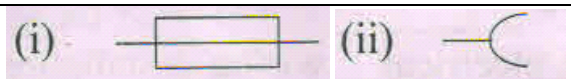
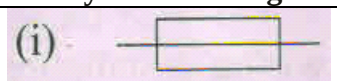
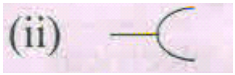
**Important suggestions to examiners**:

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)** | **Identify the following IS symbols :**   |
| Ans: |   **: Fuse** **( Each Symbol: 1 Mark)**<br>   **: 5A OR 6A Socket** |
| **b)** | **State the function of stay insulator and service pole.** |
| Ans: | **i) Stay insulator:** To insulate the stay wire from live mains or leakage current of pole and to give proper tension to stay wire **(1 Mark)**<br>**ii) Service pole:** To provide the service connection to the consumers. **(1 Mark)** |
| **c)** | **State the purpose of MCB in residential installation.** |
| Ans: | **purpose of MCB in residential installation**: - **(2 Mark)**<br>➢ Function of MCB is to trip the circuit when there is over load and short circuit fault.<br>➢ At normal condition it acts as a switch. |
| **d)** | **State two factors deciding size of conduit.** |
| Ans: | **Following factors deciding size of conduit:** **(2 Mark)**<br>1) Types of wiring method<br>2) No. of wires carried out through conduit |

| | |
|---|---|
| | 3) Size of wires required for sub circuits which is carried out through conduit<br>4) Future expansion |
| **e)** | **Give four examples of commercial unit.** |
| Ans: | **(Any four types are expected: 1/2 Mark each)**<br>**Examples of commercial Installation: (Any four examples expected)**<br>1) Hospital<br>2) Schools<br>3) Colleges<br>4) Banks<br>5) Shopping malls<br>6) Large temples<br>7) Auditorium<br>8) Cinema theaters<br>9) Show-rooms etc. |
| **f)** | **Define bus bar and state its use.** |
| Ans: | **Meaning of Bus-bar**: - **(1 Mark)**<br>Busbar means aluminums or copper strip where incoming & outgoing lines are connected. **OR** Sometimes stranded aluminums or copper conductors<br>**Use of Bus-bar**: - Distribute the load on 3-phase four wire systems. **(1 Mark)** |
| **g)** | **State two features of industrial loads.** |
| Ans: | **Following are the features of industrial loads: ( Any two point expected: 1 Mark each)**<br>1. Due to wide use of induction motors power factor is lagging.<br>2. At the time of light load if the power factor improvement capacitor is connected then P.f is leading.<br>3. Generally P.F. is near about unity if it is maintained.<br>4. Industrial load is combination of resistive, inductive and capacitive loads.<br>5. For industrial loads the tariff is different |
| **h)** | **State the meaning of security deposit.** |
| Ans: | **Security Deposit (SD):-** **(2 Marks)**<br>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. |

| | |
|---|---|
| **i)** | **Define the term 'Tender'.** |
| Ans: | **Meaning Tender:-** **(2 Marks)**<br>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). |
| **j)** | **State the importance of electrical drawing.** |
| Ans: | **Importance of electrical drawing-** **(Any Two point expected 1 Mark each)**<br>By the electrical drawing following advantages in electrical installation are obtained.<br>1) Simplicity of installation increases.<br>2) Uniqueness also increases.<br>3) Better understanding at the time of installation, repairing and maintenance of the work is possible.<br>4) Time required for installation will be less.<br>5) Space required will be also less if the drawings are correct. |
| **k)** | **Give the classification of electrical installation on the basis of location and purpose.** |
| Ans: | **Classification of electrical installation on the basis of location:** **( 1 Marks)**<br>i) Internal Electrical Installation : ( for example: Any Indoor Installation)<br>ii) External Electrical Installation: (for example: Any Outdoor Installation)<br>**Classification of electrical installation on the basis purpose:** **( 1 Marks)**<br>a) Residential Electrical Installation : e.g. Domestic, home wiring<br>b) Commercial Electrical Installation: e.g College, Mall, Hospital<br>c) Industrial Electrical Installation : Small scale industry |
| **l)** | **Define service connection.** |
| Ans: | **Service Connection:-** **( 2 Marks)**<br>It is the input conductor or wire which is carried out from supply company (authorities) pole to consumers' main board or premises. |

| Q.2 | Attempt any Four of the following : 16 Marks |
|---|---|
| a) | State the types of wiring and explain one in brief. |

**Ans:** **(Any four types are expected: 1/2 Mark each)**

**List the types of Internal wiring in residential installations –**

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

**Explanation :** **( Any one types of explanation are expected: 2 Marks)**

**1) Cleat wiring:**

The cost of wiring is less. The PVC or VIR wires are carried through porcelain cleats. This wiring is very simple and used for temporary application. The wires are exposed to the sky, so there are chances of mechanical injury. This type of wiring is rarely used.

**2) Batten Wiring:**

The cost of wiring is also less but more than cleat wiring. The PVC or VIR wires are carried through batten. This wiring is very simple and now a day it is rarely used. More number of wires can be carried through the batten. Wires are exposed to the sky, so there are chances of mechanical injury. Fault finding is easy.

**3) Wooden Casing capping wiring:**

The cost of wiring is more. The PVC or VIR wires are carried through wooden casing capping. This wiring is very simple but due to high cost and now a day it is rarely used. More number of wires can be carried through the wooden casing capping. Wires are not exposed to the sky, so there are less chance of mechanical injury but these type of wiring catch the fire easily.

