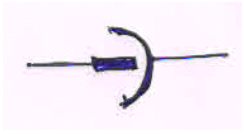
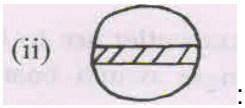
Important suggestions to examiners:

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 the symbols of the following: (i) Exhaust fan (ii) Plug and Socket:**
Ans:	**(i) Exhaust fan :** **(ii) Plug and Socket:** **(Each Symbols : 1 Mark)**  
b)	**State IE rule 29 related to electrical installation.**
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.
c)	**State the meaning of following symbols:**
Ans:	(i)  : Distribution fuse board with switches **(1 Mark)** (ii)  : Indicator **(1 Mark)**

d) What is service connection?

Ans: **Service Connection:-** **(2 Marks)**

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

e) State the purpose of ELCB in residential installation.

Ans: **purpose of ELCB in residential installation**: - **(2 Mark)**

- An Earth Leakage Circuit Breaker (ELCB) is a device used to directly to detect earth fault current from an installation and cut off the circuit from power supply and avoid electrical shock to the person.

f) Give two points of differentiation between underground and overhead service connection.

Ans: **(Any Two point expected: 1 Mark each)**

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

g) State any two examples of commercial installation.

Ans: **(Any Two types are expected: 1 Mark each)**

Examples of commercial Installation: (Any four 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.

h) State any two difference between residential and commercial wiring.

Ans: **(Any Two point expected :Each points : 1 Mark)**

S.No	Basis	Residential Wiring	Commercial Wiring
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

i)	**Name the starters used for following motors: (i) 15hp, 3phase squirrel cage induction motor. (ii D.C. shunt motor**
Ans:	**Name the starters used for following motors :** **(Each Name of Starter : 1 Mark)** **i) 15 H.P. 3-Ph squirrel cage I.M:** i) Star-Delta Starter OR ii) Auto transformer starter OR iii) Soft start starter. **ii) D.C Shunt Motor :** 1) Armature resistance starter (Three Point Starter) OR 2) Four Point Starter
j)	**State the meaning of following terms: (i) Security deposit (ii) Earnest money**
Ans:	**i) Security Deposit (SD):-** **(1 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. **ii) Earnest Money deposit (EMD) :-** **(1 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.
k)	**List the types of internal wiring.**
Ans:	**(Any four types are expected: 1/2 Mark each)** **List the 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
l)	**State the permissible limits for earth resistance in industrial installation.**
Ans:	**Permissible limit:** **(2 Mark)** **Earth Resistance:** It should be very low for industrial installation.It should be equal to or less than 5 ohm to 8 ohm for small scale industries and it should be very low, less than 5 ohm for medium scale or large scale industries.

Q.2	Attempt any Four of the following : 16 Marks
a)	**Write any four IE rules relating to lighting loads to be followed in electrical installation.**
Ans:	**(Note: Similar to following rules any eight expected 1/2 Mark each point)** **Following IE rules relating to lighting loads to be followed in electrical installation:-** 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 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 part 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** **Following IE rules relating to lighting loads to be followed in electrical 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 be not be less than $= \frac{50\ M\Omega}{Number\ of\ outlet}$

b) State commercial rate of each of following for per unit:
(i) Single phase, 15Amp, ICDP (ii) Single phase - 15A, MCB (iii) Flexible wire bundle (iv) Power three pin plug

Ans: **(Each Rate for per unit : 1 Mark)**

S.No	Unit	Rate per unit
i)	Single phase, 15 Amp, ICDP	Rs. 250/- to 350/-
ii)	Single phase, 15 Amp, MCB	Rs. 100/- to 200/-
iii)	Flexible wire bundle (90Mtr)	Rs. 230/- to 700/-
iv)	Power three pin plug (15A).	Rs. 60/- to 75/-

c) State any four advantages and two disadvantages of underground service connection.

Ans: **Four advantages of underground service connection:**
(Any Four point expected: 1/2 each point)

1. Repairing and maintenance is less
2. Appearance is good
3. Normally it is preferred for Residential commercial and Industrial consumers
4. Armoured cables are preferred
5. More safety
6. Chances of lightning stroke are less

Two disadvantages of underground service connection : **(Any Two expected: 1Mark each)**

