CMR INSTITUTE OF TECHNOLOGY

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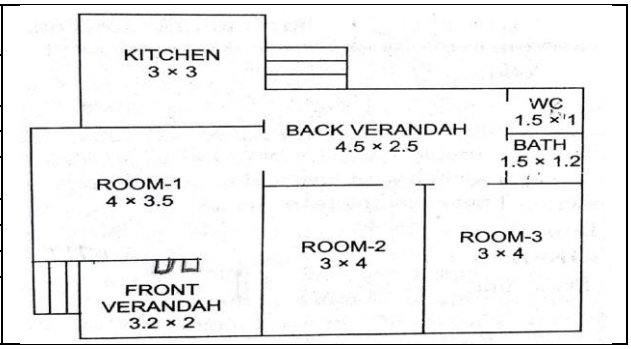
Internal Test –May 2018

Sub:	Electrical Design Estimation and Costing							Code:	10EE81
Date:	22/05 /2018	Duration:	90 mins	Max Marks:	50	Sem:	VIII	Branch:	EEE

Note: **Q1** is compulsory. Answer any **THREE** questions from **Q2** to **Q5**. Assume data wherever necessary.

		Marks	OBE CO	OBE RBT
1a.	Explain the sequence to be followed for preparing estimate of residential wiring.	[5]	CO2	L1
1b.	Details of electrical points to be installed in a residential building are given below with the plan, 1-phase, 240 V, 50 Hz, PVC wiring. Height of ceiling 3.3m, thickness of wall 0.3m. All dimensions are in metre. Draw single line diagram.	[15]	CO2	L3

	Light	Fan	Plug socket
Front Verandah	1	-	1
Room No 1	1	1	1
Room No 2	1	1	1
Room No 3	1	1	1
Kitchen	1	-	-
Bath	1	-	-
WC	1	-	-
Back Verandah	1	-	-



2.	Write a short note on indoor substation. List advantages and disadvantages of outdoor substation over indoor substation.	[10]	CO4	L2
3.	Estimate the quantity of material required for providing connection to a double storeyed building with a load of 4kW at 240 V, 50Hz. Separate meters are to be provided for the two floors. The distance between pole and building is 12m and between service bracket and service board is 10m.	[10]	CO4	L3
4.	A 37kW connection is to be given to an agricultural field at 415V, 3-phase,50Hz. The connection is to be given from a 3-phase, 11kv overhead distribution line which is available at a distance of 40metres. The motor has full load efficiency of 85% and power factor 0.8.Make a neat sketch showing how to arrange supply and estimate quantity of material.	[10]	CO4	L3
5.	Draw a neat diagram for substation earthing. What are the purposes of providing the substation earthing systems?	[10]	CO4	L2

Steps to estimate internal wiring

Step-1: Determination of Number of Sub-circuits

Number of sub-ckt is decided as per the number of points to be wired and total load to be connected to the supply system. Number of points to be wired may be known from plan and total load can be known from wattage of each point.

Step-2: Determination of Size of the conductor Main Switch and Distribution board.

The size of the conductor cable depends upon current carrying capacity.

current = power / voltage

The size of the main switch depends on current to be controlled by it. The size and type of distribution board depends on current rating and number of sub-circuits to be connected to it.

Step-3 Determination of size and Length of the conduit / Batten

The size of conduct / batten depends on

1a

number of wires passing through it. The length of conduit/batten can be determined by going through the plan of the building. i.e horizontal run, vertical up, vertical down.

Step 4: Determination of Length of Conductor Cable:

The determination of length of the cable/wire is laborious process. As a general rule length of the cable is approx. 3 times that of length of conduit/batten out of which phase wire is approx 2 times that of neutral wire

Step 5: Determination of Earth Wire:

All metal parts, metal coverings of all appliances should be properly earthed. Earth wire is approx length of conduit

