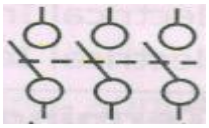
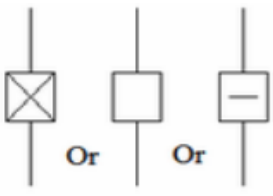
Important suggestions to examiners:

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)	**Classify electrical installation.**	
Ans:	**Types of Electrical Installation:** **(2 Marks)** i) Internal Electrical Installation : (Indoor Installation) ii) External Electrical Installation: (Outdoor Installation) **As per application there are three types** a) Residential Electrical Installation b) Commercial Electrical Installation c) Industrial Electrical Installation	
b)	**Draw symbols for: (i) ICTP (ii) OCB**	
Ans:	**i) ICTP :** **ii) OCB** **(Each Symbol : 1 Mark)**  	
c)	**Draw symbols for: (i) push button (ii) bell**	
Ans:	**i) Push Button:** **ii) Bell :** **(Each Symbol : 1 Mark)**  	

d) 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 consumers' main board or premises.

e) State different types of electrical wiring

Ans: **Types of Electrical wiring –** **(1/2 Marks for any four types)**

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 market rates for point wiring.

Ans: **Note: Marks should be given for any one of the column**

Market rates for point wiring: **(Each Type: 1 Mark)**

S.No	Types	With Material Per Point	Without material per point	Labour Charges per Point
1	PVC Casing Capping	Appxi. Rs. 300 to 500	Appxi. Rs. 80 to 120	Rs. 60 to 80
2	PVC Conduit wiring	Appxi. Rs. 200 to 400	Appxi. Rs. 60 to 100	Rs. 50 to 70

g) State any two differences between residential wiring and commercial wiring.

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

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

7	Sub-circuit	The lighting sub-circuit and power sub-circuit are separated	The lighting sub-circuit and power sub-circuit are separated
8	Power factor improvement	There is no need of power factor improvement device	If the power factor is poor then there is need of power factor improving device
9	Caution	There is no need of caution notice for residential installation	If supply voltage is equal to or more then 400V then there is need of caution notice

h) Explain why bus bar is required for larger installations.

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

- To provide proper connection of incoming line 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

For the above advantages bus bar is required for larger installation.

OR

The electrical load of commercial installation is large therefore 3-phase 4 wire power service connection is provided to satisfy the requirement of the entire load. Thus to distribute the load on this 3-phase four wire system, bas-bar chamber is used. Bus-bar is a copper or aluminum conductor (strip) to which number of inputs and number of outputs can be connected. Incoming and outgoing wires or cables are connected to bus-bar by screw and nut arrangement.

i) State difference between MCB and ELCB.

Ans: **(Any Four points expected: 1/2 Mark each)**

S.No	MCB	ELCB
1	Miniature circuit breaker operates automatically at the time of short circuit fault or over load	Earth Leakage circuit breaker operates automatically at the time of earth fault
2	The cost of the MCB is moderate	Cost of the ELCB is high compare to MCB
3	There is no need of replacement after tripping the MCB	There is no need of replacement after tripping the ELCB
4	MCB are designed for separate current rating	ELCB are designed for separate earth leakage current ratings

j)	**Define term 'industrial load'**
Ans:	**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
k)	**Write why rating of cable depends on starting current of induction motor connection.**
Ans:	**(2 Mark)** For any type of Induction Motor starter is required to minimize the starting current. In practice starting current is almost 5 to 7 times of rated current for fraction of seconds to sustain this heavy current size of cable is decided by the starting current. **Rating of cable depends upon following factors:** ➢ To sustain momentary short circuit fault. ➢ To sustain starting surge. ➢ To sustain 50 % over load on the motor. ➢ For future expansion. ➢ Permissible voltage drop in the cable Starting current is decided by the above factors. The starting current is assumed 1.5 to2 times of rated current for induction motor. According to size of cable is decided.
l)	**Explain why security deposit is to be deposited during tender process**
Ans:	**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 for small projects and it is 2 to 3 % for large projects. Security deposit is required for satisfactory completion of the project work from contractor. It is just as a guaranty of the project work for completion.

Q.2	**Attempt any Four of the following :** **16 Marks**
a)	**State commercial rate of each of following for per unit:** **(i) Single phase, 15 amp, ICDP (ii) Single phase, 15 A, MCB** **(iii) Flexible wire bundle (iv) Power three pin plug.**
Ans:	**(Each Rate : 1 Mark)**

S.No	Unit	Rate per unit
i)	Single phase, 15 amp, ICDP	Rs. 250/- to 300/-
ii)	Single phase, 15 A, MCB	Rs. 50/- to 200/-
iii)	Flexible wire bundle	Rs. 230/- to 700/-
iv)	Power three pin plug.	Rs. 20/- to 45/-

b) State different types of contract. Explain briefly each.

Ans: **(Any Four types with explanation expected: 1 Mark each)**

Different types of Engineering contract:-

1) **Lump sum contract**:
   - In this contract whenever both parties are known then project work is handed over from party No.1(Owner) to party No.2 (Contractor) for lump sum amount after the discussion and work is completed.
   - But if one of the or both parties are unknown then the quality of work may be reduces.
   - The time period for completion may delayed.
   - The lump sum contract may be uneconomical for both parties
2) **Item rate contract** :
   - This contract is more economical & advantages as compare to lump sum contract.
   - In this type of contract the whole project work is divided into number of various items & each item is separately charged.

