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Electrical Estimating & Contracting

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Electrical Engg.

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ELECTRICAL INSTALLATION & ESTIMATING

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CH-1

I. ERULES AND STANDARDS

ESTIMATING---

It is defined as an assessment of different items and their costs as per the plan which are required for executing a work before actually done.

Following words have their specific meaning according to the Indian electricity rules 1-

Amper-

- It is the unit of current
- In other words it is the unvarying electric current which when passed through a solution of nitrate of silver in the water, it deposits silver at the rate of 0.01118 gm/s

2- volt-

- It is the unit of voltage or E.M.F
- It is also defined as a 1 volt of electric potential which when applied steadily to a conductor containing 1 ohm resistance will flow or cause to flow 1 amp of current.

3- Circuit-

- It is defined as a closed path along which the electric current can flow.

4- Circuit breaker-

- It is defined as a device which is capable of making and breaking the circuit under all condition.

5- Switch-

- It is defined as a manually operated device for closing and opening of an electrical ckt.

6- Cut out-

- It is defined as an appliance which is capable of automatically interrupting the electrical energy through any conductor when the current rises above the pre-determined amount.

7- Conductor-

- It is defined as a material which conducts the electrical energy or currents when connected with an electrical system.

8- live

It is defined as something which is electrically charged.

9- Dead

It is defined as something which is disconnected from any live system and it must have the potential equal to the earth potential.

10- Span

The horizontal distance between the two adjacent consecutive supports is called a span.

11- danger

It is defined as any injury to person or property or fire explosion or burning or any part of the body from electric shock or injury to life due to generation, transmission, distribution & utilization of electric power or energy.

12- earthing system-

- It is defined as a system in which all the appliances are properly earthed.

13- system-

It is defined as an electrical arrangement in which all the conductors or apparatus are connected electrically to a common source of supply.

14- apparatus-

It is defined as an electrical equipment which includes all accessories, fittings & appliances where conductors are used.

15- bare-

It is defined as something which is not covered with any insulating materials.

16- conduit-

It is defined as a tubular structure, may be of rigid or flexible, which is mechanically strong and fire proof through which cables are drawn.

17- cable-

It is defined as a length of insulating single or more conductors which are laid together.

18- Electrician-

It is defined as a person over 21 years of age & is competent for all the rules in which, he is assigned to his work & who has been appointed by the agent or manager of the installation.

19- voltage

It means the difference of electrical potential measured in volts between any part of the conductor & the earth as measured by a suitable voltmeter.

20- Low voltage-

According to I.E. rules it is defined as a voltage which does not exceed 250v under normal condition subjected to the percentage of variation allowed by the rules.

21- medium voltage-

According to I.E. rules, it is defined as a voltage ranging from 250v to 650v under normal conditions subjected to the % of the variation allowed by the rules,

22- high voltage-

According to I.E. rule it is defined as 650v to the 33000v under normal condition allowed by the rules.

23- extra high voltage according to I.E. rule it is defined as the voltage which exceeds above 33kv under normal condition subjected to the percentage of variation allowed by the rule.

The maximum voltage regulation allowed for low voltage and medium voltage is $\pm 5\%$ as per I.E. rules.

The maximum voltage regulation allowed for high voltage and extra high voltage is $\pm 12.5\%$ as per I.E. rules.

GENERAL SAFETY PRECAUTION-

Rule-29- construction, installation, protection, operation & maintenance of electric supply lines & apparatus-

-All electric supply lines & apparatus shall be constructed, installed, protected, worked, & maintained in accordance with standards for the I.E. rule so as to prevent danger

Rule-30- service lines and apparatus on consumer's premises

-the suppliers shall ensure that all electric supply lines, wires, fittings & apparatus belonging to him or under his control which are on a consumer's premises are in a safe condition.

Rule-31- cut-out consumer's premises

-the suppliers shall provide a suitable cut-out in each conductor of every line

-such cut-out shall be contained within an adequately enclosed fire-proof receptacle.

-the owner of every electric supply line shall protect it by a suitable cut-out.

Rule-32- identification of earthed & earthed neutral conductor & position of switches & cut-outs therein

An indication of a permanent nature shall be provided by the owner of the earthed or earthed neutral conductor, such indication shall be provided.

Rule-33-Earthed terminal on consumer's premises-

The supplier shall provide & maintain on the consumer's premises use a suitable earthed terminal in an accessible position or near the point of commencement of supply as defined under rule 58

- the consumer shall take all reasonable precaution to prevent mechanical damage
- it also prevent electrical shock & machinery damage

Rule-34 –Accessibility of bare conductor-

Where bare conductors are used in a building the owner of such conductors shall—

- Ensure that they are inaccessible
- Take such other safety measures as are considered necessary by the inspector.

Rule-35-caution notice-

The owner of every medium, high, extra high voltage installations shall affix permanently in a conspicuous position a caution notice in hindi or local language of district approved by inspector .

Rule-36-Handling of electric supply lines apparatus

Before any conductor or apparatus is handling, the precautions shall be taken by earthing to discharge electrically.

- No person shall work on any live electric supply line or apparatus
- Take the safety measures approved by inspector.

Rule-40 Street box-

Precautions shall be taken to prevent, as far as reasonably possibly, say influx of water or gas.

- All owner have to install street box for prevention of danger from sparking
- All street box shall be regularly inspected for the purpose of detecting the presence of gas.

Rule-41 distinction of circuit of different voltage.

- to easy control in substation or power grid

Rule-43-provisions applicable to protective equipment-

- Fire buckets filled with clean dry sand and ready for immediate use for extinguishing fires

- First aid boxes must be installed

Rule-44 Instructions for restoration of persons suffering from electric shock-

- It shall be affixed by the owner in a conspicuous place in every generating station.

Rule-49-leakage on consumer's premises

If the inspector or the suppliers has reason to believe that there is in the system of consumer leakage which is likely to affect injuriously the use of energy by the supplier or by other person, which is likely to cause danger he may give the consumer reasonable notice in writing that he desires to inspect & test the consumer's installation.

Rule-50-supply to consumers-

Necessary all kinds of apparatus, safety devices to be supplied to consumer followed by the Rules

51-provisions applicable to medium, high or extra high voltage installations

- All conductors shall be completely enclosed in mechanically strong metal casing
- All metal work enclosing, supporting or associated with the installation
- Every main switch-board shall have a clear space of not less than 3 feet in width shall be provided in front of the switch board.

Rule-54-declared voltage of supply to consumer.

For 1- ϕ - 240v

For 3- ϕ -440v, 11kv, 33kv etc

Rule-55-declared frequency of supply to consumer

Rule-56- sealing of meters and cut-outs-

A supplier may affix one or more seals to any cut-out & to any meter, maximum demand indicator, or other apparatus placed upon a consumer's premises

Rule-57-meters, maximum demand indicators and other apparatus on consumer's premises- No

meter shall register at no load

Every supplier shall examine, test & regulate all meter, maximum demand & other apparatus

58-point of commencement of supply

Rule-59-precautions against failure of supply:

notice of failure-the supplier shall take all responsible precaution to avoid any accidental interruption of supply & also to avoid danger to the public

Rule-60-testfortheresistanceofinsulation-

Allinsulatorsaretobeinsulationtestwhichprovisionforelectricsupply , Rule-

61-connection with earth

Preventionofelectricshock&damagingofapparatusrequired

Rule-62-system at medium voltage

Where a medium voltage supply system is employed the voltage between earth & any conductorformingpartofthesaidsystemshallnot,undernormalcondition,exceedlowvoltage.

Rule-63-approvalbytheinspector

Beforeinstallinghigh&extrahighsupply,theconsumerhavetotakepermissionofinspector

Rule-64-useofenergyathighandextra-highvoltage-

Theinspectorshallnotauthorizeasuppliertconnect asupplyofenergyathighorextrahigh voltage to any consumer unless I.E rules

Rule-65-voltagetests

Rule-66-metalsheathedelectricsupplylines

Provisionforprecautionagainstexcessleakage.

Rule-68-generalconditionsastotransformationandcontrolofenergy.

Energyistransferred&convertedbysubstation&switchstation.

Substation&switchstation'shallbepreperfectlybeerectedabovegroundbutwherenecessary constructed underground , provision for ventilation & drainage shall be made.

Rule-70-condensers-

Suitableprovisionshallbemadeforimmediate&automaticdischargeofeverystaticcondenser on disconnection of supply

Rule-74-joints

Jointsofconductorsinoverheadlinemustbemechanicallystrong.

Rule-75-maximum stresses: factor of safety

- for metal supports
- for mechanically processed concrete supports
- for hand moulding concrete supports
- for wood supports

Rule-76-clearances above ground of the lowest conductor

- 1) no conductor of an overhead line, including service lines, erected across a street shall at any part thereof be at height less than-
 - a) for low or medium voltage ----- 19ft
 - b) for high ----- 20ft
- 2) along any street
 - a) For low or medium ----- 18ft
 - b) For high ----- 19ft
- 3) For extra high voltage lines the clearance above ground shall not be less than 17ft Rule-

77-clearance between conductors and trolley wires

- 1) No conductor of an overhead line crossing a tramway or trolley bus route using trolley wires shall have less than the following clearance above any trolley wire.
 - a) Low & high voltage ----- 4ft
 - b) For insulated covered conductor ----- 2ft
 - c) high voltage up to 11kv ----- 6ft
 - d) above 11kv ----- 8ft
 - e) extra high voltage ----- 10ft

Rule-78-clearances from buildings of low and medium voltage lines and service lines

- when the line passes above the building, a vertical clearance of 8ft from the highest point
- adjacent to the building, horizontal clearance of 4ft

Rule-79-clearance from buildings of high and extra-high voltage lines

- 1) Vertical clearance above the highest part of the building immediately under such lines of not less than
 - a) For high voltage up to 33kv ----- 12ft
 - b) For extra high - plus 1ft for every additional 33kv
- 2) Horizontal clearance between the nearest conductor & nearest any part of building.

- a) Upto 11kv-4ft
- b) 11kv—to---33kv-----6ft
- c) Forextrahigh----- ft&plus1ftforadditional33kv

Rule-80-conductorsatdifferentvoltagesonsamesupports'

Where conductors forming at different voltages are erected on the same supports the owner shall make adequate provision to guard. Clearance between the different conductors voltages shall be subject to the prior approval of the inspector.

Rule-86-lines crossing or approaching each other--

Where an overhead line crosses another overhead line, then guard must be used Rule-

87-guarding

Line crossing overhead line guard must be required.

Rule-88-servicelinesfromoverheadlines-

No service line or lapping shall be taken off from an overhead line except at a point Rule-

89-Earthing

All metal supports of overhead lines & metallic fittings attached thereto, shall be permanently & efficiently earthed

Rule-90-safetyandprotectivedevices

Every overhead line erected over any part of street or other public place on any consumer's premise.

Rule-91-protectionagainstlightning

For protection against lightning, the lightning arrester is used

Short question and answer-

1- write the following terms as per Indian Electric Rules?

Q.1-low voltage

Ans- according to I.E rules it is defined as a voltage which does not exceed 250v under normal condition .

Q.2-Highvoltage

Ans-accordingtoI.E.rulesitisdefinedasavoltagerangingfrom650vto33,000v or33kv under normal conditions subjected to the percentage of variation allowed by the rules.

Q.3-Extrahighvoltage

Ans-itisdefinedasavoltagewhichexceedsabove33kvundernormalcondition. Q.4-

Medium voltage

Ans-accordingtoI.E.rulesitisdefinedasanvoltagewhichrangingfrom250vto650v under normal conditions subjected to the percentage.

Q.5-Ampere

Ans-itis the unit of current

Inotherworditistheunvaryingelectriccurrentwhichwhenpassedthrougha solution of nitrate & silver in water, it is deposited the silver at the rate of 0.001118gm/sec

6-CircuitBreaker

Ans-itisdefinedasdevicewhichcapableofmaking&breakingthecircuitunderallcondition 7-

Cutout

Ans-itisdefinedasanappliancewhichiscapableofautomaticallyinterruptingtheelectrical energy through any conductor when the current rises above the pre determined amount.

8-Live

Ans-itisdefinedassomethingwhichiselectricallycharged 9-

Dead

Ansitisdefinedassomethingwhichisdisconnectedformanylivesystem&itmusthavethe potential equal to the earth potential

10-Earthingsystem

Ans-itisdefinedasthesysteminwhichalltheapplianceareproperlyearthed 11-

Span

Ans-thehorizontaldistancebetweenthe two consecutive supports is called as span 12-

Bare

Ans-itisdefinedassomethingwhichisnotcoveredwithanyinsulatingmaterials

CH-4

OVERHEAD INSTALLATION

Overhead installation (H.T)

DISTRIBUTION-

Generally for distributing for electrical energy we have two types of systems such as L.T distribution and H.T. distribution. It depends on the voltage to supply.

It may be HT & LT distribution but the following accessories must be used in the overhead distribution system

Supports-

Usually electric pole or towers are called as supports. The main function is to support the conductor so as to keep it at a suitable height above the ground.

-generally for LT distribution we use 8m or 9m PCC (pre-stressed concrete) or RCC (reinforced concrete) and also rein pole of 9m & 10m height.

Similarly for HT distribution we use 9m PCC or RCC pole & reinforced of height 12 m.

-depending on the voltage will supply & variation regions. We also use tower for HT distribution.

2- factors governing height of the pole-

Following are the important factors governing the height of the pole.

- 1- the minimum clearance of the lowest conductor from the ground.
- 2- the number of conductors to be carried out and minimum vertical clearances between the conductors.
- 3- the length of pole to be buried in the ground (generally $1/6^{\text{th}}$ of total height of the pole) must be buried in the ground in normal soil.

CROSS ARM—It is a cross piece fitted to the pole top at the end portion by means of brackets known as pole brackets such cross arm are used to hold the insulation in a suitable spacing

Generally in the distribution line we use semicircular, angle iron, U-shaped, V-shaped or zigzag shape cross arms are used.

- 4- **Pole bracket & clamps**—generally pole brackets are used to hold the cross arms with the poles. The brackets may be of the channels or angle iron and may be of pipe brackets.

-clamps are made up of flat iron & are used for fixing as well as holding service line, stay wire, earth wire, shackle Insulators and cross arms etc.

INSULATOR -

-The main function of the insulator in distribution line is to avoid the direct contact of the charged conductor with the earth.

-the commonly used material for the overhead line insulator is porcelain, toughed glass & ceramics.

-we have the following types of insulators. 1-

pin type insulator-

This type of insulators are generally used in 240V, 440V, 11KV & 33KV. 2-

Disc insulator are of two types depending upon its uses

i-suspension insulator

ii-strain insulator

i-SUSPENSION INSULATOR-

if the disc insulators are arranged in vertically then it is called as suspension insulator. ii-

STRAIN INSULATOR-

If the disc insulator is arranged in horizontally then it is called as strain insulator.

-Generally disc insulators are used 11KV upwards. 3-

SHACKLE INSULATOR-

This insulator is used only in LT line in 440V at the tapping pole, dead end pole and deviation pole.

-this insulator is also used in street light purpose. 4-

EGG INSULATOR-

The insulator which is used in stay wire L.T. line as well as H.T. line is called as egg insulator. Its appearance is similar to egg.

Conductor—

In distribution line conductor plays a vital role to transmit or circulate the electric current. hence conductor is a medium of electric supply system.

-generally we use AAC (All Aluminium conductor) & ACSR (Aluminium conductor steel reinforced) as the overhead conductor in the distribution line.

While stretching the conductor we must have to maintain a specific clearance among the conductors is called as conductor spacing and also between the ground called as ground clearance.

a general formula is used to get the conductor spacing

$$S_{\text{Spacing}} = \sqrt{s \times (v/150)}$$

Where, S = Sag of the conductor

V=Linevoltage,V

Supply voltagein (kv)	0.4	11	33	66	132	220	400
spacing	0.2	1.2	2.0	2.5	3.5	6.0	11.5

Similarlythegroundclearanceofthe conductorindifferentlocationsarementioned below.

