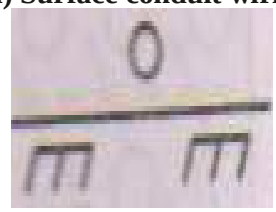
Important suggestions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more importance. (Not applicable for subject English and communication skills)
4) While assessing figures, examiner may give credit for principle components indicated in a figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case some questions credit may be given by judgment on part of examiner of relevant answer based on candidate understands.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q.1	**Attempt any TEN of the following**	**20 Marks**
a)	**Draw the symbols of the following: (i) Surface conduit wiring (ii) Exhaust fan**	
Ans:	**(i) Surface conduit wiring**  **ii) Exhaust Fan** 	**(Each Symbol: 1 Mark)**
b)	**State IE rule 29.**	
Ans:	**Rule 29:-** Construction, Installation, protection, operation and maintenance of electrical supply lines and apparatus. All electric supply lines and apparatus shall be of sufficient in mechanical strength and size for the work they may be required to do and shall be conducted, install and protected in accordance with I.S.I,s specifications.	**(2 Mark)**
c)	**State the importance of electrical drawing.**	
Ans:	**Importance of electrical drawing-** By the electrical drawing following advantages in electrical installation are obtained. 1) Simplicity of installation increases.	**(Any Two point expected 1 Mark each)**

	2) Uniqueness also increases. 3) Better understanding at the time of installation, repairing and maintenance of the work is possible. 4) Time required for installation will be less. 5) Space required will be also less if the drawings are correct.
d)	**Define service connection.**
Ans:	**Service Connection:-** **(2 Marks)** It is the input conductor or wire which is carried out from supply company (authorities) pole to consumers' main board or premises.
e)	**List types of internal wiring.**
Ans:	**(Any four types are expected: 1/2 Mark each)** **Types of Internal wiring –** 1) Cleat wiring 2) Batten wiring 3) Wooden casing capping wiring 4) PVC conduit wiring 5) PVC casing capping wiring 6) Concealed wiring 7)
f)	**List principle of circuit design in lighting circuit.**
Ans:	**The principles of circuit design in lighting circuits**: **Lighting Circuit :-** **(2 Mark)** ➢ Each sub circuit should not have more than a total 10 points (including lights, fans and 5A socket outlet) ➢ Each sub circuit should not exceed 800 watts. ➢ Make the no. of lighting sub circuit for lighting load. $No.\ of\ \ Lighting\ \ Sub\ circuits = \frac{Total\ \ Electrical\ lighting\ \ load}{800\,W}$ **OR** $No.\ of\ \ Lighting\ \ Sub\ circuits = \frac{Total\ \ No.of\ \ lighting\ \ point}{10}$

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

Ans: **(Any Two points are 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.

h) State any two examples of commercial installations.

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

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.

i) Define Bus-bar.

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

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 outgoing SFU. It is mounted on the Bakelite insulators / strips

j)	**Name the starters used for following motors: (i) 15hp, 3-ph squirrel cage 1M. (ii) D.C. Shunt motor**
Ans:	**i) 15 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 Shunts Motor:** Armature resistance starter (Three point starter) **(1 Mark)**
k)	**State the permissible limits for earth resistance in industrial installation.**
Ans:	**Permissible limit:** **(2 Mark)** **Earth Resistance:** should be very low for industrial installation it should be equal to or less than 5 ohm to 8 ohm for small scale industries and it should be very low, less than 5 ohm for medium scale or large scale industries.
l)	**State the meaning of security deposit.**
Ans:	**Security Deposit (SD):-** **(2 Marks)** Security deposit is amount or deposit given by the contractor to the owner till satisfactory completion of the project work. Generally it is a 5 to 10 % of the total estimated cost.
Q.2	**Attempt any Fourof the following :** **16 Marks**
a)	**Write any four 1E rules relating to lighting loads to be followed in electrical installation.**
Ans:	**(Note: Similar to following rules any four expected 1 Mark each point)** **Following IE rules related to lighting loads followed in an electrical installation:-** 1. Every installation is to be properly protected near the point of entry of supply cables by a two-pole linked main switch and a fuse unit. In a two wire installation if one pole is permanently earthed, no fuse, switch or circuit breaker is to be inserted in this pole. A 3-pole switch and fuse unit is to be used in 3-ph supply. 2. The conductors used are to be such a size that it may carry load current safely. 3. The conductors installed are to be safe in all respects. 4. Every sub-circuit is to be connected to a distribution fuse board. 5. Every line (phase or positive) is to protected by a fuse of suitable rating as per requirements. 6. A switch board is to be installed so that its bottom lies 1.25 to 1.5 meters above

the ground floor.