**4) PVC Conduit wiring:**

The cost of wiring is less. The PVC or VIR wires are carried through PVC conduit. This wiring is very simple. More number of wires can be carried through the different size of PVC conduit. Wires are not exposed to the sky, so there are less

chances of mechanical injury. future expansion is not easily possible.

**5) PVC Casing Capping:**

The cost of wiring is slightly more. The PVC or VIR wires are carried through PVC casing capping. This wiring is very simple so it is widely used. More number of wires can be carried through the different size of PVC casing capping. Wires are not exposed to the sky, so there are less chances of mechanical injury. Future expansion is possible and repairing and maintenance is easily possible.

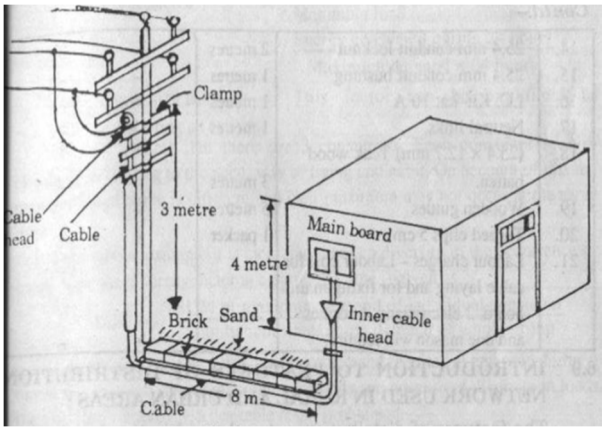
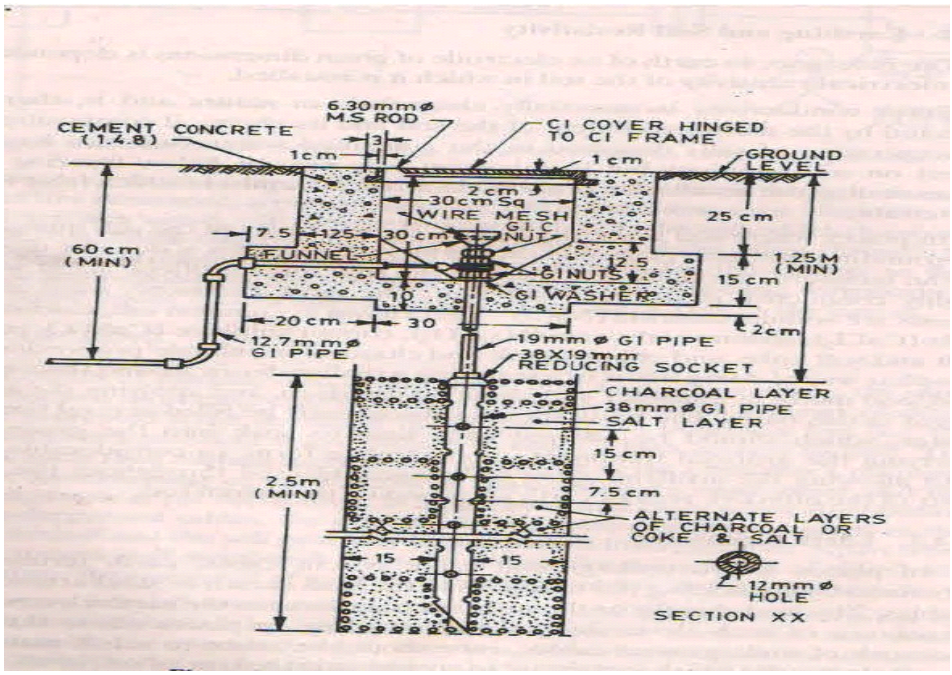
**6) Concealed wiring:**

The cost of wiring is very high. The PVC or VIR wires are carried through the channels made in ceilings and walls at the time of building construction. This wiring is slightly difficult but appearance is very good, so it is widely used. More number of wires can be carried through the different size of channels. Wires are not exposed to the sky, so there are less chances of mechanical injury. Fault finding is difficult. Future expansion is not possible and repairing and maintenance difficult.

**b) Compare overhead service connection to underground service connection. (four points)**

**Ans:** **( Each Point : 1 Mark)**

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

| | |
|---|---|
| **c)** | **Draw a neat labelled diagram for underground service connection.** |
| **Ans:** | **Underground service connection:** **(Diagram : 4 Marks )**<br>  <br><br>or equivalent figure |
| **d)** | **Draw a neat labelled diagram of pipe earthing.** |
| Ans: | **Diagram for Pipe Type earthing :** **( 4 Marks)**<br>  <br><br>**or equivalent figure** |
| **e)** | **State and explain the principles of circuit design in lighting and power circuits.** |
| Ans: | **The principles of circuit design in lighting and power circuits**:<br>**Lighting Circuit :-** **(2 Mark)**<br>➢ Each sub circuit should not have more than a total 10 points (including lights, fans and 5A socket outlet)<br>➢ 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.

