means Miniature Circuit Breaker. It is used in the place of Fuse. Generally, electricity is pass through the MCB. When the amount of current increases , the MCB turns off and it breaks the circuit. It prevents from burning of Home appliances. **Functions of MCB : (Any Two point expected: 1 Mark each, 2 Marks)**

	1. MCB is safer to handle, whereas Fuse need to remove from live circuit, and a copper or aluminium strands should be connected at both ends of strips. 2. Same MCB can trip circuit multiple times, whereas Fuse need to change every time when it trips. 3. MCB body is made of GRP (Glass Reinforced plastic) does not break with the age, whereas Fuse will break with age. 4. Flexibility in operation is possible, whenever circuit is tripped just we need to change position of MCB as like as our switch.
b)	**State the purpose of following in conduit wiring: (i) Elbow (ii) Conduit Box (iii) Bushing (iv) Nipple.**
Ans:	**i) Elbow :** **(1 Mark)** ➢ To move the direction of the conductor path as per wiring installation at the right angles. **ii) Purpose of Conduit box:** **(1 Mark)** ➢ To hold and inspect incoming and outgoing terminals **(iii) Purpose of Bushing:** **(1 Mark)** Bushings are used to protect both wires and Cables and surfaces that they pass through. To protect wires, bushings insulate openings for the wires to pass through so that it should not be damaged in any way. **(iv) Purpose of Nipple :** To joint the two separate size (diameter) PVC conduit. **(1 Mark)**
c)	**State sequence followed to prepare appropriate estimation for residential installation.**
Ans:	**(Note: Similar sequence to be followed for preparing estimate for a residential installation)** **(Any Eight point expected: 1/2-Mark each)** **Following sequence to be followed for preparing estimate for a residential installation:-** 1) Find out the 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. $No.\ of\ \ Lighting\ \ Sub\ circuits = \frac{Total\ \ Electrical\ lighting\ load}{800\ W}$

OR

$$No.\ of\ \ Lighting\ \ Sub\ circuits = \frac{Total\ \ No.of\ \ lighting\ \ point}{10}$$

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

$$No.\ of\ \ power\ \ Sub\ circuits = \frac{Total\ electrical\ \ power\ load}{1000\ W\ \ or\ \ 2000\ W}$$

OR

$$No.\ of\ \ power\ \ Sub\ circuits = \frac{Total\ \ No.of\ \ power\ \ points}{2\ or\ 3\ \ points}$$

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.

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 of 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.