7. A plugs and socket-outlets are to be of 3-pin type, the appropriate pin of socket being connected permanently to the earthing system.
8. All incandescent lamps, unless otherwise required, are to be hung at a height of 2.5 meters above the floor level. And ceiling fans are to be hung 2.75 meters above the floor.
9. Lights and fans may be wired on a common circuit. Each sub-circuit is not to have more than a total ten points of lights, fans and socket-outlets. The load on each sub-circuit is to be restricted to 800 watts.
10. No fuse and switch is to be provided in earthed conductor.
11. Every circuit or apparatus is to be provided with a separate means of isolation such as a switch.
12. All circuit or apparatus requiring attention are to be provided with means of access to it.
13. In any building, light and fan wiring and power wiring are to be kept separate.
14. In 3-Phase, 4-wire installation the load is to be distributed equally on all phases.
15. No additional load is to be connected to an existing installation unless it has been ascertained that the installation can safely carry the additional load and that the earthing arrangements are adequate.
16. Lamp holders used in bath rooms are to be constructed or shrouded in insulating materials and fitted with protective shield and earth continuity conductor is not to be size less than 7/0.915 mm.
17. The metal sheaths or conduits for all wiring and metal coverings of all consuming apparatus or applications is to be properly earthed in order to avoid danger from electrical shock due to leakage or failure of insulation.
18. Each sub-circuit is to be protected against excessive current (that may occur either due to over load or due to failure of insulation) by fuse or automatic circuit breaker.
19. All light conductors are to be insulated or otherwise safe guarded to avoid danger.

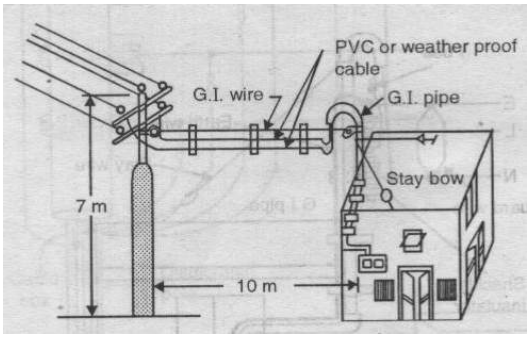
After completion of work the installations are to be tested (the test are to be carried out as described) before energisation.

20. Earth Resistance : should be very low for domestic installation it should be equal to or less than 5 ohm to 8 ohm
21. Insulation Resistance between conductor : should be very high for domestic installation it should be equal to or more than 1 mega ohm or it should be not be less than $= \frac{50\ M\Omega}{Number\ of\ outlet}$

b) Explain any one method of installation of service connection in detail.

Ans: **(Any one method is expected- Diagram- 2 Mark & Explanation-2 Mark)**

a) Overhead service connection:

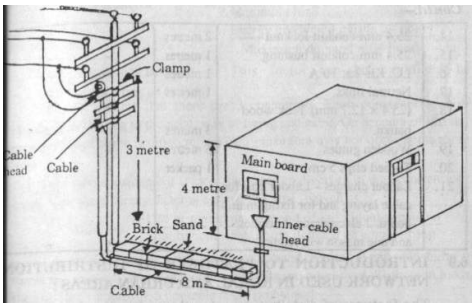


Explanation:

- Bare over head conductors are used for the service line when the consumer premises are more than 45 meter away from the supplier's distribution pole.
- This over head connection is provided with by means of PVC or whether proof cable.
- The GI wire is stretched between the pole and the GI pipe which is fixed near to the building.
- With the help of GI wire (8 SWG) whether proof cable is laid by using the ring (bobbin) insulator.
- For supporting the GI pipe stay wire and stay Bow is used.
- The minimum height of the service wire from the ground level is according to

IE rule i.e 5.7 meter from the ground level for low voltage.

b) Underground service connection:



Explanation:

- Generally for thickly populated cities or for factory premises underground service connection is preferred.
- Normally underground cable is laid 1 meter below the ground level.
- For laying of cable, cable trench is used and with the help of bricks and sand cable is laid.
- In underground service connection armoured or unarmoured cables are used according to requirement.
- Service cable is connected to the distribution line through a cable joint box, mounted on the supplier's distribution pole.
- If the proper protection against mechanical damage is to be provided then it is run through GI pipe or MS pipe.

c) Prepare schedule of material for underground service connection.

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

Scheduled of material for underground service connection is as follows:

1. 4 core Armored cable: (Size of cable is depends on load. & length of cable is depends on service connection premises)
2. Brick, soft sand for protection of cable.
3. If cable is laid across the public road then Cement pipe, DWC pipe or GI pipe is required for better protection of cable
4. Cable lug as per required size.
5. Cable Gland as per required size
6. Feeder piller or cable box or bus bar and cable end box.