3) **Cost + % rate contract**:
   - This type of contract is advantageous as compare to above two methods and it can be used for medium & large size of project.
   - In this type of contract the total material and labour cost is decided & according to the fixed & rate of profit margin of the contractor is decided & contract is handed over.
   - Sometimes it may uneconomical for both parties.
4) **Cost plus(+) percentage variable rate contract:**
   - It is similar to cost + percentage fixed rate contract. Only difference is that the profit margin of the contractor is variable.

	➢ It may change according to market condition i.e. why it is more economical for both parties. 5) **Material supply contract:** ➢ In this contract the contactor supplies various types of materials required for project work time to time as per requirements & specifications of party No.1 & billing is changed. 6) **Labour contract**: ➢ In this type of contract the various types of labours (skilled, unskilled, semiskilled labour) are provided by the contractor to the party No.1 time to time for completion of project work. 7) **Target rate contract**: ➢ In this type of contract the target of quantity, quality and time period is decided by party No.1 and then contract is handed over. 8) **Sub contract**: ➢ In this type of contract the main contract is handed over from party No.1 to party No.2 to carry the project work. ➢ But latter it the main contractor decided this project work in various number of items & each item is separately handed over to another contractor. This is subcontractor. ➢ In the sub-contracting quality of project work may be reduces. 9) **All in one contract**: ➢ It is the best contract among the all contract. But time required to decide the all in contract is very large hence it unsuitable for medium size & large size of project. 10) **D.G.S. of 'D' rate contract** (Director of general supplies or Disposal of central government contract): ➢ In this type of contract the total cost of project work is decided by the PWD (Public work Department) of government & contract is handed over. ➢ This type of contract is compulsory for government organizations, semi go, organizations & governments undertaking organizations. 11) **Cost plus(+) fluctuating fees rate contract:** in this contract contractor fee amount is variable.
c)	**State any four IE rules used in residential wiring installation.**
Ans:	**(Note: Similar to following rules any four Rules expected: 1 Mark each point)** 1. All electrics supply lines and apparatus shall be of sufficient in mechanical strength and size for the work they may be required to do and shall be conducted, install and protected in accordance with I.S.I,s specifications. 2. The electrical wire or conductor which is used for residential installation should not

be over heated at its rated load.

3. The permissible voltage drop in the wire should be proper (+ or – 5%)
4. The every metal point of the electrical device must be earthed.
5. The earth resistance should be maintained it should be very low or in between 5 to 8 ohm.
6. The switch board should be installed at the height of 1.2 meter to 1.3m from ground surface.
7. The main board should be installed at the height of 1.5m to 1.75 m from the ground surface.

OR

Following IE rules related to lighting loads followed in an electrical installation:-

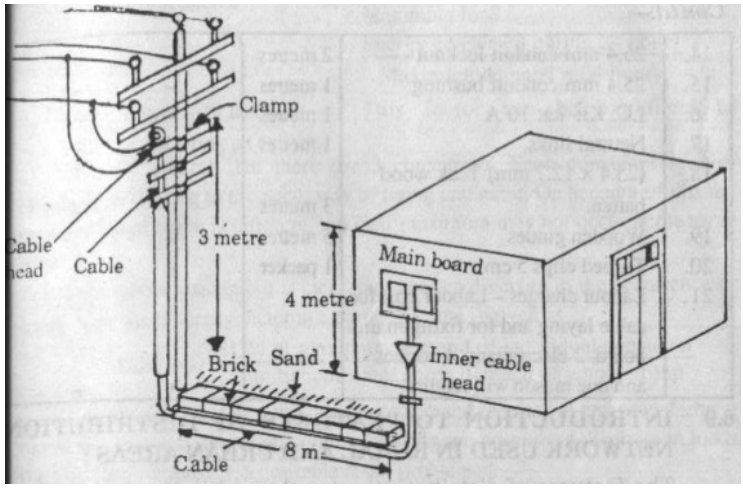
1. Every installation is to be properly protected near the point of entry of supply cables by a two-pole linked main switch and a fuse unit. In a two wire installation if one pole is permanently earthed, no fuse, switch or circuit breaker is to be inserted in this pole. A 3-pole switch and fuse unit is to be used in 3-ph supply.
2. The conductors used are to be such a size that it may carry load current safely.
3. The conductors installed are to be safe in all respects.
4. Every sub-circuit is to be connected to a distribution fuse board.
5. Every line (phase or positive) is to protected by a fuse of suitable rating as per requirements.
6. A switch board is to be installed so that its bottom lies 1.25 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 $= \frac{50\ M\Omega}{Number\ of\ outlet}$

d)	**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.
e)	**Draw a labelled diagram for underground service connection.**
Ans:	**b) Underground service connection:** **(4 Mark)**  **or equivalent figure**
f)	**Prepare a schedule of material for underground service connection for a residential load of single phase 1.5 kW**
Ans:	**(Minimum Eight point expected: ½ Mark each point)** **Scheduled of material for underground service connection is as follows:** 1. 2.5 Sqmm, 4 core Armored cable: (Size of cable is depends on load 1.5 KW. &

	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 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 nut, screws, and wooden board. etc
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:	**The principles of circuit design in lighting circuits**: **Lighting Circuit :-** **(2 Mark)** ➢ Each sub circuit should not have more than a total 10 points (including lights, fans and 5A socket outlet) ➢ Each sub circuit should not exceed 800 watts. ➢ 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 2000W for 1 to 2 points. (old rule) ➢ Make the no. of power sub circuits for power load.