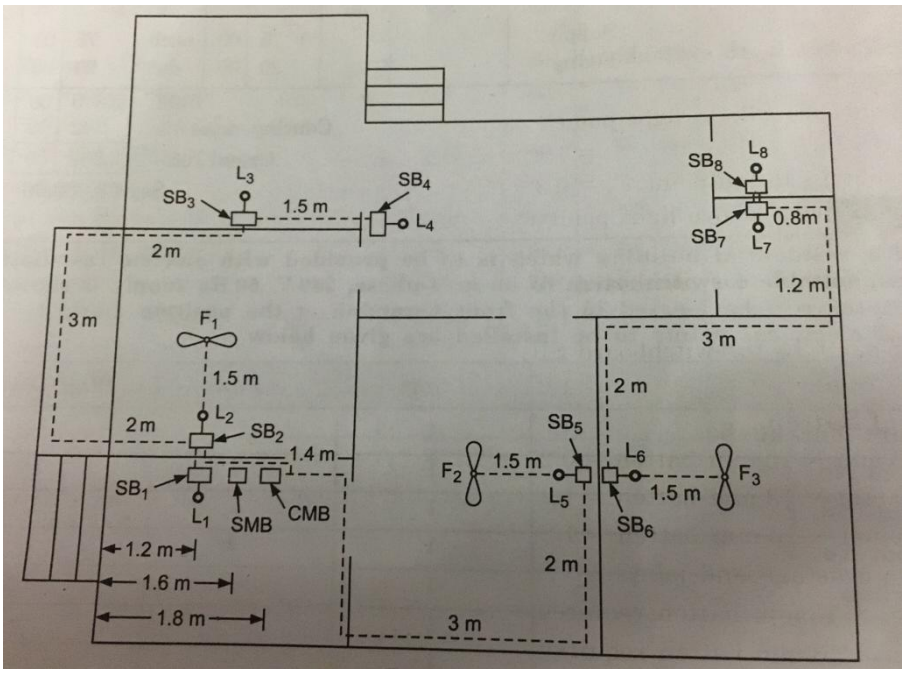
Step 6: Determination of Labour Cost.

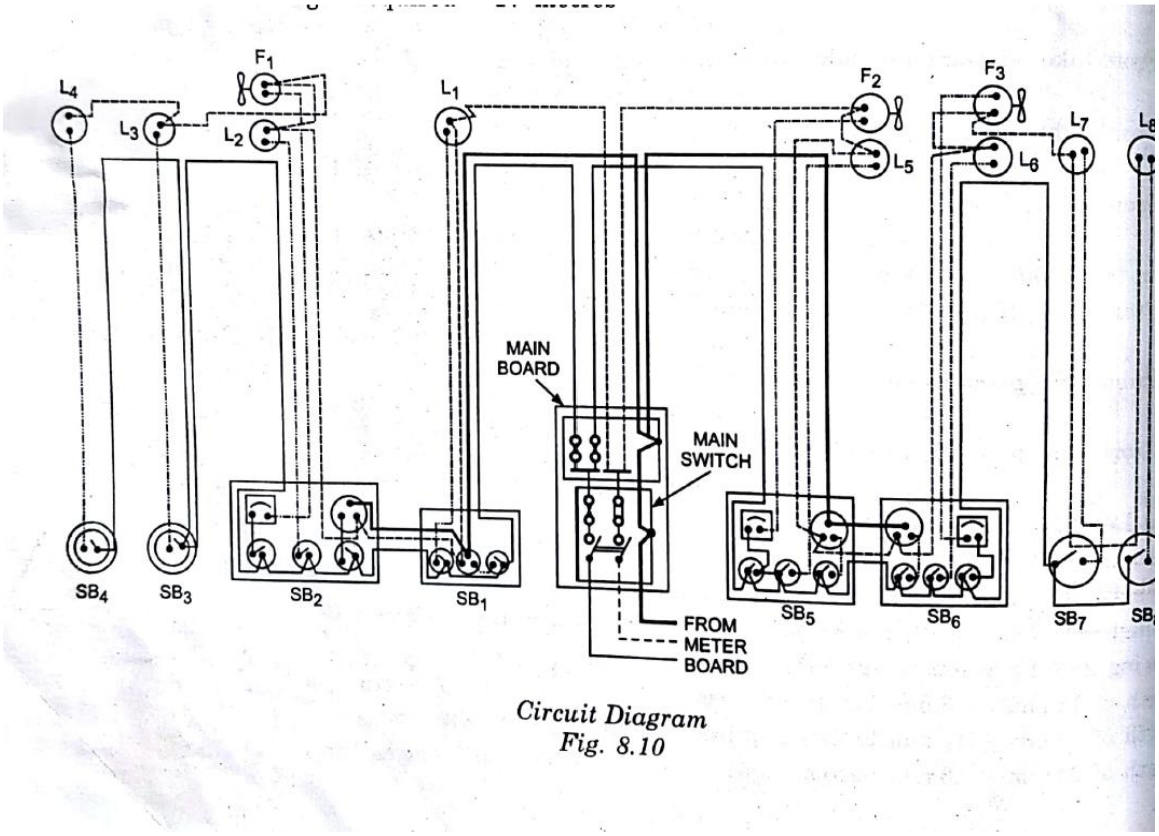
The labour cost may be calculated on the basis of number of points. M.B, D.B considered as 2 points.

