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) Define the "tender". **(2 Mark)**

Tender:-

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

b) State I.E. Rule No.90 **(2 Mark)**

I.E. Rule No.90:

- All metal supports of overhead lines and metallic fittings attached there to, shall be permanently and effectively earthed.
- For this purpose, a continuous earth wire shall be provided and securely fastened to each pole and connected with ordinary at 4 points in every 1.6 km spacing between the points is being as nearly equidistant as possible. Alternatively, each support and metallic fittings attached there to shall be efficiently earthed.
- Each stay wire shall be similarly earthed unless one insulator has been placed in at a height not less than 3.3 m from the ground.

c) State the purpose of following in conduit wiring: i) Lock nut ii) Conduit box

i) Lock nut: To hold and seal the conduit with their wires **(1 Mark)**

ii) Conduit box: To hold and inspect incoming and outgoing terminals **(1 Mark)**

d) List the name of various components of service connection. **(2 Mark)**

S.No	Schedule of Material
1	PVC insulated cable or insulated wire
2	S shaped G I pipe 50 mm diameter
3	Earth wire 8 SWG
4	Meter board
5	Stay wire
6	Stay insulator
7	cement
8	Sand
9	Reel insulator or porcelain bobbin

e) Name the starter used for following motors: i) 20 HP 3-Ph squirrel cage I.M ii) DC series Motor

i) 20 HP 3-Ph squirrel cage I.M: (Any one name of starter is expected) **(1 Mark)**
i) Star-Delta Starter ii) Auto transformer starter iii) Soft start starter.

ii) DC series Motor: Armature resistance starter (Two point starter) **(1 Mark)**

f) List any four examples of commercial electrical installation.

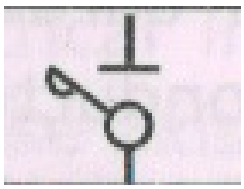
(1/2 marks each for any four types)

Examples of commercial unit: (Any four examples expected)

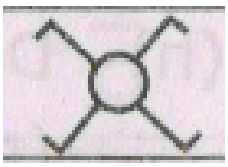
1) Hospital
2) Schools
3) Colleges
4) Banks
5) Shopping malls
6) Large temples
7) Auditorium
8) Cinema theaters
9) Show-rooms etc.

g) Draw the IS symbols for the following used in layout diagram: i) Isolator ii) Intermediate switch. **(Each symbol: 1 Mark)**

i) Isolator:



ii) Intermediate switch:



h) State the function of stay insulator and service pole.

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)**

ii) Service pole: To provide the service connection to the consumers. **(1 Mark)**

i) Define the following: i) Residential load ii) Industrial load

i) Residential load: (Any two examples expected) **(1 Mark)**

The electrical load which is used in residential installation is called as residential load. E.g. incandescent lamp, florescent tube, fan ,5A socket &15A socket etc.

ii) Industrial load: (Any two examples expected) **(1 Mark)**

The electrical load which is used in industrial installation is called as a industrial load. E.g. 1-ph or 3-ph any type of motor, electric furnace ,oven,welding transformer and any power load etc.

j) State two factors deciding size of conduit.

Following factors deciding size of conduit: **(2 Mark)**

1) Types of wiring method
2) No. of wires carried out through conduit
3) Size of wires required for sub circuits which is carried out through conduit
4) Future expansion.

k) State the function of following in motor wiring circuit: i) Main switch ii) Motor switch

i) Main switch: To give the main supply to the motor with fuse protection inside. **(1 Mark)**

ii) Motor switch: To make ON/OFF the motor. **(1 Mark)**

l) List the types of engineering contracts. **(Any Four types expected 1/2-Mark)**

Different types of Engineering contract:-

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

Q.2 Attempt any FOUR of the following: ----------16 Marks

a) State any four rules related to lighting loads followed in an electrical installation.

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

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

b) With reference to execution of work explain the following: i) Administrative approval ii) Technical sanctions

Administrative approval: **(2 Mark)**

- When any government department requires executing a project like network addition or extension work or installation of new project. It requires necessary administrative approval from government.
- Initially the project is taken up with public works department, the divisional engineer under whom the work lies prepare preliminary report in the form of a proposal.
- The proposal is in the form of plan layout drawing at approximate estimation, then the proposal is submitted to the proper authority of the department.
- The proposals are approved by competent authority, if PWD recommended that proposal are sound and estimated approximately and reasonably.
- This type of formal acceptance that is as good as order to PWD for executing the work is called as **Administrative approval**

Technical sanction: **(2 Mark)**

- After the sanction of administration approval by the competent authority, the details drawing of plan and detailed estimate are prepared by PWD engineer.
- If detailed documents are forwarded to the government for sanction or to the officer of the public work department.
- Appointed by government to whom powers are designated by government.
- The sanction given by authority is called **technical sanction**

c) List any four wiring accessories and its function.

