SUMMER – 2022 EXAMINATION

Subject Name: Electrical Estimation &Contracting **Model Answer: 22627: EEC**

Important Instructions 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 principal components indicated in the 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 of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. No.	Sub Q. N.	Answer	Marking Scheme
1.		**Attempt any FIVE of the following:**	**10 Marks**
	a)	Draw the symbol for i) Exhaust fan ii) Intermediate Switch **Ans:** **i) Exhaust Fan** **ii) Intermediate Switch** 	1 Mark for each of two symbols = 2 Marks
	b)	State any four IE rules for electrical installation. **Ans:** **Rules for Electrical Installation:** 1. Every installation is to be properly protected near the point of entry of supply cables by a two-pole linked main switch and a fuse unit. In a two wire installation if one pole is permanently earthed, no fuse, switch or circuit breaker is to be inserted in this pole. A 3-pole switch and fuse unit is to be used in 3-ph supply. 2. The conductors used are to be such that size of conductor should carry rated current and partial over load current safely. 3. The conductors installed are to be safe in all respects. 4. Every sub-circuit is to be connected to a distribution fuse board. 5. Every line (phase or positive) is to be protected by a fuse of suitable rating as per requirements. 6. A switch board is to be installed so that its bottom lies 1.25 to 1.5 meters above the ground floor. 7. A plugs and socket-outlets are to be of 3-pin type, the appropriate pin of socket being connected permanently to the earthing system.	½ Mark for each of any four rules = 2 Marks

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 energization.
20. Earth Resistance: should be very low for domestic installation it should be equal to or less than 5 ohms to 8 ohm

c) Differentiate between non-industrial and industrial load.

Ans:

Sr. No.	Basis	Industrial Load	Non-industrial Load
1	Location	In industrial estate or MIDC area	In highly population density Residential / commercial 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	Time-of-Day tariff	Block rate tariff

1 Mark for each of any two bits = 2 Marks

d) State the purpose of guarding wire used in distribution lines

Ans:

Purpose of guarding wire used in distribution lines:

Guarding wire is used to protect the personnel, lines or equipment in the event of fault. When distribution line conductor snaps (brakes down) during abnormal weather conditions such as heavy rains, storms and lightning, the live conductor touches the guard wire, which is earthed. Thus snapping of conductor creates earth fault, causing fuse to blow or protective relay to

2 Marks for correct answer

operate and disconnect the faulty line from supply. Thus snapped conductor becomes dead and no harm can occur even if somebody touches such conductor.

e) Write the aim of public lighting installation.

Ans:

Aim of Public Lighting Installation:

i) To improve the visibility to facilitate the flow of traffic and pedestrian.
ii) Reduction in night time accidents.
iii) Prevention of crimes and aid to police protection.
iv) To enhance the appearance of roads at night.
v) Promotion of business and working hours in industry during nights.

1 Mark for each of any two aims = 2 Marks

f) State the purpose of estimating and costing.

Ans:

Purpose of Estimating and Costing:

(a) Administration Approval/For Taking in Principle Decision to go Ahead:
To take "In principle decision" to go ahead with house construction /project, which is commonly known as "**Administration approval**" in government departments.

(b) Selection of Construction Materials/Technology:
Once in principle decision is taken, the owner prepare design including planning & deciding right construction materials, to decide right technology, as well as the size and area of the project and, will finally decide whether to go ahead or not or what to change in the project?

(c) Required Quantity of Materials:
Once designs are ready one can work out detailed estimates and based on the same one can work out the quantity, cost of materials, required to complete the work.

(d) Labour Requirement:
To know the detailed cost of different categories of labour needed like masonry, excavation, RCC (reinforced cement concrete) work, plaster, painting etc.

(e) Equipment, Tools and Plants Requirement:
To know the detailed cost of equipment, tools, plants and machinery to be used in construction.

(f) To Plan Time:
To plan the time schedule of construction depending upon the cash flow i.e. availability of funds.

(g) Final Decision:
At this stage, one finally need to decide whether to go ahead with the construction plan or not.

(h) Project Sanction:
To give the sanction for the project with the modification in the plan if any, keeping budget & time in view.

(i) Cost Control:
Cost control is the main objective of estimating and costing.

(j) To Invite Tender/ Quotations:
To invite Tender/Quotations from contractors and compare rates with estimates and finalize the contractor based on quantity/rates and work items.

(k) Valuation:
Valuation of existing property.

1 Mark for each of any two purposes = 2 Marks

g) State the factors to be considered in selecting the type of wiring.

Ans:

Factors to be considered in selecting the type of wiring:

1. Cost of wiring
2. Durability
3. Accessibility
4. Appearance
5. Mechanical protection
6. Safety
7. Maintenance cost

1 Mark for each of any two factors = 2 Marks

2. Attempt any THREE of the following: **12 Marks**

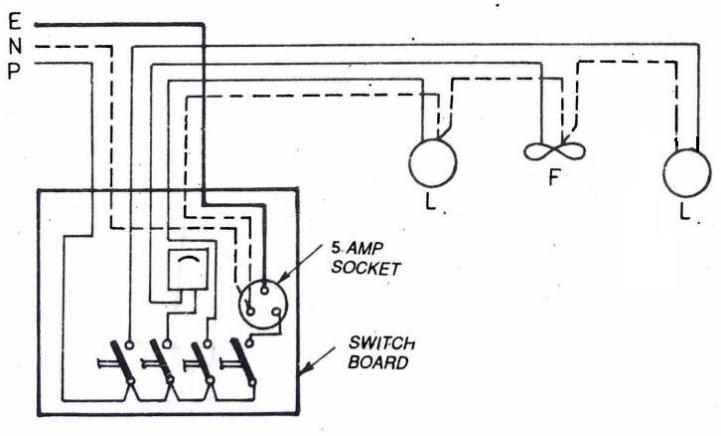
a) Two lamp points, one ceiling fan & one 5A socket to be controlled by individual switches. Draw

i) Wiring diagram

ii) Schematic diagram

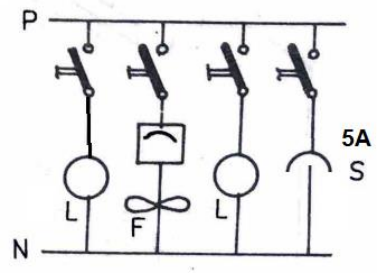
Ans:

i) Wiring diagram:



2 Marks

ii) Schematic diagram



2 Marks

b) A residential unit is having following load:

i) 4 lamps of 60 W each
ii) 6 lamps of 40 W each
iii) 4 ceiling fans of 60 W each
iv) 6 sockets of 6 A having 100 W each
v) 4 sockets of 16 A having 1000 W each

Calculate:

1. Total lighting load
2. Total power load

3. Size of distribution board
4. No. of sub-circuits for L and F and power.

Ans:

1. Total lighting load

$= (4 \times 60) + (6 \times 40) + (4 \times 60) + (6 \times 100) = \mathbf{1320\ W}$

2. Total power load

$= 4 \times 1000 = \mathbf{4000\ W}$

3. No. of sub-circuits for L and F and power

No. of lighting sub-circuit $= \frac{light\ \&\ fan\ load}{800}\ or\ \frac{No.\ of\ light\ \&\ fan\ points}{10}$

$= \frac{1320}{800}\ or\ \frac{20}{10} = \mathbf{2\ sub\text{-}circuits}$

No. of power sub-circuit $= \frac{Power\ load}{3000} = \frac{4000}{3000} = 1.33 \cong \mathbf{2\ sub\text{-}circuits}$

1 Mark for each bit = 4 Marks

4. Size of distribution board

Since there are 2 lighting sub-circuits and 2 power sub-circuit, we require 4 way distribution board. It includes main MCB with other 2 MCBs for lighting sub-circuits and 2 more MCBs for power sub-circuits.

c) Compare overhead and underground service connection on any eight points.