Supplied voltagein (kv)	0.4	11	33	66	132	220	400
Across street(m)	5.8	5.8	6.1	6.1	6.1	7.0	8.4
Along street(m)	5.5	5.5	5.8	6.1	6.1	7.0	8.4
Other areas	4.6	4.6	5.5	5.5	6.1	7.0	8.4

Spanlength:-Dependingonthe suppliedvoltageofthedistributionlineasWellastransmissionline we have following spans for the various types of supports.

- (1) woodenpolespanis40mto50m.
- (2) steeltubularpolespanis50mto80m.
- (3) RCCandPCCpolespanis50m 200m.
- (4) steeltowersspanis200mto400m.

Forrivercrossinglongspansabout800mmaybeconsiderwhichisexceptional.

LIGHTINGARRESTER-

Itisdevicewhichprotectsall theelectricalequipmentsfromdamageduetosurge

Voltageoflighting.Hencealltheoverheadconductorsarealsoconnectedlighting arresteratthesubstations,greedsetc.similarlyallthemodernprotectivedevicesmustbeconnected with this lighting arrester.

PHAGEPLATE-

Toidentifythecolour codeof overheadconductorssuchasred(R),yellow(Y),&blue(B)such Phase

plates are attached with the supports .

DANGERPLATE-usuallythisplateisplacedataheightof2.4mfromtheground onthesupport. This plate contains supplied voltage which is written in English hindi& in local language.

This plate is used to warn the human being. ANTI

–CLIMBING WIRE–

This wire is provided around the poles at a height of about 2.5m from the ground for at least 1m.

-it is used to prevent unauthorized persons from climbing. BIRD

GUARD–

These are the wooden pieces of size about 10cm*12.5cm*15cm, in case of metal poles are fitted under the insulators.

-bird guards are used to avoid the short circuit or earth fault due to sitting of birds which may short circuit live conductors or any one line conductor with earth.

JUMPER–

Jumper is the conductors which are used to continue supply line from one point to another point by jumpering.

- Jumpers are generally used in DP structure & where disconnection of supply line is exiting.

GUARDWIRE–

It is used to protect the lives of the human being as well as wildlife.

- These are used in the place or location of road crossing, over the telephone line, railway crossing etc.

STAY–

Stay is basically used to provide support to the line poles where they are unbalanced or in a direction.

- Generally stay is done at an angle of 45 degrees or not less than 30 degrees.
- For HT line this stay angle may vary from 45 degrees to 60 degrees.

Problem-1

Electric supply to a factory is to be taken from an existing 11kv overhead 3-phase line for a distance of 1km from the existing line. If this line is meant for 300A load, prepare a list of materials required for this purpose. Assume a road crossing in this distribution line.

Solution–

1)-Calculation for no of poles–

Total length of line = 1km = 1000m

Assume that span length = 50m So

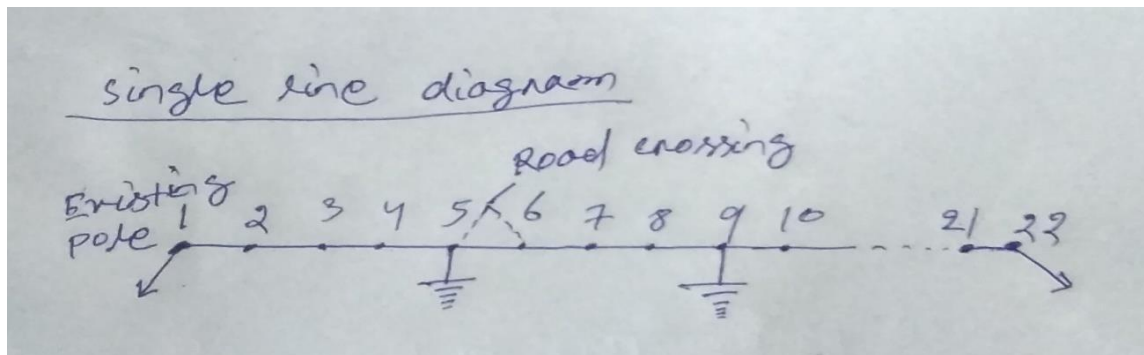
no of span = $1000/50=20$

Sono of poles required = $20+1=21$

As road crossing are there in this line, soon more pole is required for this purpose.

Hence total no of poles required = $21+1=22$

2)-single line diagram



Calculation for no. of cross arm:- According to single line diagram, let us select angle iron cross arm at the tapping pole as well as dead end pole & rest of the intermediate poles we select 'v' cross arm.

Sono of angle iron cross arm required = 2 Sono

of 'V' cross arm required = 2

4-calculation for no of insulators-

According to the above line diagram strain insulators are used at the tapping poles as well as dead end pole. 11 KV pin insulators are used in rest of the intermediate poles.

Hence no of disc insulator required = $3+3=6$

Total no of 11kv pin insulators = $21*3=63$

5)-calculation length of overhead conductor

Net length of conductor required = $3*(\text{total length of the line} + 2\% \text{ for sag}) = 3*(1000+20) = 3060\text{m}$ Considering 12m extra for twisting & binding at the tapping pole as well as dead end pole.

So gross length of conductor = $3060+12=3072\text{m}$

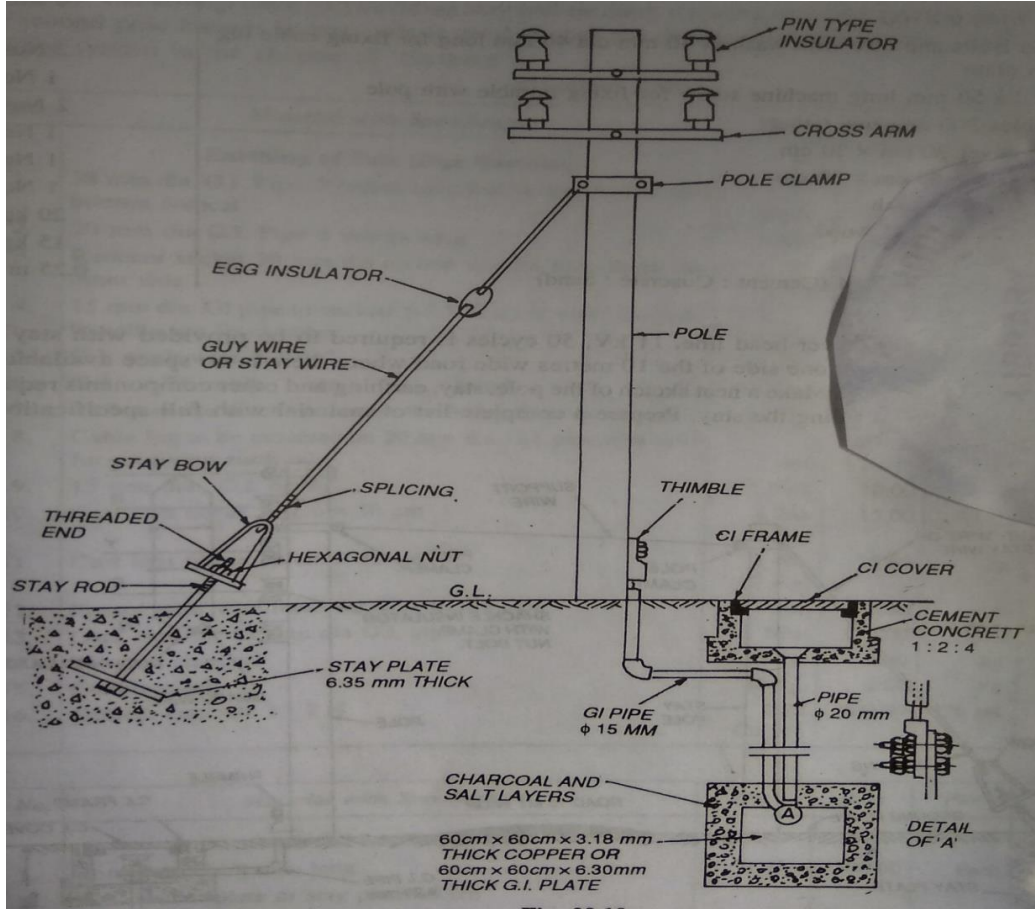
6)- selection of overhead conductor-

From the conductor table for the current rating of 305A at 40°C ACSR, 6/1×4.50, ca type conductor should be selected.

Material table-

SI	DESCRIPTION	SPECIFICATION	QUANTITY
01	Supports	RCC,9m	22nos
02	Crossarms with its fitting accessories	a) angle iron cross arm b) V-crossarm	2nos 21nos
03	Insulators with its fitting accessories	a) disc type 11kv b) pin type 11kv	06nos 63nos
04	Overhead conductor	ACSR, 6/1×4.50mm cat type	3072m
05	Stay with its fitting accessories	For 11kv line	02 set
06	Earthing with its fitting accessories	For 11kv	04 set
07	Angle iron cross arm to support the guard wire	100mm*50mm*7.5mm long, MS type	02 no
08	Guard wire	14SWG, GI	50m
09	Binding wire at the rate 100gmp per pin insulator	Aluminium type, single core	6300=6.3kg
10	Anti climbing wire at the rate 3m per pole	G.I type	66m
11	Danger plate	11kv	22nos
12	Complete the whole job		As per required

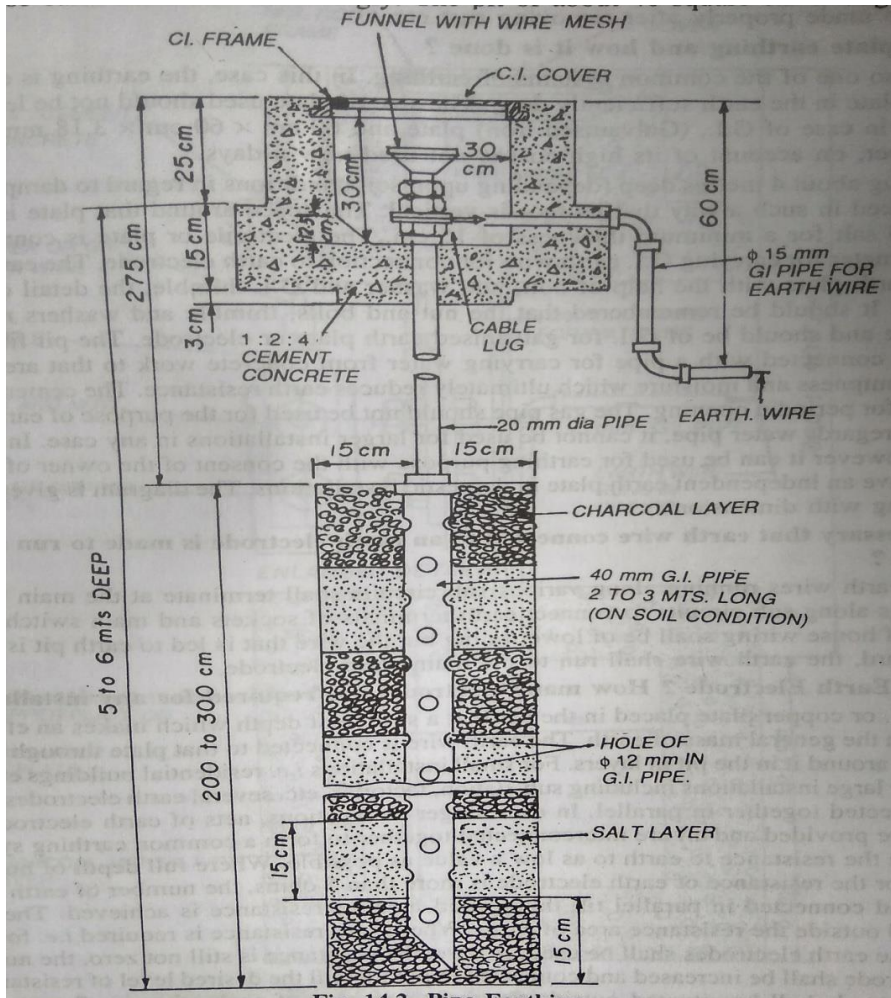
Q-1 prepare the list of materials required for a stay set & also draw neat sketch



Materialtable-

Si	Description	specification	Quantity
01	Anchorplate	(45*45*6.0)cmM.S type	01no
02	Stay rod	M.Stype16mmdia, 2.42mlng	01nos
03	Staybow	M.Stype12mmdia	01nos
04	Staywire	7/8SWG ,G.I	7.5m
05	Stayisolator	Porcelientype	01no
06	Stayclamporpole clamp	--	01no
07	Nut bolt	16mmdia,	02nos
08	Staythimble	M.S type	02nos
09	Sundriestocompletethewholejob	-----	Asper required

Q-2-prepare the list of materials required for pipe earthing and also draw the neat sketch



Material table

Sino	Description	specification	Quantity
01	G.I pipe	38mmdia,2.5mlong	01no
02	G.I pipe for watering	19mmdia,1.5mlong	01no
03	G.I pipe	13mmdia,4.5m long	01no
04	G.I wire	6SWG	12m
05	G.I lugs	G.I type	02nos
06	G.I nut bolt	10mmdia,16mmdia	04nos
07	G.I bends	13mmdia	02nos
08	Cast iron frame	30cm*30cm	01no
09	Cast iron cover	30cm*30 cm	01no
10	Funnel	-	01no
11	Channel	-	10kg
12	Common salt	-	10kg
13	Sundry to complete the whole job	-	As per required

Problem-04-

Prepare an estimate for high tension line for a distance of 5km using ACSR conductor to transmit 400kw load at 0.85 p.f. in 3-phase 11kv line, the span is 100m, and also draw the neat sketch.

Solution:- (1) Calculation for no. of poles:- Total

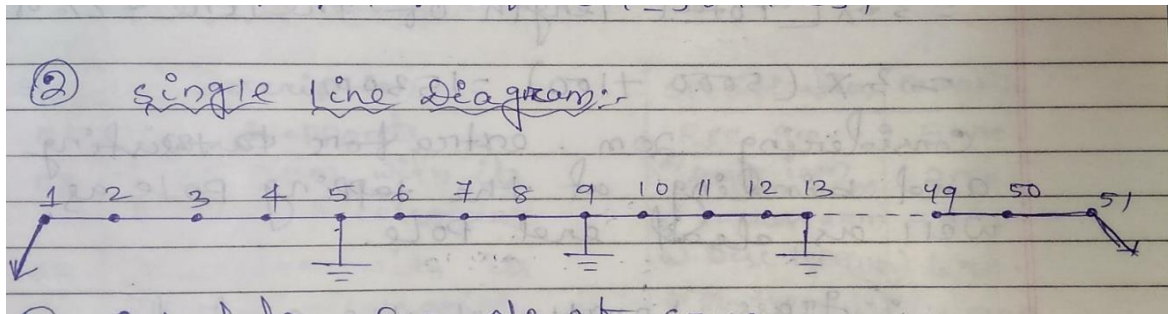
length of line = 5km = 5000m

Given that span length = 100m

No. of span = $5000/100 = 50$

No. of poles required = $50 + 1 = 51$

(2) single linediagram:-



(3) calculation for no. of cross arms;-

according to single line diagram let us select angle iron cross arm at the tapping pole as well as dead end pole and rest of the intermediate poles we select 'v' cross arm.

Hence,

$$\text{Total no. of angle iron cross arm required} = 2 \text{ no.}$$

$$\text{Total no. of v cross arm required} = 49 \text{ no.}$$

Calculation length for no. of insulator :-

According to the above line diagram strain insulators are used at the tapping pole as well as dead end pole. 11kv pin insulator are used in rest of the intermediate poles.