Following wiring accessories: **(Any Four accessories expected: 1 Mark each)**

1) **Lamp holder:** It is the holding accessory. The different types of holders used such as angle holder, batten holder, pendent holder
2) **Ceiling Rose:** Ceiling rose are of two types: i) Two plate ii) Three Plate and it is used to give supply for ceiling fan and tubes.
3) **Tube holder-** It is used to hold the tube
4) **Switch:** the function of switch is to make ON/OFF. Switches are available in the rating of 6A and 16A
5) **Plug:** Two pin plugs, three pin plugs and 5 in one plug. 16A Power plate.
6) **MCB:** It is safety device available in 6A to 32A, 40 to 60A and Single pole to Four pole MCB
7) **Kit Kat Fuse:** It is a safety device available in 6A to 32 A
8) PVC casing capping, Junction box, Elbow, Bend etc
9) Switch board, ICDP Main Switch
10) All types of size of VIR & PVC wire

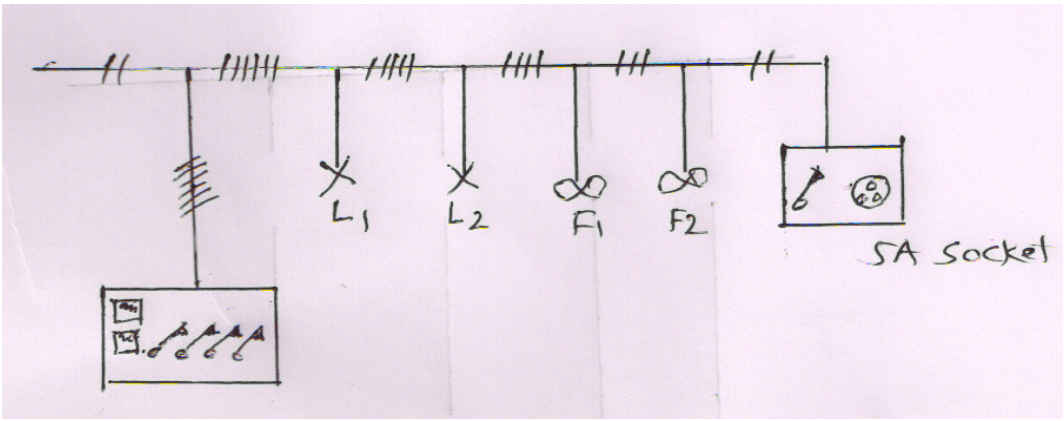
d) Differentiate between overhead service connection and underground service connection on the basis of maintenance cost, safety, appearance and labour cost.

(Any four points expected 1 Mark each)

S.No	Basis	Overhead service connection	Underground service connection
1	**Maintenance cost**	It is open to sky so repairing and Maintenance is more	Repairing and maintenance is less
2	**Safety**	Less safety	More safety
3	**Appearance**	Appearance is poor.	Appearance is good
4	**Labour cost.**	It is economical.	Cost is more

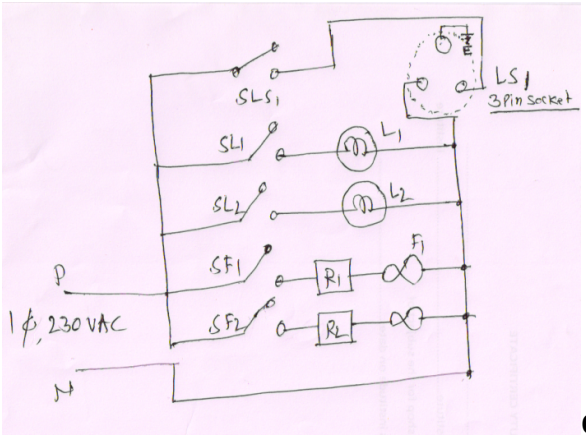
e) Draw and label multiline diagram and single line diagram for 2 Lamp, 2 Fan and one 5 Amp socket connected to single phase, 230V, 50Hz AC supply.

Single line diagram for 2 Lamp, 2 Fan and one 5 Amp socket connected: **(2 Mark)**



OR equivalent figure

Multiline diagram: **(2 Mark)**



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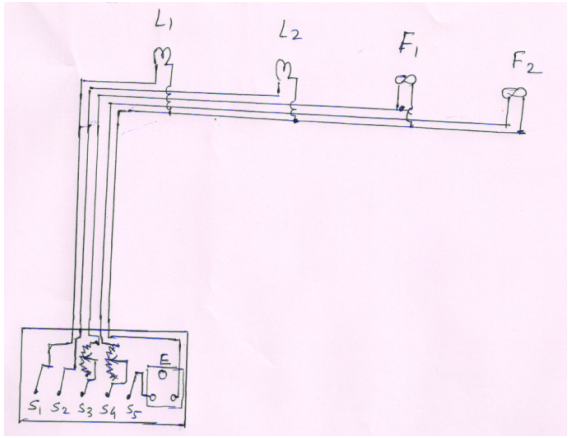


f) List the materials required to provide O.H service connection. **(4 Mark)**

S.No	Material list for O.H service connection
1	PVC insulated cable or insulated wire
2	S shaped G I pipe 50 mm diameter
3	Earth wire 8 SWG
4	Meter board
5	Stay wire
6	Stay insulator

7	cement
8	sand
9	Pipe clamp
10	GI pipe
11	Saddles for pipe fitting
12	Screw required for pipe fitting
13	Earthing sundry
14	Earthing plate
15	Bars nut bolt
16	Miscellaneous