Ans:

Comparison between Overhead and Underground service connection:

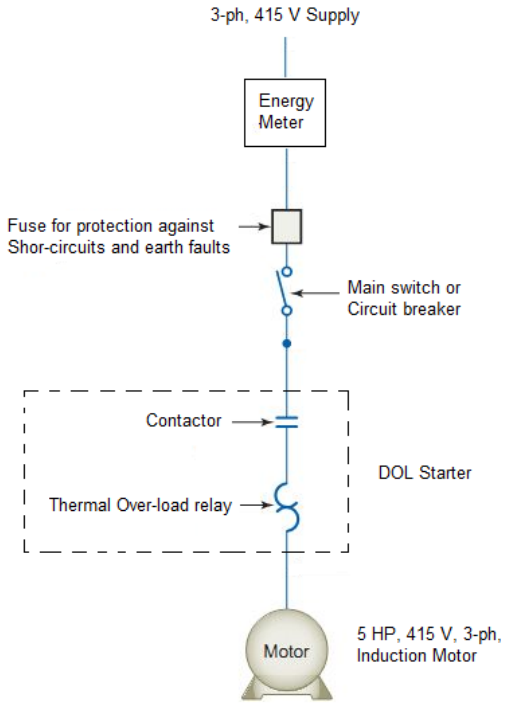
Sr. No.	Basis	Overhead service connection	Underground service connection
1	Location	Small cities and villages	Modern cities
2	Cost	Cheaper	Expensive
3	Safety	Less	More
4	Appearance	Appearance is poor and not so good	No cable is visible, so aesthetic look of building is not disturbed.
5	Identification of fault	Very easy to repair and clear the fault.	Very difficult to repair and clear the fault.
6	Cable	Service cable is used	Well insulated and armored underground cable is used
7	Environmental Impact	It gets impacted by the occurrences of environmental attacks (like lightning, windstorm, thunderstorm).	There are fewer chances of environmental attacks in an underground system.
8	Reliability	Low reliability	High reliability
9	Maintenance cost	High as the service connection is prone to more no. of faults	Low as the occurrence of fault is very less
10	Interference	Overhead service lines can interfere with communication lines.	Underground service connection does not interfere with communication lines.

½ Mark for each of any eight points = 4 Marks

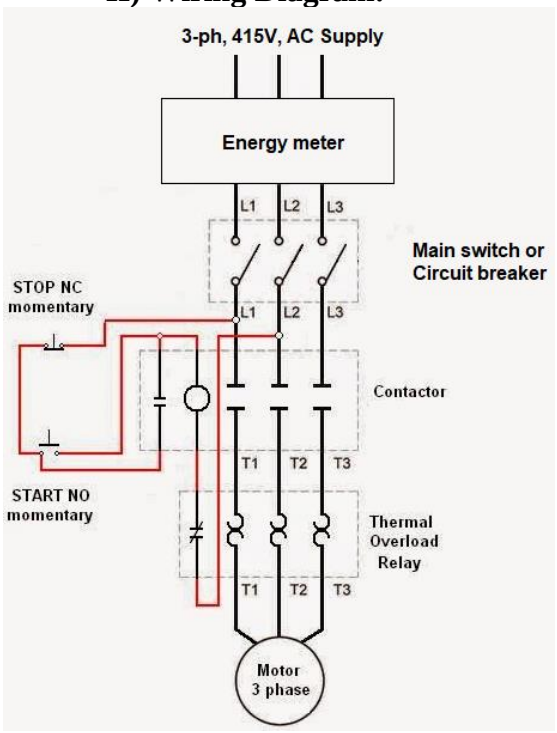
d) Draw wiring diagram and single line diagram of three phase, 415V, 5 HP, Induction motor installation.

Ans:

I) Single line diagram:



II) Wiring Diagram:



2 Marks for Single line diagram And 2 Marks for Wiring diagram

3. Attempt any THREE of the following: **12 Marks**

a) Explain two envelop method for tender.

Ans:

Two Envelop Method:

The system of submitting tender documents is also called as two envelope system. 1 Mark

- The treasury challan, deposit, call receipt, forwarding letter the copies of registration certificate, income tax clearance certificate, and list of machinery to be used to be sealed in one envelope.
- The tender set itself with quoted value should be sealed in another envelope: these two sealed envelopes should be put in one cover and sealed. On the top of this cover, the name of the work, address of the receiving authority should be written.
- These envelopes are then handed over in person or send by post to the address mentioned before the specified time and date.
- The tenders are always opened at specified date & time in front of representative of every bidder.
- Initially envelop No.1 of every party is opened. The all documents which are given as above are checked if found O.K. then envelope No.2 of those parties is opened.
- If one of the party having the any short coming in envelop No.1 then the envelop No.2 of that party is not opened.
- The all contents in envelop No.1 are checked. It is as above & after opening the all envelops of all parties the comparative statement is done and for suitable company the contract is handed over.

3 Marks for Explanation

b) State the General requirement of electrical installation.

Ans:

General requirements of electrical Installation:

1. Safety (Electrical & Mechanical)
2. Life.
3. Appearance.
4. cost
5. Maintenance & Repairing
6. Future expansion
7. Type of wires, wiring accessories and wiring methods.

1/2 Mark for any four requirement = 2 Marks

Explanation:

1) Electrical installation should be electrically and mechanically safe. All precautions should be taken.
2) Life of installation should be long.
3) Appearance should be good and decorative.
4) It should be economical
5) Maintenance & repairing should be simple and less.
6) Future expansion can be easily done.
7) For the better requirement the selection of wires, wiring method and wiring accessories with our economy is also very important
8) Precautions should be taken to prevent leakage of water into installation rooms.
9) Provide proper clearance for cable and Follow minimum wire bending

2 Marks for any Two requirement explanation

OR

Following requirements of Electrical installation:-

21. 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.
22. The conductors used are to be such that size of conductor should carry rated current and partial over load current safely.
23. The conductors installed are to be safe in all respects.
24. Every sub-circuit is to be connected to a distribution fuse board.
25. Every line (phase or positive) is to be protected by a fuse of suitable rating as per requirements.
26. A switch board is to be installed so that its bottom lies 1.25 to 1.5 meters above the ground floor.
27. A plugs and socket-outlets are to be of 3-pin type, the appropriate pin of socket being connected permanently to the earthing system.
28. 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.
29. 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.
30. No fuse and switch is to be provided in earthed conductor.
31. Every circuit or apparatus is to be provided with a separate means of isolation such as a switch.
32. All circuit or apparatus requiring attention are to be provided with means of access to it.
33. In any building, light and fan wiring and power wiring are to be kept separate.