7. GI pipe as required size.
8. Cable bushing.
9. 8 SWG Wire
10. Clamps, saddles etc
11. As such all service connection material like main switch, MCB, Energy meter, Neutral link, IC cut out, earthing nut, screws, and wooden board. etc

d) Compare overhead service connection and underground service connection on the basis of Location, Economy, Safety and Labour Cost.

Ans: **(Any four points expected 1 Mark each)**

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

e) A newly constructed residential unit is having following load: (i) 4 Lamps of 100W (ii) 8 ceiling fan of 65W (iii) 4 Sockets of 6 Amp having 100 watt. (iv) 2 Sockets of 16 Amp having 2 kw. Calculate rating of overhead service conductor.

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

$$\text{Total load in ResidentialUnit} = \text{Lamps} \times \text{watt} = 4 \times 100 = 400\ \text{W}$$

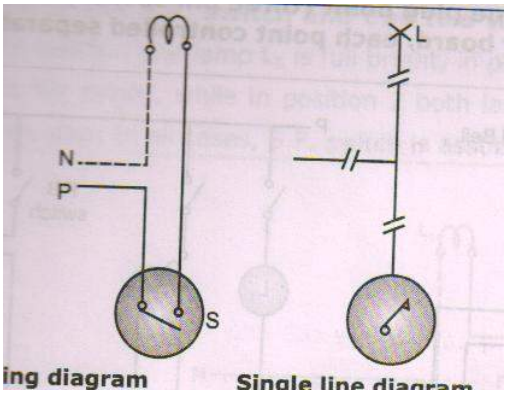
$$= \text{Fans} \times \text{watt} = 08 \times 65 = 520\ \text{W}$$

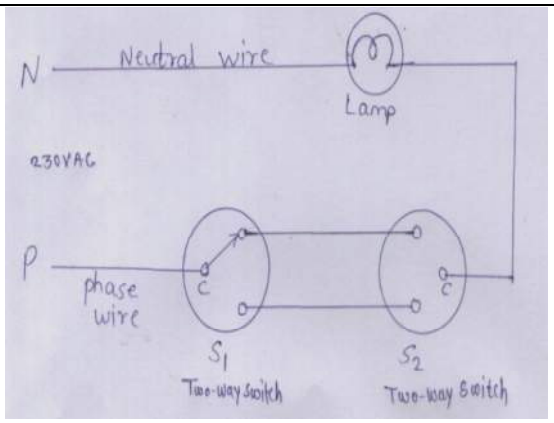
$$= \text{Sockets} \times \text{watt} = 04 \times 100 = 400\ \text{W}$$

$$= \text{Power Sockets} \times \text{watt} = 02 \times 2000 = 4000\ \text{W}$$

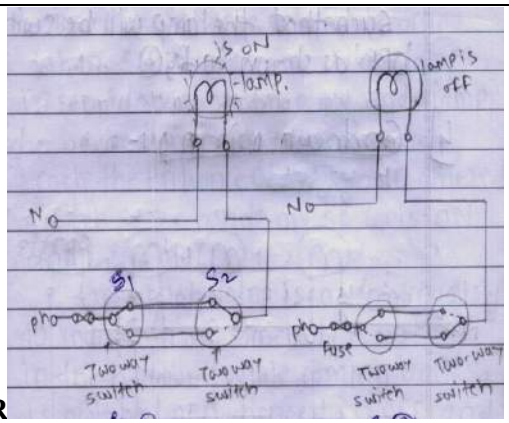
$$\text{Total load in Residential Unit} = \text{Lamps in Watt} + \text{Fans in Watt} + \text{Socket in watt} + \text{Power Socket}$$

$$\text{Total load in Res.Unitl} = 400 + 520 + 400 + 4000 = 5320\ \text{watt}$$ -------- **(1 Mark)**

	Total load in Amps $= \frac{5320}{230} = 23.13 \cong 24$ Amp assuming p.f. $= 1$ **(1 Mark)** ------ It is assumed that starting current is 1.5 times rated input current, for Starting surge, momentary short circuit, over load and future expansion: So Starting current = 1.5 x 24 = 36 Amp ----- **(1 Mark)** **Rating of service conductor is** = ----- **(1 Mark)** = 6 Sqmm, 2 Core weather proof cable is selected
f)	**What is tender? State it types.**
Ans:	**Meaning Tender:-** **(2 Marks)** Tender is offer or invitation of the work between any two parties. This offer may be written or non written. This offer is given by party no.1 (owner) to party no.2 (contractor- who has to complete the project work). **Types of Tender:** **(Any Two expected: 2 Marks each)** 1. Negotiated Tender 2. Limited competition or selective Tenders 3. Open Tender
Q.3	**Attempt any FOUR of the following :** **16 Marks**
a)	**Draw the following wiring diagrams: (i) One Lamp controlled by one switch. (ii) One Lamp controlled by two switches.**
Ans:	**(i) One Lamp controlled by one switch:** **(Figure-2 Marks)**  **(ii) One Lamp controlled by two switches:** **(Figure-2 Marks)**