Hence,

$$\text{No. of disc insulator required} = 3 + 3 = 6$$

$$\text{No. of 11kv pin insulator required} = 49 \times 3 = 147 \text{ no.}$$

Calculation length of overhead conductor:-

$$\text{Net length of conductor required} = 3 \times [\text{total length of the line} + 2\% \text{ of sag}]$$

$$= 3 \times (5000 + 100) = 1530 \text{ m}$$

Considering 20m extra for twisting and binding at the tapping pole as well as dead end pole.

$$\text{Grass length of the conductor} = 15300 + 20 = 15320 \text{ m}$$

Select ion of over head conductor :-

Here, given that

$$P = 400 \text{ kW} = 400 \times 10^3 \text{ W}$$

$$\cos \phi = 0.85$$

$$V_L = 11 \text{ kV} = 11 \times 10^3 \text{ V}$$

We know that,

$$P = \sqrt{3} V_L I_L \cos \phi$$

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

$$= \frac{400 \times 10^3}{\sqrt{3} \times 11 \times 10^3 \times 0.85} = 24.69 \text{ A}$$

Full load current, $I_{FL} = 24.69 \text{ A}$

Short-circuit current, $I_{SC} = 1.5 \times I_{FL}$

$$= 1.5 \times 24.69$$

$$= 37.035 \text{ A}$$

According to the S.C. current from the conductor table we should select 6/1×2.11 Squirrel type ACSR conductor.

Material table:-

Sino	Description	Specification	Quantity
01	Supports	RCC 9m	51 nos
02	Cross arm with its fitting accessories	a) angle iron cross arm b) V-cross arm	02 nos 49 nos
03	Insulator with its fitting accessories	a) disc type (11 kv) b) pin type (1 kv)	06 nos 147 nos
04	Overhead conductor	ACSR 6/1×2.11 squirrel type	15320 m
05	Earthing with its fitting accessories	For 11 kv	10 sets
06	Stay set with its fitting accessories	For 11 kv line	02 set
07	Binding wire at the rate 100 gm per pin insulator	Alluminium type songle core	100*147 =14.7 kg
08	Anti climbing wire at the rate 3 m per pole	G. itype	51*3=153 m
09	Danger plate	11 kv	51 nos
10	Sundries to complete the whole job	--	As per required

Problem-05:-

An overhead 11kv, 50 Hz, 3-dline is betapped up for the existing 11kv line pole at about 90° angle. the purposed line has to be erected on 10m long RCC poles with ACSR conductor of size $6/1 \times 2.11$ mm with average span of 100m line will have to pass through the city axis about $\frac{1}{2}$ km long make a list of materials required for 3.2 km long.

Solⁿ:- (i) calculation for no. of poles:-

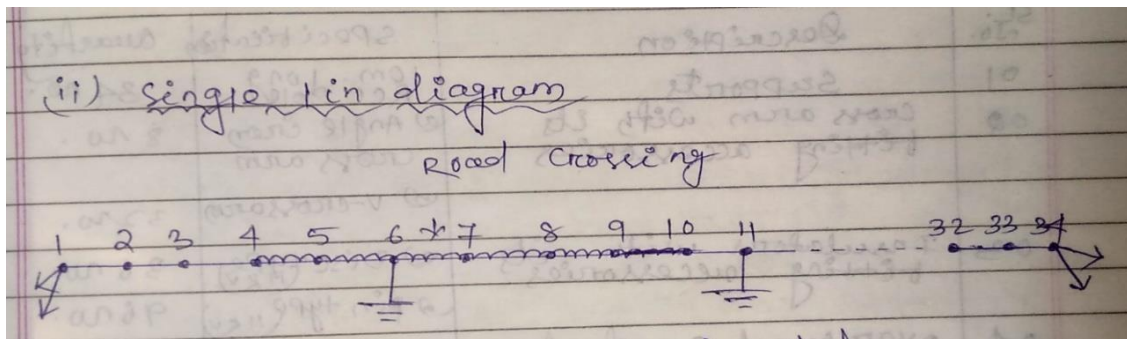
Total length of line 3.2km = 3200m. given that span length = 100m. no. of span = $3200/100 = 32$ no.

No. of pole required $32 + 1 = 33$ no.

Line will have to pass through the city areas or road crossing are there in this line so more pole required for this purpose.

Total pole required $33 + 1 = 34$ no.

(ii) single line diagram:-



(iii) calculation for no of insulators:-

According to line diagram 11kv strain insulator or disc insulator are used at the tapping pole as well as dead end pole and 11kv pin insulator are used in rest of intermediate pole.

No. of 11kv disc insulator required

$$3 + 3 + 30 = 36 \text{ no.}$$

No. of 11kv pin insulator required = 96 no.

Calculation length of overhead conductor:- Net

length of conductor required

$$= 3 \times [\text{total length of the line} + 2\% \text{ for sag}]$$

$$= 3 \times [3200 + 64] = 9792 \text{m.}$$

Considering 50m extra for twisting and binding at the tapping pole as well as dead end pole. Gross

length of the conductor

$$9792 + 50 = 9842 \text{m.}$$

Material table:-

Si no	Description	specification	Quantity
01	Supports	10m-long RCC pole	34 nos
02	Cross arm with its fitting accessories	a) angle iron cross arm b) V-CROSS ARM	8 nos 32 nos
03	Insulator with its fitting accessories	a) Disc type (11kv) b) pin type (11kv)	36 nos 96 nos
04	Overhead conductor	ACSR, 6/1 × 2.11mm	9842m
05	Earthing with its fitting accessories	For 11kv	5 sets
06	Stay set with its fitting accessories	For 11kv line	4 sets
07	Guard wire	14SWG G.I	500m
08	Binding wire at the rate log per pin insulator	Aluminium type single core	100 * 96 = 9.6 kg
09	Anti climbing wire at the rate 3m per pole	G.I type	3 * 34 = 102m
10	Danger plate	11kv	34 nos
11	Sundry to complete the whole job	----	As per required

overhead installation(L.T)

Problem:-1

A 1km long overhead distribution line of 415V, 50Hz is to be erected along a straight road from 100kV A 11/0.4 KV pole mounting substation, the line is to be laid with 6/1×3.00mm ACSR conductor with 9m RCC pole. make a list of materials required and assume span length is 50m and also draw a rough sketch of this line.

Solution:- calculation for no. of poles :-

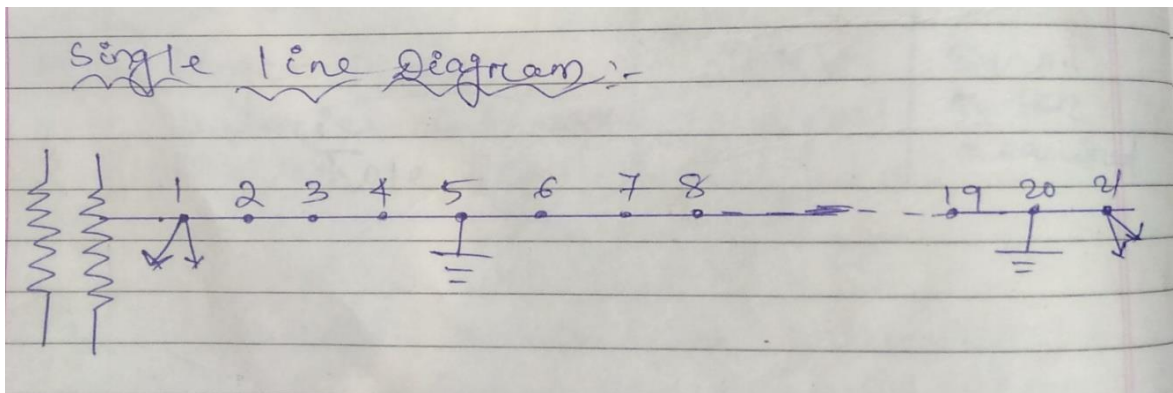
Total length of line 1km=1000m.

Given that span length=50m

No. of span= $1000/50=20$ no.

No. of poles required= $20+1=21$ no.

Single line diagram:-



Calculation for no. of cross arm:-

According to the above single line diagram let us angle iron cross arm in each pole and one more cross arm required for tapping the line from the substation.

Hence, total no. of cross arm required $21+1=22$

Calculation of no. of insulators :-

According to the single line diagram let us select shackle insulator at the tapping pole as well as dead end and rest of the intermediate poles we should select 440V pin type insulator.

Hence, no. of shackle insulators required = 4 + 4 = 8 no.

Total no. of pin insulator required = 20 × 4 = 80 no.

Calculation for length of overhead conductor :- Net,

length of the conductor

= 4 × [total length of the line + 2% for sag]

= 4 [1000 + 20] = 4080 m.

Considering 20 m. extra for twisting and cutting and binding at the tapping pole as well as dead end pole,

Hence, gross length of the conductor = 4080 + 20 = 4100 m.

Material table :-

Sino	Description	specification	Quantity
01	Supports	RCC, 9m	21 nos
02	Cross arm with its fitting accessories	Angle iron cross arm	22 nos
03	Insulator with its fitting accessories	Shackle insulator Pin type insulator	08 nos 08 nos
04	Overhead conductor	ACSR, 6.1 × 3.00 mm long	4100 m
05	Stay with its fitting accessories	For 440V lines	4 sets
06	Earthing with its fitting accessories	For 440V	4 sets
07	Binding wire at the rate 100 gm/pin insulator	Alluminium single core	8 kg
08	Anti climbing wire at the rate 3 m/pole	G.I type	3 × 21 = 63 m
09	Danger plate	440V	21 nos
10	L.T cable	Pvc insulated aluminium core	3 m
11	Sundry to complete whole job	-----	As per required

Problem-2

An overhead distribution line of 415 V, 3-d, 50Hz is to be erected along a straight road. The length of the line is 300m and the end supports are terminal structures, the span is 50m. Make a sketch of the terminal showing the disposition of the conductor on the line as follows.

- (i) phase wire: - hard drawn bare copper wire no. of 4SWG.
- (ii) neutral & street light hard drawn bare copper conductor number for 8SWG.

Prepare the list of material required for this purpose.

Solution:- calculation number of supports:-

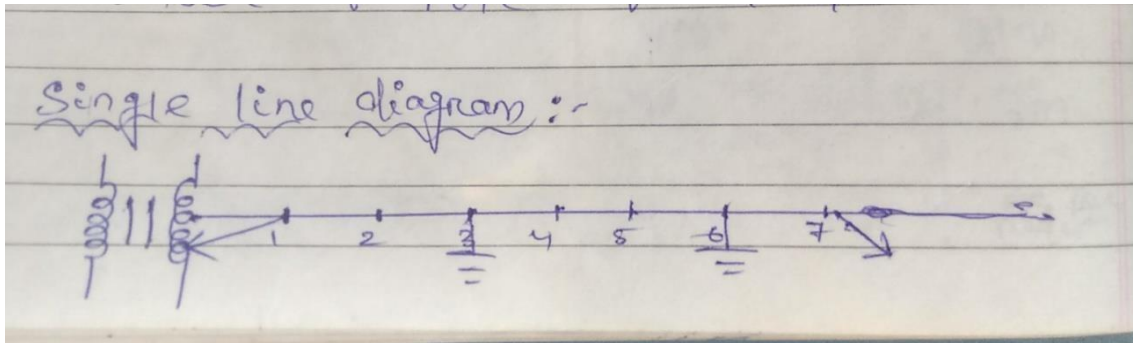
The total length of the line = 300m

Here span length = 50m

Number of span = $300/50 = 6$ no.

Number of poles required = 7 no.

Single line diagram:-



Calculation for no. of cross arm:-

According to single line diagram we should select angle iron cross arm in each pole and one more cross arm required for tapping the line from the substation.

Hence, total number of cross arm required = $7 + 1 = 8$ no.

Calculation for no. of insulator:-

According to the question three shackle insulators are required for 3-phase and two shackle insulators required for street light and neutral for one pole .

Hence total no. of insulator required $8 \times 5 = 40$ no.

Calculation for length of phase wire:-

Let length of the phase wire = $3 \times (\text{declared length} + 2\% \text{ for sag})$

$$= 3 \times (300 + 6)$$

$$= 918 \text{ m}$$

Considering 15 m extra for twisting & cutting Gross

length = $918 + 15 = 933$ m.

Calculation for length of neutral & street wire

Length = $2 \times [\text{declared length} + 2\% \text{ for sag}]$

$$= 2 \times [300 + 6] = 612 \text{ m.}$$

Material table:-

Sino	Description	specification	Quantity
01	Supports	RCC, 9m	7 nos
02	Cross arms with its fitting accessories	Angle iron cross arm	8 nos
03	Insulator with its fitting accessories	Shackle insulator	40 nos
04	Overhead conductor (phase wire)	ACSR 6.1 × 2.00 mm	933 m
05	Overhead conductor (neutral & street wire)	ACSR 6.1 × 3.00 mm	612 m
06	Stay set with its fitting accessories	440 v line	4 sets
07	Earthing with its fitting accessories	440 v line	4 sets
08	Binding wire at the rate 100 gm/shackle insulator	Aluminium type single core	$100 \times 40 = 4000 \text{ gm}$ $= 4 \text{ kg}$
09	Anti climbing wire at the rate 3 m/pole	G.I type	$3 \times 7 = 21 \text{ nos}$
10	Danger plate	440 v	7 nos
11	L.T cable	Pvc insulated 4 core aluminium type	3 m
12	Sundries to complete the whole job	-----	As per required

Shortquestion

- (1) WritethevarioustypesofcrossarmwhichareusedinLTaswellasHT.distribution?
Ans:-thevarioustypesofcrossarmusingLT&HTdistributionareangleironcrossarm& v-cross arm .
- (2) Whatistheformulausedforspacingofthe conductor ?
Ans:-theformulausedforspacingoftheconductoris= $\sqrt{S \times V / 150}$ Where ,
s=sag of the conductor
V=linevoltage,v
- (3) Whatisthespecificationofstaywire?
Ans:-thespecificationofstaywireis7/8SWG.I.type.
- (4) WritethevarioustypeofinsulatorswhichareusedinL.T.aswellasA.T.distribution.
ans:-the varioustypeofinsulatorswhichareusedin L.T.aswellasH.T.distributionaredisc insulator, pin , shackle & egg insulators .
- (5) whatisverticalclearanceofthe conductoralongthestreetandacross thestreets for supplying 11kv voltage ?
ans:-theverticalclearanceoftheconductoralongthestreetis5.5mandacrossthestreetis 5.8mforsupply11kvvoltage.
- (6) whichtypeofinsulatorsusedinstay?
ans :- egg insulator used in stay
- (7) howmanydiscinsulatorsrequiredinH.T.lineforsupplyvoltage33kv ans:-
6no.discinsulatorrequiredinH.T.lineforsupplyvoltage33kv.
- (8) whatislighting arrester&whereitused?
Ans:-itisthedeviceswhichprotectsalltheelectrical equipment fordamageduetosurge voltage of lightning .
- alltheoverheadconductorarealsoconnected lightingarresteratthesubstationandgrid etc.

long questions—

Q-1) Estimate the material required for the construction of 1 km of 11kv OH line .the line is tapped from the exiting 11kv OH line.Assume thatthe line ispassing over the main road ,trolley wayline,& rout way line.

discussaboutthetypesofinsulatorusedinohl'ine

Drawtheneat sketchofastayset&alsopreparethelistofmaterialrequired

Q.4 estimate the materials required for 3-phase ,4 wires O.H distribution line of 2km length connected loadis60kw,at400 vdistributedalongtherouteof theline.drawaneatsketchofone spanof theline showing various components

CH-6

ESTIMATE FOR DISTRIBUTION SUBSTATION

In general practice substations are of different types depending on their nature of duties, service operating voltage and its design.

Depending on the design substations can be classified into two types.