1/2 Mark for any eight requirement = 4 Marks

34. In 3-Phase, 4-wire installation the load is to be distributed equally on all phases.
35. 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.
36. 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.
37. 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.
38. 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.
39. 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 energization.
40. Earth Resistance: should be very low for domestic installation it should be equal to or less than 5 ohms to 8 ohm
41. 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 not be less than = $\frac{50\text{Mohm}}{\text{Number of Outlet}}$

c) Decide the rating of main switch, Motor switch, distribution board and cable for a industrial installation of having 2 motos of 3 HP and 5 HP.

Ans:

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

Assuming $\eta = 0.85$ and V = 415V. p.f.= $\cos\emptyset = 0.85$

Rating for 5 HP, 3-Ph I.M :-

$$\text{Total Power} = \text{HP rating} \times 735.5$$
$$\text{Total Power} = 5 \times 735.5$$
$$\text{Total Power} = 3677.5 \text{ Watt}$$
$$\text{Input Current } I_L = \frac{\text{Total Power}}{\sqrt{3} \times V_L \times \eta \times \cos\emptyset}$$ ½ Mark
$$\text{Input Current } I_L = \frac{3677.5}{\sqrt{3} \times 415 \times 0.85 \times 0.85}$$
$$\text{Input Current } I_L = 7.08 \text{ A}$$ ½ Mark

Starting current = $2 \times 7.08 = 14.16$ A

So Use, the 4 mm^2, 4 core copper cable of 500V, 50Hz with ICTP switch or MCB of 16A, 690V/ 450V. ½ Mark

Rating for 3 HP, 3-Ph I.M :-

$$\text{Total Power} = \text{HP rating} \times 735.5$$
$$\text{Total Power} = 3 \times 735.5$$
$$\text{Total Power} = 2206.3 \text{ Watt}$$ ½ Mark
$$\text{Input Current } I_L = \frac{\text{Total Power}}{\sqrt{3} \times V_L \times \eta \times \cos\emptyset}$$

$$\text{Input Current } I_L = \frac{2206.3}{\sqrt{3} \times 415 \times 0.85 \times 0.85}$$

$$\text{Input Current } I_L = 4.25 \text{ A}$$

Starting current = $2 \times 4.25 = 8.5$ A ½ Mark

So Use, the 2.5 mm^2, 4 core copper cable of 500V, 50Hz with ICTP switch or MCB of 16A, 690V/ 450V. ½ Mark

Distribution Board Consist of Two 3-Pole MCBs (3 Pole MCB of rating 16A 450/690Vfor each Motor) ½ Mark

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.

$$= 14.16 + 4.25 = 18.41 \text{ A}$$

So Use, ICTP Switch or MCB of 32A, 690/450V ½ Mark

d) Estimate the main material requirement for a 600m, 415/240V, 3 phase line with 4 wires in vertical configuration. The line emanate from substation to feed a load of 30kW. Consider span between two poles as 60 meter.

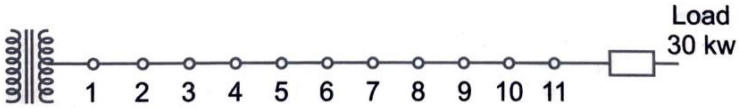
Ans:

Data Given:

Total length of line = 600 m

Length of span between two poles = 60 m

No. of poles required = $\frac{600}{60} + 1 = 11$



Main Material requirement:

1) **Poles:** Pre-stressed Concrete (PSC / PCC) Poles (8 m) = 11 nos.

2) **Conductor:** ACSR conductor (6/1 x 2.59 mm) is usually used for LT lines. The length of conductor required = 4 conductors/line x Line length + 5% for sag and wastage

$$= \frac{4 \times 600 \times 105}{100} = 2520\ m = 2.52\ km$$

1 Mark for each of any four material = 4 Marks

3) **GI wire for earthwire:** usually 8 SWG GI wire is used.
Length of GI wire required = $600 \times 105\% = 630\ m$
GI wire of 8 SWG weighs 0.131kg/m, hence the required GI wire = 0.131×630 kg
$= 82.53 \cong 83$ kg

4) **LT shackle Insulators:** These are required 4 nos. per pole
Total shackle insulators required = $4 \times 11 = 44\ nos.$

5) **Earth knobs:** It is required one per pole for carrying earth wire,
Total earth knob requirement = 11 nos.

6) **D-clamps for Shackle insulators:** It is required for each shackle insulator.
No. of D-clamps required = 44 nos.

7) **Guysets:** It is required one for each end pole and two for the pole at cut-points (Cut-point pole usually marked after five spans). Here since the no. of poles are 11, we can make only one cut-point at sixth pole. So the no. of guysets required = 1+2+1 = 4 nos.

8) **Earthing sets:** Every fifth LT pole is to be earthed. The end poles are also earthed. So the total requirement of earthing sets = 3

9) **Aluminium Binding Wire / tape:** It is usually assumed as 1kg per km length of line. So

approximately we can assume requirement as 1 kg.

4. Attempt any THREE of the following: **12 Marks**

a) Calculate the length of phase wire & neutral wire for the residential installation as shown in the Fig. No. 1.

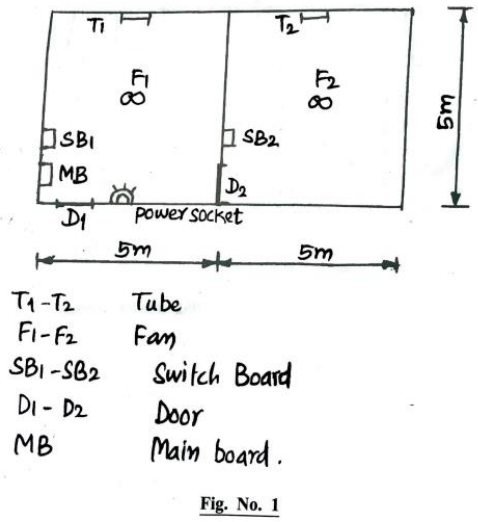


Fig. No. 1

Assume one 5A socket on each switch board. Assume height of rooms as 3 m.

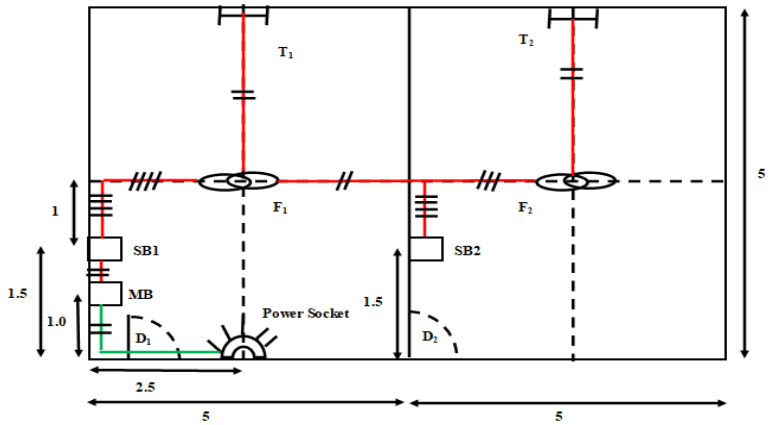
Ans:

NOTE: Answers may vary depending upon wiring layout. Examiners are requested to credit the marks wisely.