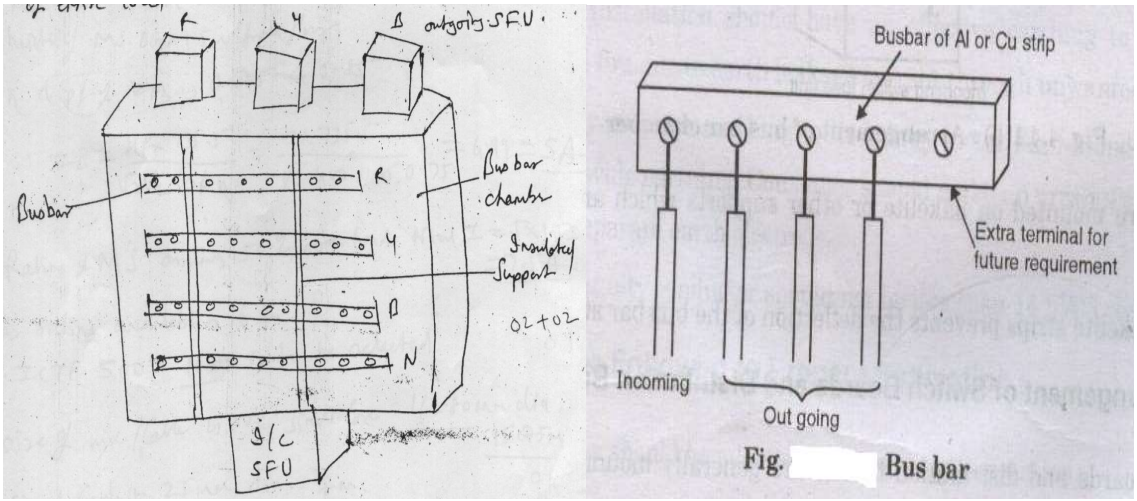
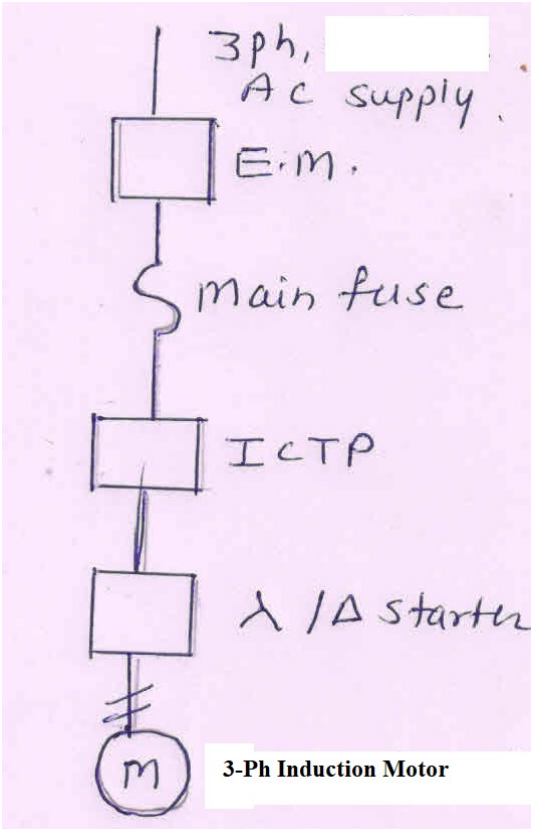
15) Find out per point charges.

16) Draw the circuit diagram.

d) Define Busbar and draw and label diagram showing its arrangement and explain it.

Ans: **Meaning of Bus-bar**: - **(2 Mark)**

Busbar means aluminium or copper strips where incoming & outgoing lines are connected. **OR** Sometimes stranded aluminium or copper conductors.

	Diagram showing the arrangement of busbar Chember: **(2 Marks)**  Fig. Bus bar **or equivalent figure**
e)	**Draw and label single line diagram for 3 phase induction motor connected to supply with star delta startor.**
Ans:	**Single line diagram for three phase Induction motor -** **(4 Mark)**  **or equivalent figure**

f) A 10 kW, 440 V, 3 ph, 50 Hz 1.M is to be installed in a workshop. The main board is 15 m away from the main switch and starter of a motor. The main switch and starter are mounted on one board and are 1.5 m away from the motor foundation. Show the layout of wiring and estimate quantity of material required.

Ans:

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 = 10 x 10 = 10000 W -------- **(1/2 Mark)**

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

Assuming efficiency of I.M is 80 %

Input power of induction motor = 10000 / 0.8 = 12500 W

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

$$P = \sqrt{3}\, V_L\, I_L Cos\phi \qquad V_L = 440\, V$$

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

$$I_L = \frac{12500}{\sqrt{3} \times 440 \times 0.8} \qquad Cos\phi = 0.8\ assumption$$

