CMR INSTITUTE OF TECHNOLOGY	USN										

Internal Assesment Test - II

Sub:	Electrical Estimation and Costing							Code:	10EE553
Date:	08/11/17	Duration:	90 mins	Max Marks:	50	Sem:	5	Branch:	EEE

Answer any five full questions

	Note: **Sketch figures wherever necessary.**	Marks	OBE CO	OBE RBT
1(a)	List important considerations regarding motor installation wiring.	5	C5053.4	L1
(b)	Explain different method of installation of service line with neat sketch?	5	C5053.4	L1
2)	A farmer requires to connect a 3 – phase , 37 Kw, 50 Hz motor to a 3 – phase , 4 – wire , 415/240 V, 50 Hz overhead line. The distance of a service line from the farmer structure having motor is 15m. The motor has an efficiency of 85% and a power factor of 0.8. Estimate the quantity and cost of materials required	10	C5053.4	L2
3)	A Small workshop(30 m x 15 m) has to be equipped with the following machinery: (a) One shaper machine with 5 hp, 415 V, 3 phase motor. (b) One lathe driven by 3 hp, 415 V, 3 phase motor (c) One drilling machine with ½ hp, 240 V, single phase motor (d) One grinding machine with 1 hp, 3 phase, 415 V motor Draw a floor plan of placing these machines and sketch the wiring diagram. Prepare a list of material required for the wiring scheme	10	C5053.4	L2
4)a)	Explain determination of following quantities for power circuit installation i) Input current and power to motor ii) Rating of fuse iii) Size of conduit, distribution board, main switch & starter.	5	C5053.4	L2

4(b)	Explain briefly about pole mounted substation and Foundation mounted substation.	5	C5053.6	L2
5)	Explain different earthing system with suitable sketch and purpose of earthing in substation.	5	C5053.6	L2
	Draw single line diagram for the substation – auxiliary supply.	5	C5053.6	L4
6)	Explain different components in substation with suitable sketch.	10	C5053.6	L4
7)	Estimate the quantity of material required for 10 MVA, 33/11Kv substation .Draw the single line diagram for the same.	10	C5053.6	L4
8)	A 37kW connection is to be given to an agriculture field at 415V, 3 – phase , 50 Hz. The connection is to be given from a 3 – phase, 11kV overhead distribution line which is available at a distance of 40 m. The motor has full load efficiency of 85% and power factor 0.8. Make a neat sketch and estimate quantity of material required.	10	C5053.6	L4

FOR HIGH ROOF BUILDING

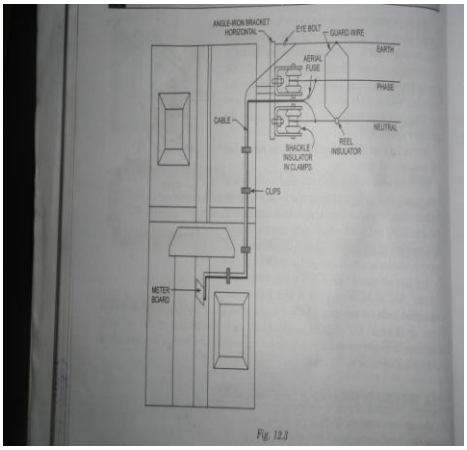


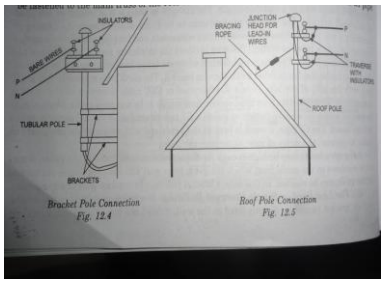
Fig. 12.9

FOR HIGH ROOF BUILDING

- Connected to the cable provided that the building has the necessary height
- **A service bracket is embedded into a wall at a suitable height.**
- **The pin type or shackle type insulators are fitted to this wall bracket**
- **The number of insulators to insulators to be fitted depends upon the number of incoming wires**
- **the vertical distance between the insulators should be 35 cm and the lateral distance 30 cm.**
- The earth wire is connected to angle iron with the help of eye bolt.
- **Now a weather proof or PVC cable is connected to the conductors**