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

**OR**

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

**f) Explain the need and method of earthing of commercial installation.**

Ans:

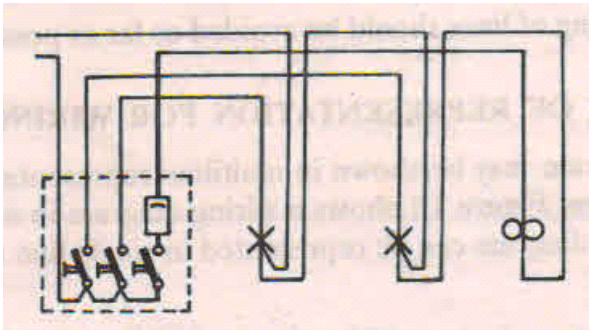
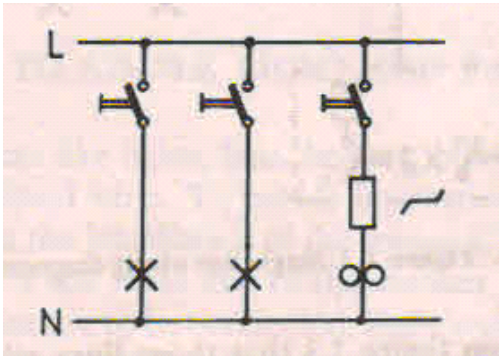
**Need of earthing of commercial installation:** **( 2 Marks)**

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.

**Method of earthing of commercial installation:** **( 2 Marks)**

- Earthing of commercial installation is very necessary to save the human life at the time of ground fault. Two types of methods are preferred for earthing.

  1) Plate type earthing 2) Pipe type earthing
- Earth resistance for commercial installation should be in between 5 to 8 ohm or less than it. This earth resistance is measure by: i) potential drop method and ii) Earth tester method. Earth resistance is maintained by pouring of water in earthing pit.
- Size of earth wire is 18 SWG copper or 16 SWG GI for lighting load.
- Size of earth wire is 8 SWG copper or 6 SWG GI for power/ machine load.

| Q.3 | Attempt any FOUR of the following : 16 Marks |
|---|---|
| a) | **Define the following terms as per IS: (i) Wiring diagram (ii) Schematic diagram** |
| Ans: | **(i) Wiring diagram :** **(2 Marks)**<br>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.<br>**For example:**<br>  <br>**(ii) Schematic diagram:** **(2 Marks)**<br>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.<br>**For example:**<br>  |
| b) | **Prepare a schedule of material for overhead service connection for a residential load of single phase 3 kW from a service pole located at a distance of 60 m.** |
| Ans: | **(Minimum Eight point expected: 1/2 Mark each point)**<br>**Scheduled of material for overhead service connection for a residential load as follows:**<br>Two types of overhead service connection are used:<br>1) By using weather proof PVC Cable:<br>2) By using bare overhead conductors when the distance is more than 45 meter from the distribution pole |

**1) By using weather proof PVC Cable:**

1. 4 Sqmm x 2 core PVC insulated cable or insulated wire 70 mtr length : (Size of cable is depends on load 3 KW. & length of cable is depends on service connection premises)
2. S shaped G I pipe 50 mm diameter 5 m
3. Earth wire 8 SWG 70 m
4. Meter board 01 Nos.
5. Stay wire 3 m
6. Stay insulator 01 Nos.
7. cement 01 Bag
8. sand 01 Bag
9. Pipe clamp 03 Nos
10. GI pipe 01 No
11. Saddles for pipe fitting Lumsum
12. Screw required for pipe fitting Lumsum
13. Earthing sundry
14. Earthing plate 01 Nos
15. SWG GI Wire
16. Brass nut bolt 02 Nos
17. Miscellaneous

**OR**

**2) By using bare overhead conductors:**

1. 2.5 Sqmm x 2 core PVC insulated cable or insulated wire approximately 6 mtr length: (Size of cable is depends on load 3 KW. & length of cable is depends on service connection premises)
2. 6 Sqmm Bare stranded conductor ( 130 Meter)
3. 8 SWG GI Wire (60 meter) or Earth wire 8 SWG 70 m
4. S shaped G I pipe 50 mm diameter 5 m
5. Meter board 01 Nos.
6. Stay wire 3 m

| | |
|---|---|
| | 7. Stay insulator 01 Nos.<br>8. cement 01 Bag<br>9. sand 01 Bag<br>10. Pipe clamp 03 Nos<br>11. GI pipe 01 No<br>12. Saddles for pipe fitting Lumsum<br>13. Screw required for pipe fitting Lumsum<br>14. Earthing sundry<br>15. Earthing plate 01 Nos<br>16. Brass nut bolt 02 Nos<br>17. LT Shackle insulator 02 Nos<br>17. Miscellaneous |
| **c)** | **State any four IE rules used in residential wiring installation.** |
| **Ans:** | **(Note: Similar to following rules any eight expected 1/2 Mark each point)**<br>**Following IE rules rules used in residential wiring installation:-**<br>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.<br>2. The electrical wire or conductor which is used for residential installation should not be over heated at its rated load.<br>3. The permissible voltage drop in the wire should be proper (+ or – 5%)<br>4. The every metal part of the electrical device must be earthed.<br>5. The earth resistance should be maintained it should be very low or in between 5 to 8 ohm.<br>6. The switch board should be installed at the height of 1.2 meter to 1.3m from ground surface.<br>7. The main board should be installed at the height of 1.5m to 1.75 m from the ground surface.<br>**OR** |

**Following rules related to electrification of residential 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 $= \frac{50\ M\Omega}{Number\ of\ outlet}$