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

a) Explain the meaning of following terms: i) MCB ii) Socket outlet iii) Neutral iv) Fuse-link

i) MCB: **(1 Mark)**

Miniature circuit breaker operates automatically at the time of fault or over load. And it is used for the protection of electrical installation. They are available from 0.5 A to 100 Amps. They can be single pole, Double pole or three poles

ii) Socket outlet: **(1 Mark)**

To give the supply to the load by using supply pins and also provided in electrical installation for adopting or connecting home appliances

iii) Neutral: **(1 Mark)**

Neutral is return path of supply system and it is a brass terminal, which is fixed on porcelain base and has tapped screws on both ends so that neutral from supply system is received at one end and it is supplied from other end.

iv) Fuse -link: **(1 Mark)**

Fuse-link melts automatically at the time of fault or over load. Fuse must be replaced after the fault.

b) Residential installation wiring consists of following load/outlets.

Light points 4 Numbers: 60 watts each Light points 3 Numbers: 100 watts each

Fan points 4 Numbers: 60 watts each 5A Socket outlet 6 numbers: 60 watts each

15A socket outlet 4 numbers: 1000 watts each **Find:**

i) Total connected lighting load in a house ii) Total connected power load in a house iii) Current rating of iron clad main switch iv) Suggested value of current rating of iron clad main switch

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

$$Total\ \ load\ in\ \ = tubes \times watt\ \ = 4 \times 60 + 3 \times 100 = 540\,W$$

$$= Fans \times watt\ \ = 4 \times 60 = 240\,W$$

$$= Sockets\ \times\ watt = 6 \times 60 = 360\,W$$

i) $Total\,connected\,lighting\,load\,in\,a\,house = 540 + 240 + 360 = 1140W\ or\ 1.14KW$, ------- **(1 Mark)**

ii) $Total\,connected\ \ Power\ load\ \ in\,a\,house = 4 \times 1000 = 4000\,W\ or\ \ 4.0\,KW$, ---------- **(1 Mark)**

$$Total\ load\ connected = 1140 + 4000 = 5140\ or\ \ 5.14\ \ \ KW$$

$$Total\ load\ in\ \ Amps = \frac{5140}{230} = 22.34 \cong 23\ Amp\ \ \ assu\min g\ \ p.f. = 1$$

iii) Current rating of iron clad main switch = since more current is 23 A.

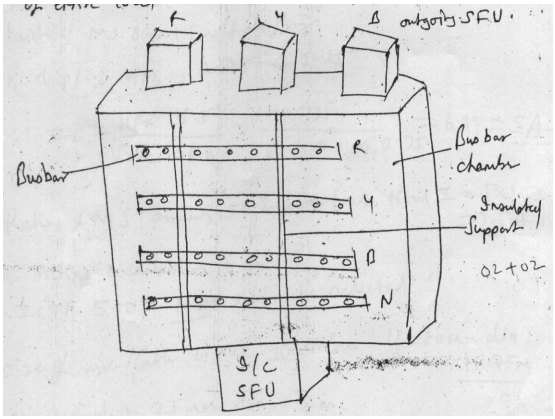
Current rating **Iron clad main switch** = 32 A ---------- **(1 Mark)**

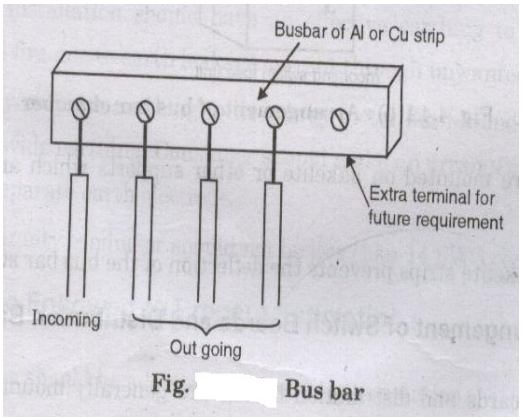
iv) Value of current rating of iron clad main switch: ---------- **(1 Mark)**

So Use: - 250V, 32A, ISI mark Main switch of any company

c) What is busbar? Draw the diagram showing the arrangement of busbar, Switch fuse unit in a busbar chamber and explain it. **(Explanation-2 Mark, Figure-2 Mark)**

Diagram showing the arrangement of busbar





or equivalent figure

Explanation:

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.

OR

Bus bar is arrangement of Copper or Aluminum strips to distribute load from 3-ph, 400 V, 4 wire, system to satisfy requirement of entire load.

It consists of 4 bus bar strips made by copper of aluminum, incoming SFU and free outgoing SFU. It is mounted on the Bakelite insulators / strips

Function of Bus-bar: - Distribute the load on 3-phase four wire systems.

d) Explain the principles of circuit design in lighting and power circuits.

The principles of circuit design in lighting and power 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 1000W for total 1 to 2 points. (old rule)
- Make the no. of power sub circuits for power load.

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

OR

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

e) Compare electrification of residential installation and electrification of commercial installation on the basis of load capacity, type of supply, initial cost and type of load used.

(Any four points expected 1 Mark each)

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

f) A 3-ph, 3-wire, connection is to be given to a premises in which an electrical motor of 50 H.P. is to be installed 40 meters of wire run from the main switch is required for this purpose . Determine the size of the wire to be used if the supply voltage is 400 volts. Assume power factor to be 0.8.