1. Cost is more
2. Repairing and maintenance is difficult.
3. Space required is more.

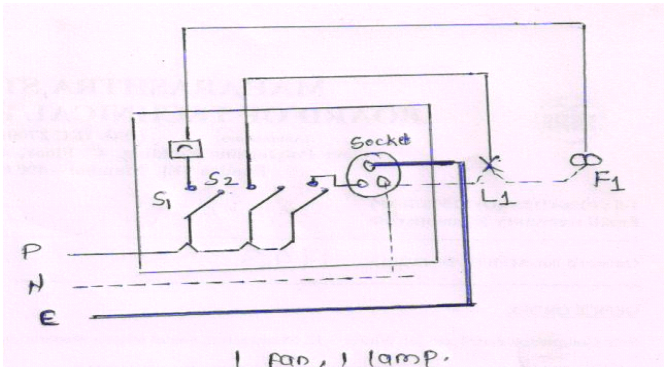
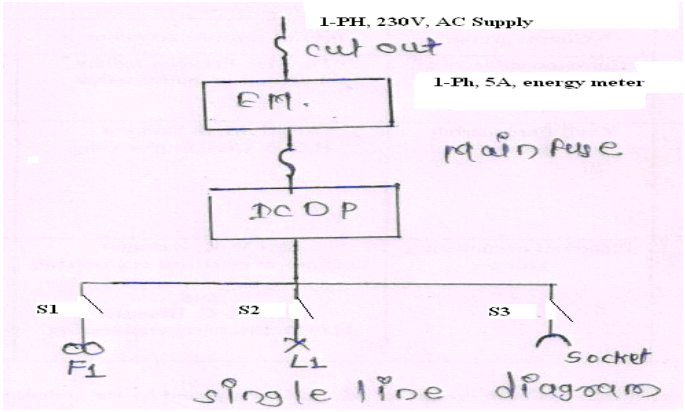
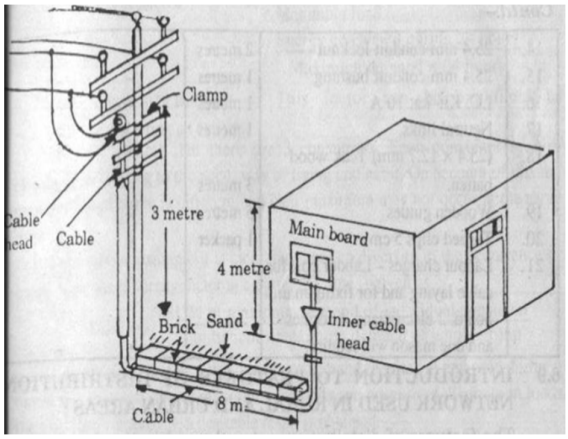
d) What is tender? State its types.

Ans: **Meaning Tender:-** **(2 Marks)**

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 has to complete the project work).

Types of Tender: **(Any Two expected: 1 Marks each)**

1. Negotiated Tender
2. Limited competition or selective Tenders
3. Open competition Tender

e)	**One light point, one ceiling fan, one 5A socket outlet are to be wired. Switches are to be provided on a single switch board. Draw the following: (i) Wiring diagram in looping - in system, (ii) Single line diagram for (i)**
Ans:	**Wiring diagram for 1 fan, 1 tube and one light socket looping system :** **(2Marks)**  **or equivalent fig** **Single line diagram for 1 light point, 1 Ceiling fan and 1 light socket :** **(2 Marks)**  **or equivalent fig**
f)	**Draw a labelled diagram for underground service connection.**
Ans:	**Underground service connection:** **(Diagram : 4 Marks)**  or equivalent figure

Q.3	**Attempt any FOUR of the following :** **16 Marks**
a)	**Explain how number of circuits and sub circuits are determined in residential wiring.**
Ans:	**Number of circuits and sub circuits are determined in residential wiring.**

Lighting Circuit :- **(2 Mark)**

- Each sub circuit should not have more than total 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)**

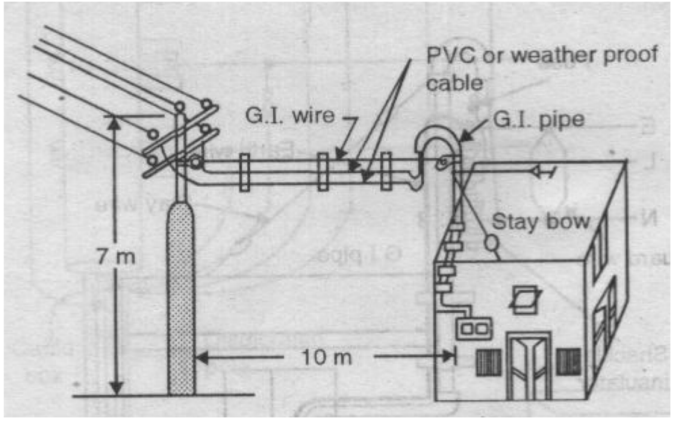
- For power load there should be maximum 3000W for 2 to 3 points.
- For power load there should be maximum 1000W for total 1 to 2 points. (old rule)
- Make the no. of power sub circuits for power load.

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

OR

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

b)	**Draw a labelled diagram for overhead service connection.**
Ans:	**Diagram of Overhead service connection:** **(Diagram- 4 Mark)**



or equivalent figure

c)	**State any Six requirements of valid contract.**
Ans:	**Following requirements of valid contract:** **(First Two point : 1 Mark each and other 4 Point: 1/2 Mark each –Total 4 Mark)** 1. Contract should be written. 2. Contract should be signed by proper witness 3. Contractor licenses should be valid. 4. Contract should be signed by competent authority. 5. Contract should be signed by proper authorized persons. 6. It should be legally challenged in the court.
d)	**State the sequence to be followed for the preparation of estimate of commercial electrical installation.**
Ans:	**(Minimum Eight point expected: 1/2 each point)** **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** $No.\ of\ \ Lighting\ \ Sub\ circuits = \frac{Total\ \ No.of\ \ lighting\ \ point}{10}$ 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** $No.\ of\ \ power\ Sub\ circuits = \frac{Total\ No.of\ \ power\ \ points}{2000\ W\ \ or\ 3000\ W}$ 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.