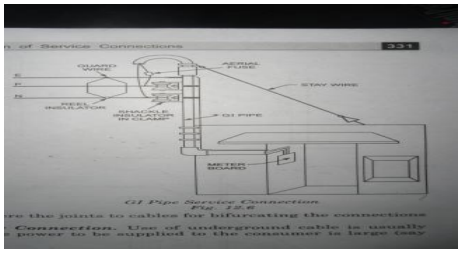
FOR LOW ROOF BUILDING

- Roof Pole Or **GI Pipe Connection** Is Made
- Roof pole connection, roof pole consists of a strong steel tube
- 60 mm,80 mm or 90 mm in diameter provided with lateral arms on which the insulators are mounted.
- The height of the roof pole should not exceed 3 meters
- To keep tensile stress low, the roof pole is braced by a steel rope
- GI pipe is raised above the roof to a suitable height
- The GI pipe is suitably clamped to the wall at its lower end and is bent back
- provided with a stay at its upper end
- The service cable is carried to service board through GI pipe and heavy gauge conduit



Bracket Pole Connection
Fig. 12.4

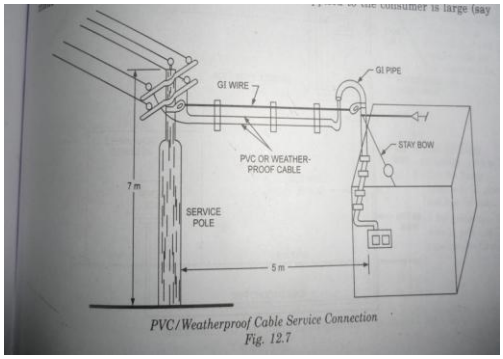
Roof Pole Connection
Fig. 12.5



GI Pipe Service Connection
Fig. 12.6

WEATHER PROOF CABLE METHOD

- 8 SWG GI wire is stretched from the service pole to eye screw bolt fixed into a wall at a suitable height
- The weather proof or PVC cable is then brought to the building by clipping it to the GI wire.



PVC/Weatherproof Cable Service Connection
Fig. 12.7

UNDERGROUND SERVICE LINES

- underground cable is usually made for service connection when the power to be supplied to the consumer is large (say above 25 Kw).
- For installation of underground cable service connection a cable box of suitable size is fitted to the service pole by means of M.S. channel of size 16mm x 250mm and bolts and nuts.

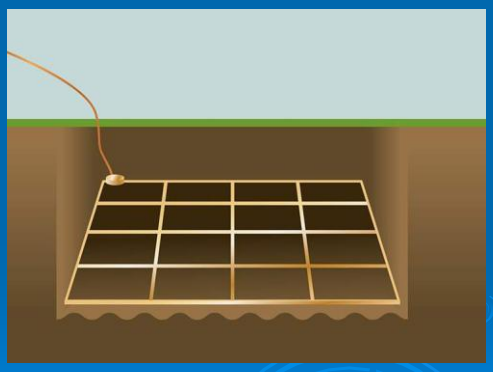
ROD EARTHING

- In this system of earthing 12.5mm diameter solid rods of copper 16mm diameter solid rod of GI or steel or hollow section of 25mm GI pipe of length not less than 3 meters are driven vertically into the earth
- In order to increase the embeded length of electrod under the ground, which is some time necessary to reduce the earth resistance to desired value more than one rod section are hammered one above the other.
- This system of earthing is suitable for area which are sandy in character .
- This system of earthing is very cheap

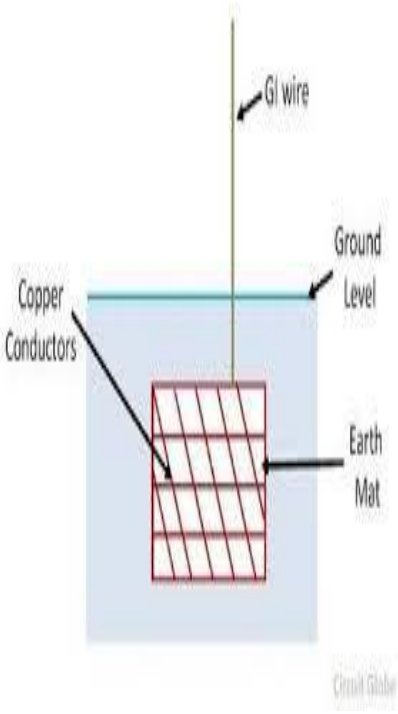
Earth / Ground Basics

Types of Grounding Systems

- A ground mesh consists of network of bars connected together, this system is often used at larger sites such as electrical substations.