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

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

$$For\ Machine\ No.1\ Rated\ input\ current\ I_L = \frac{50 \times 735.5}{\sqrt{3}\, V_L \times \eta \times Cos\phi}$$ ---------- **(1 Marks)**

$$Rated\ input\ current\ I_L = \frac{50 \times 735.5}{\sqrt{3} \times 400 \times 0.8 \times 0.85}$$

Rated /Full load Current in Motor: - = 75.23 Amp ---------- **(1 Marks)**

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

Starting current = 2 x 75.23 = 150.47 Amp

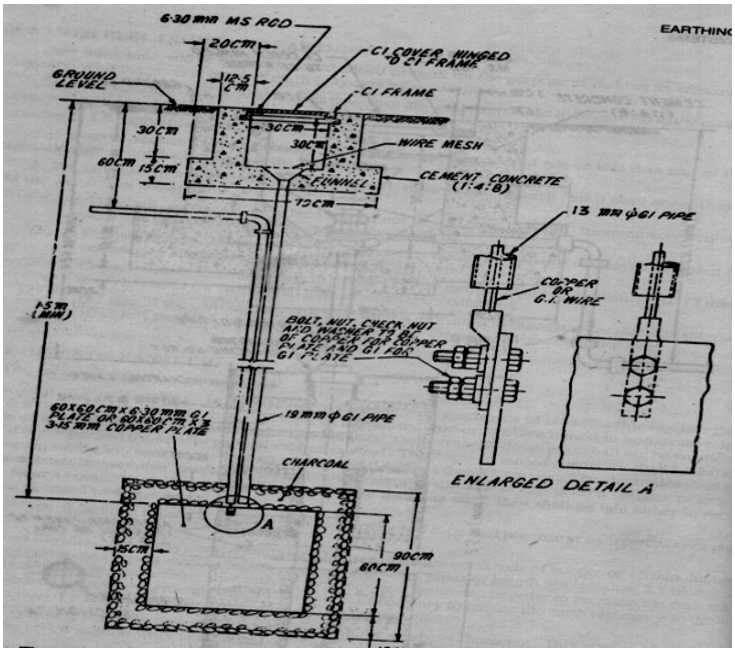
---------- **(2 Marks)**

So use, 95 Sqmm , 3.5 core Aluminum cable 19/ 2.5 mm , 600V grade should be selected rating of SFU, ICTP switch is 100A, 450V grade should be selected.

Starter Used: Star-delta starter

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

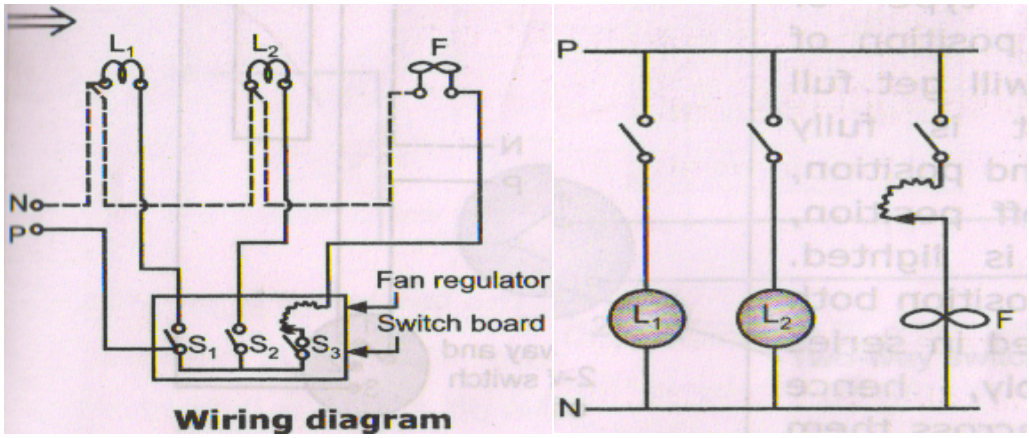
a) Draw neat labeled sketch of plate earthing. **(4 Mark)**



or equivalent circuit

b) Draw wiring diagram and schematic diagram for control of two lights, one fan by their individual switches. **(Wiring Diagram: 2 Mark & Schematic diagram: 2 Mark)**

Wiring diagram: **Schematic diagram:**



Or equivalent ckt dia.

c) An office 30m x 15m is illuminated by twin 60W tubes of limens output 6000 lumens. (total) the lamp being mounted at a height of 3m from work space the average illumination required is 280 Lu. Calculate number of lamps required to be fitted in the office assuming coefficient of utilization to be 0.6 and depreciation factor to be 0.8

Area = A = 30m x 15m = 450 m^2 Illumination = E or I= 280 meter candle (lux)

U.F. (C) = 0.6, D.F. = 0.8 lumen output by twin 60 watt = 6000 lumen

Solution:

i) Total lumens required = $Total\ \ Lumens = \frac{EAW}{C \times D}$ ---------- **(1 Marks)**

$$Total\ \ Lumens = \frac{280 \times 450 \times 1}{0.6 \times 0.8}$$

$$Total\ \ Lumens = \frac{126000}{0.48}$$

$Total\ \ Lumens\ required\ on\ working\ \ plane = 262500\ lumen$ ---------- **(1 Marks)**

ii) The number of lamps required:

$$No.\ of\ lamp\ /\ fitting\ required = \frac{Total\ lumens\ required\ on\ working\ plane}{Lumen\ output\ by\ one\ fitting}$$ ----- **(1 Marks)**