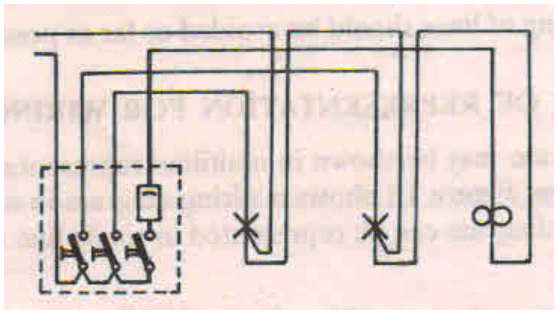
e) Define the following terms as per IS : (i) Wiring diagram. (ii) Schematic diagram

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.

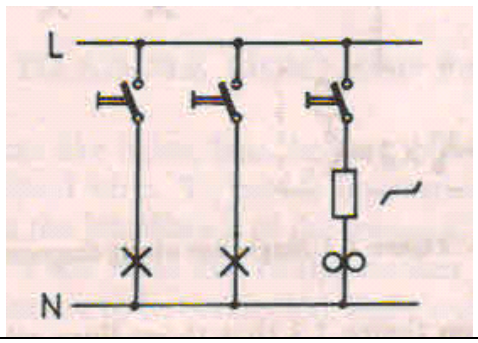
For example:

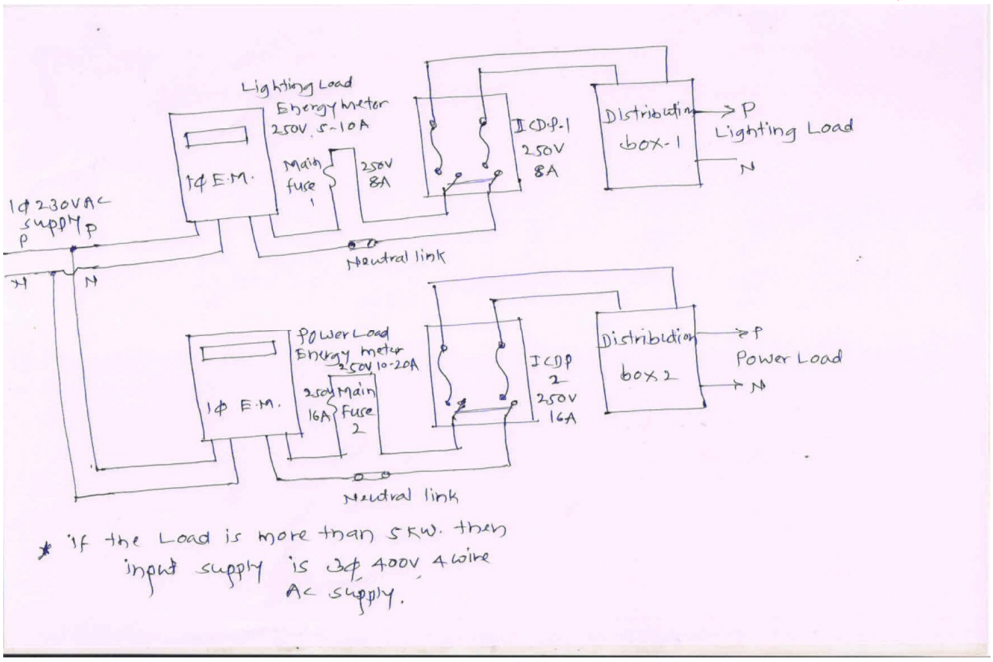


(ii) Schematic diagram: **(2 Marks)**

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:



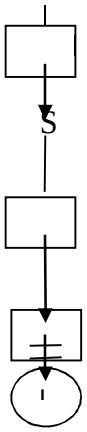
f)	**Draw the details of distribution board having separate energy meter for lighting load and power load.**
Ans:	**Distribution board having separate energy meter for lighting load and power load:** **(4 Marks)** 
Q.4	**Attempt any FOUR of the following : 16 Marks**
a)	**State any four general rules for installation of residential electrification.**
Ans:	**(Note: Similar to following rules any eight expected 1/2 Mark each point)** **Following rules and guidelines for installation of residential electrification:-** 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 be not be less than $= \frac{50\ M\Omega}{Number\ of\ outlet}$

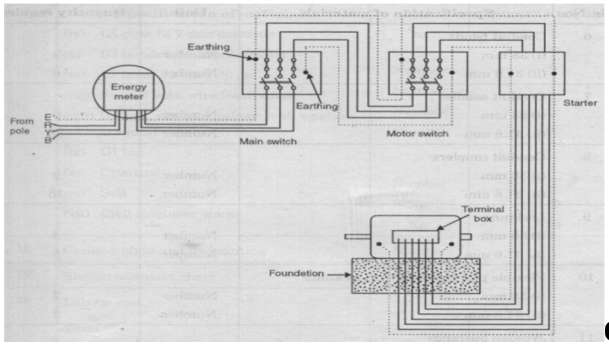
b) Draw a single line diagram for 15hp, three phase, 440V, Induction motor to be operated on suitable start.