Ground mesh



13.10. SUBSTATION AUXILIARIES SUPPLY

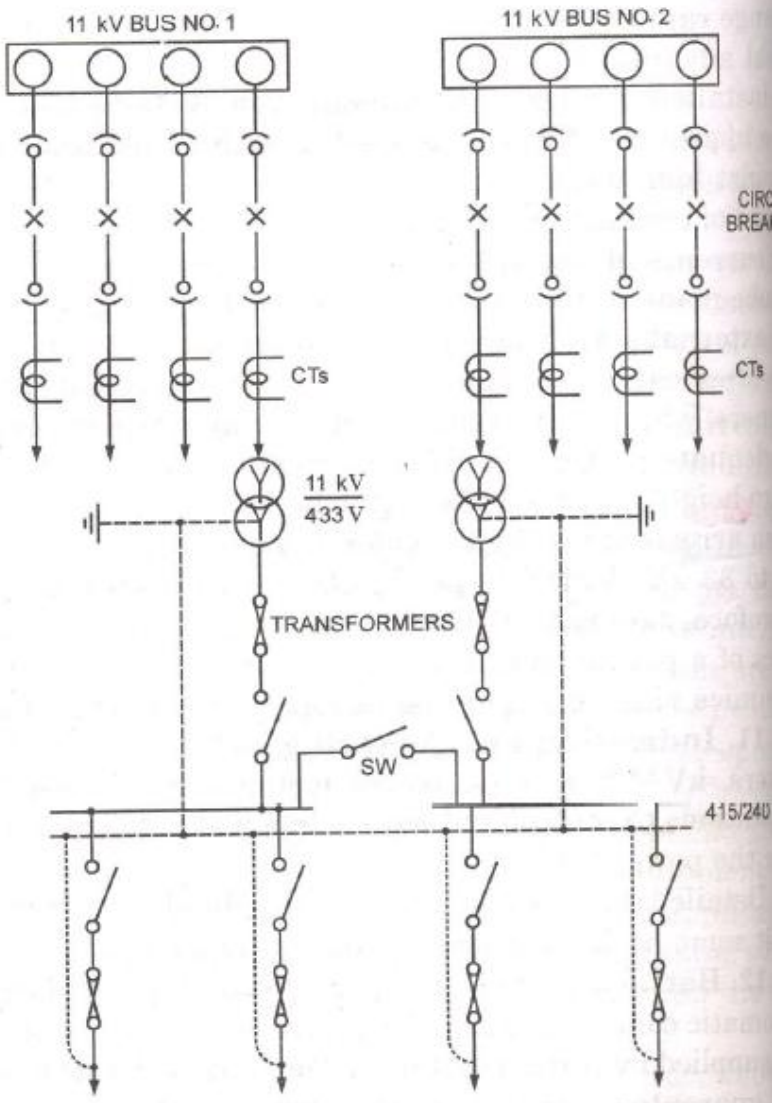
In small unattended substations only a small amount of power for electric lighting during regular periods of inspection, maintenance and repair is required.

In regional substations the electric power is required for the auxiliaries—the lighting circuits, air blast fans of power transformers, battery charging sets, oil servicing facilities, compressor units in case of air blast circuit breakers, ventilating fans of the substation buildings, water supply and heating system equipment etc.

In substations incorporating synchronous condensers the supply is also required for the operation of auxiliary equipment of the synchronous condensers.

In large substations it is wide practice to connect two transformers to the 11 kV main bus-bars for supply of the auxiliaries at a voltage of 415 V/240 V.