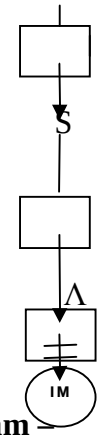
$$No.\ of\ lamp\ /\ fitting\ required = \frac{262500}{6000}$$

$$No.\ of\ lamp\ /\ fitting\ required = 43.75 \cong 44\ Nos$$

Total no. of Twin tube fitting required = 40 No ---------- **(1 Marks)**

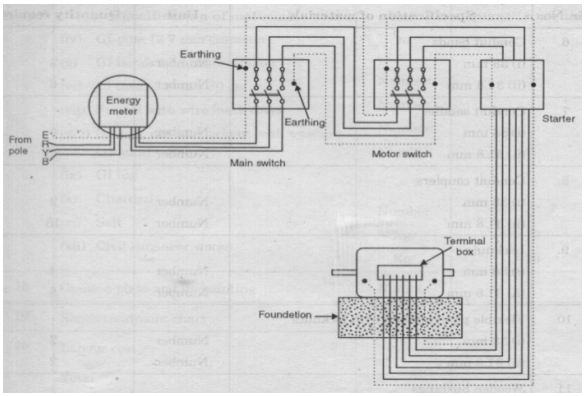
d) Draw and label wiring diagram for 3-phase induction motor connected to supply with star-delta starter. **(4 Mark)**

Single line diagram -



3-ph,4 wire 400v A.C. supply
Energy meter
Main Fuse
ICTP
Λ / Δ starter
3 Ø Induction motor **OR**

Wiring diagram –



Or equivalent ckt dia

e) State the ratings of lamps (Incandescent type), (Fluorescent type), fan (ceiling fan) and socket outlet points used in residential installation.

Following rating of lamp used in residential installation: **(Each lamp rating: 1 Mark)**

i) Incandescent type lamp : 15 watt, 25 watt, 40 watt, 60 watt, 100 watt, 200 watt, etc,

ii) Fluorescent type: 20 watt, 36 watt, 40 watt, 65 watt, 80 watt etc.

iii) Fan (ceiling fan): 60 watt, 100 watt etc depends upon blade size

iv) Socket outlet: lighting socket: 100 watt and power socket: 1000 watt

f) Write the procedure to prepare a design for commercial electrical installation.

(Minimum eight point expected 1/2 each point)

The procedure to prepare design for commercial electrical installation -

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

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

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 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.

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

a) Calculate the total load, no. of lighting and power sub circuit and draw single line diagram showing the position of switches and fitting for following data.

Power points 10 numbers each of 1000W Plug points 20 numbers each of 100 W

Light points 30 numbers each of 40 W Fan point 30 numbers each of 60 W

It is supplied from a 3-phase 400V, 4-wire, 50Hz AC Supply

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

Total load is equally distributed on 3-phases:

$ligthing\ sub-circuit\ load = 20\times100+30\times40+30\times60=5000W\ or\ 5\ KW$, ---- **(1/2 Mark)**

$Power\ \ sub-circuit\ \ Load\ =10\times1000=10000\ W\ \ or\ 10\ \ KW$ ---------- **(1/2 Mark)**

$Total\ load\ connected=5+10=15\ KW$ ---------- **(1 Mark)**

$Total\ \ number ligthing\ \ po\text{int}\ s=20+30+30=80\ nos$

$$Total\ \ number ligthing\ \ Sub-circuit=\frac{Total\ no.of\ \ po\text{int}\ s}{8\ or\ 10}$$

$$Total\ \ number\ ligthing\ \ Sub-circuit = \frac{80}{10} = 8\ \ No\ \ or\ \ \frac{80}{8} = 10\ No$$ ---------- **(1 Mark)**

$$Total\ \ number\ ligthing\ \ points\ as\ per\ the\ wattage = \frac{Total\ lighting\ load}{800\ watt}$$

$$Total\ \ number\ ligthing\ \ points\ as\ per\ the\ wattage = \frac{5000}{800}$$

$$Total\ \ number\ ligthing\ \ points\ as\ per\ the\ wattage = 6.25 \cong 7$$

So, Number of Lighting sub-circuit are selected = 8 Nos OR 10 Nos ---------- (1 Mark)

$$Total\ \ number\ Power\ \ point\ s = 10\ nos$$

$$Total\ \ number\ Power\ \ Sub-circuit = \frac{Total\ no.\ of\ \ points}{2\ or\ 3}$$