OR



b) What is DP-MCB? State its advantages

Ans: **(Meaning-2 Marks & Advanatges-2 Marks)**

DP-MCB: - It is a Double pole miniature circuit breaker

Function: The function of DP- MCB is to isolate the circuit against over current due to over load or short circuit.

Advantages of DP-MCB: - **(Any two points expected)**

1. It operate the automatically whenever there is the fault.
2. High reliability.
3. Compact in size.
4. Long life.
5. Economical.

c) Explain principle of circuit design in lighting and power circuit.

Ans: **The principles of circuit design in lighting and power circuits:**

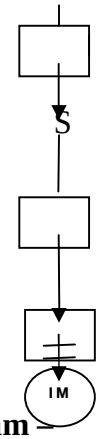
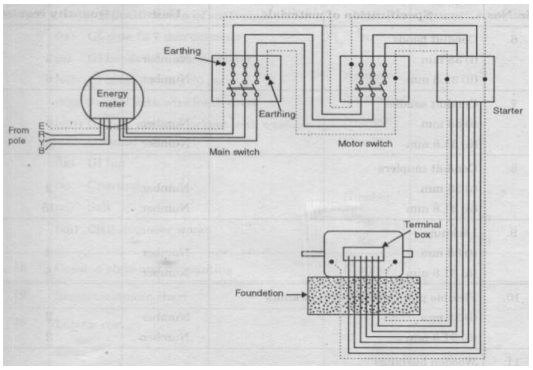
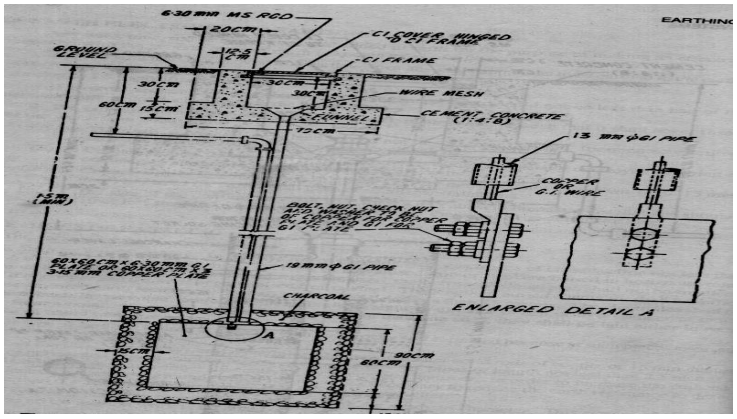
Lighting Circuit :- **(2 Mark)**

- 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** $No.\ of\ \ power\ Sub\ circuits = \frac{Total\ No.of\ \ power\ \ point\ s}{1000\,W\ \ or\ \ 2000\,W}$
d)	**State the purpose of following in conduct wiring: (i) Elbow (ii) Look-nut (iii) Conduit Box (iv) Inspection Box**
Ans:	**The purpose of following in conduct wiring:** **i) Elbow :** To move the direction of the conductor path as per wiring installation **(1 Mark)** **ii) Lock nut:** To hold and seal the conduit with their wires **(1 Mark)** **iii) Conduit box:** To hold and inspect incoming and outgoing terminals **(1 Mark)** **iii) Inspection box:** To inspect the path of wiring. **(1 Mark)**
e)	**Explain earthing of commercial installation.**
Ans:	**Explanation:** **(4 Mark)** ➢ Earthing of commercial installation is very necessary to save the human life at the time of ground fault for this earthing two types of methods are preferred a) Plate type earthing b) 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.

f)	**Draw and label single line diagram of 3-phase induction motor connected to supply with Star-Delta starter.**
Ans:	**(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.**
Q.4	**Attempt any FOUR of the following : 16 Marks**
a)	**Draw a neat sketch of plate earthing and explain it in brief.**
Ans:	**Sketch of plate earthing:** **(2 Mark)** 

Explanation: **(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

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

b) How selection of rating of main switch and distribution, board is done in residential building installation.