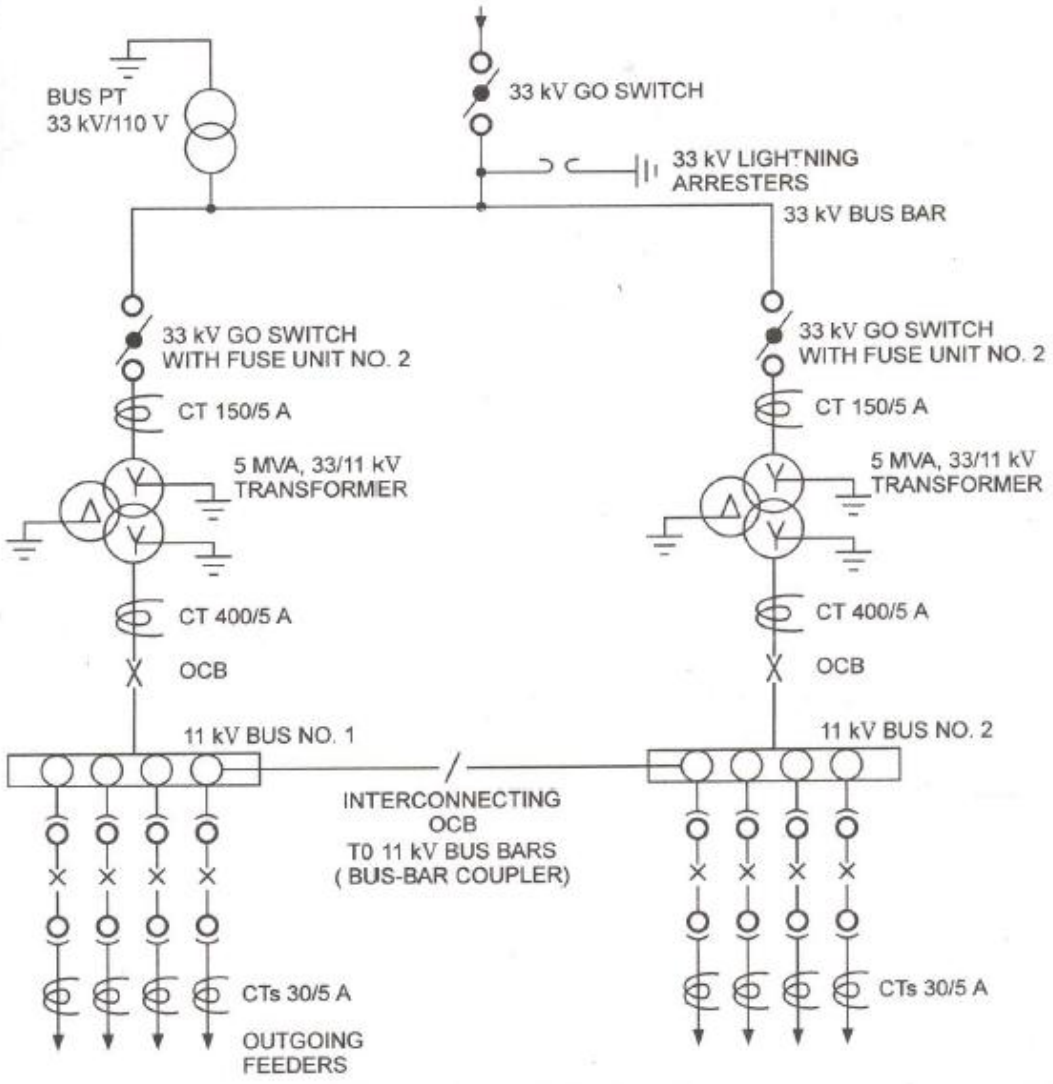
An example of the auxiliary supply connections in a substation of medium capacity is shown in Fig. 13.17.



Main Connection For Auxiliaries Supply
Fig. 13.17

Estimate the quantity of material and cost for installation of 10 MVA, 33/11 kV substation.

Solution : The key diagram of 33/11 kV, 10 MVA substation is shown below (Fig. 13.19)



10 MVA, 33/11 kV Substation

There are two 5 MVA transformers and the 11 kV bus-bars are interconnected through OCB.

Full-load current of each transformer on 33 kV side

$$= \frac{5 \times 10^6}{\sqrt{3} \times 33 \times 1{,}000} = 87.5 \text{ A}$$

Full-load current of each transformer on 11 kV side

$$= \frac{5 \times 10^6}{\sqrt{3} \times 11 \times 1{,}000} = 262.5 \text{ A}$$

The quantity of material and cost of installation of 10 MVA (2 × 5 MVA) 33/11 kV su are tabulated as below :

S. No.	Description of Material With Complete Specifications	Quantity Required		Rate			Amount		Rem
		Qnty.	Unit	₹	P	Per	₹	P	
1.	5 MVA, 33/11 kV, 3-phase transformers with first filling of oil and on-load tap changing switch	2	nos	3,800,000	00	each	7,600,000	00	
2.	33 kV isolator cum GO switches complete with supporting structures, 3-phase, 200 A	3	do	75,000	00	do	225,000	00	One for coming a two for o going (on each tran former in coming)
3.	33 kV lightning arresters	1	set of 3	5,500	00	each set	5,500	00	
4.	Power factor correction capacitors 3-phase, 11 kV, 5 MVAR, shunt type	2	nos	130,000	00	each	260,000	00	
5.	4 SWG hard drawn bare copper conductor	115 (100)	m (kg)	400	00	kg	40,000	00	For 33 kV existing lin to 33 kV ma bus-bars inc ding for jumpers and connections.
6.	6 SWG hard drawn bare copper conductor	200 (80)	m (kg)	400	00	do	32,000	00	From 33 kV bus-bars to 33/11 kV transformers including for jumpers and connections.
	11 kV 3-core XLPE insulated 240 mm² aluminium conductor armoured cable	50	m	3,000	00	m	150,000	00	From trans-formers to 11 kV panels including extra for loops in trenches
	Cable boxes 33 kV, 3 core complete with jointing materials	4	nos	1,500	00	each	6,000	00	
	Cable boxes 11 kV, 3 core complete ...								