Step 7: Estimate of Materials and Cost.

The material and their cost can be prepared by taking rate of each item separately and totalling them

1b





Circuit Diagram
Fig. 8.10

Solution : Given :

Number of light points = 8

Number of fan points = 3

Number of plug sockets = 4

Total number of points = 15

As per recommendation of ISI the wattage of each light, fan and plug socket (other than power sockets) may be taken as 60 watts for the purpose of load estimation.

Connected load = 15 × 60

= 900 watts

Since maximum number of points that can be connected in one circuit is ten and maximum load of 800 watts, two circuits will be used. Circuit No. I will control seven points (front verandah, room no. 1, back verandah and kitchen) and so have a load of 420 watts and Circuit no. II, will control 8 points (room no. 2, room no. 3, bath and WC) and so have a load of 480 watts.

$$\text{Maximum load current} = \frac{900}{240} = 3.75 \text{ A}$$

So 1/1.80 mm (or 2.5 mm^2) aluminium conductor, single core, 650 V grade PVC cable having current carrying capacity of 15 A will be used from supplier meter board to consumer's main board.

240 V, 16 A, DPIC switch fuse with neutral link of any make approved by IS will be used as main switch.

2-way, 240 V, 16 A IC distribution board (MCB type) of any make approved by IS will be used as main distribution board.

1/1.40 mm (or 1.5 mm^2) aluminium conductor, single core, 650 V grade PVC cable having current carrying capacity of 10 A will be used as phase and neutral wires beyond the main distribution board.

Assume Height of batten run = 2.8 m

Height of main boards = 1.5 m

Height of switch and switchboards = 1.3 m

Height of light brackets = 2.5 m

The wiring plan is shown in Fig. 8.9. Positions of supplier meter board, consumer main board, switch boards, and light points are shown in the wiring plan.

Length of Batten. From meter board to main board = 0.25 m of size 13 mm × 13 mm

Circuit No. I

From main board of front verandah to lamp L_1 = 1.3 + 0.6 + 0.3 = 2.2 m of size 13 mm × 13 mm

From lamp L_1 to switchboard SB_1 = 1.2 m of size 19 mm × 13 mm

From switchboard SB_2 to light point L_2 = 1.2 m of size 25 mm × 13 mm

From light point L_2 to fan point F_1 = 0.8 + 1.5 = 2.3 metres of size 19 mm × 13 mm

From take off point for light point L_2 to take off point for kitchen light point L_3

= 2 + 3 + 2 = 7.0 m of size 13 mm × 13 mm

From take off point for kitchen light point L_3 to light point L_3

= 0.3 metre of size 25 mm × 13 mm

From light point L_3 to switchboard SB_3 = 1.2 m of size 19 mm × 13 mm

From take off point for kitchen light L_3 to switchboard SB_4

= 1.5 + 1.5 = 3 m of size 13 mm × 13 mm

Circuit No. II

From main board to take off point for light point L_5
= 1.3 + 1.4 + 2 + 3 + 2 = 9.7 m of size 13 mm × 13 mm

From take off point for light point L_5 to fan point F_2
= 0.5 + 1.5 = 2.0 metres of size 19 mm × 13 mm

From take off point for light point L_5 to light point L_5
= 0.3 metre of size 19 mm × 13 mm

From light point L_5 to switchboard SB_5
= 1.2 metres of size 25 mm × 13 mm

From switchboard SB_6 to light point L_6
= 1.2 m of size 25 mm × 13 mm

From light point L_6 to fan point F_3 = 0.8 + 1.5 = 2.3 metres of size 19 mm × 13 mm

From take off point above light point L_6 to light point L_7
= 2 + 3 + 1.2 + 0.8 + 0.3 = 7.3 m of size 13 mm × 13 mm

From light point L_7 to switchboard SB_7
= 1.2 metres of size 19 mm × 13 mm

From light point L_8 to switchboard SB_8
= 1.2 metres of size 13 mm × 13 mm

Total Length of Batten.