$$Total\ \ number\ Power\ \ Sub-circuit = \frac{10}{2\ or\ 3}$$

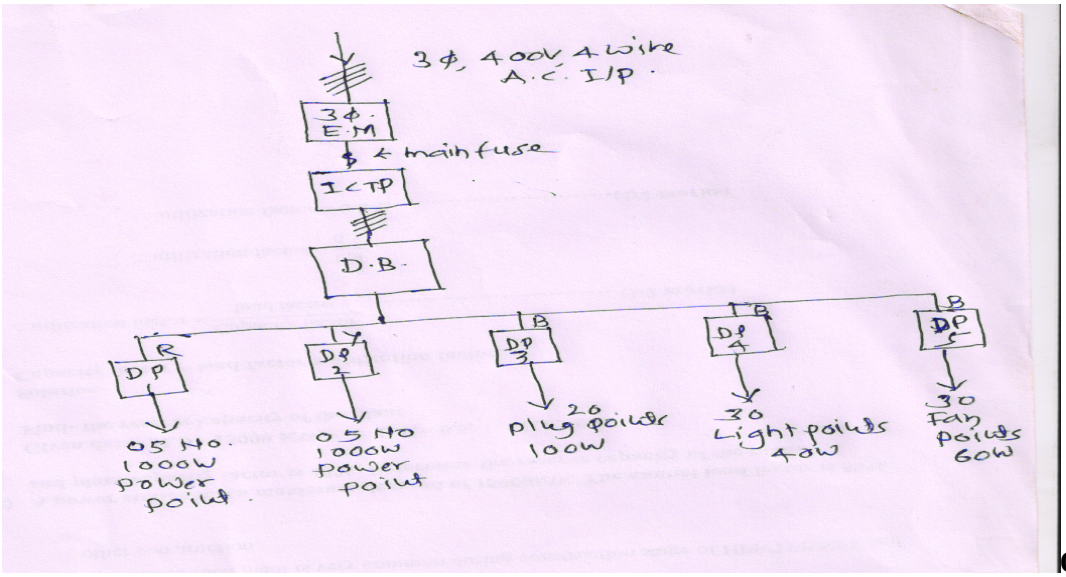
$$Total\ \ number\ Power\ \ Sub-circuit = \frac{10}{2} = 5\ Nos\ \ or\ \frac{10}{3} = 3.33 \cong 4$$ ---------- **(1 Mark)**

$$Total\ \ number\ power\ \ points\ as\ per\ the\ wattage = \frac{10000\ watt}{1000\ \ watt\ or\ 2000\ watt}$$

$$Total\ \ number\ power\ \ points\ as\ per\ the\ wattage = \frac{10000\ watt}{1000\ \ watt} = 10\ No\ \ or\ \ \frac{1000\ watt}{2000} = 5\ No$$

So, Number of Power sub-circuit are selected = 10 No OR 5 No ---------- (1 Mark)

Single Line diagram showing the position of switches and fitting: **(2 Mark)**



OR

b) i) State four rules of industrial wiring. **(Any four points expected 1 Mark each)**

Following rules of industrial wiring:-

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

ii) Each motor should be individually controlled

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

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

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

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

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

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

ii) State points considered to decide size, type, path and mounting of cable used for connecting power machines. **(4 Mark)**

Following points considered to decide size, type, path and mounting of cable used for connecting power machines:

- Size of the cable is decided by the full load current considering 50 % over load capacity and (starting current of every machine, generally starting current is assumed two times of rated input current of every machine.)
- Type of the cable is decided by the type of supply of the machine, if the machine is single phase then two core cables is used and if the machine is three phase delta connected then three core cable is selected.

  If the machine is star connected then 3.5 cores or 4- core cable is selected
- The path and mounting of cable is selected from the shortest route and convenient position of the power machine.
- Armoured cable can be selected for indoor power machine and unarmoured cables can be selected outdoor power machine.

c) Prepare a complete estimate to install a 3-phase, 400V, 50Hz, 3 HP. Induction motor have to be used for grinding purpose in a small scale type workshop having room size of 3m x 3m. Assume necessary data required for this estimation and draw installation plan and wiring diagram.

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

Assuming height of Ceiling if 3 m from the floor.

Motor is installed 1 M away from the nearest wall.

Height of Main Switch is 1.2 M from the floor

Step No. 1:- The out power of induction motor = 3 x 735.5 = 2206.5 W---------- **(1/2 Mark)**

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

Assuming efficiency of I.M is 80 %

Input power of induction motor = 2206.5 / 0.8 = 2758.12 W

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

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

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

$$I_L = \frac{2758.12}{\sqrt{3} \times 400 \times 0.8} \qquad Cos\phi = 0.8\ assumption$$

$$I_L = 4.98\ Amp \qquad Rated\ current = 4.98\ Amps$$ ---------- **(1 Mark)**

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

Starting current is assumed two times rated input current for starting surge, momentary short circuit & overload. Starting current = 2 x 4.98 = 9.96 Amps

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

Step No. 5:- Determined the size length & dimensions of ICTP earth wire at input cable:- **(1 Mark)**

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

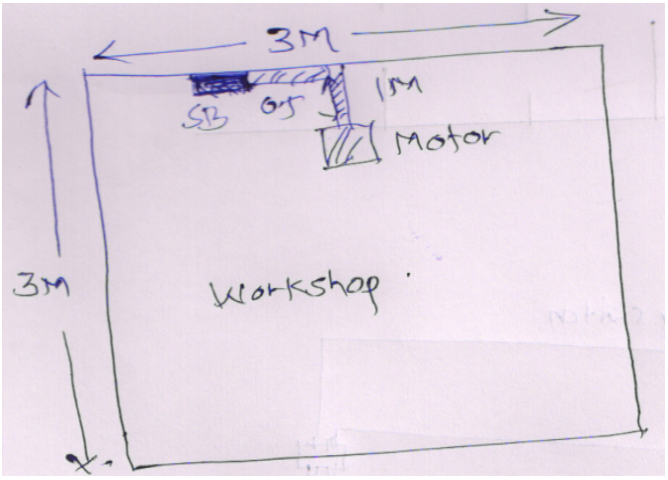
Size of earth wire 8 SWG copper or 6 SWG GI