Ans: **Selection of rating of main switch and distribution, board is done in residential building installation:**

Given Data: (All data is assumed it may vary or it may not be available, there will be only steps and this steps are expected) **(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) $Total\ connected\ lighting\ load\ in\ a\ house = 540 + 240 + 360 = 1140\,W\ or\ 1.14\,KW$, **- (1/2 Mark)**

ii) $Total\ connected\ Power\ load\ in\ a\ house = 4 \times 1000 = 4000\,W\ or\ 4.0\,KW$, **(1/2 Mark)**

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

iii) Total load in $= \frac{1140}{800} = 1.425 \cong 2$ Nos lighting sub circuit

Total load in $= \frac{4000}{200} = 2$ Nos Power sub circuit

Distribution Board: So, 4 number of MCB are required ---------- **(1 Mark)**

iv) Total Connected load is 5140 watt, so Number of sub circuit = 4 Nos.

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

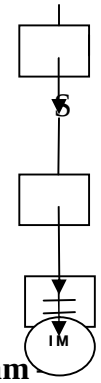
Current rating **Iron clad main switch** = 32 A ---------- **(1 Mark)**

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

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

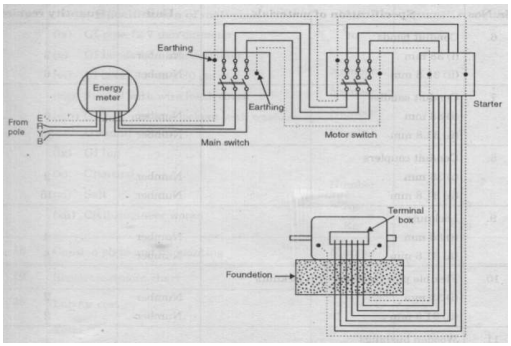
c) Draw and label single line diagram for a 3-phase motor pump connected to supply using Direct ON Line starter.

Ans: **Single line diagram for a 3-phase motor pump connected to supply using Direct ON Line starter.** **(4 Mark)**



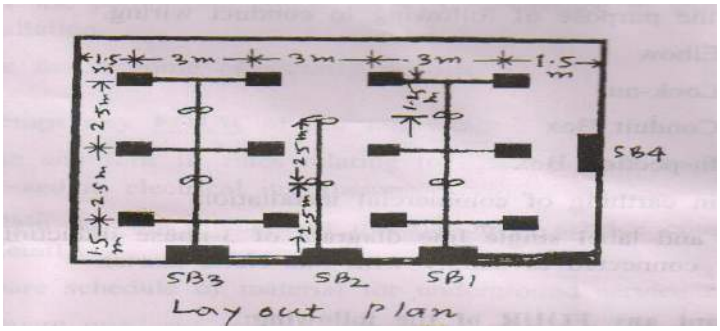
3-ph,4 wire 400v A.C. supply
Energy meter
Main Fuse
ICTP
DOL starter
3 Ø Induction motor **OR**

Wiring diagram



Or equivalent ckt dia

d)	**State the meaning of valid contract and state the conditions for the comparative statement.**
Ans:	**Meaning of valid contract:** **(Any Four point are expected: 1/2 Mark each)** 1. Contract should be written 2. Contract should be signed by proper witness 3. Contractor licenses should be valid 4. Contract should be signed by competent authority. 5. Contract should be signed proper authorized persons. 6. It should be legally valid. **Following are conditions for the comparative statement:** **(Any Four point are expected: 1/2 Mark each)** 1. The contract licenses validity 2. The quoted cost of total project work 3. Drawing details of the project works 4. Work in hand of the contractor.
e)	**Explain in brief: (i) Security deposit (ii) EMD**
Ans:	**i) 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. **ii) 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.
f)	**Flow will you select a good contractor for a particular project? Write down any four important points.**
Ans:	**Selection criteria (points) of good 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.5	**Attempt any TWO of the following : 16 Marks**
a)	**A Hall whose dimensions are 12m x 8m is to be fitted with an electric installation. Estimate the quantity of material. Assume the height of ceiling to be 5m. The wiring is running at a height of 2m from the floor. The load in the hall is 12 fluorescent lamps, 6 fans and 8 (5 Amp) Sockets and 2 (15 Amp) Socket outlets-Refer layout plan - Figure No. I** 
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 × watt $= 12 \times 40 = 480$ W $= Fans \times watt = 06 \times 60 = 360\,W$ $=$ Sockets × watt $= 08 \times 100 = 800$ W $=$ Power Sockets × watt $= 02 \times 2000 = 4000$ W Total load in Hall = tubes inWatt + Fans in Watt + Socket in watt + Power Sockect i) Total load in Hall $= 480 + 360 + 800 + 4000 = 5640$ watt ---------- **(1/2 Mark)** Total load in Amps $= \frac{5640}{230} = 24.521 \cong 25$ Amp assu min g p.f. $= 1$ -- **(1/2 Mark)** ii) Total load in $= \frac{1640}{800} = 2.05 \cong 3$ Nos lighting sub circuit ---------- **(1/2 Mark)**

iii) Total load in $= \frac{4000}{2000} = 2$ Nos Power sub circuit ---------- **(1/2 Mark)**

iv) **Length of Conduit:**

= 4+12+0.5+0.5+0.5+0.5+6.5+3+3+3+6.5+3+3+3

= 16+2+6.5+9+6.5+9+5

= 18+13+18+5

= 54 Mtr + 5.4 (10 %)