Length of 13 mm × 13 mm batten = 0.25 + 2.2 + 7.0 + 3.0 + 9.7 + 7.3 + 1.2 = 30.65 metres
Length of 19 mm × 13 mm batten = 1.2 + 2.3 + 1.2 + 2.0 + 0.3 + 2.3 + 1.2 = 10.5 metres
Length of 25 mm × 13 mm batten = 1.2 + 0.3 + 1.2 + 1.2 = 3.9 metres

Allowing 20% for wastage and joints
Length of 13 mm × 13 mm batten required = 30.65 + 6.13 = 37 metres (say)
Length of 19 mm × 13 mm batten required = 10.5 + 2.1 = 12.6 metres (say)
Length of 25 mm × 13 mm batten required = 3.9 + 0.78 = 4.7 metres (say)

Length of 19 mm conduit = 7 × 0.3 = 2.1 metres
Wastage 10% = 0.20 metres
Total = 2.30 metres

Length of 1/1.80 mm (2.5 mm^2) single core, aluminium conductor PVC cable
= 0.6 m including wastage

Length of 1/1.40 mm (1.5 mm^2) single core, aluminium conductor, PVC cable
= 2 × (length of 13 mm × 13 mm batten) + 3 × (length of 19 mm × 13 mm batten) + 4 × (length of 25 mm × 13 mm batten) + 2 × conduit length
= 2 × 30.65 + 3 × 10.5 + 4 × 3.9 + 2 × 2.1
= 61.3 + 31.5 + 15.6 + 4.2 = 112.6 metres

Allowing 15 % for wastage and connections = 16.89 m
Total length required = 112.6 + 16.9 = 129.5 = 130 metres (say)

Length of Earth Wire (14 SWG GI Wire)

From meter board to main board = 0.25 m

From main board to SB_1 = 1.3 + 0.6 + 1.5 = 3.4 m

From SB_1 to SB_2 = 0.3 m

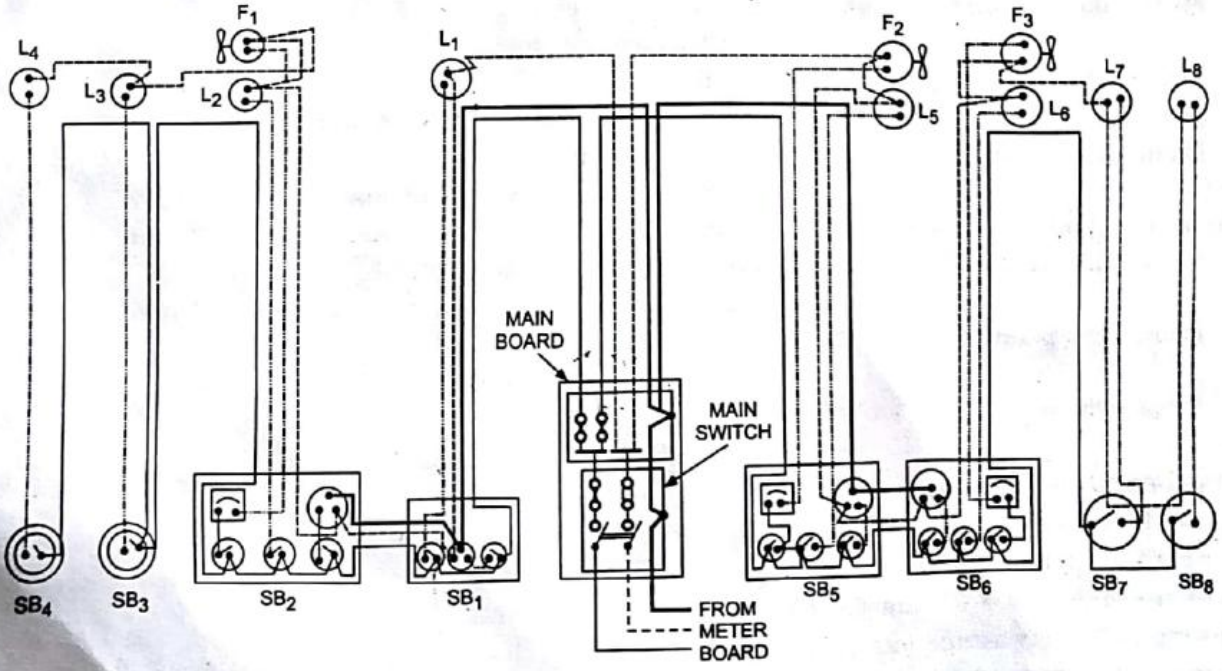
From main board to SB_5 = 1.3 + 1.4 + 2 + 3 + 2 + 1.5 = 11.2 m