Assumptions:

1. Main Board (MB) is at the height of 1.75 m considering ceiling height of 3 m
2. Conduit runs at the height of 2.5 m.
3. Switch Board at the height of 1.5 m from ground level.
4. Tubes at the height of conduit run i.e 2.5 m
5. Power socket at the height of 1.5 m and horizontally at the centre of the wall.
6. D_1 & D_2 are the doors as shown in figure and each has width of 1 m & height 2 m

Wiring Layout:



1 Mark for wiring layout diagram

1 Mark for conduit length

There will be two sub-circuits; One is lighting and other is for power socket.

Starting from Main Board (MB), the length of conduit required for lighting sub-circuit is given by,

$=0.75(V_{up})+0.5(H)+1(V_{down})+1(H)+0.5(V_{up})+2.5(H)+2.5(H)+0.5(V_{down})$
$+2.5(H)+0.5(V_{down})+1(H)+1(V_{down})+2.5(H)+2.5(H)+0.5(V_{down})$

1 Mark for Phase + Neutral wire length for lighting sub-circuit

Where, H represents horizontal run on wall or ceiling and V represents vertical run on wall, may be up / down

= **19.75 m**

Starting from Main Board (MB), the length of conduit required for power socket is given by,

$= 1(H)+2.5(H)+1(V_{down})$

(Remark: Initial Vertical up run of 0.75 m is already considered in lighting sub-circuit)

= **4.5 m**

1 Mark for Phase + Neutral wire length for power sub-circuit

Total conduit length = 19.75 + 4.5 **= 24.25 m**

Length of Neutral wire:

i) For Lighting Circuit:

$= 0.75(V_{up})+0.5(H)+1(V_{down})+1(H)+0.5(V_{up})+2.5(H)+2.5(H)+0.5(V_{down})$
$+2.5(H)+0.5(V_{down})+1(H)+1(V_{down})+2.5(H)+2.5(H)+0.5(V_{down})$

= **19.75 m**

ii) For power socket:

$= 0.75(V_{up})+1(H)+2.5(H)+1(V_{down})$

= **5.25 m**

Length of Phase Wire:

i) For Lighting sub-circuit:

$= 0.75(V_{up})+0.5(H)+1(V_{down})+3(V_{up})+3(H)+1.5(V_{up})+7.5(H)+2.5(H)+0.5(V_{down})$
$+2.5(H)+0.5(V_{down})+3(H)+3(V_{down})+5(H)+2.5(H)+0.5(V_{down})$

= **37.25 m**

ii) For power socket:

$= 0.75(V_{up})+1(H)+2.5(H)+1(V_{down})$

= **5.25 m**

Total length of phase & neutral wire (1 mm^2) for lighting sub-circuit:

= 19.75 + 37.25+ 10% = **57+5.7 = 62.7 m ≅ 63 m**

Total length of phase & neutral wire (2.5 mm^2) for power socket:

= 5.25 + 5.25 + 10% = **10.5 + 1.05 = 11.55 m ≅ 12 m**

OR

Using thumb rule,

Total length of Phase & neutral wire (1 mm^2) for lighting sub-circuit,

= 3 times length of Conduit + 10% extra

= 3 (19.75) + 10% = 59.25 + 5.925 = 65.17 m ≅ **65 m**

Total length of phase & neutral wire (2.5 mm^2) for power socket:

= 3 times length of Conduit + 10% extra

=3(4.5) + 10% = 13.5 + 1.35 = 14.85 m ≅ **15 m**

b) Prepare the schedule of material for industrial installation as shown in Fig. No.2

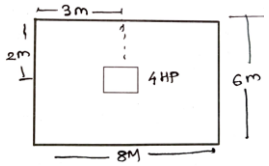


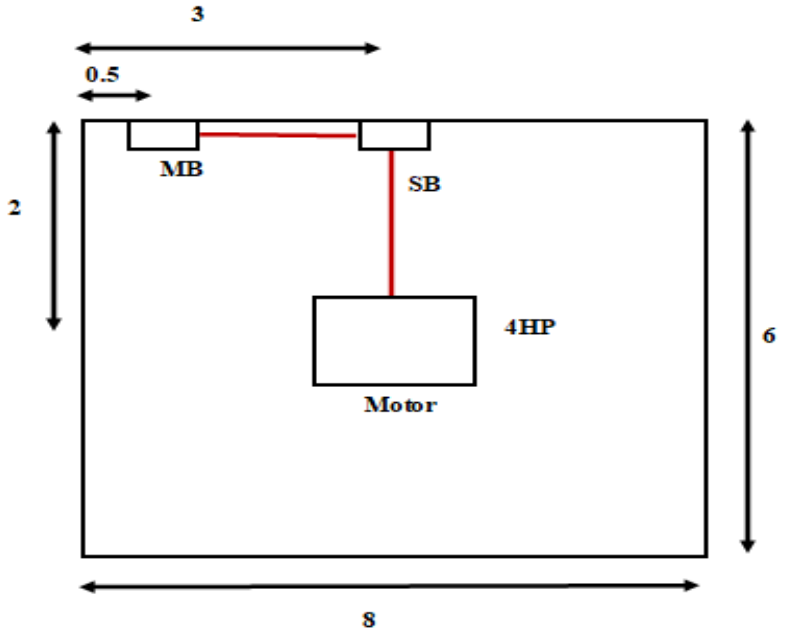
Fig. No. 2

Ans:

NOTE: Answers may vary depending upon wiring layout. Examiners are requested to credit the marks wisely.

Assumptions:

1) Motor Rating is 3- Phase 415V,50Hz, 4HP, p.f = 0.85, η = 0.85.
2) Ceiling Height is 3m.
3) Main Board (MB) is at the height of 1.75 m considering ceiling height of 3 m
4) Conduit runs at the height of 2.5 m.
5) Switch Board at the height of 1.5 m from ground level.



Rating for 5 HP, 3-Ph I.M :-

$$\text{Total Power} = \text{HP rating} \times 735.5$$

$$\text{Total Power} = 4 \times 735.5$$

$$\text{Total Power} = 2942 \text{ Watt}$$

$$\text{Input Current } I_L = \frac{\text{Total Power}}{\sqrt{3} \times V_L \times \eta \times \cos\phi}$$

$$\text{Input Current } I_L = \frac{2942}{\sqrt{3} \times 415 \times 0.85 \times 0.85}$$

$$\text{Input Current } I_L = 5.66 \text{ A}$$

Starting current = $2 \times 5.66 = 11.32$ A

So Use, the 4 mm^2, 4 core copper cable of 500V, 50Hz with ICTP switch or MCB of 16A, 690V/ 450V.