Ans: **Single line diagram 15hp, three phase, 440V, Induction motor - (4 Mark)**

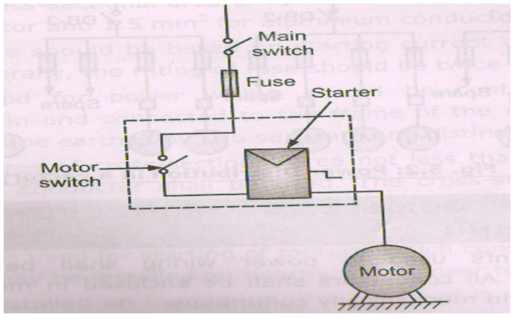


3-ph,4 wire 400v A.C. supply
Energy meter
Main Fuse
ICTP - 32A/450V
Star -Delta starter
15 HP 3 Ø Induction motor **OR**

Wiring diagram –



Or equivalent ckt dia.



or equivalent figure

c)	**Write complete procedure of submission and opening of a 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.
d)	**State any four factors on which selection of contract depends.**
Ans:	**Four factors on which selection of contract depends:** **(Any Four Expected: 1 Mark each)** 1) Previous experience 2) Financial position 3) Machinery & man power 4) Quoted Rates 5) Works in hand 6) Reputation 7) Valid Licenses 8) Taxes clearance certificate
e)	**Explain how comparative statement is prepared after opening of tender.**
Ans:	**(1 Mark)** After opening of all tenders, details in all tenders are written in only one page i.e. in one look and then comparison is made. **Following conditions are verified in comparative statement:** **(Any Three point are expected: 1 Mark each)** 1. The contract licenses validity duration 2. The quoted cost of total project work 3. Drawing details of the project works 4. Work in hand of the contractor. 5. Demand draft for S.D & EMD.

f)	**State any four important factors, which should be considered for economical execution of electrical installation work.**
Ans:	**(Any four types expected 1-Mark each)** 1. Prepare project execution plan (PEP) & map. 2. Make design of electrical installation work optimum (good design) 3. Use appropriate labour as per project work requirement whether skilled, semi-skilled or unskilled. Do not use too-much labour . only use the labour which are actually required. 4. Choose wire/cable size as per requirement, do not use higher size of wire/cable. 5. Use recommended illumination level as per Indian standard. Do not use higher illumination level. 6. Complete the electrical installation work within specified time do not use more time. 7. For laying of cable use shortest route. 8. Before finalizing labour charges it should be compare with market values. 9. Before finalizing material purchase it should be compared with other equivalent quality material other companies. 10. Select type of installation according to application. 11. Select correct method of execution
Q.5	**Attempt any TWO of the following : 16 Marks**
a)	**A shop of size 4 m x 8 m is to be provided with 14 twin tube light fittings of 80 watt each and 7 ceiling fans of 60 watt each having sweep of 800 mm. Switch boards consist of 14 nos. 6 Amp sockets of 100 watts. Design and draw installation plan using standard IS symbols for twin tube light fittings, ceiling fans, calculate the number of sub-circuit required. Show the position of switch boards on installation plan.**
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)** $Total\ \ load\ in\ \ Hall = twin\ \ tubes\ (2 \times 40\ watt = 80 watt) = 14 \times 80 = 1120\ W$ $= Fans \times watt = 07 \times 60 = 420\ W$ $= Plug \times watt = 14 \times 100 = 1400\ W$ ------ **(1 Mark)**

Total load in Hall = tubes in Watt + Fans in Watt + plug in Watt

i) *Total load in Hall* $= 1120 + 420 + 1400 = 2940$ *watt* ---------- **(1 Mark)**

Total load in Amps $= \frac{2940}{230} = 12.78 \cong 13$ *Amp assu* min *g p. f .* $= 1$ ------ **(1 Mark)**

ii) *No. of Sub circuit* $= \frac{2940}{800} = 3.675 \cong 4$ *Nos lighting sub circuit* ---------- **(1 Mark)**

According to po int *No. of Sub circuit* $= \frac{35}{10} = 3.5 \cong 4$ *Nos lighting sub circuit*

iii) Rating Main switch: - since rated input current is 25 A. ---------- **(1 Mark)**

Assumed that Staring current = 1.5 times rated current

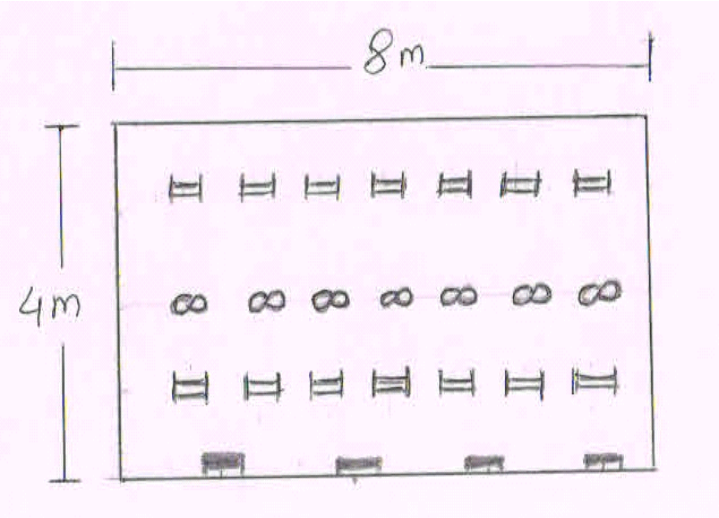
So starting current = 1.5x 13 = 19.5 A

So Use:- ---------- **(1 Mark)**

230V, 25A, ISI mark Main switch of any company

Cable selected: 2.5 Sqmm, Copper cable single core

1) layout and show the position of lamps, fans etc: ---------- **(2 Mark)**



Or equivalent diagram

b) What is industrial load? Compare it with residential load on any two points. Also write any five important points of motor wiring.