= 60 Mtr ---------- **(1/2 Mark)**

iv) **Length of Wire:**

= 60 x 3 +20 % extra

= 180 + 36

= 216 or 220 mtr ---------- **(1/2 Marks)**

v) Rating Main switch: - since rated input current is 25 A.

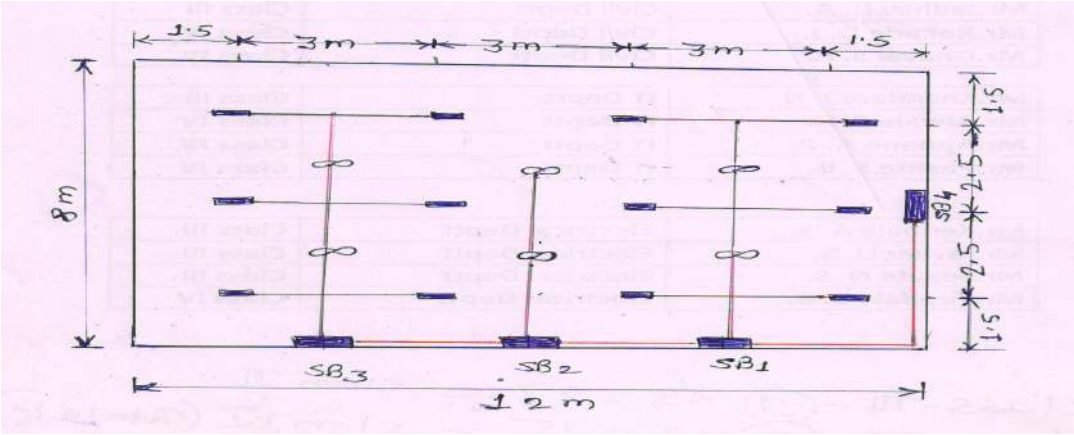
Assumed that Staring current = 1.5 times rated current

So starting current = 1.5x 25 = 37.5 A

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

236V, 36A, ISI mark Main switch of any company

Layout or Conduit Plan Drawing:- --- **(2-Marks)**



or equivalent figure

Note:- Cost of material may vary so do not stick on final figures

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

S.No	Material of Material	Quantity	Rate	Total Amount
1	ICDP 250V,40A	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	20 pipe	15.00	300.00
4	Copper Earthing Plate	01	490.00	490.00
6	DP	01	150.00	150.00
7	Earthing Sundry	lumsump	200.00	200.00
8	6A Switch	26	10.00	260.00
9	6A Three point socket	08	12.00	96.00
10	15A Three pin socket with indicator fuse	02	55.00	110.00
10	Ceiling rose	18	10.00	180.00
11	2.5 Sqmm PVC wire Running earth	15 Mtr	7.00	105.00
12	1 Sqmm PVC wire with earth wire (90 Mtr -1 bundle)	02 Bundle	780.00	1560.00
13	Junction Box	25 approx.	07.00	175.00
14	4 x 6 Switch board with cutting	01	25.00	25.00
15	10 x 12 Switch board with cutting	02	35.00	70.00
16	Labour Charges	30	110.00	3300.00
		Total Amount :-		**7406.00**
17	Contingencies+ profit margin	10% Amount:-		740.00
		Total Amount:-		**8146.00**
	iii) Cost of work:	Say Total Amount:		**8150.00**

b) **State design considerations (any eight) of electrical installation system for commercial building.**

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

The consideration to prepare design of electrical installation system for commercial building.-

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.

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

OR

$$No.\ of\ \ power\ Sub\ circuits = \frac{Total\ No.of\ \ power\ \ po\text{int}\,s}{1000\,W\ \ or\ 2000\,W}$$

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.

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

Ans:

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

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

Comparation for Industrial laod and residential load:

(Any Two points expected: 1 Mark each)

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

Five important points of motor wiring:

(Any Four points are expected: 1 Mark each)

1. The supply to every motor is controlled by main switch. Main switch may be ICDP for single phase machine and ICTP for 3-ph machine.

2. Starter is required to start the motors, if the capacity of the motor is less than 5 HP then DOL starter can be used and if it is more then star-delta starter, auto transformer starter, or rotor resistance starter etc (depends upon types of motor) can be used.