Length of earth wire = 2 times length of cable

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

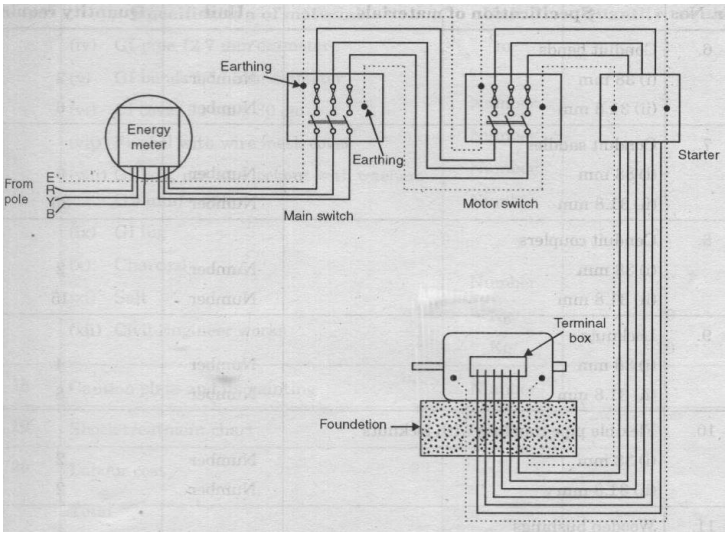
Length of input cable for I .M = 3.2 meter---------- **(1 Mark)**

Step No.6: Installation Plan. ---------- **(1 Mark)**



or equivalent diagram

Step 7: Wiring diagram: ---------- **(1 Mark)**



or equivalent figure

Q.6 Attempt any TWO of the following: ----------16 Marks

a) i) Prepare a tender notice with details for supply of 3-Phase 250 KVA, 11 KV/400V transformer to your industry. **(4 Mark)**

Tender Notice

Sealed quotations are invited from reputed manufacturing & suppliers for supply of 3-phase 250 KVA, 11 KV/400V transformer, quantity one to the under mentioned polytechnic as per the terms & conditions specifies in tender form available in the office.

The estimated cost is Rs. 4 lacs & cost of blank tender form is 1000/-

Last date for issue the tender form & document is 30 April 2014 & it should be submitted before 5 pm of 15 may 2014.

Right of rejection the tender without any intimation is kept.

Tender form available place

Date & Time:

Name of the officer to contact –

Place: Principal

Date: ABC Polytechnic

Mumbai

Phone: Fax: e-mail Id:

ii) Explain earnest money and security deposit

Earnest Money deposit (EMD) :- **(2 Marks)**

EMD is a deposit taken as a guaranty from the bidder if the tender is accepted by the owner and if the contractor (bidder) refuses to accept that work in that case the EMD is not returned to that party it is generally 2 to 5 percent estimated cost. It is refundable to every successful bidder.

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.

b) A 1 H.P. 3-phase motor, 5HP 3-phase 415V motor, 1/2 HP, 1-phase 230V motor, 3HP 3-phase 415V motor are proposed to be connected to ac supply. Calculate full load current, starting current, rating of main switch and selection of rating of cable.

(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, 415V, assumption P.f. of motor 0.8 & η = 0.85: ---------- (2 Marks)

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

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

$$Rated\ input\ current\ I_L = \frac{1 \times 735.5}{\sqrt{3} \times 415 \times 0.8 \times 0.85}$$

Rated /Full load Current **in Motor No. 1:- = 1.50 Amp**

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

Starting current = 2 x 1.50 = 3 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, 415V, Assumption P.f. of motor 0.8 & η = 0.8: ---------- (2 Marks)

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

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

$$Rated\ input\ current\ I_L = \frac{5 \times 735.5}{\sqrt{3} \times 415 \times 0.8 \times 0.8}$$

Rated /Full load Current in Motor No. 2:- = 7.523 Amp

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

Starting current = 2 x 7.523 = 15.04 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) 1/2 HP, 1-Ph, 230V, assumption P.f. of motor 0.8 & η = 0.85: ---------- (1Marks)

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

$$For\ Machine\ No.1\ Rated\ input\ current\ I_L = \frac{0.5 \times 735.5}{V_L \times \eta \times Cos\phi}$$

$$Rated\ input\ current\ I_L = \frac{0.5 \times 735.5}{230 \times 0.8 \times 0.85}$$

Rated /Full load Current **in Motor No. 1:- = 2.351 Amp**

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

Starting current = 2 x 2.351 = 4.702 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, 415 V, 3-Ph and assumption of motor 0.8 & η = 0.8: ---------- (2 Marks)

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

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

$$Rated\ input\ current\ I_L = \frac{3 \times 735.5}{\sqrt{3} \times 415 \times 0.8 \times 0.8}$$