S. No.	Description of Material With Complete Specifications	Quantity Required		Rate			Amount		Remarks
		Qnty.	Unit	Rs	P	Per	Rs	P	
10.	11 kV 3-phase, 50 Hz metal clad switch board with								
	(i) horizontal draw out type OCBs of rating 400 A complete with CTs, PTs, ammeters, voltmeters kWhr meters, selector switches and protective equipment IDMT relays.	8	do	200,000	00	do	1,600,000	00	4 for each transformer
	(ii) Bus-bar coupler consisting of 11 kV horizontal draw out type OCB 400 A with metering equipment rupturing capacity 1 MVA	1	do	200,000	00	do	200,000	00	1 for bus coupler
11.	Jointing material	18	do	600	00	do	10,800	00	For 11 kV units
12.	Transformer platforms (plinths) with oil drain facility and one pit for collection of drained oil.	2	do	22,500	00	do	45,000	00	
13.	Cable trench with cement slab	35	m	600	00	m	21,000	00	
14.	Substation structures for GO switches, isolators, breakers	2	sets	38,000	00	each	76,000	00	(i) Double girder structures (ii) Double girder beams
	33 kV OCB, 3-phase for								
	(i) Incoming control	1	no	300,000	00	do	300,000	00	
	(ii) Transformer control metering equipment with CTs 150/5 control panel	2	nos	300,000	00	do	600,000	00	
	Control cable of 1.5 mm^2 copper conductor multi-strand 660 V PVC insulated	20	m	800	00	m	16,000	00	
	Earthing for								
	(i) 33 kV ht panels	6	nos	5,500	00	each	33,000	00	3 panels
	(ii) transformers	4	do	5,500	00	do	22,000	00	2 transformers
	(iii) 11 kV ht panels	18	do	5,500	00	do	99,200	00	9 panels
	Empire tape	30	rolls	150	00	each roll	4,500	00	
	HT tape	18	rolls	400	00	do	7,200	00	
	Sundries to complete the job such as sand, cement, mortar, petty items						40,000	00	LS provision
						Total	11,397,000	00	
						Storage and transportation charges 5%	569,850	00	
						Labour charges 10%	1,139,700	00	
						Contingencies 1%	113,970	00	
						Electrical inspection fee	60,000	00	
						Grand total	13,280,520	00	

Say ₹ 13,282,000.00

A 37 kW connection is to be given to an agriculture field at 415 V, 3-phase, 50 Hz. The connect is to be given from a 3-phase, 11 kV overhead distribution line which is available at a distan of 40 metres. The motor has a full-load efficiency of 85% and power factor 0.8.

Make a neat sketch showing how will you arrange the supply and estimate quantity material required with cost.

Solution : Consumer load = 37 kW (output) = $\frac{37}{0.85}$ (input) = 43.529 kW

$$\text{Load in kVA} = \frac{\text{Load in kW}}{\text{Power factor}} = \frac{43.529}{0.8} = 54.41 \text{ kVA}$$

Full-load current on primary side of transformer,

$$I_1 = \frac{\text{Output in kVA} \times 1{,}000}{\sqrt{3} \times V_1} = \frac{54.41 \times 1{,}000}{\sqrt{3} \times 11{,}000} = 2.856 \text{ A}$$