Ans:

i) Meaning of Industrial Load: **(Any Four points expected: 1/2 Mark each)**

- In industrial load power load, electrical machines load is more than lighting load.
- 3-ph load is more than single phase load.
- Power factor of the load is less than unity, it should be improved.
- The tariff of industrial load is different.
- The all safety precausions e.g. MCB, MCCB, ELCB, Fuses should be installed.
- The earthing resistance should be maintained, the size of earth wire is 8SWG copper or 6 SWG GI

ii) Compare industrial load and residential load:

(Any Three Point expected : 1 Mark each)

S.No	Basis	Industrial load	Residential load
1	**Location**	In industrial estate or MIDC area	Highly population density area
2	**Cost**	More	Less
3	**Precautions**	All precautions should be taken	All safety precautions should be taken
4	**Supply**	Generally 3-ph, 400V AC supply is provided	Generally 1-ph, 230V AC supply is provided
5	**Tariff**	Tariff for industrial load is different	Block rate tariff is applied

(Any Three points expected 1 Mark each)

iii) Following rules and regulations of industrial wiring:-

1) Each motor should be provided with separate cable for distribution board or main board.
2) Each motor should be individually controlled
3) Rating of fuse, ICTP or ITDP, & starter should be based on starting current which is assumed two times rated input current.

4) The motor should be earthed at two distinct terminals by 8 SWG copper wires.

5) The voltage drop in the cable should be with the tolerance limit + or – 5 %

6) All protective measures should be installed for each motor.

7) Control unit should be near to motor as far as possible.

8) Suitable KVAr rating of capacitor should be installed near to motor.

OR

(Any Three points 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 than that, star-delta starter,or 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 such that it should be a shortest route and convenience to distribute the power to the machine.
5. Armaoured cable can be selected for indoor power machine and unarmored cables can be selected outdoor power machine.

c) Draw the wiring diagram for the industrial load shown in Figure No. l show all TCTP,

starters cables with ratings. Assume suitable power factor and efficiency and squirrel cage induction motors.

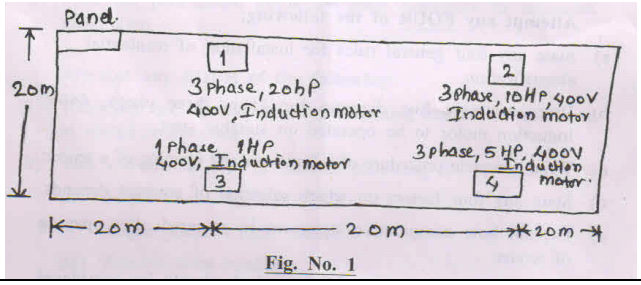
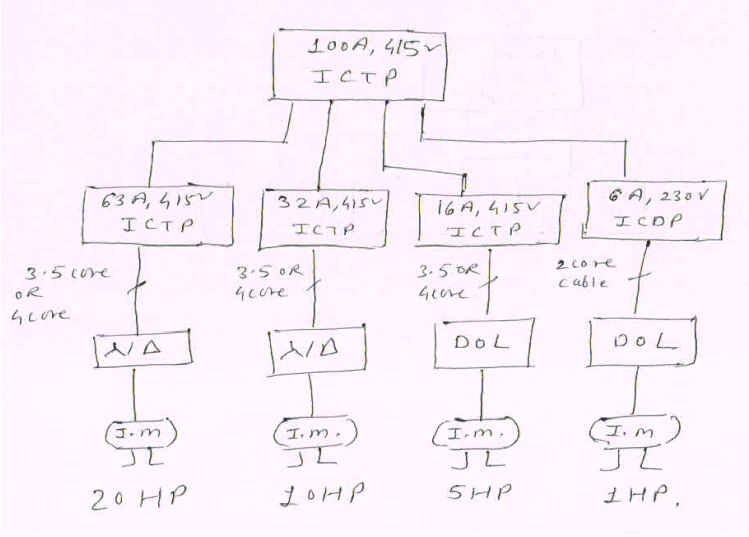


Fig. No. 1

Ans: **NOTE: Single 1-Ph Induction motor voltage should be 230V but in numerical 400V is given so assume any one and marks should be given**

(Diagram: 4 Mark)



or equivalent Ckt Digram

Following Ratings for ICTP, Starters, Cables with rating: **(Rating: 4 Mark)**

S.No	Motor rating	ICTP/ICDP	Type of Starter	Cable Size & Core of cable	P.F	Efficiency of Motor
1	For 3-Ph 20 HP 400V I.M:	450V, 63A	Star-Delta	3.5 core x 6 Sqmm	0.8	0.8
2	For 3-Ph 10 HP 400V I.M:	450V, 32A	Star-Delta	3.5 core x 4 Sqmm	0.8	0.8
3	For 3-Ph 5 HP 400V I.M:	450V, 16A	DOL	3.5 core x 2.5 Sqmm	0.8	0.8
4	For 1-Ph 1 HP 230V I.M:	250V, 6A	DOL	2 core x 2.5 Sqmm	0.8	0.8