$$I_L = 20.5\ Amp \qquad Rated\ current = 20.5\ Amps$$

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 20.5 = 41 Amp

So use,

10 Sqmm 4 core **OR** 16 Sqmm 4 core cable for the I.M.(or 3 core cable)

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

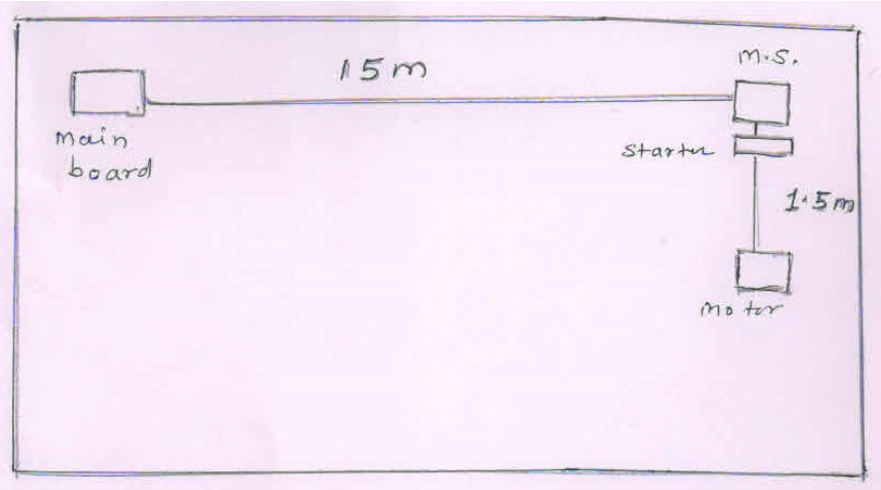
The rating of main switch is 450 V, 60 Amp ICTP ISI mark

Size of earth wire 8 SWG copper or 6 SWG GI ---------- **(1/2 Mark)**

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. ---------- **(1/2Mark)**



or equivalent figure

Step No. 7:- Find out the estimation chart with material cost & labour cost: ----- **(1 Mark)**

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

Material Schedule:

1	60 A or 50A Busbar with Netural link	01
2	3-ph,4 wire 415V, 40-60A, A.C. supply Energy Meter	01
3	ICTP 450V,60A	02
4	Star Delta Starter or soft starter	01
5	8 SWG Earthing Wire	0.5.kg
6	60 cm x 60cm x6.36 mm Copper Earthing Plate	01
7	Earthing nut-board	04
8	Earthing Sundry	lumpsum
9	12x12 Wooden Board for SDB	02
10	Screw 3 inch length	12 No
11	Screw 1 inch length	06 No
12	R,Y,B Indication Lamp	03
13	PVC Tape	04
14	Saddles	1 box
15	32mm PVC conduit (3 Mtr pipe) 1.5mm thickness	7 pipe
17	10 Sqmm x 4 Copper armored cable	20 Mtr
18	Junction Box	03 approx.
19	Lug & gland	06 approx

Q.6	Attempt any TWO of the following: 16 Marks
a) i)	**(i) State any four rules for motor wiring.**
Ans:	**Important rules of motor wiring:** **(Any Four points are expected: 1 Mark each)**

1. The supply to every motor is controlled by main switch. Main switch may be ICDP for single phase machine and ICTP for 3-ph machine.
2. Starter is required to start the motors, if the capacity of the motor is less than 5 HP then DOL starter can be used and if it is more then star-delta starter, auto transformer starter, or rotor resistance starter etc (depends upon types of motor) can be used.
3. The size and core of cable is also decided . Size of the cable is decided by the starting current of every machine, generally starting current is assumed two times of rated input current of every machine
3. Type of the cable is decided by the type of supply of the machine, if the machine is single phase then two core cables is used and if the machine is three phase delta connected then three core cable is selected.

   If the machine is star connected then 3.5 cores or 4- core cable is selected
4. The path and mounting of cable is selected so that shortest route and convenience of power machine.
5. Unarmourded cable can be selected for indoor power machine and armored cable can be selected for outdoor power machine.

OR

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 ICDP, & 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.
v) The voltage drop in the cable should be with the tolerance limit + or – 5 %
vi) All protective measures should be installed for each motor.
vii) Control unit should be near to motor as far as possible.
viii) Suitable KVAr rating of capacitor should be installed near to motor.