Full-load current on secondary side of transformer,

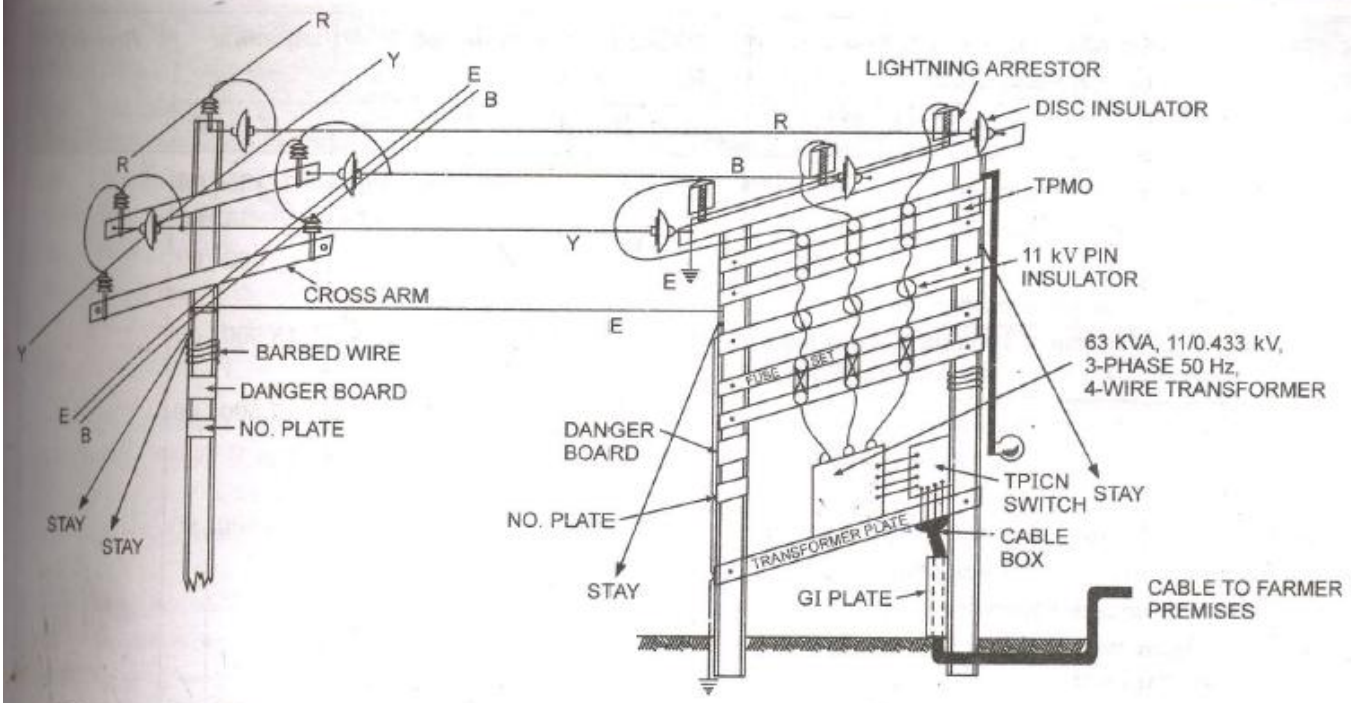
$$I_2 = \frac{\text{Output in kVA} \times 1{,}000}{\sqrt{3} \times V_2} = \frac{54.41 \times 1{,}000}{\sqrt{3} \times 415} = 75.7 \text{ A}$$

Thus the service connection is proposed to be provided by installing an outdoor pole-mount 63 kVA, 11/0.433 kV Δ/λ-connected, 3-phase, 50 Hz transformer.

The service connection is proposed to be provided by a $3\frac{1}{2}$-core, 25 mm^2 (7/2.24 mm) aluminium conductor armoured cable having current carrying capacity of 107 A.

The transformer will be mounted on a two-pole structure 10 metres from the consumer's premises.

ACSR 6/1 × 2.11 mm conductor will be used to connect the transformer to the overhead line. Impedance of the cable is 1.4 Ω/km. Current carrying capacity is 115 A.



Connection Diagram For Pole-Mounted Transformer Substation
Fig. 13.18

Voltage drop in 30 metre span $= \sqrt{3} \times \frac{30}{1{,}000} \times 1.4 \times 2.856 = 0.2$ V

Length of ACSR conductor = 3 × 30 + 1 m for sag = 91 m

Length of cable required = Length along pole up to ground + length along trench + length up to cable box + for wastage and connections

= 6 + 10 + 2 + 1 + 1 = 20 metres

The quantity of material with cost is estimated as below:

S. No.	Description of Material With Complete Specifications	Quantity Required		Rate			Amount		Remarks
		Quantity	Unit	₹	P	Per	₹	P	
	(a) HT Connection								
1.	MS channel 100 mm × 50 m × 7.5 mm × 1.5 m long	1	no	300	00	each	300	00	
2.	ACSR conductor squirrel 6/1 × 2.11 mm	91 (7.735)	m kg	160	00	kg	1,237	60	1,000 m weighs 85 kg
3.	GI wire 7/16 SWG	30 (3)	m (kg)	270	00	kg	810	00	
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	960	00	each	2,880	00	
5.	11 kV pin type insulators	2	do	200	00	do	400	00	
6.	Stay set with GI 19 mm × 1.8 m long stay rod complete in all respects	1	do	2,100	00	do	2,100	00	
7.	Earth wire clamp	1	do	60	00	do	60	00	

Contd...