Rated /Full load Current in Motor No. 3:- = 4.514 Amp

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

Starting current = 2 x 4.514 = 9.028 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:-

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 1/2 HP, 3 HP = 15.04 + 1.5 + 2.35 + 4.51

Rating of main switch for all motors = **23.4 Amp**---------- **(1 Marks)**

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

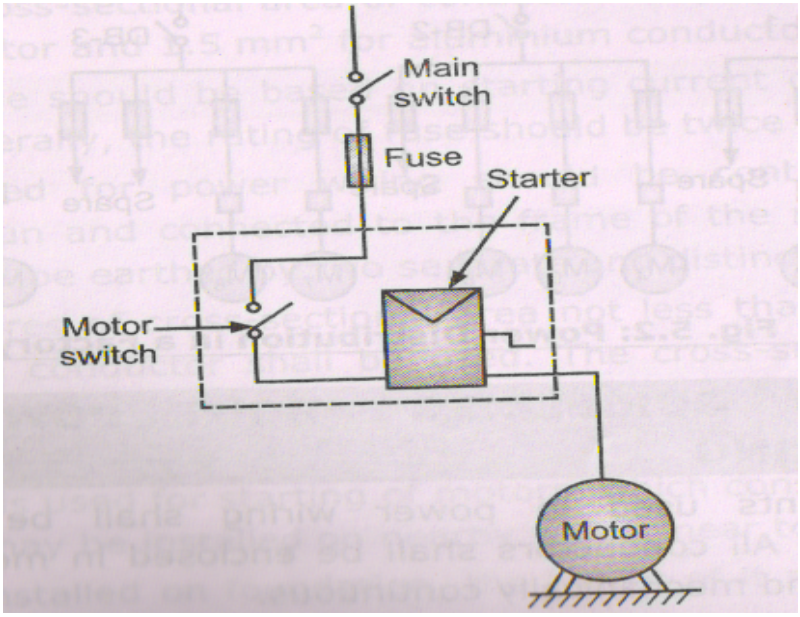
c) Explain: i) Concept of motor wiring circuit and single line diagram **(2 Mark)**

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

If the machine is star connected then 3.5 cores or 4- core cable is selected

4. The path and mounting of cable is selected shortest route and convenience of power machine.
5. Armaoured cable can be selected for indoor power machine and unarmored cables can be selected outdoor power machine.

Single line diagram: **(2 Mark)**



or equivalent figure

ii) Proper method of earthing for industrial installation. **(2 Mark)**

- For earthing of industrial installation the value of earth resistance should be minimum and maintained. In that case effective earthing is very important.
- The effective earthing is the proper earthing of which earth resistance is properly maintained. It is as below:

a) Major generating station below 0.5 ohm

b) Minor generating station below 0.5 to 1 ohm

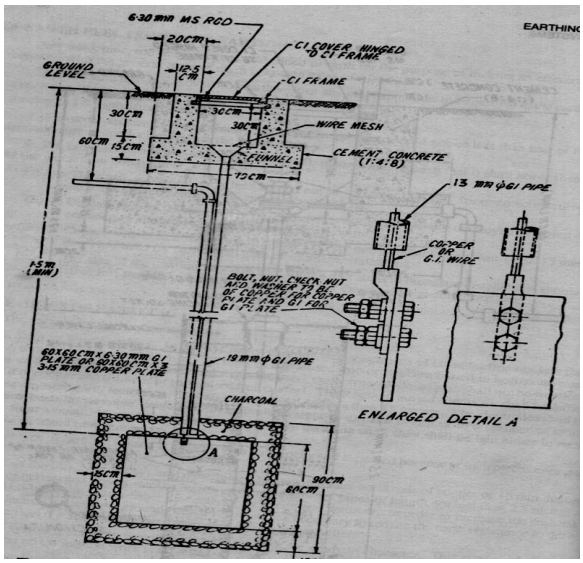
c) Major substations below 1 ohm to 1.5 ohm

d) Minor substation below 1.5 ohm to 2 ohm

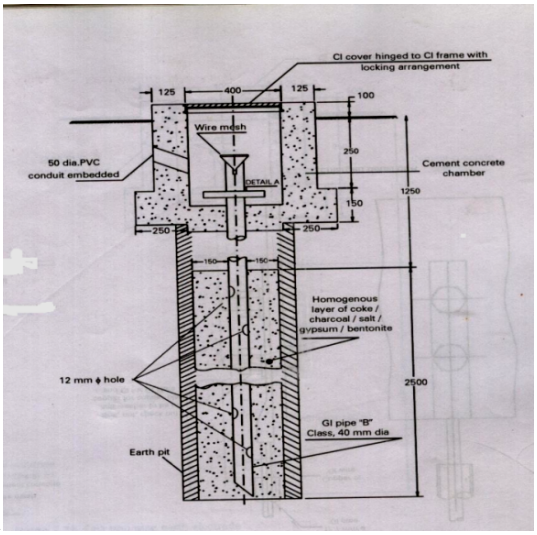
e) For the general installation below 5 to 8 ohm

The earthing should been done by following ways

i) Plate type: **ii) Pipe type earthing:** **(2 Mark)**



OR



- If the area of industrial premises is more and if there are more earthing pits then all pits are connected in mesh.