(i) indoor substation

(ii) outdoor substation

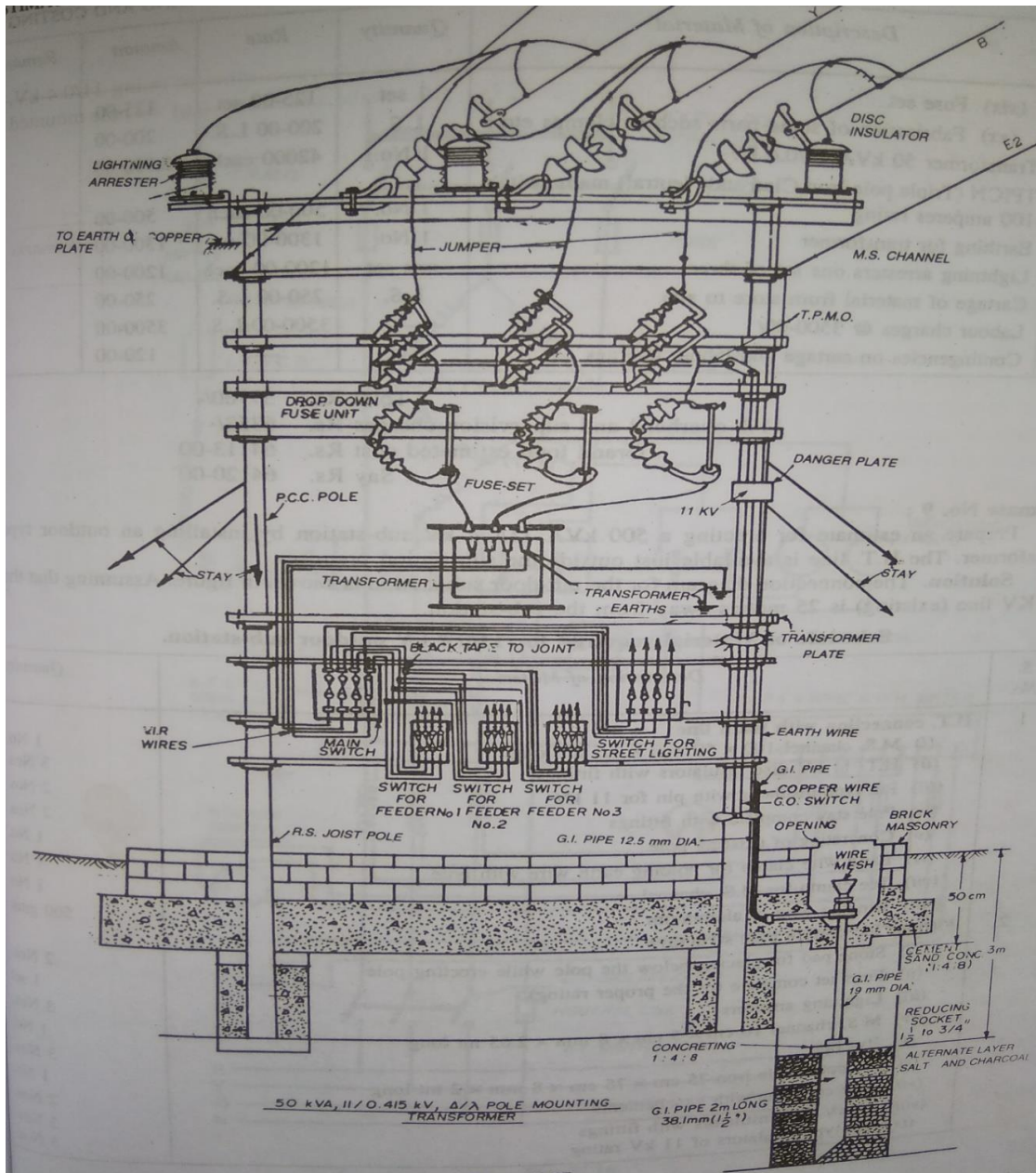
Again outdoor substation can be divided into two categories.

(i) pole mounting substation which is feasible up to 125 KVA or sometimes 250 KVA.

(ii) plinth mounting substation which is feasible up to more than 250 KVA T/F.

Problem:-1

Draw the neat sketch of a 63KVA, 50Hz 11/0.4KV substation and prepare the list of materials required for this purpose.



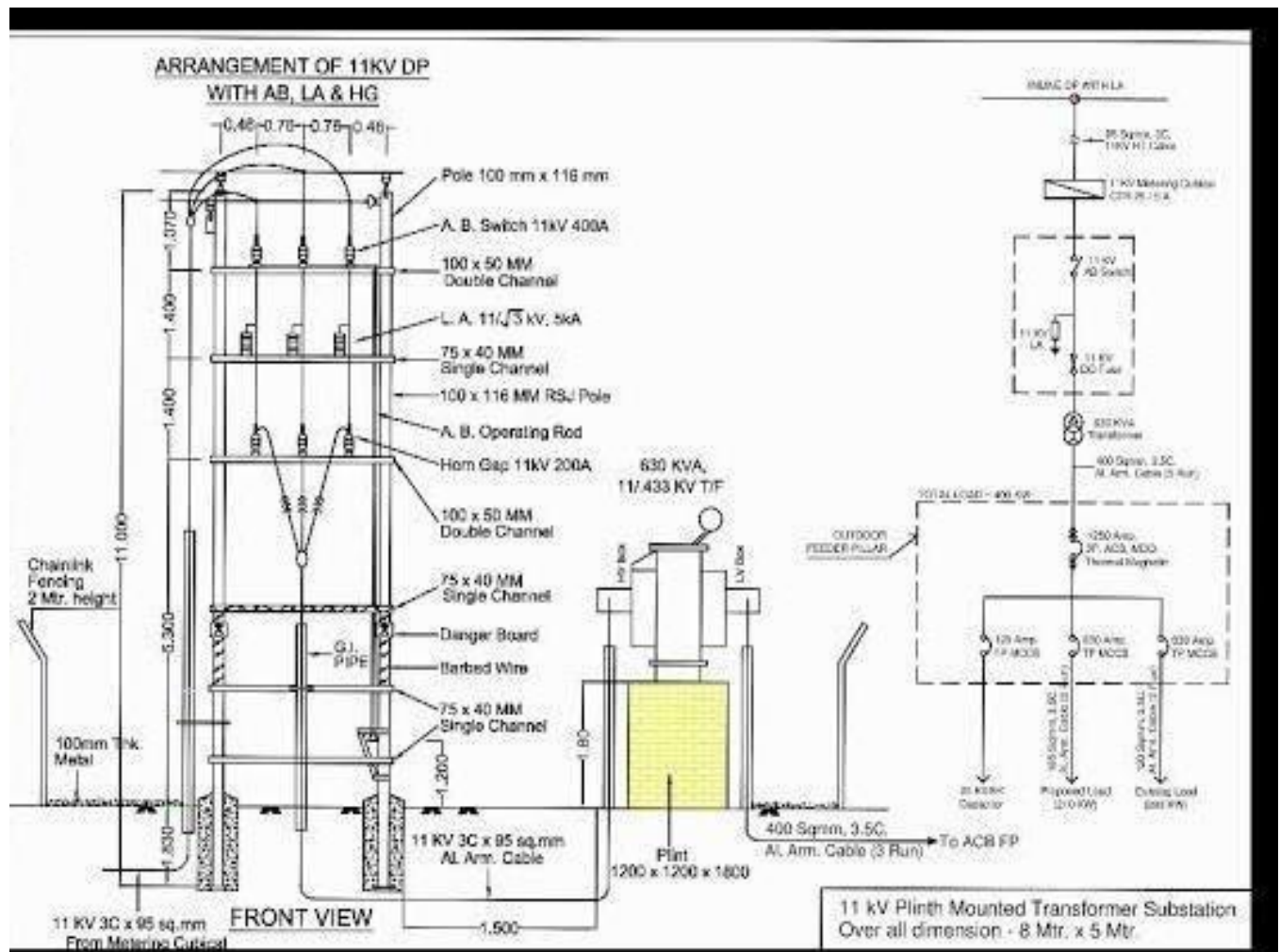
Material table-

Sino	Description	specification	Quantity
A -For H.T. arrangement			
01	Supports	RCC, 1m	2 nos.
02	Cross arms with its fitting accessories	M. Stype, 100mm×50mm×7.5mm×2m	2 nos.
03	Insulators with its fitting accessories	Disc insulator	3 nos.
04	Stay with its fitting accessories	For H.T.	2 sets
05	Lighting arrester with its fitting accessories	For 11kv	3 nos.
06	Earthing with its fitting accessories	For 11kv, pipe earthing	1 sets
B-For A.B switch arrangement			
07	Cross arms with its fitting accessories	100mm×50mm×7.5mm×2m	2 nos.
08	Angle iron cross arm to fixed the pin insulators with its fitting accessories	M.S. type 100mm×50mm×7.5mm×0.75m	3 nos.
09	Insulators with its fitting accessories	For 11kv, pin type	06 nos.
10	A.B switch or ganged operated air breaker switch with 6m long G.I pipe along with its handle locking arrangement	For 11kv	1 set
c Drop-out arrangement			
11	Cross arm with its fitting accessories	M.S. type, 100mm×50mm×7.5mm×2m	02 no
12	Angle iron cross arm to support the insulators with its fitting accessories	M.S. type, 100mm×50mm×7.5mm×0.75m	03 nos.
13	Insulators with its fitting accessories	Pin type, 11kv	6 no.
14	Arcing rod to be installed on the pin type insulator to support the explosion type fuse wire	For 11kv	6 nos.
15	Explosion type fuse wire	For 11kv	1.5m
D- Transformer installation			
16	Cross arms with its fitting accessories	M.S., 100mm×50mm×7.5mm×2m	02 nos.
17	Angle iron cross arm to be used for base plate	M.S. type, 100mm×50mm×7.5mm×0.75m	02 nos.
18	M.S. channel cross arm to support the T/F	M.S. type 100mm×50mm×7.5mm×0.75m	02 nos.
19	Transformer	63kVA, 11/0.4kv	01 no.
20	Earthing with its fitting accessories	Pipe earthing	2 sets.
21	L.T. cable	4 core aluminium type pvc insulation	3m
22	L.T. cable	ICTPN, 1100 grad with rewirable 3-unit	01 no.
23	Energy meter	3-phased digital type	01 no.
24	Anti climbing wire	G.I type	6m.
25	Danger plate	11kv	02 nos

26	JumperconductorfromHParrangement upto transformer installation	AcSRconductor	25m
27	Bindingwireattherate100gm/pin insulator	Aluminiumtypesinglecore	1.2 kg
28	Sundriestocompletethewholejob	-----	As per required

Problem:-2

Preparethelistofmaterialsrequiredforplinthmountingsubstationof 11/0.4kv,50hz,3-phase,250kva T/F .



Materialtable-

Sino	Description	specification	Quantity
A-H.Tarrangement			
01	Supportsatthesubstation	Railpole,12m	2nos
02	Angleironcrossarmatthetapping pole	100mm×50mm×7.5mm×1m	1nos
03	Disctypeinsulatoratthetapping pole with its fitting accessories	Disctypefor11kv	6nos
04	Angleironcrossarmwithitsfitting accessories at the substation	M.Stype,100mm×50mm ×7.5mm×0.75m	3nos
05	Lightingarrestorwithfitting accessories	For11kv	3nos
06	Earthingwithitsfitting accessories	For11kv	3 sets
07	Staywithitsfittingaccessories	ForH.T line	3sets
08	Overheadconductor	ACSR6/1×4.50	159m
B -ABswitcharrangement			
09	Crossarmwithitsfittingaccessories	M.Stype100mm×50mm ×7.5mm×2m	2nos
10	Angleironcrossarmtosupportthe pin insulator	M.Stype100mm×50mm ×7.5mm×0.75m	3nos
11	Insulatorswithitsfitting accessories	Pintype11kv	6nos
12	GOABswithwith6mlongG.Ipipe along with handle locking arrangmen	For11/0.4kv substation	1set
C -dropoutarrangement			
13	Crossarmwithitsfittingaccessories	M.Stype100mm×50mm ×7.5mm×2m	2nos
14	Angleironcrossarewithitsfitting accessories	M.Stype100mm×50mm ×7.5mm×0.75m	3nos
15	Insulatorswithitsfitting accessories	Pintype11kv	6nos
16	Arcingrodtobefittingtopofthe insulator	for11kv	6nos
17	Explosiotypefusewire	For11kv	1m
D -Transfomerinstallation			
18	Angleironcrossarmatthe base plateoftheT/Fwhichisfixedin the plinth	M.Stype100mm×50mm ×7.5mm×0.75m	2nos
19	Transformer	250kva,11/0.4kv	1no
20	L.Tcable	4corealuminiumtypepvcinsulate d	5m
21	Energymeter	Digitaltype3-phase	1no
22	L.Tcablebox	ICTPNwithrewirabletype fuse unit	1no
23	Earthingwithitsfittingaccessories	Pipeearhing	2 sets

24	Jumperconductor	ACSR6/11×4.50mm	30m
25	Dangerplate	For11kv	3nos
26	Anticlimbing wire	G.I type	6m
27	Plinth	Cementconcrete	1:4:8
28	Sundriestocompletethewholejob	-----	As per required

SHORTQUESTIONS

(1) whatisthemaximumrating ofthetransformerwhichisinstalledinpolemounting substation?

Ans:-generallyinpolemountingsubstationupto250KVAtransformerisinstalled.

(2) whatisGOABswitchandwhereitis used?

Ans:-GOABstandsforangeoperatedairbreakerswitchanditisusedtomakeand breakthe existing line manually.

---itisusedindistributionsubstationandintermediatelineoftheH.T.distribution.

(3) whatisTPMOswitchwhereandwhyitis used?

Ans:-TPMOstands for triplepolemanuallyoperatedswitchanditisusedindistribution substation as well as mid way of the H.T. line.

-itisusedtomakeandbreaktheexistinglinemanually.

(4) whatisTPIC switch?

Ans:-TPICmeanstriplepoleironcladmainswitch. GenerallyitisusedinD.C. distribution.

(5) whatisTPICNswitchandwhereitis used?

Ans:-TPICNstandsfortriplepoleironcladwithneutrallink.Itisusedin3-phasedistribution main switch.

(6) whatisABswitchandwhyitisused?

Ans:-ABstandsforairbreakerswitchitisusedindistributionsubstationas wellasinthemid way of the H.T. lines

- Itisusedtomakeandbreak theexisting.

LONG QUESTION :-

varioustypeofproblemsbasedonpolemount

- (1) Draw the single line diagram of 33/11 kV substation.
- (2) Draw the single line diagram of 11/0.4 kV substation

CH-5

OVERHEAD SERVICE CONNECTION (1- ϕ & 3- ϕ)

The overhead line or cable or underground cable connected between supplied line and consumer premises is called as service line or connection.

Generally service connections are of two types

- (1) single phase service connection
- (2) 3-phase service connection

Depending on the field situation the service connections are of two types

- (1) overhead service connection
- (2) underground service connection

Important points to be remembered:-

- If the service pole is situated more than 45 m from the consumer's premises then overhead line may be used pole brackets.

- If consumer's premises is more than 50 m from the service pole then one intermediate pole may be used

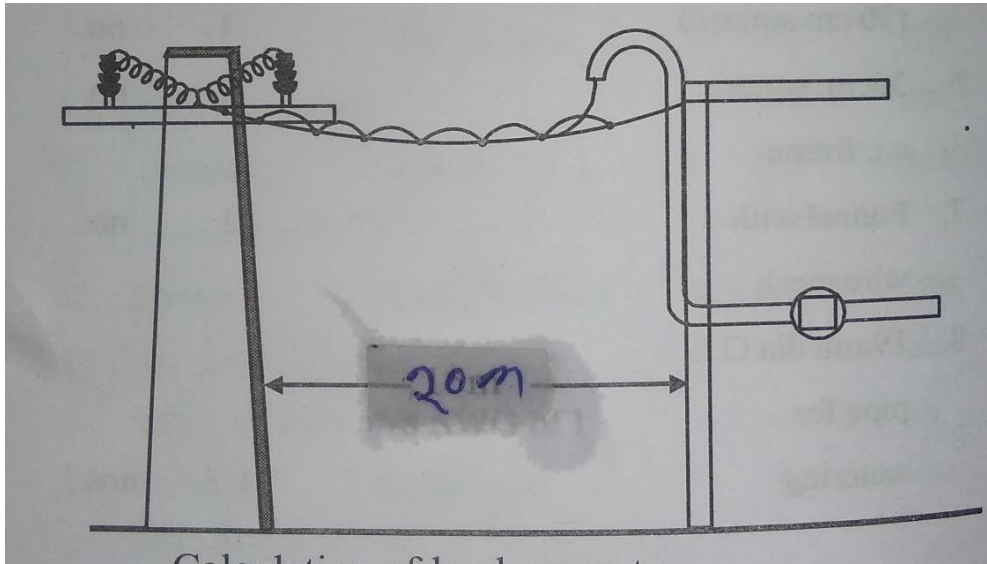
If the consumer's load does not exceed 1 kW then 10 SWG hard drawn copper conductors may be used.