a) ii)	**(ii) Give the procedure to calculate motor current in any industrial installation.**
Ans:	**Following the procedure to calculate motor current in any industrial installation:-** $Total\ output\ power = Total\ H.P \times 735.5$ **(1 Mark)** $Rated\ input\ current\ I_L = \frac{HP \times 735.5}{\sqrt{3}\, V_L \times \eta \times Cos\phi}$ $Rated\ input\ current\ I_L = \frac{.H.P \times 735.5}{\sqrt{3} \times 415 \times efficency \times P.f}$ = …….. Amp **(2 Mark)** It is assumed that starting current is two times rated input current. Starting current = 2 x …….. = …….. Amp by this ampere rating the size and type of cable is decided. The fuses are also selected for this current. **(1 Mark)**
b)	**Prepare a complete estimate to install a 3-phase 400 V, 50 Hz, 3 Hp induction motor to be used for grinding purpose in a small workshop having room size of 3 m x 3 m. Assume necessary data required for the estimation. Draw installation plan and wiring diagram.**
Ans:	**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 = 3 x 735.5 = 2206.5 W---------- **(1/2 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 = 2206.5 / 0.8 = 2758.12 W **Step No. 3:-** To determine the rated current for I.M ---------- **(1/2 Mark)** $P = \sqrt{3}\, V_L\, I_L Cos\phi \qquad V_L = 400\ V$ $I_L = \frac{P}{\sqrt{3}\, V_L Cos\phi}$ $I_L = \frac{2758.12}{\sqrt{3} \times 400 \times 0.8} \qquad Cos\phi = 0.8\ assumption$ $I_L = 4.98\ Amp \qquad Rated\ current = 4.98\ Amps$ ---------- **(1 Mark)** **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 4.98 = 9.96 Amps

So use, 2.5 Sqmm 3.5 core cable for the I.M.

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

(1/2 Mark)

The rating of main switch is 450 V, 16 Amp ICTP ISI mark

Size of earth wire 8 SWG copper or 6 SWG GI

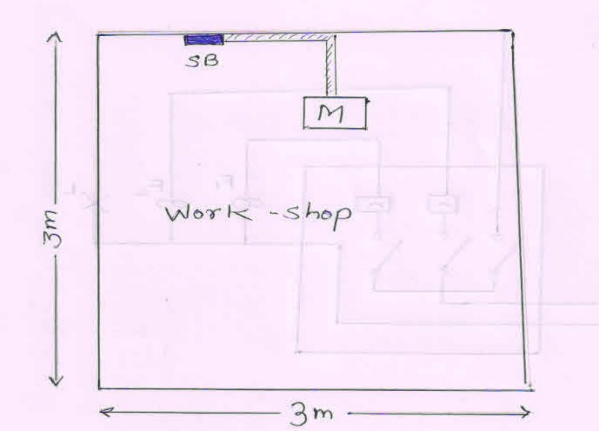
Length of earth wire = 2 times length of cable

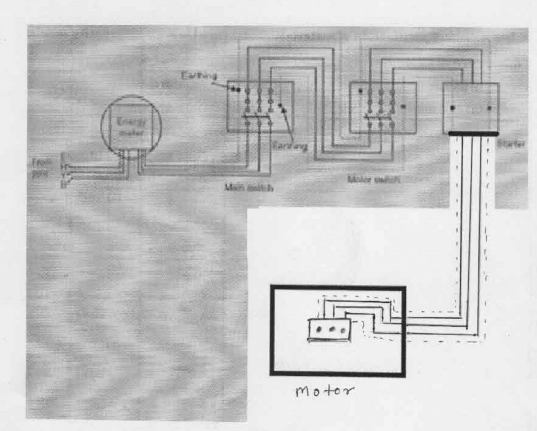
Length of input cable for I .M = 1.2 meter + 0.5 meter +1 meter + 1 mtr (up to motor terminals)

Length of input cable for I .M = 3.7 meter

Total length of cable=3.7+.37=4.07M 3.5core cable , size of 2.5sq.mm --------- (1 Mark)

Step No.6: Installation Plan & Wiring Diagram ---------- (2 Mark)





or equivalent diagram

Step 7: Material Schadule: ---------- (1 Mark)