	$$No.\ of\ \ power\ \ Sub\ circuits = \frac{Total\ electrical\ \ power\ load}{2000\,W\ \ or\ 3000\,W}$$ **OR** $$No.\ of\ \ power\ \ Sub\ circuits = \frac{Total\ \ No.of\ \ power\ \ point s}{2000\,W\ \ or\ 3000\,W}$$
b)	**State any six requirements of valid contract.**
Ans:	**Following requirements of valid contract:** **(First Two point: 1 Mark each & other Four 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 valid.
c)	**Explain why IE rules are framed and made compulsory for electric installations.**
Ans:	**(Note: Similar to following rules any four expected: 1 Mark each point)** **Reason for why IE rules are framed and made compulsory for electric installations:** ➢ Any type of electrical installations should be more simple & without any complications. ➢ The operations, control of any type of electrical installation should be more simple. ➢ The electrical installation should be safe from any electrical & mechanical accidents i.e. why the danger of electrical shock to operator or anybody should be avoided & the risk from fire hazard is also avoided. ➢ Due to IE rules the any type of installation should be unique, simple for maintenance & repair also. **OR** 1. All electrics supply lines and apparatus shall be of sufficient in mechanical strength and size for the work they may be required to do and shall be conducted, install and protected in accordance with I.S.I,s specifications. 2. The electrical wire or conductor which is used for residential installation should not be over heated at its rated load.

3. The permissible voltage drop in the wire should be proper (+ or – 5%)
4. The every metal point of the electrical device must be earthed.
5. The earth resistance should be maintained it should be very low or in between 5 to 8 ohm.
6. The switch board should be installed at the height of 1.2 meter to 1.3m from ground surface.
7. The main board should be installed at the height of 1.5m to 1.75 m from the ground surface.

OR (Expected any four points)

1. Every installation is to be properly protected near the point of entry of supply cables by a two-pole linked main switch and a fuse unit. In a two wire installation if one pole is permanently earthed, no fuse, switch or circuit breaker is to be inserted in this pole. A 3-pole switch and fuse unit is to be used in 3-ph supply.
2. The conductors used are to be such a size that it may carry load current safely.
3. The conductors installed are to be safe in all respects.
4. Every sub-circuit is to be connected to a distribution fuse board.
5. Every line (phase or positive) is to protected by a fuse of suitable rating as per requirements.
6. A switch board is to be installed so that its bottom lies 1.25 meters above the floor.
7. A plugs and socket-outlets are to be of 3-pin type, the appropriate pin of socket being connected permanently to the earthing system.
8. All incandescent lamps, unless otherwise required, are to be hung at a height of 2.5 meters above the floor level. And ceiling fans are to be hung 2.75 meters above the floor.
9. Lights and fans may be wired on a common circuit. Each sub-circuit is not to have more than a total of ten points of lights, fans and socket-outlets. The load on each sub-circuit is to be restricted to 800 watts. If a separate circuit is installed for fans only.
10. No fuse and switch is to be provided in earthed conductor.
11. Every circuit or apparatus is to be provided with a separate means of isolation such as a switch.
12. All circuit or apparatus requiring attention are to be provided with means of access to it.
13. In any building, light and fan wiring and power wiring are to be kept separate.
14. In 3-Phase, 4-wire installation the load is to be distributed equally on all phases.
15. No additional load is to be connected to an existing installation unless it has been ascertained that the installation can safely carry the additional load and that the

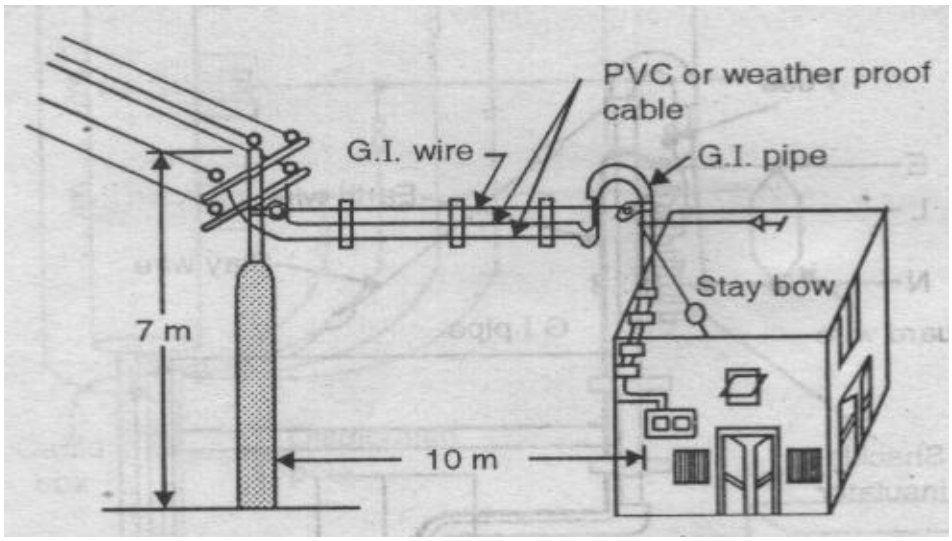
earthing arrangements are adequate.