Schedule of Material: -

1 Mark

Sr.No.	Material	Quantity
1	16 A Busbar with Natural link	1
2	3-ph,4 wire 415V, 30-60A, A.C. supply Energy Meter	1

3	MCB/ICTP 450V,16A	2
4	4 mm2, 4 core copper	9m
5	1 inch PVC Conduct	9m
6	DOL starter	1
7	1 inch saddle	30
8	8 SWG earthing wire	20m
9	60 cm x 60cm x6.36 mm Copper Earthing Plate	1
10	Earthing Sundry	Lumsump
11	Earthing nut-board	2
12	R,Y,B Indication Lamp	3
13	Screw 3 inch length	10
14	Screw 1 inch length	10
15	Junction Box	4 Approx
16	4 x 6 Switch board with cutting	1
17	10 x 12 Switch board with cutting	1
18	Main Switch Board	1
19	Labour Charges	at actual

1 Mark for each of any three Material = 3 Marks

c) State the methods of laying underground cables and write the list of material required for laying underground cable.

Ans:

Methods of laying underground cables:

i) Direct Laying (Cables buried directly underground)
ii) Draw-in-system
iii) Solid system

1 Mark for each of any two methods = 2 Marks

List of material required for laying underground cable:

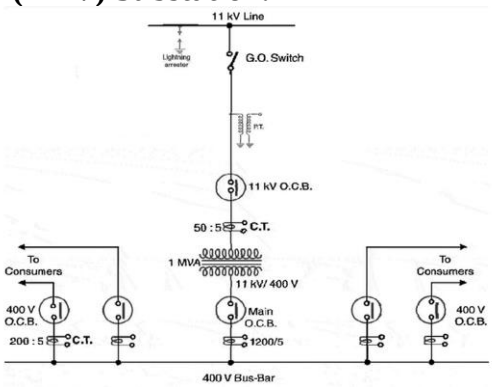
1) Sand
2) Bricks
3) China clay
4) Bitumen compound
5) Conduits, ducts or tubes made of either iron, clay or cement concrete

½ Mark for each of any four material = 2 Marks

d) Draw the single line diagram of HT (11kV) substation

Ans:

Single Line Diagram of HT (11kV) Substation:



4 Marks for Fully labeled diagram

2 Marks for Partially labeled diagram

(OR Any Other Equivalent Diagram)

e) **Explain the on-off control used for the street light installation.**

Ans:

On-off control used for the street light installation:

On-off control for the street light installation can be easily implemented by manually switching the street lights at fixed time. The switching can be decided by observing the availability of sun shine. But manual management is liable to errors and ends up in energy wastage. Also, dynamically following the sun shine is manually unworkable. So the present trend is the introduction of automation and remote management solutions to manage street lighting. Street light monitoring and control is an automated system designed to increase the efficiency and accuracy by automatically timed controlled switching of street lights. The street light control system may include client-server mechanism where a user can directly interact with the web based application to manage the street lamp of any location from the single position. Usually street light control systems have been developed to monitor and reduce the use of power in town's public street lighting system. It includes a monitoring circuit of street lights and individual lights with network operating protocols.

In this system, the street lights are automatically switched ON once the sunlight goes below the visible region of our eyes and switched OFF when the ample amount of sun shine returns. The element used for sensing the light may be Light Dependent Resistor (LDR). The LDR's resistance is inversely proportional to the light falling on it. When sun shine falls below certain level, the LDR resistance increases to high level, which is used in feedback loop in control circuitry to turn on the street lights using electromagnetically operated switch. During night time, no sun shine condition maintains LDR resistance high and street lights remain ON. However, in the morning when sun shine becomes sufficient to lower the LDR resistance, the feedback control loop is activated to turn off the electromagnetic switches, thereby switching off the street lights.

4 Marks for conceptual explanation of the scheme

OR Equivalent Answer

5 Attempt any TWO of the following: 12 Marks

5 a) State the design considerations in case of industrial installation.

Ans:

Design considerations in case of industrial installation:

1) Find out output power of every machine in watts.
   (i) 1 HP = 735.5 w
   (ii) Assume power factor, if not given.
   (iii) Assume efficiency, if not given.
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

(i) For 1-phase machine.

$$\text{Input power} = V\, I \cos \emptyset$$

1 Mark for each of any 6 relevant points with brief description = 6 Mark

where,
V = Input voltage
cos Ø = power factor
I = Input current

(ii) For 3-phase machine

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

where,
V_L = Line voltage
I_L = Line current or Input current
cos Ø = power factor

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 sustain starting surge, overload momentary short circuit and future expansion.
5) Find out total Electrical load of given factory/industry.
6) Determine the Input current required for whole factory/industry.

$$P = \sqrt{3}\ V_L\ I_L \cos \text{Ø}$$

7) Determine the size & core of Input cable required for whole factory/industry. To decide the size, the 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/industry electrification.
9) Make the estimation chart for material and labour charges also.
10) Find out total cost of estimation by assuming contingencies, changes and profit margin.

1 Mark for each of any 6 relevant points with brief description = 6 Mark

OR

Design considerations in case of industrial installation:

(i) Input current of the motor

When motor is connected to the supply, it draws much more current than its rated current till the motor comes up to rated speed. This is starting current of the motor.
The current rating of cables for supply to motor may be based upon the normal full load current of motor, but the rating of fuse should be based upon the starting current.

(ii) Selection of size of cable

The cables shall have a current carrying capacity of not less than 150 % of the motor full load current rating.

(iii) Selection of size of conduit

The required size of conduit depends on (a) no. of cables to be installed (b) the cross sectional area of the cable and (c) the permissible conduit fill.

(iv) Determination of rating of fuse

The criteria for selecting the correct size of fuse for motor protection is that it may carry the starting current safely.
Starting current = 1.5 x full load current

(v) Selection of starter

1. Induction motor of low rating ----Direct On Line starter
2. Induction motor of medium rating (upto 15 Hp) ----Star delta starter
3. Induction motor of high rating ----Auto transformer starter
4. Slip ring Induction motor of high rating---- Rotor resistance starter
5. DC series motor ---- two point starter

6. DC shunt/compound motors --- Three point starter/ Four point starter

(vi) Selection of rating of Main switch

The current rating of main switch is the starting current of one motor of highest rating plus full load current of remaining motor.

(vii) Selection of rating of Distribution board

The specification of the distribution board is decided from the no. of circuits to be fed from it.
The voltage rating is decided by operating voltage of the circuits.
The current rating is the highest starting current of the circuits fed from it.

(viii) Type of supply required for every machine

- DC
- Single phase AC
- Three phase AC

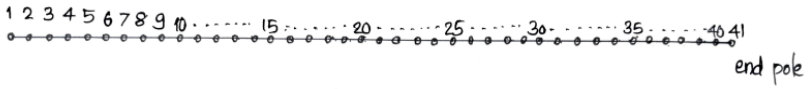
(ix) Earthing type and its size.

- Pipe earthing
- Plate earthing
- Chemical earthing

5 b) Estimate the main material required for a 2km overhead line to extend from existing line. Assume a span of 50m.

Ans:

NOTE: Examiner is requested to observe the assumptions made by students. Answers may vary depending upon the assumptions made. The credit should be given to the process followed to solve the problem.



As LT/HT line is not mentioned, students can solve by considering LT or HT line.