**d) Explain the design considerations of commercial electrical installation.**

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

**The following procedure to prepare a design for commercial electrical installation:**

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

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

**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.<br>$P = V1 \cos\phi$ P = Input power for every sub circuit<br>V = voltage = 230 V<br>I = Input current for every sub circuit<br>7) Determine the size of wire required for every sub circuit by considering overload starting surge and future expansion.<br>8) Draw the single line diagram.<br>9) Mark the batten on plan layout.<br>10) Find out the total length of batten required for every sub circuit and whole commercial installation.<br>11) Find out the total length and size of wire required for every sub circuit.<br>12) List out the material required for whole commercial installation.<br>13) Find out cost of material and labour in estimation chart.<br>14) Find out the total cost of estimation with profit margin and contingencies charges.<br>15) Find out per point charges.<br>16) Draw the circuit diagram. |
| **e)** | **State the principle of circuit design for motor loads.** |
| **Ans:** | **the principle of circuit design for motor loads:**<br>**(Any Four points are expected: 1 Mark each)**<br>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.<br>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 star-delta starter, auto transformer starter, or rotor resistance starter etc (depends upon types of motor) can be used.<br>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<br>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.<br>If the machine is star connected then 3.5 cores or 4- core cable is selected<br>4. The path and mounting of cable is selected shortest route and convenience of power machine. |

5. Unarmoured cable can be selected for indoor power machine and armored cables can be selected outdoor power machine.

**OR**

i) Each motor should be provided with separate cable for distribution board or main board.

ii) Each motor should be individually controlled

iii) Rating of fuse, ICTP or ICDP, & starter should be based on starting current which is assumed two times rated input current.

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

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

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

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

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

**f) State the criteria for selecting a contractor for electrical installation work.**

**Ans: Following the criteria for selection of contractor:**

**( Any Four points are expected: 1 Mark each)**

1. Contractor should be well reputed
2. Past experience of the Contractor
3. Contractor licenses should be valid
4. Work in hand of the Contractor.
5. Manpower, Machines, Material availability of the contractor.
6. Tax clearance certificate & financial power of contractor.

**Q.4 Attempt any FOUR of the following : 16 Marks**

**a) Compare residential and commercial electrical installation.**

Ans: **(Each points : 1 Mark)**

| 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 |

**b) State the factors governing no. of lighting and power circuits in commercial installation.**

Ans:

**The Following factors governing number of lighting sub-circuits and power sub-circuits in commercial installation.**

**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**

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

**c) Write the procedure to prepare a design for industrial installation.**

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

**Explanation of design consideration in industrial installation :-**

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

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

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

Input power = V I cos $\phi$

V = Input voltage = 230V

Cos $\phi$ = P.f.

I = Input current

If the machine is 3-ph

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

$V_L$ = Line voltage = 400V

$I_L$ = Line current or Input current

Cos $\phi$ = P.f.

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

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

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

8) List out the material required for factory electrification.

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

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

OR

**Design consideration to prepare estimate for a factory installation:-**

i) Input current of the motor

ii) Selection of size of cable and conduit

iii) Determination of rating of fuse

iv) Selection of rating of main switch

v) Distance between Main board and control board

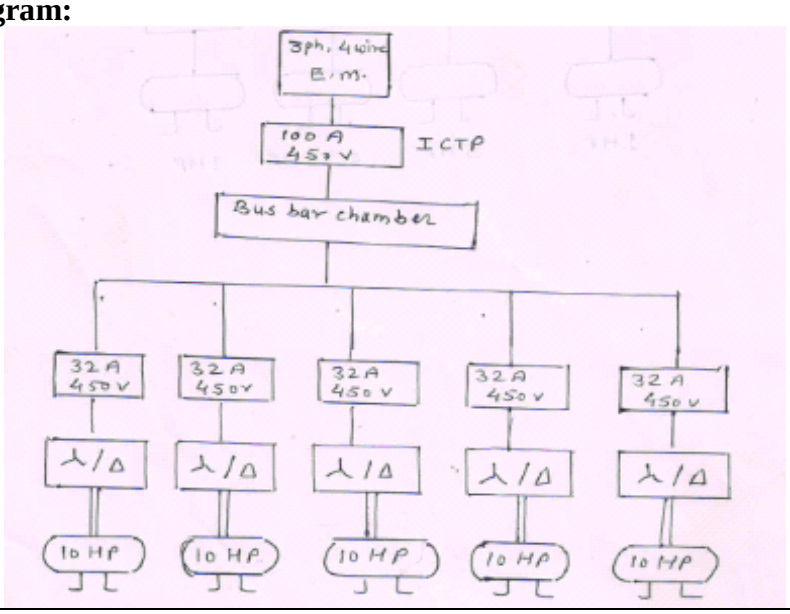
vi) Type of supply for every machine

vii) Earthing type and its size.

**d)** **Decide the number of sub circuits and draw single line diagram with specification for five 3-ph, 10 HP, 440 V squirrel cage IM.**

Ans: **the number of sub circuits : 05 Nos** **( 1 Marks)**

**Single line diagram:** **( 3 Mark)**



**e) State the sequence to be followed in preparing estimate for a commercial installation.**

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

**The consideration the sequence to be followed for prepare estimate commercial electrical Installation:**

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

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

**OR**

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

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

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

**OR**

$$No.\ of\ \ power\ Sub\ circuits = \frac{Total\ \ No.of\ \ power\ \ po\text{int}s}{2000\ W\ \ or\ 3000\ W}$$

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

$P = V1\cos\phi$ P = Input power for every sub circuit
V = voltage = 230 V
I = Input current for every sub circuit

7) Determine the size of wire required for every sub circuit by considering overload starting surge and future expansion.
8) Draw the single line diagram.
9) Mark the batten on plan layout.
10) Find out the total length of batten required for every sub circuit and whole commercial installation.
11) Find out the total length and size of wire required for every sub circuit.
12) List out the material required for whole commercial installation.
13) Find out cost of material and labour in estimation chart.
14) Find out the total cost of estimation with profit margin and contingencies charges.
15) Find out per point charges.
16) Draw the circuit diagram.

| f) | What are the different types of contracts? Explain any one. |
|---|---|
| Ans: | **Different types of Engineering contract:-** **(Any Four types expected 1/2-Mark)** |

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

**Explanation:** **( Any one explanation expected:2 Mark)**

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 government

organizations & government undertaking organizations.