3. The size and core of cable is also decided Size of the cable is decided by the starting current of every machine, generally starting current is assumed two times of rated input current of every machine

3. Type of the cable is decided by the type of supply of the machine, if the machine is single phase then two core cables is used and if the machine is three phase delta

connected then three core cable is selected.

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

4. The path and mounting of cable is selected 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.

Q.6 Attempt the following :

a) Describe how rating of cable and fuses are to be decided for three phase squirrel cage induction motor by taking suitable rating. 04 Marks

Ans: **(Rating point -2 Mark and Procedure – 2 Mark)**

Ratings of cables & fuses are decided by the following points:-

- Type & Capacity of motor which is used in the installation.
- Supply providing to the motor which is used in installation.
- Power factor of the motor.
- Future expansion.
- Starting surge, over load and momentary short circuit on the motor.

The procedure is as follows:-

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

$$Total\ power = ...watt$$

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

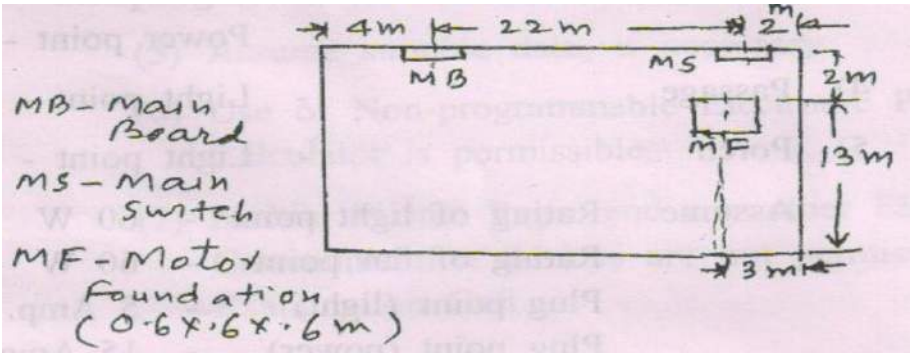
$$Rated\ input\ current\ I_L = \frac{.....\times 735.5}{\sqrt{3} \times 415 \times efficency \times P.f}$$

= …….. Amp

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

Starting current = 2 x …….. = …….. Amp by this ampere rating the size and type of cable is decided. The fuses are also selected for this current.

b)	**Attempt any ONE of the Following** **12 Marks**
	(i) In a work shop 20 hp, 415 V, 3ph, 50Hz motor is to be installed. Prepare the estimate required for motor installation assuming PVC surface conduit type of wiring. Detailed Plan is shown in Figure No. 2.



Ans:

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

Assuming height of Ceiling if 3 m from the floor.

Motor is installed 1 M away from the nearest wall.

Height of Main Switch is 1.2 M from the floor

Step No. 1:- The out power of induction motor = 20 x 735.5 = 14710 W---------- **(1 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 = 14710 / 0.8 = 18387.5 W

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

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

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

$$I_L = \frac{18387.5}{\sqrt{3} \times 400 \times 0.8} \qquad Cos\phi = 0.8 \text{ assumption}$$

$I_L = 33.21$ Amp Rated current = 33.21 Amps

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 33.21 = 66.42 Amps

So use,

16 Sqmm 4 core cable for the I.M.

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

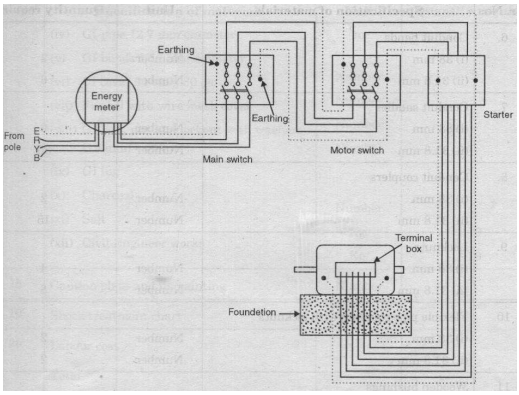
The rating of main switch is 450 V, 63 Amp ICTP ISI mark