From SB_5 to SB_6 = 0.3 m

Total length required = 0.25 + 3.4 + 0.3 + 11.2 + 0.3 = 15.45 m

Wastage (10%) = 1.55 metres

Total length required = 17 metres



Circuit Diagram

ESTIMATE ON THE BASIS OF

S. No.	Description of Material With Full Specifications	Quantity Required		Remarks
		Quantity		
1.	240 V grade, 16 A, DPIC switch with fuse	1	)	
2.	2-Way, 240 V, 16 A, IC Distribution board (MCB type)	1	0	Board ₹ 200.00 MCBs 2 nos ₹ 100.00 each
3.	PVC cable, 650 V grade, 1/1.80 mm (or 2.5 mm^2), aluminium, single core.	0.6	70	
4.	P V C cable, 650 V grade, 1/1.40 mm (or 1.5 mm^2), aluminium conductor, single core	130	00	
5.	16 SWG GI wire (earth wire)	17 (0.5)	00	
6.	Earthing thimbles with nuts and bolts	3	00	
7.	Teak wooden batten			
	(*i*) 13 mm × 13 mm	37	50	
	(*ii*) 19 mm × 13 mm	12.6	10	
	(*iii*) 25 mm × 13 mm	4.7	20	
8.	Teak wood boards (double)			Main board
	(*i*) 25 cm × 30 cm	1	00	SB_2, SB_5
	(*ii*) 20 cm × 25 cm	3	00	and SB_6
	(*iii*) 18 cm × 13 cm	1	00	SB_1
9.	Round wooden blocks 10 cm × 4 cm	15	00	4 nos for switch board
10.	Piano switches, 5A, 240 V surface type	15	00	
11.	Brass brackets with holders	6	00	
12.	Watertight brackets complete with holders and globes	2	00	
13.	Ceiling rose 2 plate, 5 A, PVC	3	00	
14.	Plug socket 3 pin, 5 A, 240 V	4	00	
15.	Teak wood gutties	200		
16.	Wooden screws			
	(*i*) 51 mm for boards	35	8 00	
	(*ii*) 32 mm for batten	120	4 00	
	(*iii*) 19 mm for switches	30	9 00	
	(*iv*) 13 mm for plugs, sockets and ceiling roses	20	6 00	
17.	Link clips (*i*) 38 mm	4	48 00	
	(*ii*) 50 mm	1	15 00	
18.	Nails 13 mm	0.5	75 00	
19.	Conduit 19 mm diameter	2.3	69 00	
20.	Conduit bushings	14	10 50	
21.	Cement, sand, paint, varnish etc		350 00	Lump-sum provision

2. **Indoor substations**

- Apparatus is installed within the substation building.
- For voltages up to 11,000V but can be for 33kV and 66kV, if the surrounding atmosphere is contaminated with impurities such as metal corroding gases and fumes, conductive dust etc.
- Supply or primary side(of transformer) consists of oil circuit breakers and isolators and also measuring instruments.
- Buchholz's relay is used for oil filed transformer protection.
- Auxiliaries:

1. Storage batteries for operation of protective gear, switch operating solenoids and emergency lighting in substation in case of failure of supply.