11) **Cost plus(+) fluctuating fees rate contract:** in this contract ,contractor fee is variable.The fluctuating fee is inversely proportional to the actual cost of project. Higher the actual cost, lower will be the value of the fee that contractor receives and Vice versa.

**Q.5** **Attempt any TWO of the following :** **16 Marks**

**a)** **Estimate quantity of material and calculate the cost for casing capping wiring system used in a house, the plan of which is shown in Figure No. I. Assume height of ceiling of 3.5 m and one plug point is to be provided in each room. Assume suitable rates.**

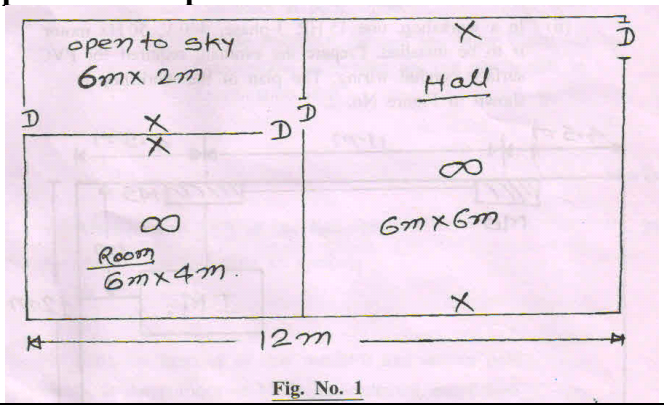


Fig. No. 1

**Ans:** **( Quantity of Material for wire and casing capping may vary according to student layout)**

$Total\ \ load\ in\ \ Installation = tubes \times watt\ \ = 4 \times 40 = 160\,W$

$= Fans \times watt\ \ = 2 \times 60 = 120\,W$

$= Plug \times watt\ \ = 3 \times 100 = 300\,W$ ---------- **(1 Mark)**

$Total\ load\ in\ \ Hall = tubes\ in\ Watt + Fans\ in\ \ Watt + Lamps\ in\ WC\ \&\ Bath$

i) $Total\ load\ in\ \ Installation = 160 + 120 + 300 = 580\ \ watt$ ---------- **(1/2 Mark)**

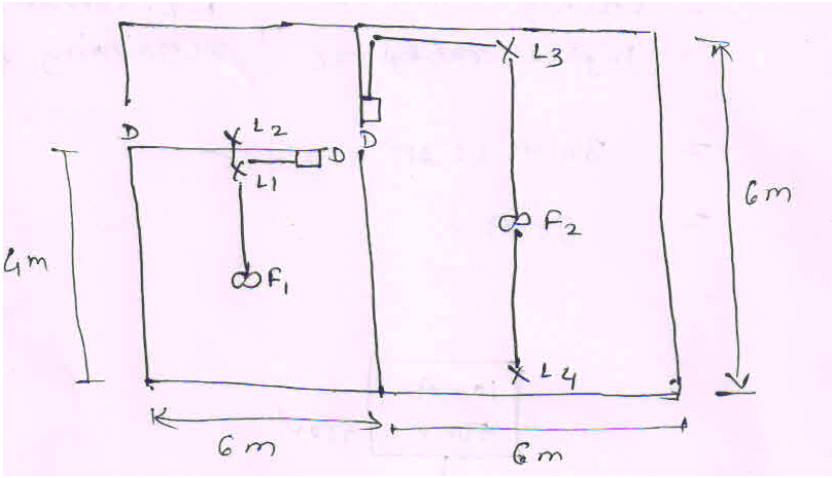
$Total\ load\ in\ \ Amps = \frac{580}{230} = 2.52 \cong 3\ Amp$ --- **(1/2 Mark)**

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

230V, 5A, ISI mark Main switch of any company and lighting load 580 watt & 9 points.

Therefore one sub circuit is required

**Wiring Layout:** --- **(1 Mark)**




**Length of the Casing Capping:** --- **(1 Mark)**

$$= \overset{V}{1.5} + \overset{H}{2} + \overset{V}{1} + \overset{H}{2} + \overset{H}{1} + \overset{V}{1.5} + \overset{H}{1} + \overset{H}{3} + \overset{H}{1} + \overset{H}{6} + \overset{H}{1} + 10\%$$

$$= 15 + 6 + 10\%$$

$$= 21 + 10\%$$

$$= 21 + 2.1$$

$$= 23.1 \approx 24\ Mtr$$

**Length of the Wire as per thumb rule in neutral loop in system :** --- **(1 Mark)**

$$= 24 \times 3 + 20\%$$

$$= 72 + 20\%$$

$$= 72 + 14.4$$

$$= 86.4 \approx 87\ Mtr$$

**Schedule of Material:** **( 2 Mark)**

| S.No | Material | Quantity | Rate | Total Amount |
|---|---|---|---|---|
| 1 | ICDP 250V, 6A | 01 | 250.00 | 250.00 |
| 2 | 6A MCB for lighting load | 01 | 45.00 | 45.00 |
| 3 | PVC casing capping (2 Mtr patti 1.5mm thickness, 1 inch | 24 Mtr | 15.00 | 360.00 |