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

Length of earth wire = 2 times length of cable

Length of input cable for I .M at actual

Step No.6: Draw the circuit Diagram. ---------- **(2 Mark)**



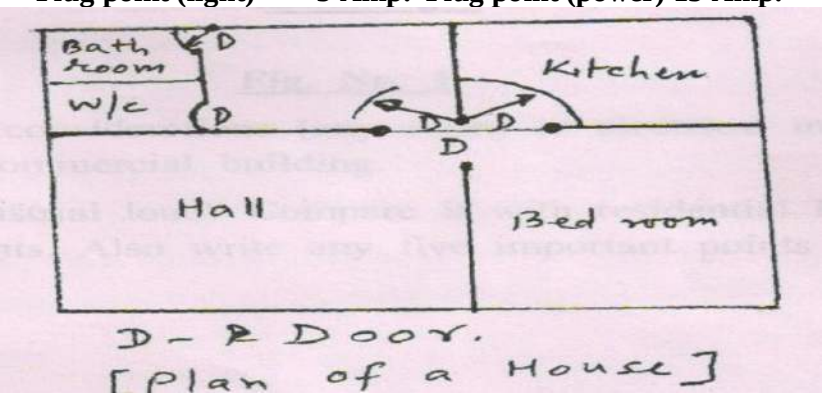
or equivalent figure

Step No. 7:- Find out the estimation chart with material cost & labour cost: ----- **(4 Mark)**

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

Common Material: (Any eight points expected)

1. 4 core Armored cable: (Size of cable is depends on load. & length of cable is depends on service connection premises)
2. Brick, soft sand for protection of cable.
3. If cable is laid across the public road then Cement pipe, DWC pipe or GI pipe is required for better protection of cable
4. Cable lug as required size.
5. Cable Gland as required size
6. Feeder piller or cable box or bus bar and cable end box.
7. GI pipe as required size.
8. Cable bushing.

	9. 8 SWG Wire 10. Clamps, saddles etc 11. As such all service connection material like main switch, MCB, Energy meter, Neutral link, IC cut out, earthing nut, screws, and wooden board. etc 12. 16 mm^2, 4 core cable having the length of 15 meter and 6 core 2 Mtr for starter. 13. RYB mains indication lamps. 14. 1m x 1m wooden board as main board. 15. Earthing plate 60cm x 60 cm x 3.18 mm – 1 Nos. 16. Earthing sundry char coal and salt. 17. 15 HP Star-delta starters. 18. 8 SWG copper or 6 SWG GI earthing wire, having the length of 40 Mtr.
c)	**ii) Design the sub-circuits, main circuit and conductor size for a residential building whose plan is given in Figure No. 3 and load in each room is as follows.** **1) Hall - Light points - 2 Nos, Fan points - 1 No, Plug point - 2 Nos.** **2) Bed room and Kitchen each : Light points:2 Nos, Fan points:1 No, Plug point:1 No.** **3) W.C. and Bath - Light point - 1 No, Power point - 1 No.** **4) Passage: Light point - 1 No.** **5) Porch: Light point - 1 No.** **Assume: Rating of light point - 60 W, Rating of fan point 60 W** **Plug point (light) - 5 Amp. Plug point (power) 15 Amp.** 
Ans:	**Given Data: (The Assumed data may be vary (Give stepwise Marks as mention below)** Total loadin Resi.Building= TotalLight point + Fan Point + 5A Plug Point + 15 A Plug Point Total loadin Resi.Building= 07 + 02 + 03 + 01 = 13 No. of Point ---------- **(1 Mark)** Total load in Resi.Building = Light × watt = 07 × 60 = 420 W ---------- **(1/2 Mark)** = Fans × watt = 02 × 60 = 120 W ---------- **(1/2 Mark)**

$= \text{Sockets} \times \text{watt} = 03 \times 100 = 300\ \text{W}$ ---------- **(1/2 Mark)**

$=$ Power Sockets $\times$ watt $= 01 \times 2000 = 2000\ \text{W}$ ------ **(1/2 Mark)**

Totalloadin Resi.Building= LightsinWatt+ Fansin Watt+ Socket in watt + PowerSockect

i) Total load in Hall = 420 + 120 + 300 + 2000 = 2840 watt ---------- **(1 Mark)**

Total load in Amps $= \frac{2840}{230} = 12.34 \cong 13$ Amp assu min g p.f. = 1 ---- **(1 Mark)**

ii) Total load in $= \frac{840}{800} = 1.05 \cong 1$ Nos lighting sub circuit ---------- **(2 Mark)**

iii) Total load in $= \frac{2000}{2000} = 1$ Nos Power sub circuit ---------- **(2 Mark)**

iv) Rating Main switch: - since rated current is 13 A. ---------- **(1 Mark)**

Assumed that Staring current = 1.5 times rated current

So starting current = 1.5x 13 = 19.5 A

So Use:-

240V, 32A, ISI mark Main switch of any company

v) Determine size of conductor : ---------- **(2 Mark)**

Starting current is assumed two times rated input current for starting surge, momentary short circuit & overload. Starting current = 2 x 19.5 = 39 Amps

So use,

= 6 Sqmm, 2 Core weather proof conductor is selected

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