OR

1. *For* $20HP$ *machine current* $I_L = \dfrac{HP \times 735.5}{\sqrt{3}\, V_L \times \eta \times Cos\varphi}$ ----------**(1/2 Marks)**

$$Rated\ input\ current\ I_L = \frac{20 \times 735.5}{\sqrt{3} \times 440 \times 0.8 \times 0.8} = \frac{14710}{443.392}$$

Rated /Full load Current in Motor:- = 33.17 Amp ----------**(1/2 Marks)**

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

Starting current = 2 x 33.17 = 66.34 Amp ---------- **(1/2 Marks)**

2. *For* $10HP$ *machine current* $I_L = \dfrac{HP \times 735.5}{\sqrt{3}\, V_L \times \eta \times Cos\varphi}$

$$Rated\ input\ current\ I_L = \frac{10 \times 735.5}{\sqrt{3} \times 440 \times 0.8 \times 0.8} = \frac{7355}{443.392}$$

Rated /Full load Current in Motor:- = 16.585 Amp ----------**(1/2 Marks)**

3. *For* $5\,HP$ *machine current* $I_L = \dfrac{HP \times 735.5}{\sqrt{3}\, V_L \times \eta \times Cos\varphi}$

$$Rated\ input\ current\ I_L = \frac{5 \times 735.5}{\sqrt{3} \times 440 \times 0.8 \times 0.8} = \frac{73553677.5}{443.392}$$

Rated /Full load Current in Motor:- 8.294 Amp -----**(1/2 Marks)**

4. *For* $1HP\ 1-Ph$ *machine current* $I_L = \dfrac{HP \times 735.5}{\sqrt{3}_{\ L} \times \eta \times Cos\varphi}$

$$Rated\ input\ current\ I_L = \frac{1 \times 735.5}{230 \times 0.8 \times 0.8} = \frac{735.5}{147.2}$$

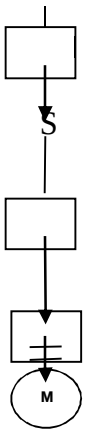
Rated /Full load Current in Motor:- = 4.99 or 5 Amp -----**(1/2 Marks)**

5. *For* $1HP\ \ 400V$ *machine current* $I_L = \dfrac{HP \times 735.5}{\sqrt{3}\, V_L \times \eta \times Cos\varphi}$

$$Rated\ input\ current\ I_L = \frac{1 \times 735.5}{\sqrt{3} \times 400 \times 0.8 \times 0.8} = \frac{735.5}{256}$$

Rated /Full load Current in Motor:- = 1.658 Amp ----------**(1/2 Marks)**

	Main Switch for Four Motor = Starting Current of highest rated m/c = full load current of remaining all m/c = 66.34 +16.585 + 8.29 + 5 = 96.215 Amp Rating of Main switch for all Motors = 100 Amps, 415 Volt---------- **(1/2 Mark)**
Q.6	**Attempt any FOUR of the following : 16 Marks**
a)	**Calculate the no of circuits for four, 3 phase, 10 HP, 400 V, squirrel cage induction motor. Justify your answer.**
Ans:	**Four 3-Ph ,10HP, 440V, Assumption P.f. of motor 0.8 & η = 0.8** **For Single Motor:** $Total\ power = Total\ H.P \times 735.5$ $For\ Machine: Rated\ input\ current\ I_L = \frac{HP \times 735.5}{\sqrt{3}\, V_L \times \eta \times Cos\phi}$ ----------**(1 Marks)** $Rated\ input\ current\ I_L = \frac{10 \times 735.5}{\sqrt{3} \times 440 \times 0.8 \times 0.8}$ **Rated /Full load Current in Motor:- = 16.66 Amp** ----------**(1/2 Marks)** It is assumed that starting current is two times rated input current. **Starting current = 2 x 16.66 = 33.32 Amp**---------- **(1/2 Marks)** So use, 6.0 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. **Starter Used:** Star-Delta Starter Similarly for the Four squirrel cage induction motors 4 Separate sub-circuits with separate star-delta starters are required. **Justification:** **(1 Marks)** This is for single squirrel cage induction motor for single sub-circuits and it is repeated for other four Motors also after the ICTP (Main switch) **i.e. there are four sub circuits.**



3-ph,4 wire 400v A.C. supply
Energy meter

Main Fuse

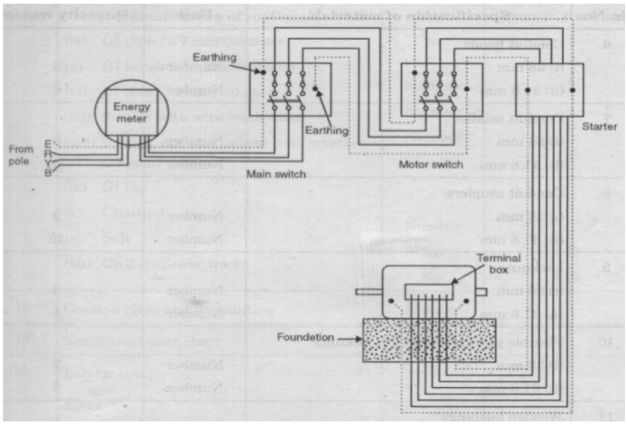
ICTP

Λ / Δ starter

15 HP 3 Ø Induction motor

OR

Wiring diagram – ----------**(1Marks)**



Or equivalent ckt dia

b) Also state 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)**

$$Rated\ input\ current\ I_L = \frac{HP \times 735.5}{\sqrt{3}\, V_L \times \eta \times Cos\phi}$$