| | | | | |
|---|---|---|---|---|
| 4 | 1 Sqmm Copper Wire (90 mtr bundle) | 01 coil | 650.00 | 650.00 |
| 5 | Copper Earthing Plate | 01 | 490.00 | 490.00 |
| 6 | Earthing Sundry | lumsump | 200.00 | 200.00 |
| 7 | 6A Switch | 09 | 15.00 | 135.0 |
| 8 | 6A Three point socket | 03 | 20.00 | 60.00 |
| 9 | Ceiling rose | 06 | 10.00 | 60.00 |
| 10 | Junction Box | 06 | 10.00 | 60.00 |
| 11 | 4 x 4 Switch board with cutting | 02 | 20.00 | 40.00 |
| 12 | 25 x 8 screws | 01 | 35.00 | 70.00 |
| 13 | Raval plug | 03 | 05.00 | 15.00 |
| 14 | Labour Charges | 09 | 100.00 | 900.00 |
| | | **Total Amount :-** | | **3335.00** |
| 15 | Contingencies+ profit margin | 10% Amount:- | | 333.50 |
| | | **Total Amount:-** | | **3668.50** |
| | **iii) Cost of work:** | Say Total Amount: | | **3669.00** |

**b)** **A 1 HP, 3-phase 400 V motor, 5 HP 3-phase 400 V motor, 0.75 HP 1-phase 230 V motor, 3 HP 3-phase 400 V motor are proposed to be connected to ac supply. Calculate full load current, starting current, rating of main switch and selection of cable and draw single line diagram for the same.**

Ans: **(Give stepwise Marks as mention below)**

**Note: Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.**

**i) 1 HP, 3-Ph, 400V, assumption P.f. of motor 0.8 & η = 0.85: ---------- (1 Marks)**

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

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

$$Rated\ input\ current\ I_L = \frac{1 \times 735.5}{\sqrt{3} \times 400 \times 0.8 \times 0.85}$$

**Rated /Full load** Current **in Motor No. 1:- = 1.561 Amp**

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

**Starting current = 2 x 1.561 = 3.122 Amp**

So use, 2.5 Sqmm , 3 ½ core cable Aluminum 1/ 2.80 mm , 600V grade should

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

**Starter Used:** DOL

**ii) 5HP, 3-Ph, 400V, Assumption P.f. of motor 0.8 & η = 0.8: ---------- (2 Marks)**

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

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

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

**Rated /Full load Current in Motor No. 2:- = 8.293 Amp**

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

**Starting current = 2 x 8.293 = 16.58 Amp**

So use, 4.0 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:** DOL Starter

**iii) 0.75 HP, 1-Ph, 230V, assumption P.f. of motor 0.8 & η = 0.85: ---------- (1 Marks)**

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

$$For\ Machine\ No.1\ Rated\ input\ current\ I_L = \frac{0.75 \times 735.5}{V_L \times \eta \times Cos\varphi}$$

$$Rated\ input\ current\ I_L = \frac{0.75 \times 735.5}{230 \times 0.8 \times 0.85}$$

**Rated /Full load** Current **in Motor No. 1:- = 3.527 Amp**

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

**Starting current = 2 x 3.527 = 7.054 Amp**

So use, 2.5 Sqmm , 2 or 3 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:** DOL starter

**iv) 3 HP, 400 V, 3-Ph and assumption of motor 0.8 & η = 0.8: ---------- (2 Marks)**

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

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

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

**Rated /Full load Current in Motor No. 3:- = 4.976 Amp**

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

**Starting current = 2 x 4.976 = 9.952 Amp**

So use, 4 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:** DOL starter

**Rating of main switch for all motors:- ---------- (1 Marks)**

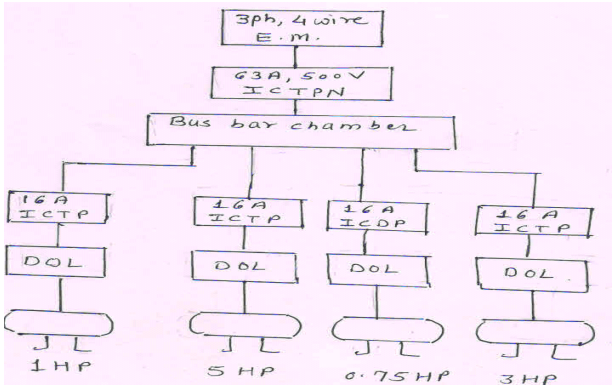
Rating of main switch for all motors = staring current of highest rated m/c + Full load current of all remaining machines

Rating of main switch for all motors = Staring current of 5 H.P + Full load current of 1 H.P 0.75 HP, 3 HP = 16.58 + 1.561+3.527 + 4.976

Rating of main switch for all motors = **26.644 Amp**

Main switch for all Motors is selected 63A, 500V, ICTP used

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




**Or equivalent ckt dia**

**c) State the sequence to be followed for preparing estimate for a residential installation.**

Ans:

**(Note: Similar sequence to be followed for preparing estimate for a residential installation)** **(Any Eight types expected 1-Mark each)**

**Following sequence to be followed for preparing estimate for a residential installation:-**

1) Find out the total electrical load for the given residential installation.

2) Differentiate this total electrical load in lighting load and power load.