16. Lamp holders used in bath rooms are to be constructed or shrouded in insulating materials and fitted with protective shield and earth continuity conductor is not to be size less than 7/0.915 mm.
17. The metal sheaths or conduits for all wiring and metal coverings of all consuming apparatus or applications is to be properly earthed in order to avoid danger from electrical shock due to leakage or failure of insulation.
18. Each sub-circuit is to be protected against excessive current (that may occur either due to over load or due to failure of insulation) by fuse or automatic circuit breaker.
19. All light conductors are to be insulated or otherwise safe guarded to avoid danger. After completion of work the installations are to be tested (the test are to be carried out as described) before energisation.
20. Earth Resistance : should be very low for domestic installation it should be equal to or less than 5 ohm to 8 ohm
21. Insulation Resistance between conductor : should be very high for domestic installation it should be equal to or more than 1 mega ohm or it should be not be less than $= \frac{50\ M\Omega}{Number\ of\ outlet}$

d) Draw a labelled diagram for overhead service connection.

Ans: **(Diagram- 4 Mark)**

Diagram of Overhead service connection:



or equivalent figure

e) Estimate cost of installation of overhead service connection for a residential load 1.5 kW, single phase.

Ans:

Following cost of installation of overhead service connection for a residential load 1.5KW: **(4 Mark)**

S.No	Schedule of Material	Quantity	Cost of Material Approxi	
1	2.5 Sqmm x 2 core PVC insulated cable or insulated wire	15 mtr length	250.00	
2	S shaped G I pipe 50 mm diameter	5 m	125.00	
3	Earth wire 8 SWG	15 m	75.00	
4	Meter board	01 Nos.	75.00	
5	Stay wire	3 m	20.00	
6	Stay insulator	01 Nos.	110.00	
7	cement	01 Bag	350.00	
8	sand	01 Bag	80.00	
9	Pipe clamp	03 Nos	75.00	
10	GI pipe	01 No	40.00	
11	Saddles for pipe fitting	Lumsum	50.00	
12	Screw required for pipe fitting	Lumsum	45.00	
13	Earthing sundry	-	500.00	
14	Earthing plate	01 Nos	390.00	
15	Bars nut bolt	02 Nos	20.00	
16	Miscellaneous	Lumsum	200.00	
		Total Amount:	**2405.00**	

f) State any eight major electrical equipments required in 11 kV HT substation.

Ans: **Eight major electrical equipments required in 11 kV HT substation:**

(Explanation is not expected Any eight Equipment expected-1/2 Mark each)

i) Busbar: - Bus bar is common conductor to which incoming & outgoing lines are connected. It is generally made from ACSR conductor. Cross section of conductor depends on current. In Substation, there are three bus bar:

1) Incoming bus bar (33KV/66KV)

2) Station bus bar (11 KV) 3) Outgoing bus bar (11KV)

ii) Power Transformer:- Its function is to step down the incoming voltage to outgoing voltage without change in frequency.

iii) Auxiliary Transformer: - Its function is to step down the input voltage (11 KV) to distribution voltage (3-ph, 4wire, 440V) to give supply to control room, area lighting, staff quarters etc,

iv) Lighting Arrester: - It is provided for protection of substation, transformer against lighting stroke

v) Earth switch: - It is used for safety purpose. It is closed during maintenance to discharge capacitor.

vi) Isolator: - Its function is to isolate the circuit whenever required. e.g at the time of maintenance.

vii) Circuit Breaker: - It is protective device. It open or break the circuit whenever there is fault & protect the equipment.

viii) Relay: It sense that faults & gives signal to tripping circuit of C.B to open.

ix) Instrumental Transformer (CT & PT):- C.T & P.T are used for measurement of electrical quantities also C.T. is used for protection purpose.

x) Horn Gap Fuse: - It is provided to primary side of transformer for protection against over current

xi) Control Room: - It is construction near switchyard in which control panel is installed from which various circuits are controlled by operator.

xii) Control Panel: - Control panel consists of different types of relays to detect different types of faults.

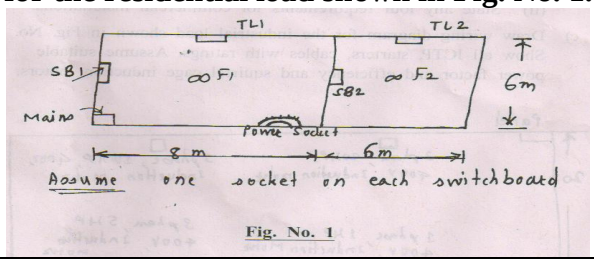
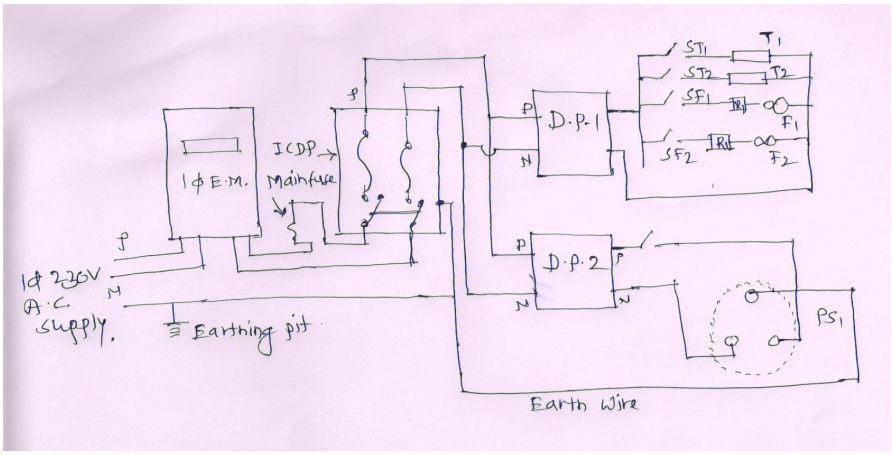
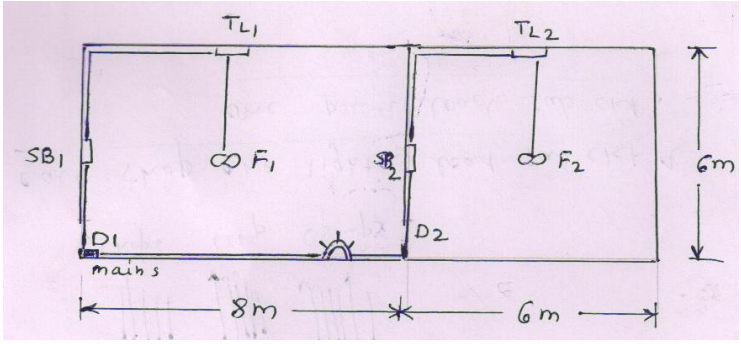
xii) PLCC (Power Line carrier communication):- It is used for direct communication between substations to generating station also between two major substations. For this purpose same transmission line carries communication signal.