S.No.	Name of Material	Qty
1	16 A Busbar with Netural link	01
2	3-ph,4 wire 415V, 15-30A, A.C. supply Energy Meter	01
3	ICTP 450V,16A	02
4	DOL Starter	01
5	8 SWG Earthing Wire	0.5.kg
6	60 cm x 60 cm x 6.36 mm Copper Earthing Plate	01
7	Earthing Nut-bolt	04
8	Earthing Sundry	lumsump

	9	12x12 Wooden Board for SDB	02
	10	Screw 3 inch length	12 No
	11	Screw 1 inch length	06 No
	12	R,Y,B Indication Lamp	03
	13	PVC Tape	01
	14	Saddles	1 box
	15	32mm PVC conduit (3 Mtr pipe) 1.5mm thickness	7 pipe
	17	2.5 Sqmm x 4 Copper armored cable	10 Mtr
	18	Bend	02 approx.
	19	Lug & gland	06 approx

c) A college canteen hall has 6 m x 4 m size. It is provided with the following electric load: (i) 12 nos of tube lights 40 watt each. (ii) 6 nos of fan points of 60 watt each. (iii) 4 nos of plug points of 240 watt each. Design and draw electrical installation scheme and estimate quantity of material and their cost required for casing capping wiring system.

Ans:

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)**

$Total\ load\ in\ \ Hall = tubes \times watt\ = 12 \times 40 = 480\,W$

$= Fans \times watt\ = 06 \times 60 = 360\,W$

$= Sockets \times watt = 04 \times 240 = 960\,W$

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

$Total\ load\ in\ \ Hall = 480 + 360 + 960 = 1800\ watt$ ---------- **(1 Mark)**

$Total\ load\ in\ \ Amps = \frac{1800}{230} = 7.82\ A \cong 8\ Amp \quad assu\min g\ \ p.f. = 1$

Rating main switch: - since more current is 8 A.

Assumed that Staring current = 1.5 times rated current

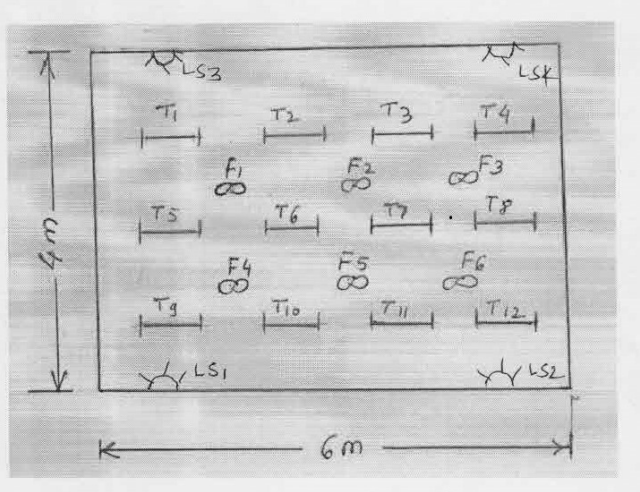
So starting current = 1.5x 8 = 12 A

So Use:-

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

$No.\ of\ lighting\ sub\ circuit = \frac{1800}{800} = 2.25 \cong 3$ ---------- **(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-Mark)**

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 Casing Capping (2Mtr pipe) 1.5mm thickness	16 Nos (32 Mtr)	45.00	720.00
4	Copper Earthing Plate	01	490.00	490.00
6	DP	03	150.00	450.00
7	Earthing Sundry	lumsump	200.00	200.00
8	6A S.P.S.T.	22	10.00	220.00
9	6A Three point socket	04	12.00	48.00
10	Ceiling rose	18	10.00	180.00
11	1.5 Sqmm PVC wire (90 Mtr -1 bundle)	01 Bundle	550	550.00
11	1 Sqmm PVC wire Running earth	40 Mtr	7.00	280.00
12	10” x12” Switch Board	02 Nos	25.00	50.00
12	Labour Charges	22	70.00	1540.00
		Total Amount :-		**5068.00**
13	Contingencies+ profit margin	10% Amount:-		507.00
		Total Amount:-		**5575.00**
	iii) Cost of work:	Say Total Amount:		**5575.00**

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