Assuming 11kV HT line:

Total length of line = 2km = 2000m
Span between two poles = 50m
No. of poles required= (2000/50) + 1 = 40+1 = 41 (if tap is taken from existing pole it can be 40)

Insulators:

11kV pin type insulators (excluding start and end pole) = 41-2 = 39 x 3= 117
11kV strain type disc insulators = 3 each on start pole and end pole = 3 x 2 = 6
For HT line, cut-point is created after 5 spans. So for 40 or 41 pole line, there will be 7 cut-points and on each cut-point poles, 6 disk type insulators will be required.
11 kV strain type disc insulators on cut-point poles = 6 x 7 = 42
Total strain type disc insulators required = 6 + 42 = 48

1 Mark for each of any relevant 6 main items = 6 Marks

Cross arms:

Cross arms of suitable size (1.52m x 12.5cm x 12.5cm) = 31
Cross arms of suitable size (2.15m x 12.5cm x 12.5cm) one for each dead end structure = 2
Cross arms of suitable size (2.15m x 12.5cm x 12.5cm) two for each cut-point = 14
Total Cross arms of (2.15m x 12.5cm x 12.5cm) size = 16
Top insulator brackets excluding start and end pole = 41
Screw eye bolts and nuts 23cm x 1.6cm for supporting earth wire on intermediate single pole structures = 39 x 2 =78

Knee bracing sets = 39

Conductor

Length of ACSR conductor 6/1x2.11 mm = (3x2000)+5% for sagging and wastage
=(3x2000x105/100)=6300m = 6.3km

Length of No.8 SWG GI wire for earthing (2runs) = 2km + 5% for sagging and wastage
= (2x2x105/100) = 4.2 km

Taking GI wire weight approximately as 100 kg per km.

Weight of No.8 SWG GI wire = 4.2 x 100 = 420kg

Miscellaneous

Guysets complete with guy plate (one for end pole and 2 for every 5th pole) = 1+ (2x7)=15

Guywire 7/8 SWG = 25kg

Earthing sets (every pole is earthed) = 41

Danger plates one on every pole structure = 41

Barbed wire to be used as anti-climbing device = 60kg

Estimate of the material

Sr. No.	Description of the material	Quantity required	Unit
1	PCC poles, 9m long	41	No.
2	ACSR conductor 6/1 x 2.11 mm or equivalent conductor	6.3	km
3	Pin insulators 11 kV along with pins	117	No.
4	11 kV strain disc insulator	48	No.
5	Cross arms 1.52m x 12.5 cm x 12.5 cm	31	No.
6	Cross arms 2.15 m x 12.5 cm x 12.5 cm	16	No.
7	Top insulator brackets	41	No.
8	Screw type bolts and nuts 23 cm x 1.6 cm	78	No.
9	No. 8 SWG GI wire for earthing	420	kg
10	Guy sets complete with guy plate and other accessories	15	No.
11	Guy wire 7/8 SWG	25	kg
12	Earthing set	41	set
13	Knee bracing sets	39	set
14	Danger plates	41	No.
15	Barbed wire	60	kg
16	Bolts and nuts of various sizes	60	kg
17	MS flats for clamps	10	Kg
18	Cement and concrete	Lumpsum	Lumpsum
19	Binding wire, PG clamps etc.	Lumpsum	Lumpsum

OR

Assuming LT line (3 phase 4 wire):

Total length of line = 2m = 2000m

Span between two poles = 50m

No. of poles required= (2000/50) + 1= 40+1 = 41 (if tap is take from existing pole it is 40)

Insulators:

Assuming vertical configuration, 3 phase 4 wire

LT shackle insulators for the poles (4 for each pole) = 4 x 41=164

Earth knobs for carrying the earth wire = 41
D clamps made from MS flats of suitable sizes

Conductor

Length of AAC Ant conductor (phase conductor) = (3x2000)+5% for sagging and wastage
=(3x2000x105/100)=6300m=6.3km
Length of AAC Gnat conductor (neutral conductor) = (2000)+5% for sagging and wastage
=(2000x105/100)=2100m=2.1km
Length of No.8 SWG GI wire Taking its weight approximately as 100 kg per km.
=2km x 105/100 = 2.1km
Weight of No.8 SWG GI wire=2.1x100=210 kg including guarding

Miscellaneous

Guysets complete (one for end pole and 2 for every 5th pole)=1+(2x7) =15
Guywire 7/20 SWG = 35kg (lumpsum)
LT Earthing sets (every 5th pole is earthed) = 8
Aluminium binding wire and binding tape = 2kg each

Estimate of the material

Sr. No.	Description of the material	Quantity required	Unit
1	PCC poles, 8m or 7m long	41	No.
2	AAC Ant conductor or equivalent conductor	6.3	km
3	AAC Gnat conductor or equivalent conductor	2.1	km
4	LT Shackle insulator	164	No.
5	8 SWG GI wire	210	Kg
6	Guy sets complete	15	set
7	Guy wire 7/20 SWG	35	kg
8	MS flats for D clamps	35	kg
9	Earth knobs	41	No.
10	Earthing set	08	set
11	Aluminium binding wire	02	kg
12	Aluminium binding tape	02	kg
13	Bolts and nuts of various sizes	60	kg
14	Aluminium paint	02	liter
15	Sundries to complete the job	Lumpsum	Lumpsum

5 c) Prepare the list of materials and devices required for street lighting.

Ans:

List of materials and devices required for street lighting:

Sr. No.	Description of the material
1	PCC poles, 9m long
2	AAC Ant conductor for phase
3	AAC Gnat conductor for neutral
4	LT Shackle insulator with fitting arrangement such as D clamps
5	8 SWG GI wire
6	Guy sets complete
7	Guy wire 7/8 SWG

½ mark for each of any 12 materials / devices = 6 Marks

8	Eye Bolts and nuts of various sizes
9	Earthing set
10	Street light fittings, weather proof type
11	GI brackets of suitable length to support the light fitting
12	ICDP switch 250V, 15 A, Pole mounted
13	MS board with cover
14	Charcoal and sand
15	Cement and concrete
16	Binding wire, clamps, other sundry items
17	Sensors / controller for automatic ON/OFF switching of street light

6 Attempt any TWO of the following: 12 Marks

6 a) Prepare tender notice and quotation for supply for 3 phase, 200 kVA, 11kV/415V transformer for a polytechnic.

Ans:

Tender Notice

Sealed quotations are invited from reputed manufacturers & suppliers for supply of 3 phase 200KVA, 11 kV/415V transformer, quantity -01, to the under mentioned polytechnic as per the terms & conditions specified in tender form available in the office.

Estimated cost = Rs. 4 lacs
Cost of blank tender form = Rs. 1000/-
Earnest Money deposit (EMD) = Rs. 8000/-

3 Marks for Tender notice

Last date for issue the tender form & document is 31 July 2022 & it should be submitted before 5 pm of 16 August 2022.

Right of rejection the tender without any intimation is reserved.
Tender form available place: ABC Polytechnic
Name of the officer to contact –

Phone: Fax: e-mail Id:

Terms and conditions:

1. The tenderers shall be reputed manufacturer or supplier of Distribution Transformers and they should submit the documentary evidence in support of the same while submitting the technical bid.
2. The tenderers shall pay either Earnest Money Deposit or submit valid certification of registration with National Small Industries Corporation (NSIC).
3. The tenderers shall accept all Commercial Tender Conditions in TOTO.
4. The tenderers shall submit Schedule of Guaranteed Performance and Other Technical Particulars as shown in the prescribed format.
5. The tenderer shall submit their own delivery schedule in the prescribed format.