3) Make the no. of lighting sub circuit for lighting load.

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

**OR**

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

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

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

**OR**

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

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 residential installation.

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

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

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

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

15) Find out per point charges.

16) Draw the circuit diagram.

| Q.6 | Attempt the following : 04 Marks |
|---|---|
| a) | **Describe the procedure for execution of work.** |

Ans:

**(Any four types expected 1-Mark each)**

**The following procedure for execution of work:**

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

**OR**

**The actual execution of the work is carried out in three stages: ( 4 Marks)**

1. Planning
2. Organizing
3. Execution

**1. Planning:**

Before actual execution of work planning is done.This is most important and involves detail study of the project.

**2. Organizing:**

It is the arrangement of planned function.

**3. Execution of Work:**

The project work is classified into following categories.

a) Major work
b) Minor work
c) deposit work

d) current repairing or maintenance work
e) special work

Depending upon the nature of the project the method of execution of the work is followed. The methods generally used are

a) Contracts
b) Employment of daily labour
e) Piece work
d) Rate list
e) Day Work

**b) Attempt any ONE of the following : 12 Marks**

**i) A hall whose dimensions are 20 m x 15 m is to be fitted with an electrical installation of following load — Fluorescent lamps 16 Nos. Ceiling fan 10 Nos. Plug points 06 Nos. 1) Draw a layout and show the position of lamps, fans etc., Calculate the rating of equipments. 2) Prepare a schedule of material. 3) Find out cost of work.**

Ans:

**Note: Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.**

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

$Total\ \ load\ in\ \ Hall = tubes \times watt\ \ = 16 \times 40 = 640\ W$

$= Fans \times watt\ \ = 10 \times 60 = 600\ W$

$= Plug \times watt\ \ = 06 \times 100 = 600\ W$ -------- **( 2 Marks)**

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

i) $Total\ load\ in\ \ Hall = 640 + 600 + 600 = 1840\ \ watt$ ---------- **(1 Mark)**

$Total\ load\ in\ \ Amps = \frac{1840}{230} = 8\ Amp\ \ \ assu\min g\ \ p.f. = 1$ ---------- **(1 Mark)**

ii) $No.\ of\ \ Sub\ circuit\ \ = \frac{1840}{800} = 2.3 \cong 2\ \ Nos\ lighting\ sub\ circuit$ ---------- **(1 Mark)**

$According\ to\ \ po\text{int}\ No.\ of\ \ Sub\ circuit\ \ = \frac{32}{10} = 3.2 \cong 3\ \ Nos\ lighting\ sub\ circuit$

**iii) Rating Main switch**: - since rated input current is 16 A. ---------- **( 2 Marks)**

Assumed that Staring current = 1.5 times rated current

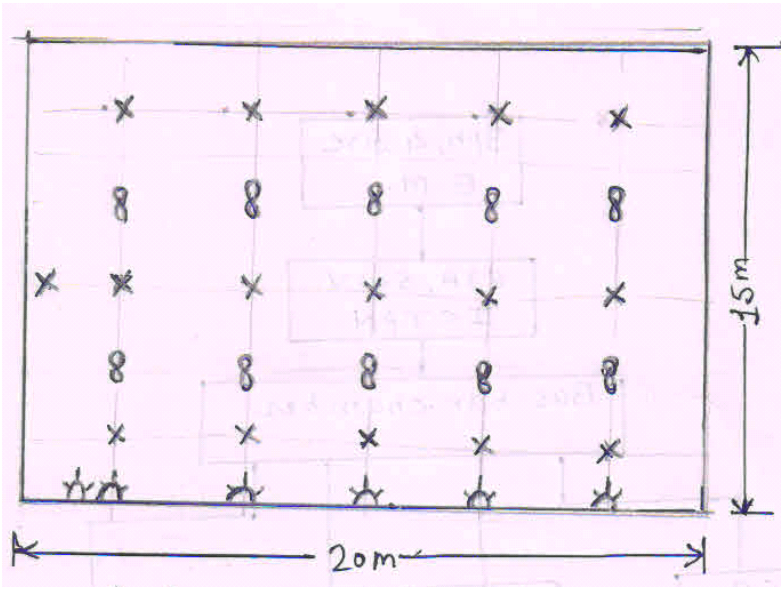
So starting current = 1.5x 8 = 12 A

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

230V, 16A, ISI mark Main switch of any company

Cable selected: 1.5 Sqmm, Copper cable single core

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




**2 &3) Schedule & cost of Material: -** **(2-Marks)**

| S.No | Schedule of Material | Quantity | Rate | Total Amount |
|---|---|---|---|---|
| 1 | ICDP 250V,16A | 01 | 250.00 | 250.00 |
| 2 | 6A MCB for lighting load | 03 | 45.00 | 135.00 |
| 3 | PVC conduit (3 Mtr pipe) 1.5mm thickness | 90 Mtr | 15.00 | 1350.00 |
| 4 | Copper Earthing Plate | 01 | 490.00 | 490.00 |
| 5 | DP | 01 | 150.00 | 150.00 |
| 6 | Earthing Sundry | lumsump | 200.00 | 200.00 |
| 7 | 6A Switch | 32 | 10.00 | 320.00 |
| 8 | 6A Plug | 06 | 20.00 | 120.00 |
| 9 | Ceiling rose | 26 | 10.00 | 260.00 |
| 10 | 2.5 Sqmm PVC wire Running earth | 15 Mtr | 7.00 | 105.00 |
| 11 | Flexible wire for connection of tube & Fan | Approxi 15 Mtr | 5.00 | 75.00 |
| 12 | 1.5 Sqmm PVC wire (90 Mtr -1 bundle) | 03 Bundle | 950.00 | 2850.00 |
| 13 | Junction Box | 30 approx. | 07.00 | 210.00 |