xiii) Series Reactor: - To limit the short circuit current

xiv) Shunt Reactor: - It supplies lagging KVAR to control voltage of transmission line.

xv) Series Capacitor: - It supplies leading KVAR

xvi) Shunt Capacitor: - For power factor improvement.

Q.4	**Attempt any FOUR of the following :** **16 Marks**
a)	**Draw wiring diagram for the residential load shown in Fig. No. 1.**  Fig. No. 1
Ans:	**Wiring Diagram for residential Load:**  or equivalent figure
b)	**Calculate total length of conduit and total length of conductor for PVC conduit wiring for the residential load mentioned in Fig. No. 1 of Q. 4 (a).**
Ans:	**Note: According assumptions the answer may vary give marks accordingly:** **Assumptions:** 1. Mains at the height of 3.5 meters considering ceiling height 4 meters 2. Conduit runs at the height of 3 meters. 3. Switch Board at the height of 1.5 meter from ground level and at the centre of the wall. 4. Tubes at the height of conduit run i.e 3 meters 5. Power socket at the height of 1.5 meter and 1 meter away from the nearby wall 6. D_1 & D_2 are the doors shown in figure and its weight 1 meter & height 2 meters  or equivalent figure

i) **Length of Conduit:**

= 0.5+3+1.5+3+4+1+3+0.5+8+1.5+3+1.5+3+3+1+3+10 % (extra)

= 40.5 + 10 %

= 44.5 Mtr

= Appri. 45 Mtr ---------- **(1/2 Mark)**

OR

= (4-1.2-0.3 x 4) +8+6+3+6+2+0.3+4+6+ 10 % (extra)

= 45.3 + 10 %

= 49.8 Mtr

= Appri. 50 Mtr ---------- **(1/2 Mark)**

ii) **Length of Conductor for Lighting Load 1.0 Sqmm copper wire are used :**

= 45 x 3 +20 % extra

= 135 + 27

= 162 or 165 mtr ---------- **(1/2 Marks)**

OR

= 50 x 3 as per the thumb rule in neutral looping system

= 150

= 150 mtr ---------- **(1/2 Marks)**

iii) **Length of Conductor for Power Wiring 2.5 Sqmm copper wire are used :**

= 9 x 3 +20 % extra

= 27 + 5.4

= 32.4 or 35 mtr ---------- **(1/2 Marks)**

OR

= {(4-1.5-0.3) + 7 +(4-1.2-0.3)} x3 as per the thumb rule in neutral looping system

= 2.2+7+2.5 x 3

= 11.7 x 3

= 35.1 or 35 mtr ---------- **(1/2 Marks)**

c)	**State any four requirements of good cable.**
Ans:	**four requirements of good cable: (Any Four requirement are expected: 1 Mark each)** 1. Size and core of cable should be proper. 2. Quality of cable should be proper. 3. Cable should not be over heated at rated load. 4. Voltage drop in the cable should be within permissible limit. 5. Cable should be weather and moisture proof. 6. The cost of cable should be less.
d)	**Write complete procedure of submission and opening of a tender.**
Ans:	**Procedure of submission Procedure 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 envelop 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 **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. **OR** ➢ 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.
e)	**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
f)	**Explain how comparative statement is prepared after opening of tender.**
Ans:	**After opening of all tenders , details in all tenders are written in only one page i.e. in one look and then comparision is made.** **Following conditions are verified in comparative statement:** **(Any Four 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.

Q.5	Attempt any TWO of the following : 16 Marks
a)	**A three storeyed building has 18 shops on each floor. Each shop has electrical load of 2 fans, 4 tube lights, one power socket, one light power socket. Draw complete wiring diagram of above load.**
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)

$$Total\ \ load\ in\ \ One\ Shop = tubes \times watt\ \ = 04 \times 40 = 160\,W$$

$$= Fans \times watt\ \ = 02 \times 60 = 120\,W$$

$$= Sockets \times watt = 01 \times 100 = 100\,W$$

$$= \ Power\ Sockets \times watt = 01 \times 1000 = 1000W$$

$$Total\ load\ in\ \ One\ Shop = tubes\ in Watt + Fans\ in\ Watt + Socket\ \ in\ watt + Power\ Sockect$$

i) $Total\ load\ in\ \ one\ Shop = 160 + 120 + 100 + 1000 = 1380\ watt$ ---------- **(1 Mark)**