Quotation
Letter Head of the Organization/firm

To,
The Principal,
ABC Polytechnic, ……

3 Marks for Quotation

SUB: Quotation for Distribution transformer: 3-phase, 200 kVA, 11 kV/415V.
Ref: Your tender / quotation notice dated ……...

Dear Sir,
With reference to the your tender / quotation notice, we are pleased to quote as follows:

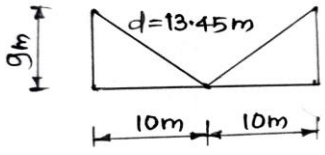
Sr. No.	Particulars	Unit Price	Total
1	3-phase, 200 kVA, 11 kV / 415 V Distribution transformer	Rs. 3, 50,000/-	Rs. 3,50,000/-

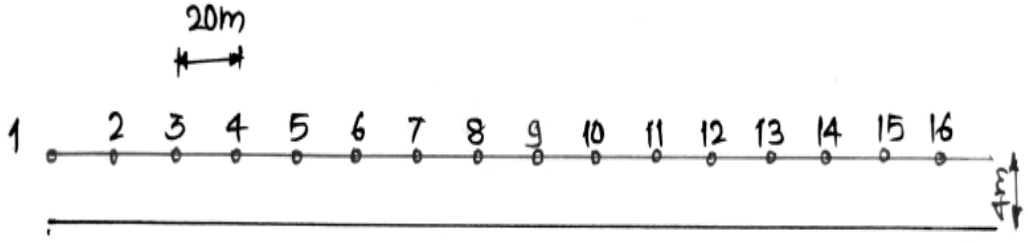
Terms & Conditions:
1. All the prices quoted in this quotation are valid for 30 days from the date of this quotation.
2. For any query, contact our office from 10 am to 6 pm on working days only.
3. If you want breakdown of the quoted price, we will try where possible to clarify the quoted cost.

Sign of the Proprietor with seal

6 b) A road 300m long is required to be illuminated by providing 40W fluorescent lamps with 222 candle power, the width of road is 4m. Design a street lighting scheme and estimate the material required if the scheme is to be estimated for obtaining minimum level of illumination of 0.8 lux.

Ans:





4 Marks for stepwise design scheme

Luminous intensity of the given lamp is I = 222 cd

Assumptions:

Assume height of the lamp as 9m
Assume Coefficient of utilization as 0.5
Illumination at mid point of span (more than minimum value specified)
= more than 0.8 lux = 0.82 lux
∴ $0.82 = 2 \times I \times h \times COU/d^3$
$= (2x222x9x0.5)/(d)^3$
∴ $(d)^3 = 2436.58$
∴ (d) = 13.45 m
∴ Span = $2 \times \sqrt{13.45^2 - 9^2} = 20m$

1) No. of poles =(300/20) + 1=15+1=16
2) No. of street light weather proof fittings =16
3) Total load on the line= 40x16=640 W
4) Load current = 640/230=2.78 A
5) AAC ant conductor is selected for street light phase wire, Length=600x5% extra =(600x5)/100=630m
6) AAC Gnat conductor is selected for street light phase wire, Length=600x5% extra =(600x5)/100=630m
7) No. of guys = 6 (two for every fifth pole and one for each end pole)
8) No. of shackle insulators =16x2=32
9) 8 SWG GI wire for earth =(300x105%) =315m
10) Pole earthing set =4 sets (for every fifth pole and end pole)
11) Eye bolt for earthing =16 Nos.

Estimate of the material

2 Marks for estimation of material

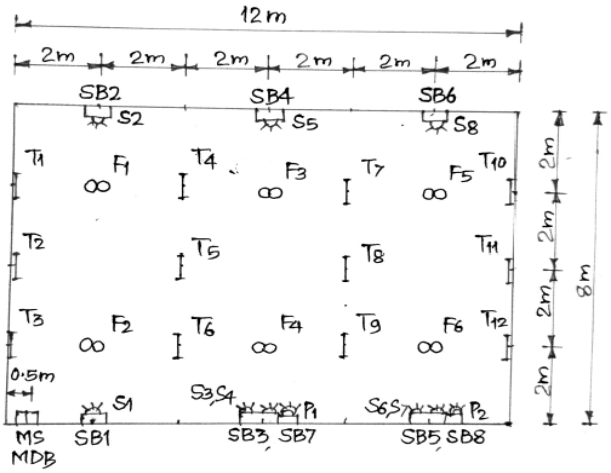
Sr. No.	Description of the material	Quantity required	Unit
1	PCC poles, 9m long	16	No.
2	AAC Ant conductor for phase	630	m
3	AAC Gnat conductor for neutral	630	m
4	LT Shackle insulator with fitting arrangement such as D clamps	32	No.
5	8 SWG GI wire	315	m
6	Guy sets complete	4	set
7	Guy wire 7/8 SWG	25	kg
8	Eye Bolts and nuts of various sizes	16	No.
9	Earthing set	4	set
10	Street light fittings, weather proof type	16	No.
11	GI brackets of suitable length to support the light fitting	16	set

12	ICDP switch 250V, 15 A, Pole mounted	1	No.
13	MS board with cover	1	No.
14	Charcoal and sand	Lumpsum	Lumpsum
15	Cement and concrete	Lumpsum	Lumpsum
16	Binding wire, clamps, other sundry items	Lumpsum	Lumpsum

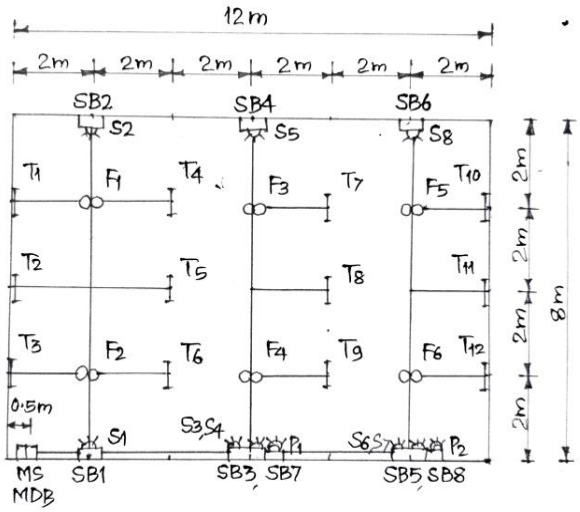
6 c) A commercial hall of dimensions 12m x 8m is to be fitted with an electric installation. Estimate the quantity of material required. Assume the height of ceiling to be 4m. The wiring is running at a height of 3m from the floor. The load in the hall is 12 fluorescent lamps of 40W each, 6 fans of 60 W each and 8 no. of 5 A sockets and 2 no. of 15 A socket outlets.

Ans:

NOTE: Examiner is requested to observe the assumptions made by students. Answers may vary depending upon the assumptions made. The credit should be given to the process followed to solve the problem.