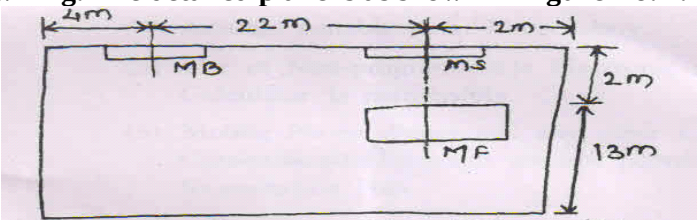
$$Rated\ input\ current\ I_L = \frac{.H.P \times 735.5}{\sqrt{3} \times 415 \times efficency \times P.f}$$

= …….. 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)**

c) In a workshop 10 h.p.(metric), 415 V, three phase, 50 Hz motor is to be installed.

	Prepare the estimate required for the motor installation assuming PVC surface conduct type of wiring. The detailed plane is as shown in Figure No. 2.  **Fig. No. 2**
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 735.5 = 7355 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 = 7355 / 0.8 = 9193.75 W **Step No. 3:-** To determine the rated current for I.M ---------- **(1/2 Mark)** $P = \sqrt{3}\, V_L\, I_L Cos\phi \qquad V_L = 400\, V$ $I_L = \dfrac{P}{\sqrt{3}\, V_L Cos\phi}$ $I_L = \dfrac{9193.75}{\sqrt{3} \times 400 \times 0.8} \qquad Cos\varphi = 0.8\ assumption$ $I_L = 16.587\ Amp \qquad Rated\ current = 16.587\ Amps$ **Step No. 4:-** To determine the size & core of cable:- ---------- **(1 /2Mark)** Starting current is assumed two times rated input current for starting surge, momentary short circuit & overload. Starting current = 2 x 16.587 = 33.175 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:-

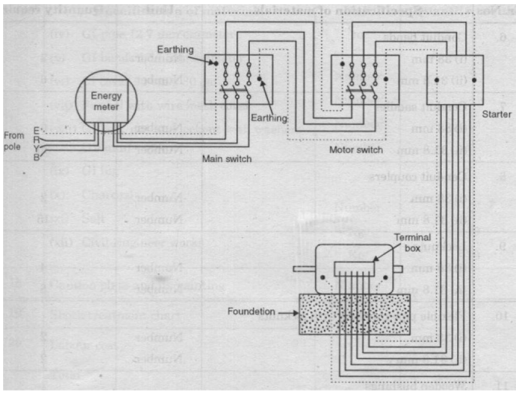
The rating of main switch is 450 V, 40 Amp ICTP ISI mark

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



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

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 23 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. 10 HP Star-delta starters.
18. 8 SWG copper or 6 SWG GI earthing wire, having the length of 50 Mtr.

d) Prepare a schedule of material for electrical wiring of industrial load as shown in figure No.1 of Q.5 (c)

Ans: **(Costing of material is not required marks are only allotted for Material list: 8 Point Expected Each Point: 1/2 Marks –Total 4 Marks)**

Schedule of Material: -

S.No.	Name of Material	Qty
1	63 A Busbar with Neutral link	01
2	3-ph,4 wire 415V, 60-80A, A.C. supply Energy Meter	01
3	ICTP 450V,100A	01
4	ICTP 450V,63A	01
5	ICTP 450V,32A	01
6	ICTP 450V,16A	01
7	Star-Delta Starter	03
8	DOL Starter	01
9	8 SWG Earthing Wire	50 Mtr
10	60 cm x 60 cm x 6.36 mm Copper Earthing Plate	01
11	Earthing Nut-bolt	04
12	Earthing Sundry	lumsump
13	36 x 36Wooden Board for SDB	03
14	24 x 24 Wooden Board for SDB	03
15	Screw 3 inch length	30 No
16	Screw 1 inch length	50 No
17	R,Y,B Indication Lamp	03
18	PVC Tape	04
19	Saddles	1 box
20	32mm PVC conduit (3 Mtr pipe) 1.5mm thickness	20 pipe
21	3.5 core x 6 Sqmm Al. armoured cable	40 Mtr
22	3.5 core x 4 Sqmm Al. armoured cable	20 Mtr
23	3.5 core x 2.5 Sqmm Al. armoured cable	60 Mtr

24	2 core x 1.5 Sqmm Al. armoured cable	40 Mtr
25	Steel Angle for SDB (2 Mtr length)	06
26	Nut bolt required for wooden board fitting	16
27	Junction Box	20 approx
28	4 x 6 Switch board with cutting	01
29	10 x 12 Switch board with cutting	02
30	Labour Charges	Lum sum
		Total Amount:-
31	Contingencies + profit margin	10 % Amount
		Total Amount:
	iii) Cost of Work:	Say Total Amount:

OR

1. *For* $20HP$ *machine current* $I_L = \dfrac{HP \times 735.5}{\sqrt{3}\, V_L \times \eta \times Cos\varphi}$ ----------**(1/2 Marks)**

$$Rated\ input\ current\ I_L = \frac{20 \times 735.5}{\sqrt{3} \times 440 \times 0.8 \times 0.8} = \frac{14710}{443.392}$$