Firefighting equipment such as water buckets, fire extinguishers, etc

- The chamber space within which the equipment of any one main bus-bar connection is mounted, as a whole, is called as a cell, cubicle or compartment

- Compartments:

1. Control compartment
2. Indicating and metering instruments and protective device compartment
3. Circuit breaker and operating mechanism compartment
4. Main bus-bar compartment
5. CT and cable sealing box compartment

- According to construction indoor substations are further subdivided as

1. Substations of integrally built type, the apparatus is installed on site, cell structures are constructed of concrete or bricks
2. Substations of the composite built-up type, the assemblies and parts are factory pre-fabricated, but are assembled on site with in a substation switchgear room. Compartments are of metal cabinets or enclosures.
3. Unit type factory fabricated substations and metal clad switch boards, built in electrical workshops and are shipped to the site of installations fully pre-assembled. Cubicles of fully enclosed metal clad type.

Advantages of outdoor substations over indoor substations

1. All the equipment is viewable and therefore fault identification is easier.
2. Extension of the installation is easier, if required.
3. Time required in erection is less.
4. Smaller amount of building materials (steel-concrete) is required.
5. Construction work required is comparatively smaller and cost of switchgear installation is low.
6. There is practically no danger of a fault which appears at one point being carried over to another point in the installation.
7. Repairing work is easy.

Disadvantages of outdoor installation in comparison of Indore installation

- Various switching operations with isolators, as well as supervision and maintenance of the Apparatus used to be performed in the open air during all kinds of weather
- More space is required for the substation.
- Protection devices are required to be installed for protection against lighting surges.
- The length of control cables required is more.
- The influence of rapid fluctuations in ambient temperature and dust and dirt deposits upon the outdoor substation equipment makes it necessary to install apparatus specially designed for outdoor service and therefore more costly.

3

Solution : Connected load, $P = 4$ kW

Taking diversity factor of 1.6 and future growth 100% in load, we have

$$\text{Load} = \frac{4 \times 1{,}000}{1.6} \times 2 = 5{,}000 \text{ W}$$

$$\text{Load current in amperes} = \frac{5{,}000}{240} = 20.833 \text{ A}$$

Hence twin core 1/2.80 mm (or 6 mm^2) aluminium conductor weatherproof cable having a current capacity of 27 A may be employed.

S. No.	Description of Material With Complete Specifications	Quantity Required	
		Quantity	Un
1.	6 mm^2, 650 V, twin core aluminium conductor weather proof cable	25	m
2.	Aerial fuse 32 A capacity	1	no
3.	GI pipe 50 mm diameter	4	m
4.	MS angle iron bracket 50 mm × 50 mm × 6.0 mm × 1.5 m long	1	no
5.	Conduit 16 SWG 25 mm diameter	6	m
6.	Conduit reducer 50 mm × 25 mm	1	no
7.	Conduit bends 25 mm	2	do
8.	Conduit lock nuts 25 mm	2	do
9.	Conduit bushings 25 mm	2	do
10.	Wooden bushings for 50 mm GI pipe	1	do
11.	Wooden plugs	25	do
12.	Conduit saddles 50 mm	4	do
13.	Conduit saddles 25 mm	8	do
14.	LT shackle insulators 50 mm × 65 mm complete with fittings	4	do
15.	GI thimbles	2	do
16.	8 SWG hard drawn copper wire	28	m

		(3.2)	(kg)
17.	GI bends 50 mm diameter	1	do
18.	8 SWG GI wire	50	m
		(5)	(kg)
19.	IC board 25 cm × 30 cm	2	no
20.	Kit-kat 32 A capacity	2	do
21.	Neutral link	2	do
22.	Cement	1	bag
23.	Sand	5	bags
24.	Petty items (Lump-sum provision)		