S. No.	Description of Material With Complete Specifications	Quantity Required		Rate			Amount		Remarks
		Quantity	Unit	₹	P	Per	₹	P	
8.	Binding wire (aluminium)	0.5	kg	270	00	kg	135	00	
9.	T clamps for MS channel	1	no	75	00	each	75	00	
10.	Concreting 1 : 4 : 8	1	do	600	00	do	600	00	
	(b) Pole-Mounted Substation								
11.	RS joists 175 mm × 100 mm × 11 m long	2	nos	7,800	00	do	15,600	00	
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	7,500	00	do	7,500	00	
13.	11 kV lightning arresters, expulsion type complete with all fittings transmission class, discharge capacity 65 kA	1	set	5,500	00	each set	5,500	00	
14.	Expulsion type fuses 11 kV installed on three insulators								
	Fuses	3	nos	800	00	each	2400	00	
	Insulators	3	do	950	00	do	2,850	00	
	MS angle iron 5 mm × 5 mm × 6.0 mm	6	m	75	00	m	450	00	For fixing fus and LT cubicl
15.	MS channel iron 10 mm × 50 mm × 6.0 mm × 2 m long	2	nos	900	00	each	1,800	00	For supporti 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	150,000	00	do	150,000	00	
17.	ICTPN switch 100 A, 660 V switch fuse type with rewireable type porcelain fuses outdoor type	1	do	6,300	00	do	6,300	00	
18.	ACSR conductor, squirrel (6/1 × 2.11 mm)	15 (1.275)	m kg	160	00	kg	204	00	For HT connections between overhead conductors and transformer
19.	11 kV disc insulators with fittings	3	nos	960	00	each	2,880	00	
20.	PG clamps	3	do	150	00	do	450	00	
21.	PG bimetallic clamps	3	do	165	00	do	495	00	
22.	PVC cable, 25 mm^2, 3½ core, aluminium conductor armoured 1100 V complete in all respects	4	m	180	00	m	720	00	For connecting *lt* switch to transformer on *lt* side
23.	GI pipe 64 mm diameter	5	m	280	00	m	1,400	00	For supporti cable at sl. 22
24.	GI bends 64 mm	2	nos	90	00	each	180	00	
25.	Earthing set complete (copper plate earthing)	2	do	5,200	00	do	10,400	00	
26.	Stay rod sets complete in all respects	2	do	2,100	00	do	4,200	00	
27.	Stay insulators	2	do	100	00	do	200	00	

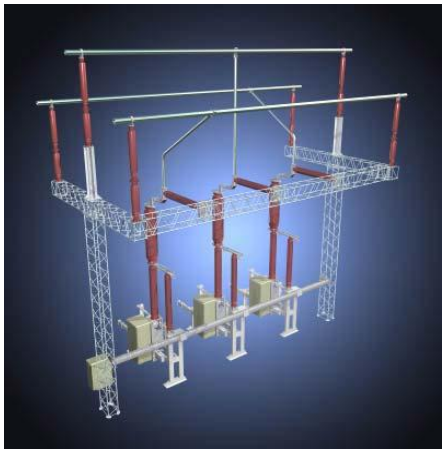
Contd

S. No.	Description of Material With Complete Specifications	Quantity Required		Rate			Amount		Remarks
		Quantity	Unit	₹	P	Per	₹	P	
28.	Binding wire (aluminium)	0.5	kg	270	00	kg	135	00	
29.	Danger plate with clamp	1	no	90	00	each	90	00	
30.	Barbed wire	6	kg	60	00	kg	360	00	
31.	Nuts and bolts of different sizes (LS provision)						150	00	
32.	Concreting 1 : 4 : 8	2	nos	750	00	each	1,500	00	
	(C) Service Connection								
33.	PVC cable, 25 mm^2, 3½ core, aluminium conductor armoured 1100 V complete in all respects	20	m	180	00	m	3,600	00	
34.	LT cable box indoor type 3½ core, 25 mm^2 complete with all jointing material	1	no	500	00	each	500	00	
35.	As above but outdoor type	1	do	550	00	do	550	00	
36.	IC cutouts fitted with fuse wires complete with sealing device for 3½ core, 25 mm^2 cable	1	set of three	750	00	each set	750	00	
37.	Meter box sheet metal type with locking arrangement, painting etc.								
	25 × 30 cm	1	no	400	00	each	400	00	
	45 × 60 cm	1	no	850	00	do	850	00	
38.	Energy meter, 3-phase, 4-wire, 50 Hz, 100 A, 415 V	1	no	3,000	00	do	3,000	00	
39.	Energy meter, single phase, 50 Hz, 5 A, 250 V	1	do	1,200	00	do	1,200	00	
).	8 SWG GI wire	20	m	270	00	kg	540	00	
.	Nuts and bolts (LS provision)	(2)	(kg)				400	00	
.	Bricks (second class)	300	nos	3	20	each	960	00	
	Sand	2	m^3	200	00	m^3	400	00	
						Total	238,361	60	
						Storage and transportation charges 5%	11,918	08	
						Labour charges 10%	23,836	16	
						Contingencies 1%	2,383	62	
						Electrical inspection fee	2,000	00	
						Grand total	278,499	46	

Say ₹ 279,000.00

BUSBAR

- In electrical power distribution, a **busbar** is a metallic strip or **bar** (typically copper, brass or aluminium) that conducts electricity within a switchboard, distribution board, substation, ...
- **BUSBAR** *(or bus, for short)* – is a term we use for a main bar or conductor carrying an electric current to which many connection may be made.