If the consumer's load does not exceed 2.5 kW then 8 SWG copper conductor or 13.9 mm² aluminium conductor may be used.

Problem-1-

Prepare a list of materials required for providing a service connection to a single-staired building at 240 V 1-phase, 50 Hz a light & fan load of 5 kW. The supply is to be given from an overhead line 20 m away from the building

Solution-



Calculation for short circuit current---

Given that

$$P = 5 \text{ kw} = 5000 \text{ w}$$

$$V = 240 \text{ v}$$

$$F = 50 \text{ hz}$$

We know that

$$P = VI \cos \phi$$

$$I = \frac{P}{V \cos \phi} = \frac{5000}{(240 * 1)} = 20.83 = 21 \text{ A}$$

So full load current = 21 A

So short circuit current = 1.5 × full load current

$$= 1.5 \times 21$$

$$= 31.5 \text{ A}$$

Selection of cable---

Through hours current is 31.5A but from the conductor table it is observed that for a current rating of 34A pvc insulated twin core aluminium conductor of 10mm², 240V, whether proof is to be selected.

Calculation for length of cable—

Net length = declared length + 2% for sag + 1m coil at the pole + 1.5 m from coil to the overhead conductor + 1m coil at the service pipe + 3m along the pipe + 0.3m for wall thickness + 0.5m for meter clearance

$$\begin{aligned} \text{Net length} &= 20 + 0.4 + 1 + 1.5 + 1 + 3 + 0.3 + 0.5 \\ &= 27.7\text{m} \end{aligned}$$

Considering 10% extra for twisting cutting,

$$\text{gross length} = 27.7 + 2.7 = 30.4\text{m}$$

Calculation for length of G.I wire—

$$\begin{aligned} \text{Net length} &= \text{declared length} + 2\% \text{ for sag} + 1\text{m at the pole} + 0.5\text{ at the service pipe} \\ &= 2.0 + 0.4 + 1 + 0.5 = 22\text{m} \end{aligned}$$

Calculation for length of alluminium clip----

Let us assume the length of G.I alluminium clip = 10cm Spacing of

clip = 20 cm

Length of the conductor = 20m

$$= 20 \times 100$$

$$= 2000\text{cm}$$

No. of clip required = 2000/20 = 100 nos

Length of clip wire = 100 × 10 = 1000cm = 10m

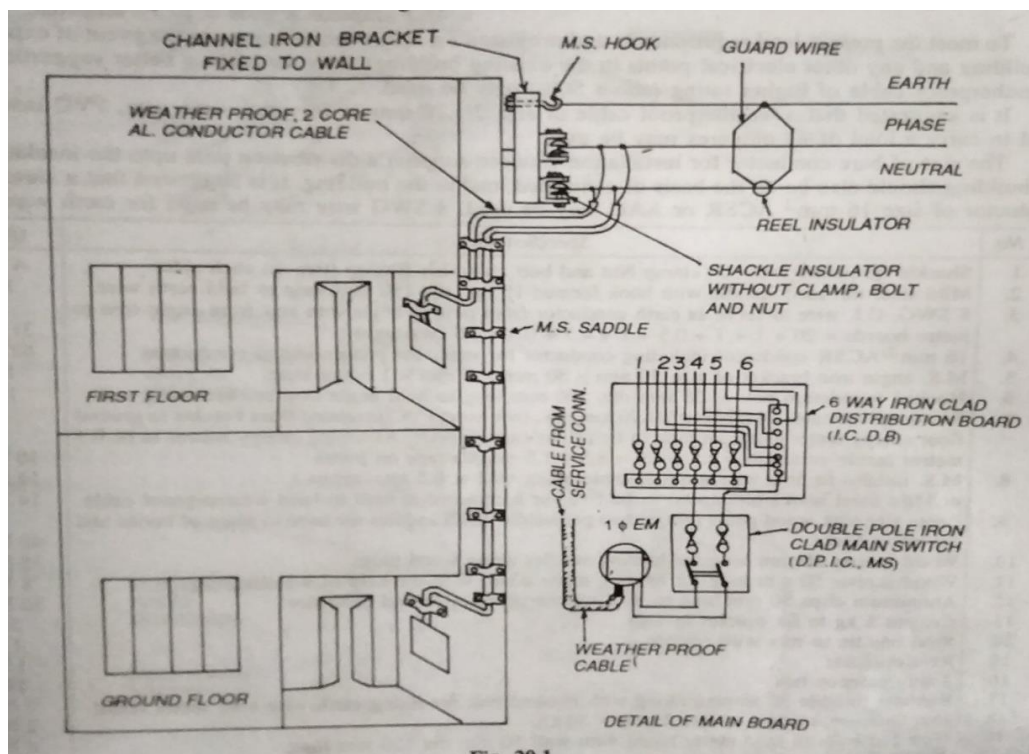
Sino	Description	specification	Quantity
01	Support wire	G.I type, 14SWG	22m
02	Cable	Pvc insulated twin core alluminium conductor 10mm ² weather proof	30.4m
03	Support wire clips	Alluminium type, 38mm	10m
04	Service pipe	G.I type, 50mm dia, 2m height	01 no

05	Clampstosupportstheservicepipe along with it's fitting accessories	G.Itypewithappropriate diameter	03nos
06	Energymeter	240v,1- ϕ digitaltype	01 no
07	Boardtofixtheenergymeterwithit's fittingaccessories	45cm \times 60cm,ironcladwith bakelight cover	01no
08	Sundriestocompletethewholejob	----	As per required

Problem-2-

Estimate the quantity of materials required to providingconnection to a double storeyed 'buildingwithaloadof4kw at240v ,50 hz ,separate meteraretobeprovidedfor thetwo floors.the distance between pole & building is 12m& between the service bracket ' & service board is 10 m

Solution-



Calculation for short circuit current'-

Given that ,

$$P = 4 \text{ kw} = 4000 \text{ w}$$

$$V = 240 \text{ v}$$

$$f = 50 \text{ hz}$$

we that

$$p = v \cos \phi$$

$$\text{so } i = p / v \cos \phi$$

$$= 4000 / (240 * 1)$$

$$= 16.67 \text{ (full load)}$$

$$\text{Short circuit current} = 1.5 * \text{full load current}$$

$$= 1.5 * 16.67$$

$$= 25.05 \text{ A}$$

Selection of cable—

Though our short circuit current is 25.05 A but from the conductor table, it is observed that for a current rating of 27 A pvc insulated twin core aluminium conductor of 6mm² 240v weather 'proof' is to be selected.

Calculation for length of cable-

$$\text{Net length} = \text{declared length} + 1 \text{ m coil at the pole} + 1.5 \text{ from coil to the overhead conductor} + 0.3 \text{ for wall thickness} + 0.5 \text{ meter clearance}$$

$$= 12 + 1 + 1.5 + 0.3 + 0.5$$

$$= 15.3 \text{ m}$$

Calculation for length of overhead conductor—

Net length = $2(\text{declared length} + \text{excess of height from the pole top} + 2\% \text{ for sag})$

$$= 2 * (12 + 6.5 + 0.24)$$

$$= 37.48 \text{ m}$$

Considering 10% extra for twisting & cutting So

$$\text{gross length} = 37.48 + 3.748 = 41.228 \text{ m}$$

Calculation for no of G.I clamps —

Assuming the installation G.I clamps at an interval of 1m along the angle iron & wall surface. Hence no of clamps required = 11

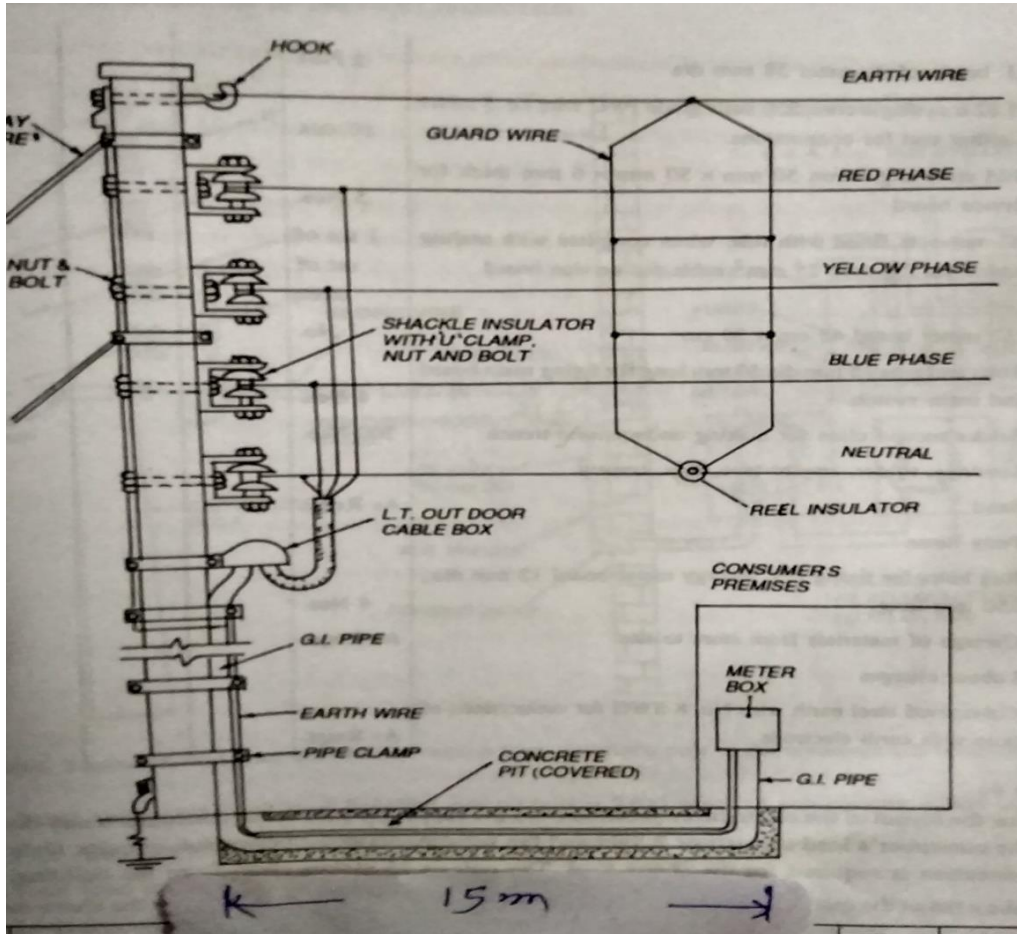
Sino	Description	specification	Quantity
01	Angle iron at the bracket with its fitting accessories	M.Stype, 50mm x 50mm x 6mm x 10m long	1no
02	Cross arm with its fitting accessories	M.Stype, 50mm x 50mm x 6mm x 0.75m long	01no
03	Insulators with its fitting accessories	Pintype, ' 440	02nos.
04	Overhead conductor	AAC	41.228m
05	Cable	pvc insulated twin core aluminium conductor, 6mm ² weatherproof	15.3m
06	Clamp to hold the cable on the wall with its fitting accessories	G.I.type	11nos.
07	Energymeter	240v, 1- ϕ , digital type	02nos.
08	Board to fix the energymeter with its fitting accessories	45cm x 60cm, IC type with bakelite	02nos.
09	Flexible conduit	Appropriated dimension	01m.
10	Sundry to complete the whole job	-----	As per required

Problem-3

:- a firm is required to connect a three phase 37kw, 415v, 50hz motor to a 3- ϕ 4 wire, '415v/ 240v, 50hz over head line. The distance of the service line from the firm structure having 15m. the motor has an efficiency of 85% and power factor of 0.8 estimate the quantity of materials required for this purpose.

Solution:-

The neat sketch of service connection is shown below.



Calculation of short circuit current-

Output power of the motor (p_{out}) = 37 kW = 37000 W

know that

Given efficiency = 85% = 0.85

Efficiency = $\frac{\text{output power}}{\text{input power}}$

So, input power = $\frac{\text{output power}}{\text{efficiency}}$

$$= \frac{37000}{0.85}$$

$$=43529.41\text{w}$$

$$=43.5\text{kw}$$

$$\text{But, input power} = \sqrt{3} v \cos \phi$$

$$\text{So, } i = \text{input power} / \sqrt{3}$$

$$v \cos \phi = 4352.42 / (\sqrt{3} * 415 * 0.$$

8)

$$=75.69\text{A}$$

$$\text{So short circuit current} = 2 * \text{full load current}$$

$$= 2 * 75.69 = 151.38\text{A}$$

Selection cable:-

From the conductor table it is observed that for a current rating of 158A, 50mm² paper insulated, 1100v grade 4 core aluminium under ground cable is to be selected.

calculation for length of cable:-

net length = 2m from the overhead conductor + 5.5m along the core up to ground + 0.2m trench depth + 15m along the trench + 0.2m trench depth + 2m meter clearance

$$= [2 + 5.5 + 0.2 + 15 + 0.2 + 2]$$

$$= 24.9$$

$$= 25\text{m}$$

Considering 10% extra for twisting & cutting Gross

$$\text{length} = 25 + 2.5 = 27.5\text{ m}$$

Calculation for no of G.I clamps'—

Assuming the distance between two clamps to be 1m, as per diagram we need 6 nos of clamps.

Material table-

Sino	Description	specification	Quantity
01	Cable	4 core aluminium type, 1100v grade, 50mm ² paper insulated	27.5m
02	'clamps to hold the cables with its fitting accessories	G.I type appropriate dimension	6 nos.

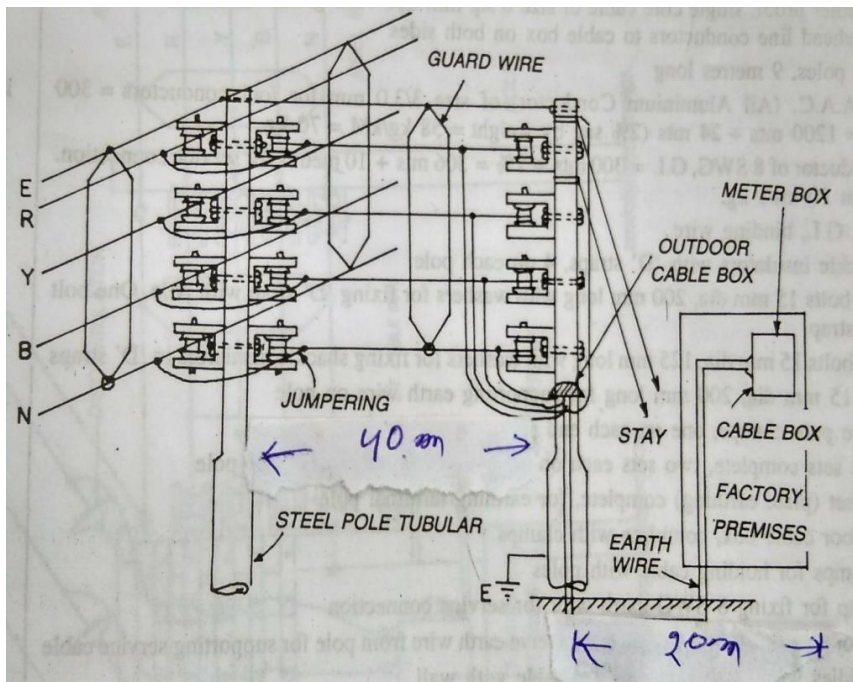
03	L.T.cablebox	TIPCN,withwirabletypefuse unit	01 no.
04	Energymeter	3- ϕ ,digitaltype	01no.
05	Boardtofixtheenergymeter	45cm \times 60cmironcladewith backelitecover	01 no.
06	Earthingthimble	G.I.type	02nos.
07	Sundriestocompletethewholejob	-----	As per required

Problem-4

:- A factory man requires to connect a three phase 37kw, 415 v, 50hz motor to a 3- ϕ 4 wire, 415v/240v,50hz overheadline.Thedistanceof
theservicelinefromthefirmerstructurehaving60m.themotorhas anefficiencyof85% andpowerfactor
of0.8estimatethequantityofmaterialsrequired for this purpose.