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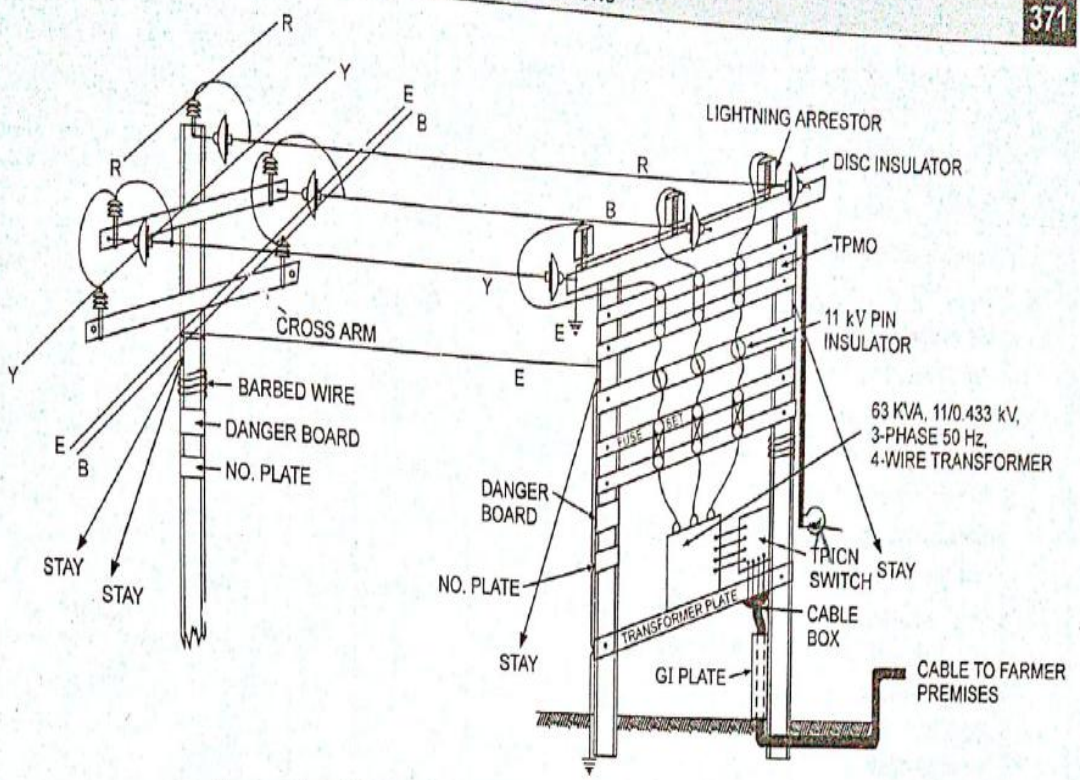

Connection Diagram For Pole-Mounted Transformer Substation

The quantity of material with cost is estimated as below

S. No.	*Description of Material With Complete Specifications*	*Quantity Required*	
		Quantity	*Unit*
	(a) HT Connection		
1.	MS channel 100 mm × 50 m × 7.5 mm × 1.5 m long	1	no
2.	ACSR conductor squirrel 6/1 × 2.11 mm	91 (7.735)	m kg
3.	GI wire 7/16 SWG	30 (3)	m (kg)
4.	Disc type insulators porcelain vitreous 145 mm height × 255 mm diameter ball and socket type brown, two in series assembly with tension clamps for	3	nos
5.	11 kV pin type insulators	2	do
6.	Stay set with GI 19 mm × 1.8 m long stay rod complete in all respects	1	do
7.	Earth wire clamp	1	do

8.	Binding wire (aluminium)	0.5	kg
9.	T clamps for MS channel	1	no
10.	Concreting 1 : 4 : 8	1	do
	(b) Pole-Mounted Substation		
11.	RS joists 175 mm × 100 mm × 11 m long	2	nos
12.	11 kV GO switch (air-break triple-pole) complete with fixing angles and 25 mm diameter, 6 m long operating pipe, lock and handle complete	1	do
13.	11 kV lightning arresters, expulsion type complete with all fittings transmission class, discharge capacity 65 kA	1	set
14.	Expulsion type fuses 11 kV installed on three insulators		
	Fuses	3	nos
	Insulators	3	do
	MS angle iron 5 mm × 5 mm × 6.0 mm	6	m