VOLTAGE TRANSFORMER

- **VOLTAGE TRANSFORMER** – also know as potential transformer,
- **Potential transformer** or **voltage transformer** gets used in electrical power system for stepping down the system voltage to a safe value which can be fed to low ratings meters and relays. Commercially available relays and meters used for protection and metering, are designed for low voltage. This is a simplest form of **potential transformer definition**.

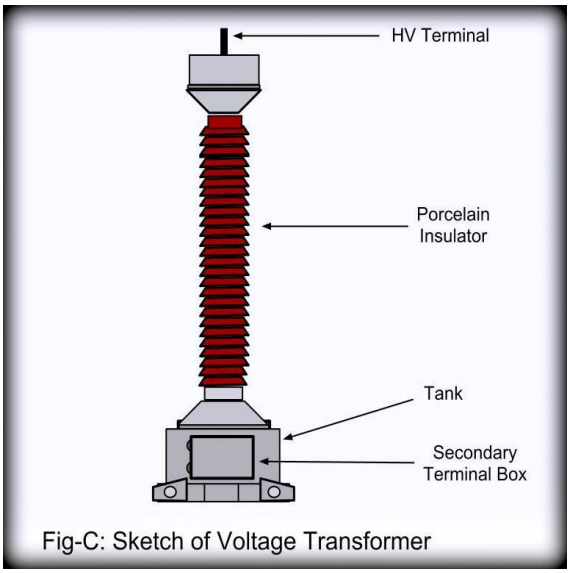
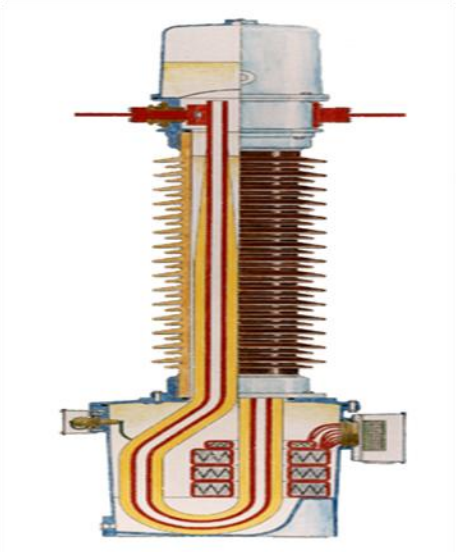


Fig-C: Sketch of Voltage Transformer

. CURRENT TRANSFORMER

- Current transformers are basically used to take the readings of the currents entering the substation. This transformer steps down the current from 800 amps to 1 amp. This is done because we have no instrument for measuring of such a large current.



POWER TRANSFORMER

C. CIRCUIT BREAKER

- **CIRCUIT BREAKER** – The circuit breakers are used to break the circuit if any fault occurs in any of the instrument. These circuit breaker breaks for a fault which can damage other instrument in the station. For any unwanted fault over the station we need to break the line current. This is only done automatically by the circuit breaker.

EARTHING SWITCH

- **EARTHING SWITCH** – also known as ground disconnect, which used to connects the equipment to a grid of electrical conductors buried in the earth on the station property. It is intended to protect people working on the grounded equipment. It does this by completing a circuit path, thereby reducing the voltage difference between the equipment and its surroundings..

G. SURGE ARRESTOR

- **SURGE ARRESTOR –**

- Lightening arrestors are the instrument that are used in the incoming feeders so that to prevent the high voltage entering the main station. This high voltage is very dangerous to the instruments used in the substation. Even the instruments are very costly, so to prevent any damage lightening arrestors are used.

Isolator

The use of this isolator is to protect the transformer and the other instrument in the line. The isolator isolates the extra voltage to the ground and thus any extra voltage cannot enter the line. Thus an isolator is used after the bus also fo protection.

WAVE TRAP

Wave Traps are used at sub-stations using **Power Line Carrier Communication** (PLCC). PLCC is used to transmit **communication** and control information at a high frequency over the power lines. This reduces need for a separate infra for **communication** between sub-stations.

coupling capacitor

A coupling capacitor in substation is used for power line communication purposes. It used after the wave trap. The capacitance ranges from 2200pf to 10,000pf. It offers very low impedance to high frequency carrier signal and allows them to enter the line matching unit and offers a very high impedance path to low frequency signal or wave and blocks it for reaching the line matching unit.

In short, it allows only those frequencies needed for communication purposes.