Solution:-

Theneatsketchofserviceconnectionisdawnbelow.



According to the rule, if consumer premises is more than 50m from the service pole then no intermediate pole is used.

So according to question

Service pole to intermediate pole distance is 40m which is used in bare conductor according to overhead line process.

Intermediate pole to meter box distance is 15m which is used in underground insulated wire according to service line process.

Calculation for overhead line accessories - No

'of pole = 1

Cross arm - 1 + 1 = 2

No 'of shackle insulator - 4 + 4 = 8

Calculation for length of overhead conductor —

Net length of conductor = 4 (total length 'of line + 2% of sag)

$$= 4(40 + 0.2)$$

$$= 4 * (40.2)$$

$$= 80.8 = 81\text{m}$$

Calculation for service line accessories -

Calculation of short circuit current -

Output power of the motor (P_{out}) = 37kw = 37000w We

know that

Given efficiency = 85% = 0.85 Efficiency =

output power / input power

So, input 'power' = output power / efficiency

$$= 37000 / 0.85$$

$$= 43529.41\text{w}$$

$$= 43.5\text{kw}$$

$$\text{But, input power} = \sqrt{3} V \cos \phi$$

$$\text{So, } i = \text{input power} / \sqrt{3}$$

$$V \cos \phi = 4352.42 / (\sqrt{3} * 415 * 0.8)$$

$$= 75.69 \text{ A}$$

So short circuit current = 2 * full load current

$$= 2 * 75.69 = 151.38 \text{ A}$$

Selection cable:-

From the conductor table it is observed that for a current rating of 158A, 50mm² paper insulated, 1100V grade 4 core aluminium underground cable is to be selected.

Calculation for length of cable:-

net length = 2m from the overhead conductor + 5.5m along the core up to ground + 0.2m trench depth + 20m along the trench + 0.2m trench depth + 2m meter clearance

$$= [2 + 5.5 + 0.2 + 20 + 0.2 + 2]$$

$$= 29.9$$

$$= 30 \text{ m}$$

Considering 10% extra for twisting & cutting Gross

$$\text{length} = 30 + 3 = 33 \text{ m}$$

Calculation for no. of G.I clamps'—

Assuming the distance between two clamps to be 1m, as per diagram we need 6 nos of clamps.

Material table-

Sino	Description	Specification	Quantity
overhead line materials			
01	Supports	RCC, 9m	01 no
02	Cross arm with its fitting accessories	Angle iron cross arm	2 nos
03	Insulator with its fitting accessories	Shackle insulator	8 nos
04	Overhead conductor	ACSR, 6.1 x 3.00mm long	81m
05	Earthing with its fitting accessories	For 440V lines	1 set

06	Staysetwithitsfittingaccessories	For440v	1set
07	Bindingwireattherate100gmperpin insulator	Alluminiumsinglecore	As per required
08	Anticlimbingwireattherate3mper pole	G.I type	'3m
09	Dangerplate	440v	1no
UndergroundServicelinematerials			
10	Cable	4corealluminiumtype,1100v grade ,50mm ² paper insulated	33m
11	'clampstoholdthecableswithits fittingaccessories	G.Itypeappropriatedimension	6nos.
12	L.T.cablebox	TIPCN,withrewirabletypefuse unit	01 no.
13	Energymeter	3- ϕ ,digitaltype	01no.
14	Boardtofixtheenergymeter	45cm \times 60cmironcladewith backelitecover	01 no.
15	Earthingthimble	G.I.type	02nos.
16	Sundriestocompletethewholejob	-----	As per required

Shortquestion:-

(1) whythecoreofservicecableismostlyselectedasaluminium?

Ans- the core of the service cable is selected as aluminium because the over head conductor at the serviceisalsoaluminium.Hencetoavoidinterruptionofenergysupplyduetodis-similarityofmaterial contact.

(2) write the size of G.I. wire used as a support wire in service line.

Ans-generally14SWG.G.I.wireusedasasupportwireinserviceline.

(3) atwhatconditionoverheadbareconductorisusedforprovidingserviceconnection.

Ans-theoverheadbare conductorisusedfor providingtheservice connectiononlywhenthe distance between the distribution pole and consumer premises exceeds 45m.

(4) whyG.I.isusedforcarryingcableforserviceconnectionisbentbackattheupperendwith opening facing downward.

Ans-the G.I. pipe is used for carrying cable for service connection has been made bent to prevent entering of rain water into the pipe.

(5) what are the various types of service connection.'

Ans- depending on the field situations service connections are of two types. (1) overhead service connection

(2) underground service connection

depending on the voltage it is of two types

(i) single phase service connection

(ii) 3- ϕ service connection

Long question-

Q-1) Prepare a list of materials required for providing a service connection to a single storeyed building at 240 v 1-phase load of 2kw. The supply is to be given from an overhead line 20 m away from the building. draw the sketch

2) Prepare a list of materials required for providing a service connection to a single storeyed building at 240 v 1-phase, 50hz a light & fan load of 5kw. The supply is to be given from an overhead line 20 m away from the building

3) Estimate the quantity of materials required to providing connection to a double storeyed 'building with a load of 4kw at 240 v, 50 hz, separate meters are to be provided for the two floors. the distance between pole & building is 12 m & between the service bracket & service board is 10 m

Chapter-2

ELECTRICAL INSTALLATION

Wiring system:- it is defined as a network of wires connecting with various electrical loads from supplier meter boards through the safety and controlling device.

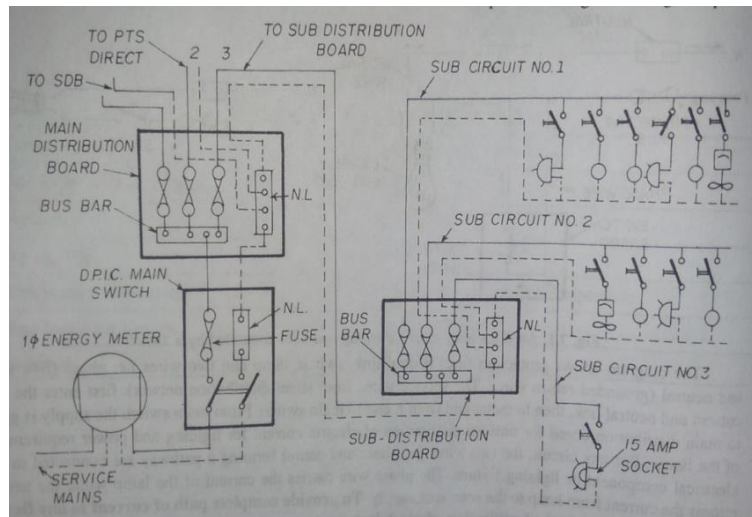
Various systems adopted for distributing electrical energy:-

In our country basically following two types of systems are adopted for distributing electrical energy.

(i) distribution board system

(ii) tree system

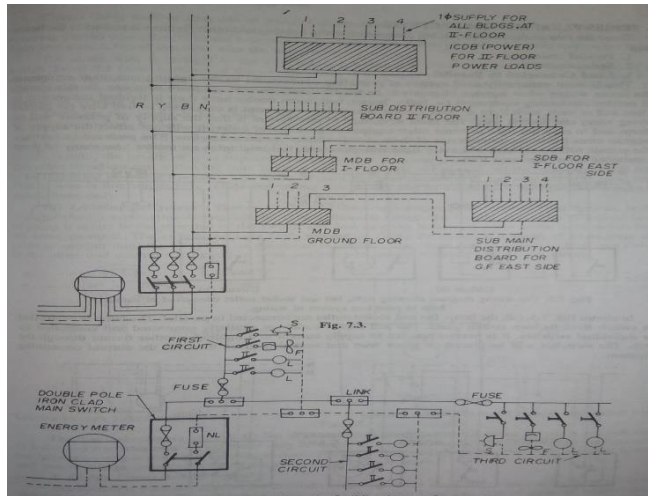
(i) distribution board system:-



This is one of the widely used energy distribution systems in our country, this system has an iron clad, in each circuit one cutout must have to be installed on the iron clad or board so this board sometimes called as fuse board or distribution board.

- For every circuit phase and neutral wire must be taken from the respective busbar which is also fitted on the distribution board.
- In this system each circuit must contain 10 points or 800 watt.

■ TREESYSTEM:-



This system of wiring is not used frequently due to the following reasons

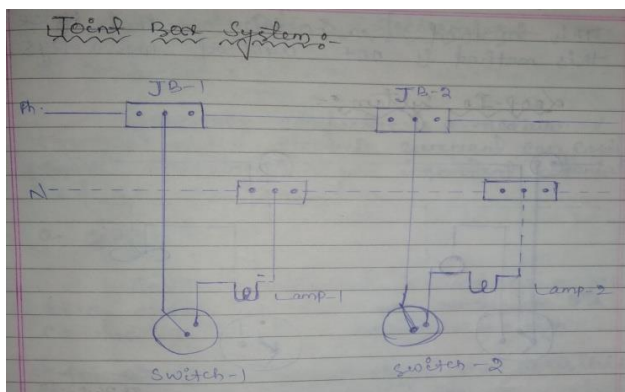
- (i) the extremend load or last end load cannot get the declared voltage due to resistive drop.
- (ii) fuses are rescertered which causes more expensive.
- (iii) in this system fuses are connected in the phase wire, neutral link connectors are also connected in neutral and phase wire respectively for each circuit phase and neutral are taken from the connector and neutral links as shown in above figure.

Methodsofwiring:-

Generally we have two types of methods for wiring that are

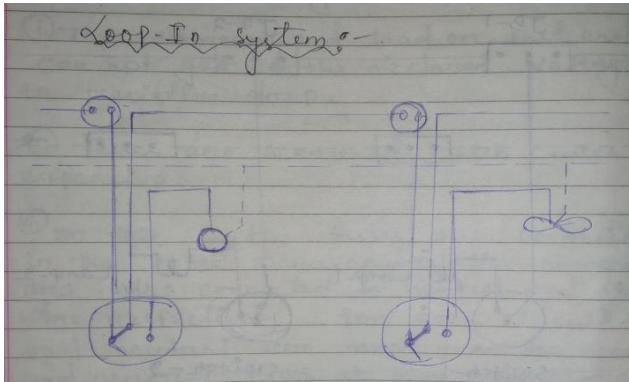
- (i) joint box
- (ii) loop system

Joint box system :-



In this system phase and neutral wires are reconnected with the joint boxes as shown in above figure for each electrical load phase wire is to be taken from the joint box through the switch and neutral wire from the joint box directly to the load by this way for each one of electrical loads, joint boxes are used and accordingly switches are used.

This method is a costlier method. Hence this method is not adopted nowadays. Loop – in system :-



In this system phase wire is to be controlled by the switches and the same phase to be connected to a particular load as shown in the above figure, the neutral is directly connected to each load but not through the switches. This system of wiring is widely used now a days.

Types of wiring:- in the wiring system may be domestic or industrial following wiring systems are adopted

- (1) Cleat wiring
- (2) Wood casing & capping wiring
- (3) CTS or TRS or LEAD sheathed wiring
- (4) Conduit wiring

(i) Cleat wiring :-

At first in this wiring demarcation is given on the wall surface, using hand drill holes are made long the demarcation at 3cm to 60cm apart then wood gutties (plugs) of size 38mm x 38mm of 6.5cm. long are placed in the drilled holes. Then the base cleats are to be fixed on the gutties then VTR cables are taken through the base cleats and immediately after it the top cleats are screwed over the base cleat. Now the cables are permanently placed in the cleats.

Application:-

- This wiring system is basically used in undamped places and also where temporary wiring is needed.

Wooden casing & capping wiring:-

In this wiring demarcation is given on the wall surface at a height of 3m from the ground. Using drilling holes are made along the demarcation line with 15cm apart. The wooden gutties (plugs) are inserted in the drilled holes the wooden casing are fixed on the gutties by means of screw. The length of such casing is about 2.5m to 3m. After it PVC or VIR cables are drawn through the casing then the top cover named as capping is now fixed by the help of screws.

- .

Application:-

This wiring system is basically used in low voltage (1-phase, 240v) domestic wirings. Normally in dry places where there is no risk of fire.

CTS or TRC or lead sheathed or battery wiring:-

In this wiring demarcation is given on the wall surface and height 3m from ground using hand drill holes are created along the demarcation line of distance 75cm apart. The wooden gutties are plugged of the size 32mm x 8mm about 6.5 cm. Long are inserted in the drilled holes then for holding the cables links is made with tinned brass are fixed on the batten with an interval of 10cm. In case of horizontal and 15cm. In case of vertical then the teak wood batten of different sizes as applicable such as 13x13mm, 19x13mm, 25x13mm and 31x13mm etc. are fixed over the gutties by means of machine screws or wooden plugs with appropriate size. Then TRs or CTS cables are laid over the nail pins are twisted so as to hold the cable permanently.

- For providing the no. of cables and link pins the different size of batten are mentioned in the following table.

Batten size	Number and size of link clips	Number of single core cable to carried out
13mm x 13mm	1 x 38mm	2
19mm x 13mm	1 x 50mm	3
25mm x 13mm	2 x 28mm	4
31mm x 13mm	1 x 38mm & 1 x 50mm	5

APPLICATION-

This type of wiring is used for low voltage installation in domestic, commercial or industrial workshop.

CONDUIT WIRING-

In this wiring the demeritation is given on the wall surface at a height of 3m from the ground using hand drill holes are created along the demeritation line at a distance of 75cm apart the wooden gutties or plug of size 32 mm × 8mm about 6.5 long are inserted in the drilling holes. Then the base shackle is fixed on the gutties .

-in this wiring, all wires are enclosed in steel pipe known as conduit. It is metal is annealed to permit to easy bending. The inner surface of the conduit is carefully prepared so that the wires can be easily pulled into it with a minimum of effort .

There are three types of conduit wirings

- Concealed wiring
- Surface conduit wiring
- Flexible conduit wiring

LEAD OR METAL SHEATHED WIRING:-

The conductor having insulated covering of V.I. Rare covered with an outer sheath of lead or lead alloy. The max^m thickness of lead covering thus formed may not exceed 1 mm or 1.5 mm .this metal sheath provides toughness and gives protection to the cable against mechanical injury and atmospheric corrosion.

WIRING MATERIALS & ACCESSORIES:-

(1) Conductor:-

Generally conductor is a medium through which electric current can easily flow. following are the important materials use for the conductors.

a. Copper:-

- Copper material is used as a best material for the conductor. Its conductivity is comparatively high.
- At 20^oc temperature the resistivity of copper is $1.786 \times 10^{-8} \Omega m$.
- The specific weight of copper is 8900 kg/m³.
- It has high resistance to corrosion, oxidation and pitting.

b. aluminium:-

- in the electrical field basically in transmission, distribution and utilization it dominates the copper material.
- It is the next immediate choice of material for the conductor.

- Its resistivity is $2.87 \times 10^{-8} \Omega \text{m}$ at 20°C .
- This material is less cost as used in different cables as well as overhead bare conductors.
- It is also affected by oxidation.

(2) wires & cables:-

The term wire is very much familiar in wiring system which means a strip of bare conductor with negligible thickness.

- Similarly the term cable is also a popular word used in wiring system. Its meaning is a wire covered with insulated materials.
- A cable may be single core, double core & more core.

(3) Insulating materials:-

The sole purpose of insulating materials used in cable or covered with the bare conductor is to prevent leakage current from the conductor or core.

Following are the important properties of insulating materials.