$Total\ load\ in\ \ one\ shop\ \ Amps = \dfrac{1380}{230} = 6.66\ Amp \quad assu\min g\ \ p.f. = 0.9$ ---- **(1/2 Mark)**

ii) $Total\ load\ in\ \ = \dfrac{380}{800} = 0.475 \cong 1\ \ Nos\ lighting\ sub\ circuit$ ---------- **(1/2 Mark)**

iii) $Total\ load\ in\ \ = \dfrac{1000}{2000} = 0.5 \cong 1\ Nos\ \ \ Power\ sub\ circuit$ ---------- **(1/2 Mark)**

iv) $Total\ load\ in\ \ one\ \ floor = Total\ Shop \times Total\ load\ in one\ shop$ -------- **(1/2 Mark)**

$$Total\ load\ in\ \ one\ \ floor = 18 \times 1380$$

$$Total\ load\ in\ \ one\ \ floor = 24840\ \ Watt$$

$$Total\ load\ in\ \ one\ \ floor = 24.840KW$$

v) $Total\ load\ in\ \ One\ Floor\ in\ Amp = \dfrac{24840}{\sqrt{3} \times 415 \times 0.9}$

$$Total\ load\ in\ \ One\ Floor\ in\ Amp = \frac{24840}{646.902}$$

$Total\ load\ in\ \ One\ Floor\ in\ Amp = 38.398\ Amp$ ---------- **(1 Mark)**

vi) Total Load in Building = 3 floor x 1 floor total Load

= 3 x 24840

= 74520 watt

= 74.520 KW

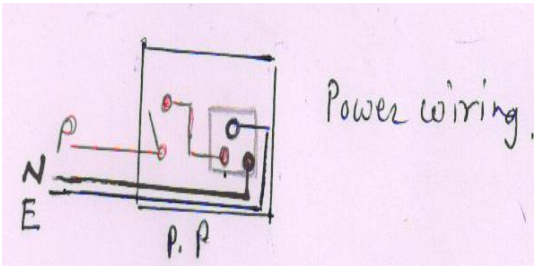
vii) $Total\ load\ in\ \ building = \frac{74520}{\sqrt{3} \times 415 \times 0.9}$

$Total\ load\ in\ \ building = \frac{74520}{646.902}$

$Total\ load\ in\ \ building = 115.195 Amp$ ---------- **(1 Mark)**

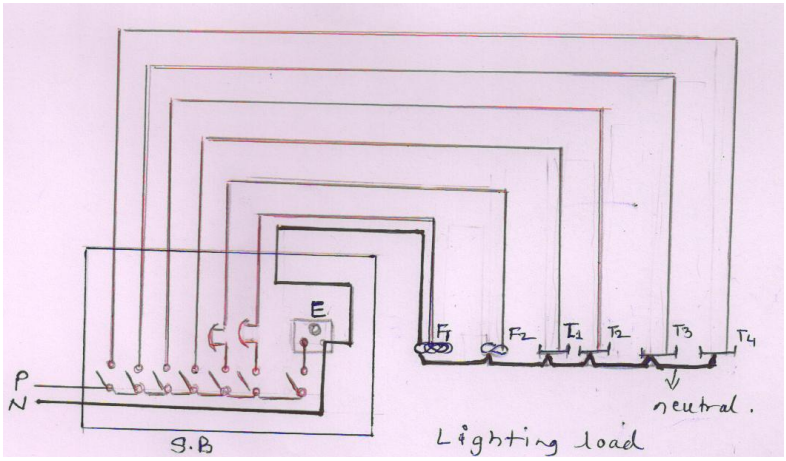
- For each floor 3-ph, 415 V, 4 Wire is to be supplied.
- On every phase 6 Shops are connected for every storeyed building.

Wiring Diagram for Power Circuit:- **(1-Marks)**



or equivalent figure

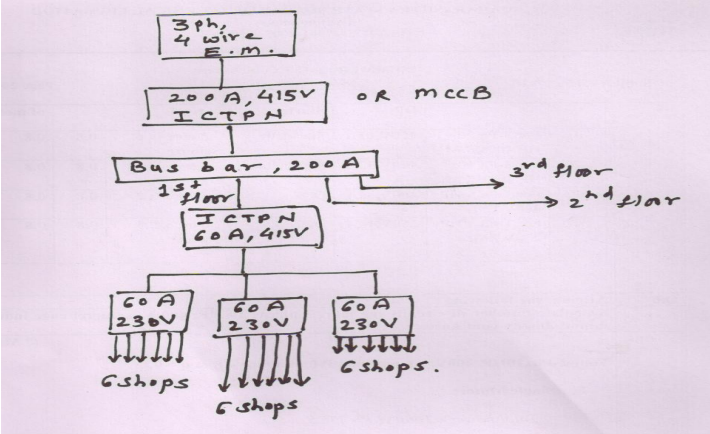
Wiring Diagram for Lighting circuit in one shop:- (Similar to other shop & Building floor) **(1-Marks)**



or equivalent figure

or equivalent figure

Wiring Diagram for Main Board & Circuit: **(1-Marks)**



or equivalent figure

b) **(i) State any four differences between wire and cable.**
(ii) State any four requirements for commercial installations.

Ans: **i) Differences between wire and cable :** **(Any Four Point expected: 1 Mark each)**

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.