Rated /Full load Current in Motor:- = 33.17 Amp ----------**(1/2 Marks)**

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

Starting current = 2 x 33.17 = 66.34 Amp ---------- **(1/2 Marks)**

2. *For* $10HP$ *machine current* $I_L = \dfrac{HP \times 735.5}{\sqrt{3}\, V_L \times \eta \times Cos\varphi}$

$$Rated\ input\ current\ I_L = \frac{10 \times 735.5}{\sqrt{3} \times 440 \times 0.8 \times 0.8} = \frac{7355}{443.392}$$

Rated /Full load Current in Motor:- = 16.585 Amp ----------**(1/2 Marks)**

3. *For* $5\,HP$ *machine current* $I_L = \dfrac{HP \times 735.5}{\sqrt{3}\, V_L \times \eta \times Cos\varphi}$

$$Rated\ input\ current\ I_L = \frac{5 \times 735.5}{\sqrt{3} \times 440 \times 0.8 \times 0.8} = \frac{73553677.5}{443.392}$$

Rated /Full load Current in Motor:- = 16.588.295 Amp -----**(1/2 Marks)**

4. *For* $1HP\ 1-Ph$ *machine current* $I_L = \dfrac{HP \times 735.5}{\sqrt{3}_{\ L} \times \eta \times Cos\varphi}$

$$Rated\ input\ current\ I_L = \frac{1\times 735.5}{230\times 0.8\times 0.8} = \frac{735.5}{147.2}$$

Rated /Full load Current in Motor:- = 4.99 or 5 Amp **-----(1/2 Marks)**

5. *For* 1*HP* 400*V* *machine current* $I_L = \frac{HP\times 735.5}{\sqrt{3}\,V_L\times\eta\times Cos\varphi}$

$$Rated\ input\ current\ I_L = \frac{1\times 735.5}{\sqrt{3}\times 400\times 0.8\times 0.8} = \frac{735.5}{256}$$

Rated /Full load Current in Motor:- = 1.658 or 2 Amp **-----(1/2 Marks)**

Main Switch fir Four Motor = Starting Current of highest rated m/c = full load current of remaining all m/c

= 66.34 +16.585 + 8.29 + 5

= 96.215 Amp

Rating of Main switch for all Motors = 100 Amps, 415 Volt---------- **(1/2 Mark)**

e) State the rating of lamps, Fan and socket outlet points used in residential installation.

Ans:

Rating of lamps, fan and socket outlet points used in residential installation: (4 Mark)

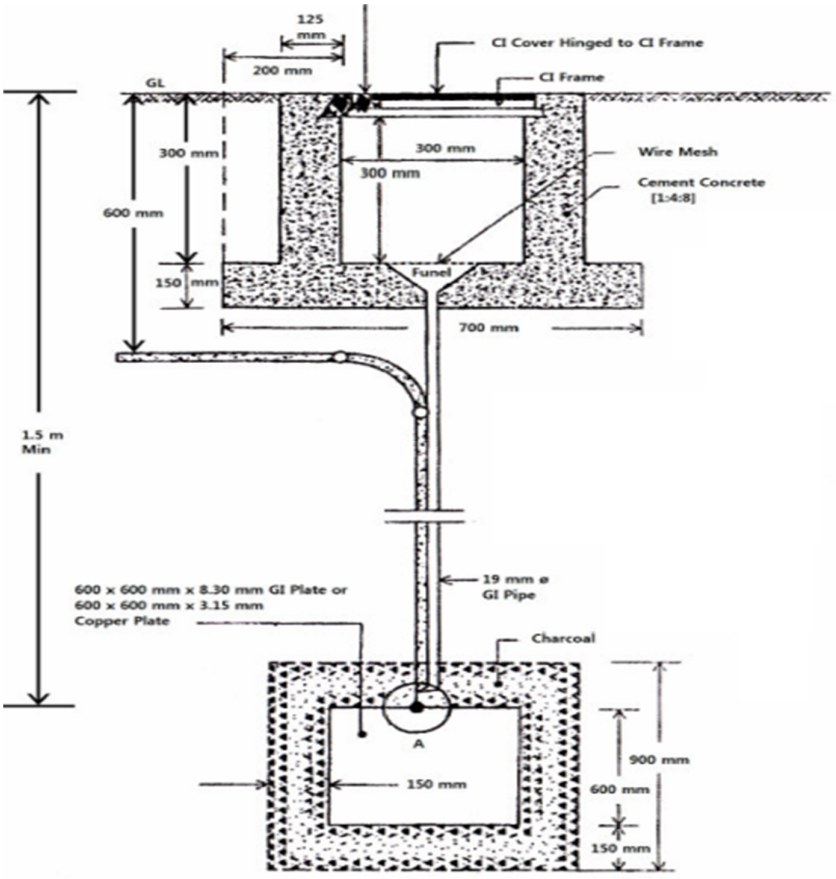
S.No	Points used in residential installation	Rating of Lamp
1	Lamps	40 watt or 60 watt
2	CFL	20 watt
3	LED	12 watt or 25 watt
4	Fan	60 watt or 100 watt
5	Socket outlet	Lighting socket: 100 watt Power socket : 1000 watt

f) State the need of earthing. Draw neat diagram of Plate earthing

Ans: **Need of earthing of commercial installation:** **(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 plate earthing : **(2 Marks)**



or equivalent figure

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