- (i) High resistivity
- (ii) High dielectric strength
- (iii) High resistant to moisture, acids & alkalies.
- (iv) Capable of withstanding high rupturing voltage.
- (v) Capable of withstanding at high temperature.
- (vi) High flexibility.

4- TYPES OF INSULATING MATERIALS—

Following are the important insulating materials that are used in various electrical fields.

- (i) Rubber
- (ii) Vulcanized Indian rubber (VIR)
- (iii) Impregnated paper
- (iv) Polyvinyl chloride (PVC)
- (v) Silk & cotton

5- MECHANICAL PROTECTION-

Generally a cable should be designed in such a manner that it can help mechanical stability. Usually in power cables to protect against mechanical injury two layers of steel tape are used or now a days aluminium sheathing is introduced.

(6) TYPES OF CABLES USED IN INTERNAL WIRING:-

Generally cables are categorized based on the conductors used, no. of cores, amount of voltage supply and type of insulation. Hence following are the important cables used in internal wiring

- (i) VIR(240v/415vand650v/1100v)
- (ii) TRSorCTS(240v/440vand650v/1100v)
 TRS-tough rubber seathed
 CTS-capyreseathed
- (iii) Leadseathedcable(240v/415v)
- (iv) PVC(polyvinylechloride)(240v/415vand650v/1100v)
- (v) Weatherproofcable(240v/415vand650v/1100v)
- (vi) XLPEcable–itmeanscrosslinkpolythilineinsulatedaluminiumconductorarmouredcable.

(7) MULTI-STRANDED CABLES:-

The multi-strand cable is composed of several fine copper wires.



PVC multi-strand wires

(8) VOLTAGE GRINDING OF CABLES :-

It is the process of archiving uniform distribution of dielectric stress or voltage gradient in a dielectric of cable.

- There are different types of voltage grade (240v/415v), (650/1100)v, (240/415)v mms:-
- Voltage between conductor & earth is 240v.
- Voltage between two conductors is 415v.

(9) GENERAL SPECIFICATION OF CABLE:-

While purchasing or estimating the cable we must emphasize on following factors.

- (i) Size of the cable (19/2.24mm, 7/1.70mm etc.)
- (ii) Types of conductors used (Aluminium or copper)
- (iii) No. of core (single core, double core, 3 core etc)

- (iv) Voltage grade (240/415V or 650/1100V etc.)
- (v) Type of insulation material (PVC or TRS etc.)

(10) MAIN SWITCH & DISTRIBUTION BOARD:-

According to the I.E. rules a suitable linked switch has to be provided immediately after the meter board.

Following are the important specifications of main switches according to their applications.

- (a) 240V, 16A, DPIC switch for two wire DC circuit or 1-phase.
- (b) 500V, 32A/63A/100A/150A TPIC main switch for 3 wire D.C. circuit.
- (c) 415V, 32A/63A/100A/150A TPIC used for 3-phase 4 wire A.C. circuit.

Similarly for distribution board we have main specifications as two ways, three ways, four ways etc.

(11) CONDUIT:-

Generally in household wiring we use following type of circuit

- (a) Light gauge steel conduit
- (b) Heavy gauge steel conduit
- (c) Flexible conduit
- (d) PVC conduit

(12) CONDUIT ACCESSORIES & FITTINGS:-

In the wiring system basically for conduit wiring following accessories are frequently used.

- (a) Bend (L-conduit) conduits and T-conduits.
- (b) Bushings or coupler (male or female conduits)
- (c) Clips and saddles conduits.
- (d) Conduit boxes (2 ways, 3 ways, 4 ways etc.)

(11) LIGHTING ACCESSORIES & FITTINGS:-

For lighting purpose we use following accessories and fittings.

- (a) Switches
Following switches are generally used in household wiring
 - (i) One way switch
 - (ii) Two way and two way centre of switch
 - (iii) DP main switch
 - (iv) Push button switch
 - (v) Bed switch

- (vi) Table lamp switch
- (vii) Tumbler or surface switches
- (viii) Flush switches
- (b) Ceiling rose:-
Ceiling rose may be of two plates ceiling rose is basically used for ceiling fans.
- (c) Socket outlets :-
Depending on the field application a socket outlet may be of two pin, three pin, five pin and six pin of 240v, 6A/ 16A or 32A etc.
- (d) Lampholders:-
We have following types of lampholders
 - (i) Batten holder
 - (ii) Pendant holder
 - (iii) Angle holder
 - (iv) Slanting holder
 - (v) Bracket holder
 - (vi) Water type bracket holder
 - (vii) Miniature lampholder

From the above holder the specification may be 5A, 250A, bakelite holder of any make.

FUSE :-

It is a low melting point electrical safety device that operates to provide overcurrent protection.

FUSE ELEMENT:- it is made of zinc, copper, silver, aluminium or alloy.

Best fuse is alloy of lead & tin which has low melting point & very high resistance. TYPES OF

FUSE:-

- Drop-out fuse
- Striker fuse
- Switch fuse
- Cartridge type (HRC fuse)
- Explosion type HV fuse

Determine the current rating of a fuse:-

The value of current at which the installation is working without any damage is the current rating of the fuse. Following are the main factors which determine the current rating of a fuse :

- (a) Minimum size of cable or fuse for mechanical reasons.
- (b) Voltage drop.
- (c) Current carrying capacity.

(d) Type of insulation of the fuse.

- The unit of fuse is – ampere.

Current rating of fuse element: – it is the value of maximum current which the fuse element can normally carry without overheating or melting at normal full load current.

FUSING CURRENT: – it is the maximum value of current at which, the fuse element melts and thus disconnects the circuit.

FUSING FACTOR: – it is defined as the ratio of minimum fusing current to the fusing rating of the fuse element. i.e.

$$\text{Fusing current} = \text{minimum fusing current} / \text{current rating of fuse element.}$$

CUT-OFF CURRENT: – the maximum value of fault current actually reached before the fuse melts is called cut – off current.

Different types of protective devices used both in domestic & factories

- Fuse
- MCB (miniature circuit breaker)

LIGHTING SCHEME: –

Principle of good lighting: –

- It is the requirement of general lighting to obtain uniform, diffused and glareless lighting. This can be obtained by using fluorescent lighting or by using lamps made of diffusing glass
- Light intensity is chosen depends upon choosing of area.

Types of lighting schemes

- (i) Direct lighting
- (ii) Semi-direct lighting
- (iii) Semi-indirect lighting
- (iv) Indirect-lighting

Direct lighting :-

This light is directly made to fall on the working plane, if proper reflectors are used, about 80% to 90% of total light flux can be made to fall on the working plane

- It is used in industrial & outdoor lighting.

Semi-direct lighting: –

In this system semi-direct reflectors are used as a result, 60 to 90% of the total light flux is made to fall on working plane.

Semi-indirect lighting:-

It produces very soft lighting system the 60% to 90% is thrown upward to the ceiling for reflect & the remaining light reaches the working plane directly.

- This type scheme is adopted for indoor light decoration purposes.

Indirect lighting:-

In this system 90% to 100% of total light flux is thrown upward to the ceiling for diffused reflection by using inverted or bowl reflectors in this system glare is reduced is softer.

- This scheme is used in decoration purpose.

General rules of wiring :-

- In factor lighting:- the direct lighting scheme is used.
- Public lighting installation:- both direct & semi-direct lighting scheme is used.
- Street lighting :- the wiring light points are installed approximately near to provide uniform illumination.

DETERMINATION OF NO OF POINTS TO BE USED IN A CIRCUIT & TOTAL LOAD (NO OF SUB-CKT)

Luminous flux (ϕ):- it is the total lumen produced by lamp.

- Unit of flux is :- lumen

Total lumen given by lamp:-

$$\phi = N \times \text{wattage of each lamp} \times \text{luminous efficiency of each lamp.}$$

$$= \text{total lumen falling on working plane } \phi$$

$$\phi_{\text{net}} = \phi \times cu \times Mf$$

cu - coefficient of utilisation Mf

- maintenance factor

Φ - total lumen by lamps

Φ_{net} = total lumen fall on working plane

Illumination(E):- it is the total lumen in working plane per unit area. $E = \frac{\phi}{A}$

$\phi_{net} \div A$ (A = light falling area)

$$\phi_{net} = E \times A$$

$$= \phi \times CU \times MF = E \times A$$

$$= N \times \text{watt / lamp} \times \text{luminous efficiency} \times CU \times MF = E \times A$$

$$N = E \times A \div (\text{watt / lamp} \times \text{luminous efficiency} \times CU \times MF)$$

(14) Earthing system:-

We know that earthing is defined as a connection of the neutral point of the supply system and non-current carrying parts of electrical apparatus such as metallic frame work, metallic covering of cables, earth terminal of the socket outlet and stay wires etc. To the general mass of the earth so as to discharge the electrical energy immediately to the earth without any danger.

(a) Resistance of earth:-

According to I.E.Rule the resistances should be low enough to cause the flow of electric quickly. The earth resistance is not equal in all places because it depends on the moisture content and the type of soils etc.

■ Therefore following are the important values of earth resistance that can be permitted.

- (i) For large power station – 0.5Ω
- (ii) Major power station – 1Ω
- (iii) Small substation – 2Ω
- (iv) In all other cases – 5Ω

The resistance from the earth plate to any point in the installation is 1Ω

(b) Size of earth continuity conductor:-

Normally use 14 SWG or 16 SWG or 18 SWG G.I. or copper.

(c) Distance of earth from the building:-

In general the distance of earth electrode from the building should not be less than 1.5m

(d) Methods of earthing:-

Following methods are adopted for earthing:-

(i) Strip or wire earthing :-

For copper dimension is 25mm × 1.6mm For

G.I. dimension is 25mm × 4mm

(ii) rodorspikeearthing:-

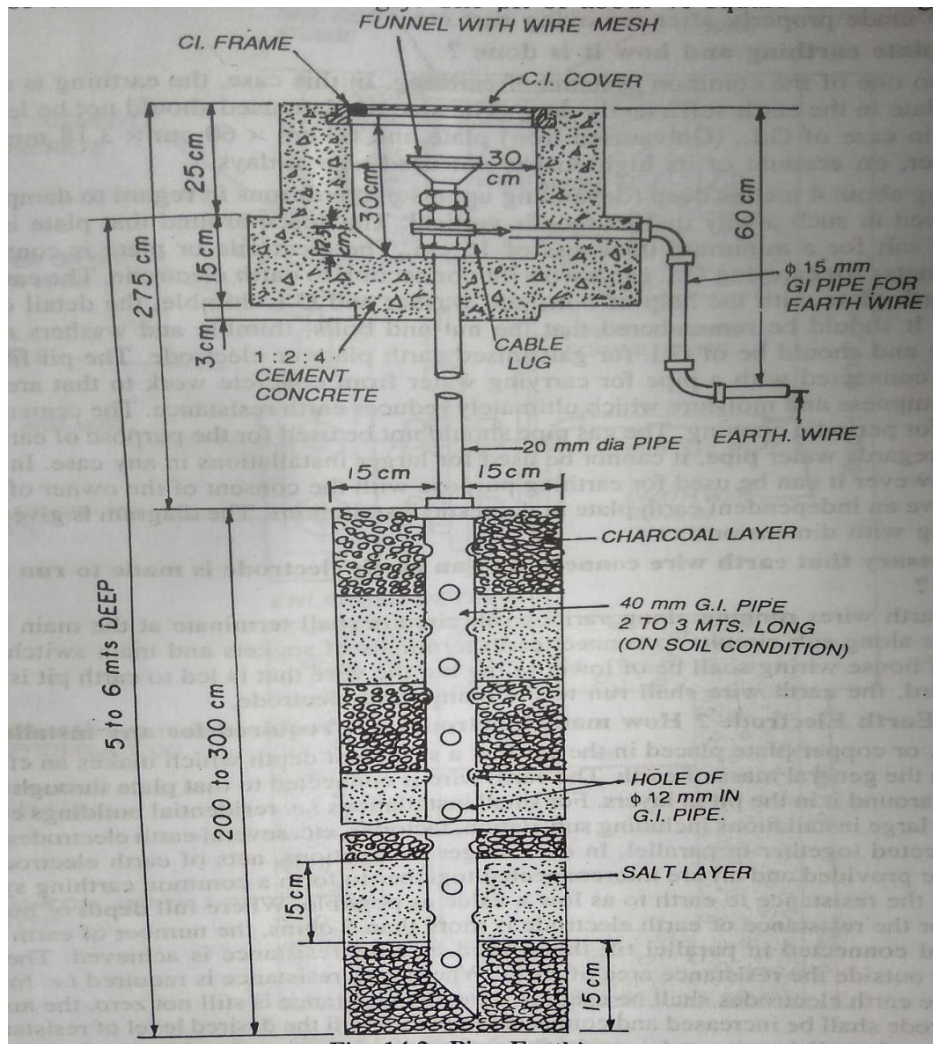
Variousrodsareavailableinmarketforearthingthatare 12.5mmdiasolidrodsofcopperand2.5m long .

- 16mmdiasolidrodsofG.I. orG.S.of2.5mlongand25mmdiaG.I.of2.5m long.

(iii) pipeearthing:-

Pipearthingthevarioustypeofpipesareavailableindifferentsizesthatare40mmwith2.5m long G.I. and 19mm dia with 1.25 m long G.I.

Q-2-preparethelistofmaterialsrequiredforpipeearthingandalsodrawtheneatsketch



Materialtable

Sino	Description	specification	Quantity
01	G.I pipe	38mm dia, 2.5m long	01 no
02	G.I pipe for watering	19mm dia, 1.5m long	01 no
03	G.I pipe	13mm dia, 4.5m long	01 no
04	G.I wire	6SWG	12m
05	G.I lugs	G.I type	02 nos
06	G.I nut bolt	10mm dia, 16mm dia	04 nos
07	G.I bends	13mm dia	02 nos
08	Cast iron frame	30cm * 30cm	01 no
09	Cast iron cover	30cm * 30cm	01 no
10	Funnel	-	01 no
11	Channel	-	10kg
12	Common salt	-	10kg
13	Sundry to complete the whole job	-	As per required

(iv) plate earthing:-

In plate earthing different sizes of plates are available in market that are For

copper plate size 60cm × 60cm × 3mm

For G.I. plate size 60cm × 60cm × 6mm

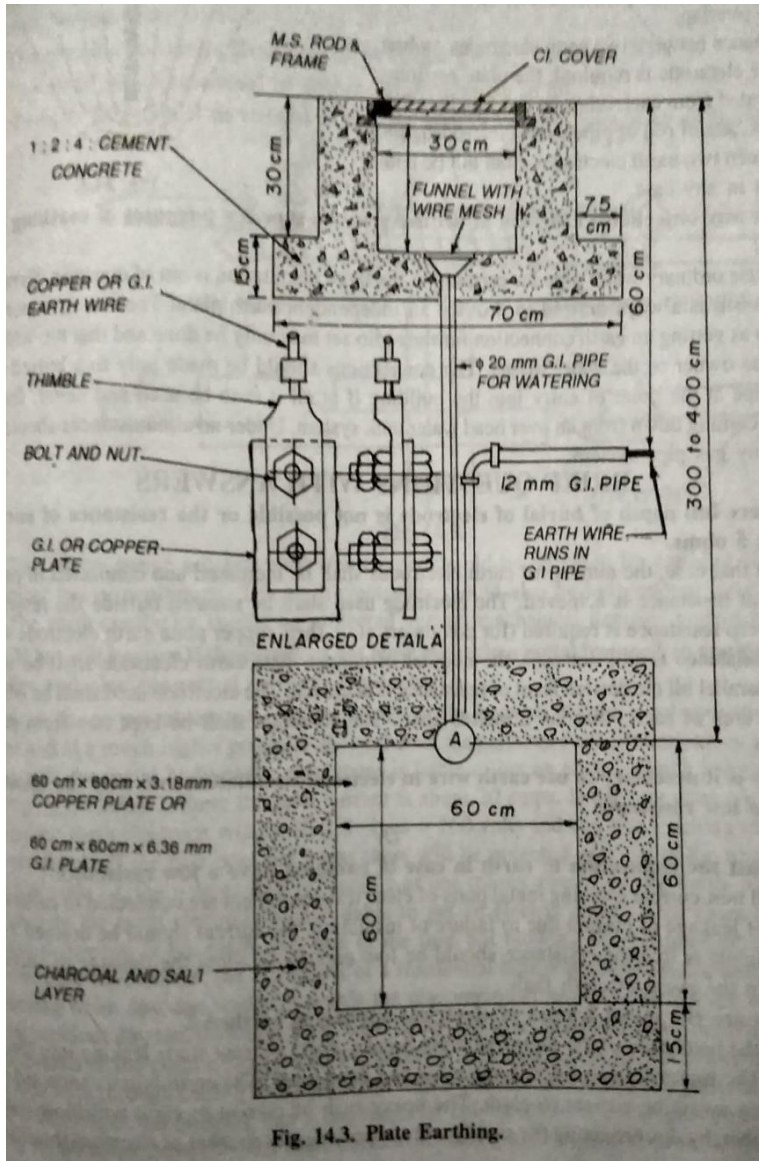


Fig. 14.3. Plate Earthing.