Arrangement of Tubes, Fans, sockets, MS, MDB, SBs



Layout of sub circuits

1 Mark for diagram

SUMMER – 2022 EXAMINATION

Subject Name: Electrical Estimation &Contracting **Model Answer:** **22627: EEC**

1) Total Load

a) Lighting & Fan:

12 Fluorescent tubes each of 40 W =12x40= 840 W
06 Fans each of 60 W = 06x40 = 240 W
08 No. of 5 Amp Sockets = 08 x 100 = 800W
L & F Total=1880 W

1½Mark for L & F circuit calculations

b) Power Load:

02 No. of 15 Amp sockets = 02x1000=2000 W
Total =1880+2000= 3880 W

1½ Mark for power circuit calculations

2) No. of Sub circuits

a) Lighting & Fan Load:

Total no. of L & F points 26 and wattage 1880 W
As per no. of points 26/10 = 2.6 means 3 sub circuits
As per wattage 1880/800 = 2.35 means 3 sub circuits
So for L & F there will be 3 sub circuits

2 Marks for Materials estimation

b) Power Load:

Total no. of power points 02 and wattage 2000 W
As per no. of points 02/02 = 1 sub circuit
As per wattage 2000/3000 = 0.66 means 1 sub circuit
So for power there will be 1 sub circuit
Hence total 03+01= 04 Sub circuits.

Sub circuit wise Load distribution

Sub circuit No. and Switch boards	Tube	Fan	5 A Socket	15 A Socket
L & F sub circuit No. I – SB1 and SB2	T1,T2,T3,T4,T5,T6	F1,F2	S1,S2	----
L & F sub circuit No. II – SB 3 & SB4	T7,T8,T9	F3,F4	S3,S4,S5	----
L & F sub circuit No. III – SB5 & SB6	T10, T11,T12	F5,F6	S6,S7,S8	----
Power Sub circuit no. IV – P1 & P2	----	----	----	P1, P2

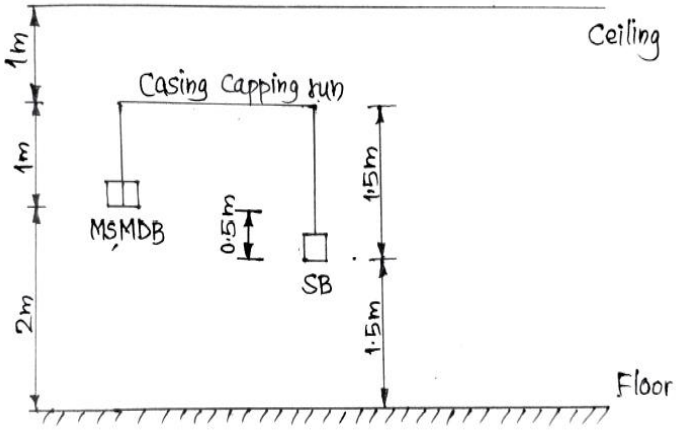
3) Sizes of wire

Sub circuit No.	Wire
L & F sub circuit No. I, II,III	1/1.40mm, 1.5 mm^2Aluminium conductor or equivalent
Power Sub circuit no. IV	1/1.80mm, 2.5 mm^2 Aluminium conductor or equivalent
Energy meter-Main switch-Main Distribution board	1/2.24mm, 4 mm^2 Aluminium conductor or equivalent

4) Rating of main switch (MS) and Main distribution board (MDB)

Main Switch (MS)- ICDP, 36 Amp, 250 V
Main distribution board (MDB)- 4 way, 15 Amp per way, 250 V

Assumptions:
Wiring is casing capping type
Height of EM-MS-MDB from floor- 2 m
Height of switch boards from floor- 1.5 m



5) Calculation of length of casing capping
=1+1.5+1.5+1+8+(3x2)+(1x3)+(3x2)+1+1.5 +4+1.5+1+8+(2x3)+1+1.5
+4+1.5+1+8+(2x3)+(1x3)+1+1.5
=79.5m ≅ 80 m + Add 20% extra
= 80 m +16 m= 96 m ≅ Say **100 m**

6) Calculation of length of wire for L & F circuit

(i) Sub circuit No.I

(a) Phase wire for Sub circuit No I:
Switch board 1 controls socket S1, Tubes T3, T5 & T6 and fan F2.
Switch board 2 controls socket S2, Tubes T1, T2 & T4 and fan F1.
=1+1.5+1.5+(1.5x5) +(1x5)+(2x5)+(1x3)+(1x2)+(2x2)+(1x2)+(1x6.5)
+(4x2.5)+(4x2)+(1x2)+(1x3)+(1x3)+(1x2) = 72 m

(b) Neutral wire for Sub circuit No I
= 1+1.5+1.5+1+8+(2x6)+(1x3)+1+1.5=30.5m

(ii) Sub circuit No.II
Switch board 3 controls sockets S3 & S4, Tubes T8 & T9 and fan F4.
Switch board 4 controls socket S5, Tubes T7 and fan F3.

(a) Phase wire for Sub circuit No II
=1+5.5+1.5+(4x1.5)+(4x1)+(4x2)+(1x2)+(2x2)
+(1x2)+(1x4)+(1x2.5)+(2x2.5)+(2x2)+(1x2)
= 51.5 m

(b) Neutral wire for Sub circuit No II
=1+1.5+4+1.5+1+8+2.5+6 =25.5 m

(ii) Sub circuit No.III
Switch board 5 controls sockets S6 & S7, Tubes T11, T12 and fan F6.
Switch board 6 controls socket S8, Tubes T10 and fan F5.

(a) Phase wire for Sub circuit No III
=1+5.5+4+1.5+(4x1.5)+(4x1)+(4x2)+(1x3)+(2x2)

+(1x3)+(1x4)+(1x2.5)+(2x2.5)+(2x2)+(1x3)

= 58.5 m

(b) Neutral wire for Sub circuit No II

=1+1.5+4+4+1.5+1+8+2.5+(3x3) =32.5 m

Total for L & F circuit

=72+30.5+51.5+25.5+58.5+32.5

=270.5m + add 20% extra

=270.5 +54.1

=324.6 m ≅ Say 325 m

7) Calculation of length of wire for power circuit

Phase and neutral

=2 x (1+1.5+4+1.5+4+1.5)

=(2 x 13.5) = 27m add 20 % extra

=27+5.4=32.4 ≅ Say 33m

8) Earth wire calculation (14 No. SWG)

=2+1+1.5+1.5+1+8+2.5+4+1.5+8+2.5+4+1.5+8+2.5

=49.5 + add 20% extra

=49.5+9.9 =59.4 ≅ Say 60m

Schedule of material

Sr. No.	Description of the material	Quantity required	Unit
1	ICDP, Main switch, 36A, 250V	1	No.
2	MDB, 4 way, 15 A per way, 250 V	1	No.
3	PVC casing capping	100	m
4	1/1.40mm, 1.5 mm^2 Aluminium conductor or equivalent	325	m
5	1/1.80mm, 2.5 mm^2 Aluminium conductor or equivalent	33	m
6	1/2.24mm, 4 mm^2 Aluminium conductor or equivalent	1	m
7	5A socket	8	No.
8	5 A switch	26	No.
9	15A socket	2	No.
10	15 A switch	2	No.
11	14 No. GI wire for earthing	60	m
12	Ceiling rose	18	No.
13	Miscellaneous items	Lumpsum,	Lumpsum