(Any Four requirements are expected: 1 Mark each point)

ii) Four requirements of commercial building.-

1) Find out the total electrical load for the given commercial installation.
2) Differentiate this total electrical load in lighting load and power load.
3) Find out 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) Find out power sub circuits for power load.

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

OR

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

5) Find out the type of load and Power factor of commercial installation.
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) Find out total power consumption of every lighting and power sub circuits.
8) Determine the size of wire required for every sub circuit by considering overload starting surge and future expansion.
9) Balance the load on every phase for commercial installation.

OR

1)Safe precautions
2)Fire extinguishers
3) Smoke detection system
4)Fire alarm System

c) Draw wiring diagram for the industrial load shown in Fig. No. 2. Show all ICTP, starters, cables with ratings. Assume suitable power factor and efficiency and squirrel cage induction motors.

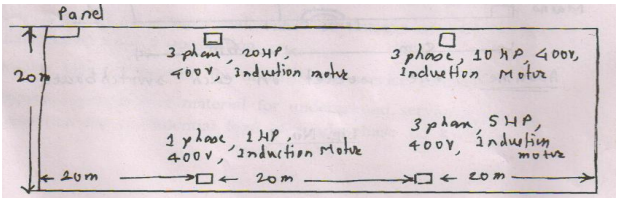
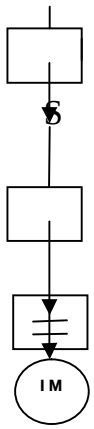


Fig. No. 2

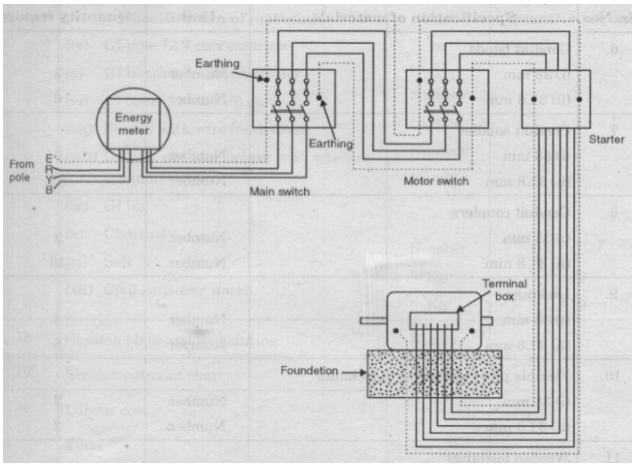
Ans: **NOTE: Single 1-Ph Induction motor voltage should be 230V but in numerical 400V is given so assume any one and marks should be given**

(Diagram: 2 Mark)



3-ph,4 wire 400v A.C. supply
Energy meter
Main Fuse
ICTP
Star-delta starter
3 Ø Squirrel cage Induction motor **OR**

Wiring diagram – **(2 Mark)**



Or equivalent ckt dia

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,32A	DOL	3.5 core x 2.4 Sqmm	0.8	0.8
4	For 1-Ph 1 HP 230V I.M:	250V,10A	DOL	2 core x 2.5 Sqmm	0.8	0.8

Q.6 **Attempt the following :**

a) **Calculate number of circuits for four, 3 phase, 10 HP, 400 V, squirrel cage induction motor. Justify your answer.**

Ans: **Four 3-Ph ,10HP, 400V, Assumption P.f. of motor 0.8 & η = 0.8** **(1 Marks)**

For Single Motor:

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

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

$$Rated\ input\ current\ I_L = \frac{10 \times 735.5}{\sqrt{3} \times 400 \times 0.8 \times 0.8}$$

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)

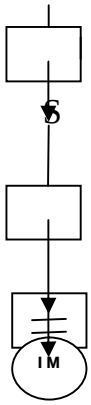
So use, 6.0 Sqmm , 3 ½ core cable Aluminum 1/ 2.80 mm , 600V grade should be selected rating of SFU, ICTP switch is 16A, 450V grade should be selected.

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 for single squirrel cage induction motor for single sub-circuits and it is repeated for other four Motors also after the ICTP (Main switch)



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

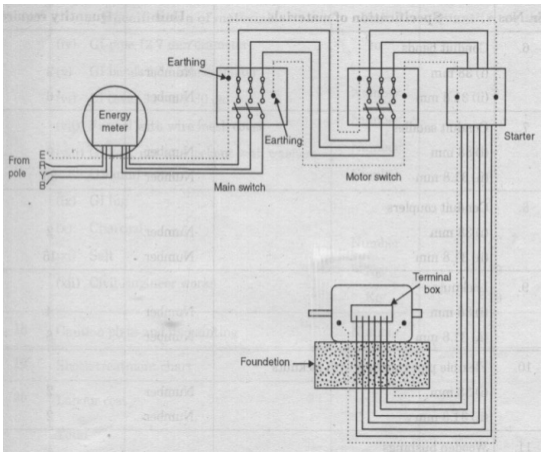
Main Fuse

ICTP

$tar-delta starter

3 Ø Squirrel cage Induction motor **OR**

Wiring diagram – ----------(1Marks)



Or equivalent ckt dia

b)	**Attempt any ONE of the Following** **12 Marks**
b)	**i) Prepare a schedule of material for the electrical wiring of residential load shown in Fig. No. 1 of Q. 4 (a).**

Ans:

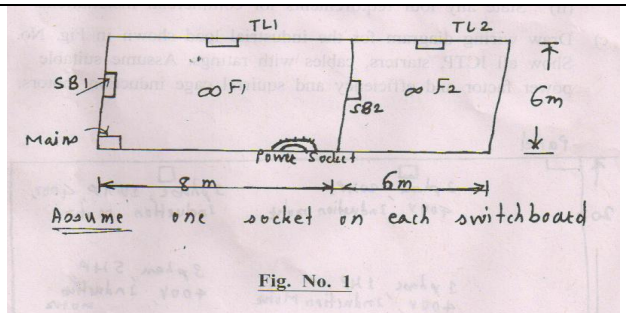


Fig. No. 1

(Costing of material is not required marks are only allotted for Material list: 12 Point Expected Each Point: 1 Marks –Total 12 Marks)

S.No	Material of Material	Quantity
1	ICDP 250V,40A	01 No
2	6A MCB for lighting load	04 No
3	PVC conduit (3 Mtr pipe) 1.5mm thickness	20 pipe
4	Copper Earthing Plate	01 No
6	DP	01 No
7	Earthing Sundry	lumsump
8	6A Switch	06 No
9	6A Three point socket	02 No
10	15A Three pin socket with indicator fuse	01 No
11	15A Three pin socket with indicator fuse	01 No
12	Ceiling rose	04 No
13	2.5 Sqmm PVC wire Running earth	30 Mtr
14	1 Sqmm PVC wire with earth wire (90 Mtr -1 bundle)	02 Bundle
15	Junction Box	06 approx.
16	6 x 8 Switch board with cutting	02
15	6 x 4 Switch board with cutting	01
17	Labour Charges	Job
		Total Amount :-
18	Contingencies+ profit margin	10% Amount:-
		Total Amount:-
	iii) Cost of work:	Say Total Amount:

b) ii) Prepare a schedule of material for electrical wiring of industrial load shown in Fig. No. 2 of Q. 5 (c).

Ans: **(Costing of material is not required marks are only allotted for Material list: 12 Point Expected Each Point: 1 Marks –Total 12 Marks)**

Schedule of Material: -

S.No	Material of Material	Quantity
1	63 A Busbar with Netural 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	ICDP 250V,16A	01
7	Starter Delta-Starter	03
8	DOL Starter	01
9	8 SWG Earthing Wire	50 Mtr
10	60 cm x 60cm x6.36 mm Copper Earthing Plate	01
11	Earthing nut-board	04
12	Earthing Sundry	lumsump
13	36 x36 Wooden Board for SDB	03
14	24 x 24 Wooden board	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	25 PVC conduit (3 Mtr pipe) 1.5mm thickness	20 pipe
21	6 Sqmm x 3.5 Al. core aramoured cable	20 Mtr
22	4 Sqmm x 3.5 Al.core aramoured cable	40 Mtr
23	2.5 Sqmm x 3.5 Al. core aramoured cable	60 Mtr
24	1.5 Sqmm x 2 Al.core armoured cable	40 Mtr
25	Steel angle for SDB (2 Mtr length)	06
26	Nut board 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	30
		Total Amount :-
31	Contingencies+ profit margin	10% Amount:-
		Total Amount:-
	iii) Cost of work:	Say Total Amount:

OR

1. *For* 20 *HP Machine* : *Rated input current* $I_L = \frac{HP \times 735.5}{\sqrt{3}\, V_L \times \eta \times Cos\phi}$ ------ **(1 Mark)**

$$Rated\ input\ current\ I_L = \frac{20 \times 735.5}{\sqrt{3} \times 400 \times 0.8 \times 0.8} = \frac{14710}{443.392}$$

$$Rated\ input\ current\ I_L = 33.17\ Amp$$ ---------- **(1 Mark)**

Starting Current: 2 x 33.17 = 66.34---------- **(2 Mark)**

2. *For* 10 *HP Machine* : *Rated input current* $I_L = \frac{HP \times 735.5}{\sqrt{3}\, V_L \times \eta \times Cos\phi}$

$$Rated\ input\ current\ I_L = \frac{10 \times 735.5}{\sqrt{3} \times 400 \times 0.8 \times 0.8} = \frac{7355}{443.392}$$

$$Rated\ input\ current\ I_L = 16.585\ Amp$$ ---------- **(1 Mark)**

3. *For* 5 *HP Machine* : *Rated input current* $I_L = \frac{HP \times 735.5}{\sqrt{3}\, V_L \times \eta \times Cos\phi}$

$$Rated\ input\ current\ I_L = \frac{5 \times 735.5}{\sqrt{3} \times 400 \times 0.8 \times 0.8} = \frac{3677.5}{443.392}$$

$$Rated\ input\ current\ I_L = 8.29\ Amp$$ ---------- **(1 Mark)**

4. *For* $1HP, 1-Ph$ *Machine* : *Rated input current* $I_L = \frac{HP \times 735.5}{V_L \times \eta \times Cos\phi}$

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

$$Rated\ input\ current\ I_L = 4.99 \cong 5 Amp$$ ---------- **(1 Mark)**

5. *For* $1HP$, $400V$ *Machine* : *Rated input current* $I_L = \frac{HP \times 735.5}{\sqrt{3} \times V_L \times \eta \times Cos\phi}$

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

$$Rated\ input\ current\ I_L = 1.658 \cong 5 Amp$$ ---------- **(1 Mark)**

Main Switch for Four Motor = Starting current of highest rated m/c + full load current of reaming all m/c ----------**(1 Mark)**

= 66.34 +16.585 +8.25 +5

= 96.215---------- **(1 Mark)**

Rating of main switch for all Motors = 100 Amp, 415Volt ---------- **(2 Mark)**

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