| | | | | |
|---|---|---|---|---|
| 14 | 10 x 12 Switch board with cutting | 03 | 35.00 | 105.00 |
| 15 | Labour Charges for full and half point ( 26 +6 half point) | 29 | 100.00 | 2900.00 |
| 16 | Other labour charges | lumsum | | 1000.00 |
| | | **Total Amount :-** | | **10520.00** |
| 17 | Contingencies+ profit margin | 10% Amount:- | | 1052.00 |
| | | **Total Amount:-** | | **11572.00** |
| | **iii) Cost of work:** | Say Total Amount: | | **11572.00** |

**ii)** **In a workshop, one 15 HP, 3-phase, 440 V, 50 Hz motor is to be installed. Prepare the estimate required for PVC surface conduit wiring. The plan of the workshop is shown in Figure No. 2.**

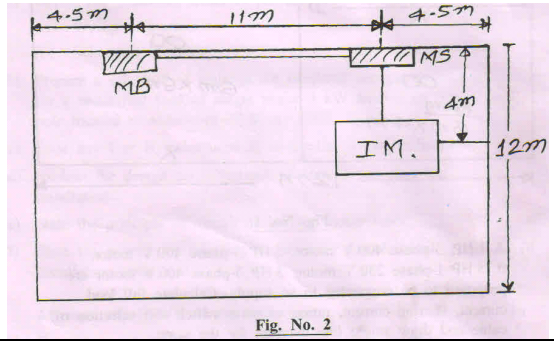


Fig. No. 2

Ans: **Four 3-Ph ,15HP, 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)**

$$Rated\ input\ current\ I_L = \frac{15 \times 735.5}{\sqrt{3} \times 440 \times 0.8 \times 0.8}$$

**Rated /Full load Current in Motor:- = 22.61 Amp** ----------**(2 Marks)**

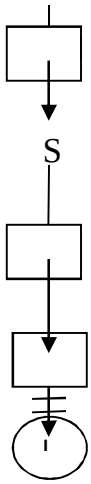
It is assumed that starting current is two times rated input current.

**Starting current = 2 x 22.61 = 45.238 Amp**---------- **(1 Marks)**

So use, 25 Sqmm , 3 ½ core cable Aluminum 1/ 2.80 mm , 600V grade should be selected rating of SFU, ICTP switch is 63A, 450V grade should be selected. ---------- **(1 Marks)**

**Starter Used:** Star-Delta Starter ---------- **(1 Mark)**

**Single Line Diagram:** ----------**(1 Marks)**




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

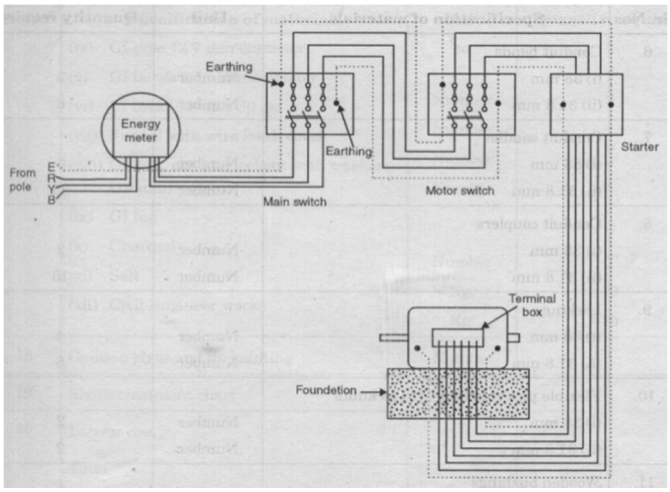
Main Fuse

ICTP

Star-delta starter

3 Ø Squirrel cage Induction motor **OR**

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




**Or equivalent ckt dia**

**Schedule of Material: -** ----------**(4 Marks)**

| S.No | Material of Material | Quantity |
|---|---|---|
| 1 | 32 A Busbar with Natural link | 01 |
| 2 | 3-ph,4 wire 415V, 30-60A, A.C. supply Energy Meter | 01 |
| 3 | ICTP 450V,32A | 02 |
| 4 | 3.5 x 25 Sqmm Al. cable | 25 Mtr |
| 5 | 1 inch PVC conduit | 15 Mtr |
| 6 | 1 inch saddle | 48 Nos |
| 7 | Star Delta Starter | 01 |
| 8 | 8 SWG Earthing Wire | 35 Mtr |
| 9 | 60 cm x 60cm x 6.36 mm Copper Earthing Plate | 01 |
| 10 | Earthing nut-board | 01 |

| | | | | |
|---|---|---|---|---|
| | | 11 | Earthing Sundry | lumsump |
| | | 12 | Screw 3 inch length | 10 No |
| | | 13 | Screw 1 inch length | 10 No |
| | | 14 | R,Y,B Indication Lamp | 03 |
| | | 15 | PVC Tape | 04 |
| | | 16 | Junction Box | 04 approx. |
| | | 17 | 4 x 6 Switch board with cutting | 01 |
| | | 18 | 10 x 12 Switch board with cutting | 01 |
| | | 19 | Main Switch Board | 01 |
| | | 20 | Labour Charges | At actual |

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