15.	MS channel iron 10 mm × 50 mm × 6.0 mm × 2 m long	2	nos	For supporting transformer
16.	Step-down transformer, 11/0.433 kV, 63 kVA, 3-phase, 50 Hz outdoor type complete with all accessories and oil filled suitable for pole mounting	1	do	
17.	ICTPN-switch 100 A, 660 V switch fuse type with rewireable type porcelain fuses outdoor type	1	do	
18.	ACSR conductor, squirrel (6/1 × 2.11 mm)	15 (1.275)	m kg	For HT connections between overhead conductors and transformer
19.	11 kV disc insulators with fittings	3	nos	
20.	PG clamps	3	do	
21.	PG bimetallic clamps	3	do	
22.	PVC cable, 25 mm^2, 3½ core, aluminium conductor armoured 1100 V complete in all respects	4	m	For connecting *lt* switch to transformer on *lt* side

23.	GI pipe 64 mm diameter	5	m	For supporting cable at sl. 22
24.	GI bends 64 mm	2	nos	
25.	Earthing set complete (copper plate earthing)	2	do	
26.	Stay rod sets complete in all respects	2	do	
27.	Stay insulators	2	do	

Contd...

		Quantity	Unit
28.	Binding wire (aluminium)	0.5	kg
29.	Danger plate with clamp	1	no
30.	Barbed wire	6	kg
31.	Nuts and bolts of different sizes (LS provision)		
32.	Concreting 1 : 4 : 8	2	nos
	(C) Service Connection		
33.	PVC cable, 25 mm^2, 3½ core, aluminium conductor armoured 1100 V complete in all respects	20	m
34.	LT cable box indoor type 3½ core, 25 mm^2 complete with all jointing material	1	no
35.	As above but outdoor type	1	do
36.	IC cutouts fitted with fuse wires complete with sealing device for 3½ core, 25 mm^2 cable	1	set of

38.	Energy meter, 3-phase, 4-wire, 50 Hz, 100 A, 415 V	1	no
39.	Energy meter, single phase, 50 Hz, 5 A, 250 V	1	do
40.	8 SWG GI wire	20	m
41.	Nuts and bolts (LS provision)	(2)	(kg)
42.	Bricks (second class)	300	nos
43.	Sand	2	m^3

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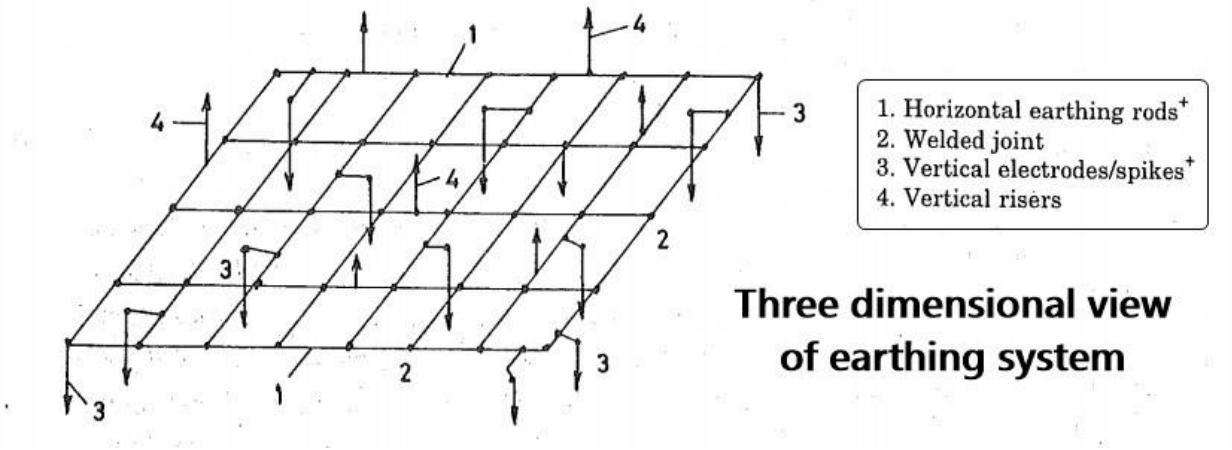
Purpose for substation earthing

- Safety of operational and Maintenance Staff
- Discharge of electrical charges to ground
- Grounding of overhead Shielding Wires
- Electromagnetic Interference



Three dimensional view of earthing system