Material table:-

Sino.	Description	Specification	Quantity
-------	-------------	---------------	----------

01	G.I.plate or cu plate	60cm×60cm×6.36mm 60cm×60cm×3.18mm	01no 01no
02	G.I.pipeforwatering	20mmdia,2mlong	01no
03	G.Ipipe	12mmdia,2.3mlong	01no
04	GIwire	6SWG	12 m
05	Gllugs	GItypes	02nos
06	G.Inutbolt	10mmdia,16mmdia	04nos
07	Castironframe	30cm×30cm	01no
08	Castiron cover	30cm×30cm	01no
09	Funnel	-----	01no
10	Charcoal	-----	10kg
11	Salt	-----	10kg
12	Sundriestocompleteholejob	-----	As per required

Shortquestions:-

- (1) Accordingtoruralelectrificationanl.E.ruleseachcircuitcontainshawmanypointsandpower ratings.
Ans:-accordingtoruralelectrificationandl.Eruleseachcircuitcontains10pointsand800watt.
- (2) What is height of ceiling, switch board, horizontal run up and ceiling fan from the ground?
Ans:-according tol.Erules theheightofceilingmustbe3.5mfrom thegroundandheightof switchboardis1.5mand theheightofhorizontalrunupis3mandthe heightofceilingfanis 2.75m.
- (3) Ina1- phaseA.C.supplyfuseisconnectedtowhichwire.
Ans:-ina1-phaseA.C.supplyfuseisconnectedtofuse wire.
- (4) Writethespecificationofmainswitchwhichisusedforlightingpurposeonly.
Ans:-thestandardspecificationofamainswitchforlightingisDPIC,6A240v
- (5) Whatisthegeneralruletoinstallaswitchboardinaroomneartheentrancedoor? Ans:- generally inleftside ofthe entrance door of a room switch board isinstalled.

- (6) Write the full form of SPST switch and DPDT switch.
 Ans:-the full form of SPST switch is single pole single through.
 The full form of DPDT switch is double pole double through.
- (7) What is the permissible voltage drop of internal house wiring?
 Ans:-the permissible voltage drop of internal house wiring is $\pm 2\%$.
- (8) What is the full form of PILC ?
 Ans:-the full form of PILC is PVC insulated live conductor.
- (9) What is the full form of AAC, ACSR, TRS, VIR and PVC? Ans :-
 the full form of
 AAC-all Aluminium conductor
 ACSR–Aluminium conductor steel reinforced.
 VIR – Tough Rubber Seathed.
 PVC–polyvinyl chloride.
- (10) Why fuse is not provided in neutral of A.C. supply?
 Ans:-since neutral wire is the return path of A.C. supply in case of unbalanced load or any fault condition the heavy current returns to that neutral path of fuse it place then the current can not pass to that path. And the system will be damage.
- (11) State the criteria required to fulfill for selecting a conductor for an installation.
 Ans:-the criteria required to fulfill for selecting a conductor for an installation are
- (i) Types of conductor
 - (ii) No. Of core
 - (iii) Current carrying capacity
 - (iv) Voltage grade
 - (v) Types of insulation
- (12) State the difference between main distribution board and sub-distribution board.
 Ans:-main distribution board
- The main distribution board provide power feed to other distribution board or sub-distribution board but the sub distribution board will provide power feed to the individual load.
- (13) What is the difference between fuse & MCB. Ans
 :- fuse:-
- It is made up of piece of metal that melts when overheated or large amount of current flows.
 - It melts then it replace by now one.
- MCB :-
- The miniature circuit breaker have an internal switch mechanism that can be tripped by an abnormal cases or when excess of current flows.
- (14) What is TPIC and TPICN main switch and where it is used?
 Ans:-the full form of TPIC is triple pole iron clad.
- It is used in three wire D.C. distribution line.
 - The full form of TPICN is triple pole iron clad with neutral link. And it is used in 3-phase A.C. supply.
- (15) Write the full form of DPIC main switch and where it is used.

- The full form of DPIC is double pole iron clad and it is used in 1-phase A.C. and two wire D.C. distribution line.
- LONG QUESTION:-
 - (1) Prepare the list of materials required for plate earthing and also draw the neat sketch.
 - (2) Prepare the list of materials required for pipe earthing and also draw the neat sketch.

Chapter-3

INTERNAL WIRING

Types of wiring:- in the wiring system may be domestic or industrial following wiring systems are adopted

- (5) Cleat wiring
- (6) Wood encasing & capping wiring
- (7) CTS or TRS or LEAD sheathed wiring
- (8) Conduit wiring

(i) Cleat wiring :-

At first in this wiring demarcation is given on the wall surface, using hand drill holes are made long the demarcation at 3cm to 60cm apart then wood gutties (plugs) of size 38mm x 38mm of 6.5cm. long are placed in the drilled holes. Then the base cleats are to be fixed on the gutties then VTR cables are taken through the base cleats and immediately after it the top cleats are screwed over the base cleat. Now the cables are permanently placed in the cleats.

Advantages-

- (i) It is easiest method of installation
- (ii) Fault finding is easy & repairing is also required very less time
- (iii) Dismantling is easy & quick

Disadvantages-

- (i) It is temporary wiring system.
- (ii) It is not good looking
- (iii) Since the cables are exposed to the air, so it may be chemically affected which causes damage to the insulations.

Application:-

- This wiring system is basically used in undamped places and also where temporary wiring is needed.

Wooden casing & capping wiring:-

In this wiring demarcation is given on the wall surface at a height of 3m from the ground. Using drilling holes are made along the demarcation line with 15cm apart. The wooden gutties (plugs) are inserted in the drilled holes the wooden casing are fixed on the gutties by means of screw. The length of such casing is about 2.5m to 3m. After it PVC or VIR cables are drawn through the casing then the top cover named as capping is now fixed by the help of screws.

Advantages:-

- To some extent it is easy to install.
- Fault finding and repairing is also easy.

Disadvantages:-

- There is a risk of fire hazard.
- It is costlier nowadays.
- It cannot be used in damped places.

Application:-

This wiring system is basically used in low voltage (1-phase, 240v) domestic wirings. Normally in dry places where there is no risk of fire.

CTS or TRC or lead sheathed or batten wiring:-

In this wiring demarcation is given on the wall surface and height 3m from ground using hand drill holes are created along the demarcation line of distance 75cm apart. The wooden gutties are plugged of the size 32mm x 8mm about 6.5 cm. Long are inserted in the drilled holes then for holding the cables links is made with tinned brass are fixed on the batten with an interval of 10cm. In case of horizontal and 15cm. In case of vertical then the teak wood batten of different sizes as applicable such as 13x13mm, 19x13mm, 25x13mm and 31x13mm etc. are fixed over the gutties by means of machine screws or wooden plugs with appropriate size. Then TRs or CTS cables are laid over the nail pins are twisted so as to hold the cable permanently.

- For providing the no. of cables and link pins the different size of batten are mentioned in the following table.

Batten size	Number and size of link clips	Number of single core cable to be carried out
13mm x 13mm	1 x 38mm	2

19mm×13mm	1×50mm	3
25mm×13mm	2×28mm	4
31mm×13mm	1×38mm &1×50mm	5

Advantages:-

- It is highly durable.
- It can withstand the action of acids and alkalis.
- Its installation is easy
- Fault finding can be detected easily

DISADVANTAGE-

- It is very costly nowadays
- There is a risk of fire
- It cannot be used in a damp place
- Skilled labour is required for making the smooth batten

APPLICATION-

This type of wiring is used for low voltage installation in domestic, commercial or industrial workshop.

CONDUIT WIRING-

In this wiring the demeritation is given on the wall surface at a height of 3m from the ground using hand drill holes are created along the demeritation line at a distance of 75cm apart the wooden gutties or plug of size 32 mm × 8mm about 6.5 long are inserted in the drilling holes. Then the base shackle is fixed on the gutties .

-in this wiring, all wires are enclosed in steel pipe known as conduit. It is metal is annealed to permit to easy bending. The inner surface of the conduit is carefully prepared so that the wires can be easily pulled into it with a minimum of effort .

There are three types of conduit wirings

- Concealed wiring
- Surface conduit wiring
- Flexible conduit wiring

LEAD OR METAL SHEATHED WIRING:-

The conductor having insulated covering of V.I. Rare covered with an outer sheath of lead or lead alloy. The max^m thickness of lead covering thus formed may not exceed 1 mm or 1.5 mm. This metal sheath provides toughness and gives protection to the cable against mechanical injury and atmospheric corrosion.

Advantages:-

- It can be used in places exposed to sun or rain, provided no joint is exposed
- It may have comparatively a longer life

Disadvantages :-

- It is costly as compared to TRS wiring system
- If proper earthing is not done and insulation is damaged, the metal sheath becomes alive & gives electric shock
- Skilled labour is required to execute the work
- It may not be suitable for places where chemical corrosion may occur.

INDUSTRIAL WIRING-

In this wiring, the different ratings of motors are used, so the power equipments are used in this wiring such as main switch board, starter etc

Determination of input power of motor—

$$\text{Input in watt} = (\text{rated BHP of motor} \times 735.5) / \text{motor efficiency}$$

Determination of input current of motor-

$$\text{Input current} = (\text{rated BHP of motor} \times 735.5) / (p.f. \times \text{voltage} \times \text{efficiency}) \text{ ----- (1-}\phi\text{)}$$

$$\text{Input line current} = (\text{rated BHP of motor} \times 735.5) / (\sqrt{3} \times p.f. \times \text{voltage} \times \text{efficiency}) \text{ ----- (3-}\phi\text{)}$$

Selection & rating of cable---

This selection & rating of cable depends upon current drawn by motor at full load. But starting current is greater than full load current. So finally selection of cable is chosen by starting or overload current. Choosing of cable from below table.

Table 12.1. Current Rating of Copper Conductor Single Core Cables
(V.I.R., PVC or Polythene insulated including tough rubber sheathed, PVC or lead sheathed)

Size of conductor		Two cable d.c. or single phase a.c.		Three or four cables balanced three phase a.c.	
Nominal area (mm ²)	No. and dia of wire in (mm)	Current Rating (amps)	Approximate length of run for one volt drop (mt.)	Current Rating (amps)	Approximate length of run for one volt drop (mt.)
1.0	1/1.12	5	4.9	5	5.8
1.5	3/1.06	10	3	10	3.7
2.5	3/1.06	15	3.4	13	4.3
4.0	7/1.06	20	3.7	15	5.2
6.0	7/1.06	28	4.0	25	5.8
8.0	7/1.12	36	4.9	32	6.1
10.0	7/1.40	43	5.5	39	7.0
15.0	7/1.63	52	7.0	48	8.8
20.0	19/1.12	62	7.6	56	9.8
25.0	19/1.40	74	8.8	67	11.3
35.0	19/1.63	97	10	88	12.8
50.0	19/1.80	160	19.4	155	13.4

Table 12.2. Current Rating of aluminium conductor single core cables
(V.I.R., PVC or Polythene insulated tough rubber, PVC or lead sheathed)

Size of conductor		Two cable d.c. or single phase a.c.		Three or four cables balanced three phase		Four cables d.c. or single phase a.c.	
Normal area (mm ²)	No. and dia. of wire in (mm)	Current Rating in (amps)	Approx. run for one volt drop (mt.)	Current Rating (amps)	Approx. run for one volt drop (mt.)	Current rating (amps)	Approx. run for one volt drop (mt.)
1.5	1/1.40	10	2.3	9	2.9	9	2.5
2.5	1/1.80	15	2.5	12	3.6	11	3.4
4	1/2.24	20	2.9	17	3.9	15	4.1
6	1/2.80	27	3.4	24	4.3	21	4.3
10	1/3.55	34	4.3	31	5.4	27	5.4
16	7/1.70	43	5.4	38	7.0	35	6.8
25	7/2.24	59	6.8	54	8.5	48	8.5
35	7/2.50	69	7.2	62	9.3	55	9.0
50	7/3.00	91	7.9	82	10.1	69	10.0
	19/1.80						
70	19/2.24	134	9.0	131	9.5	—	—
95	19/2.50	153	9.8	152	10.0	—	—
120	37/2.06	165	10.8	161	10.9	—	—
150	37/2.24	181	11.4	179	11.1	—	—
185	37/2.50	209	12.3	207	11.8	—	—
225	37/2.80	240	13.5	235	13.1	—	—

Table 12.3. Current Rating of copper conductor Twin, Three and Four Core Cables

Three core and four core cables (VIR, PVC or Polythene insulated and sheathed with tough rubber PVC or lead sheathed).

Size of conductor		Two cable d.c. or single phase a.c.		One three core or four core cable balanced three phase	
Nominal area (mm) ²	No. and dia. of wire (mm)	Current Rating (amps)	Approx. run for one volt drop (mt.)	Current Rating (amps)	Approx. run for one volt drop (mt.)
1.0	1/1.12	5	4.6	5	5.5
1.5	4/737	10	3.0	8	5.3
2.5	3/1.06	15	3.0	10	5.5
4.0	7/737	20	3.4	15	5.5
6.0	7/1.06	28	4.0	20	6.4
8.0	7/1.12	36	4.6	25	7.6
10.0	7/1.40	43	5.2	30	8.8
15.0	7/1.63	53	6.4	37	11.0
20.0	19/1.12	62	7.0	43	11.9
25.0	19/1.40	74	8.2	52	13.7
35.0	19/1.63	97	9.8	68	15.8
50.0	19/1.80	140	11.3	88	18.3

Table 12.4. Current rating and voltage drop for vulcanised rubber, P.V.C. or

Polythene insulated or tough rubber PVC lead sheathed, twin three or four core aluminium wire or cables.

Size of conductor		One twin core D.C. or single phase A.C.		One 3 core or 4 core cable balanced three phase		
Nominal area in Sq. mm	Number and dia of wire in mm	Current Rating in Amperes	Approximate length of run for 1 volt drop		Current Rating in Amperes	App. length of run for one volt drop in meters
			D.C. metres	A.C. metres		
1.5	1/1.40	10	2.3	2.3	7	3.7
2.5	1/1.80	15	2.5	2.5	11	3.9
4.0	1/2.24	20	2.9	2.9	14	4.8
6.0	1/2.80	27	3.4	3.4	19	5.5
10.0	1/3.55	34	4.2	4.2	24	6.8
16.0	7/1.70	43	5.3	5.3	30	8.7
25.0	7/2.24	59	6.6	6.6	42	10.8
35.0	7/2.50	69	7.1	7.1	48	11.7
50.00	7/3.0	91	7.7	7.7	62	13.1
	19/1.80					
70.0	19/2.24	118	9.0	8.8	82	14.7
95.0	19/2.50	135	9.8	9.5	94	15.7
120.0	37/2.06	165	10.8	10.3	114	16.8
150.0	37/2.24	181	11.4	10.7	127	17.5
185.0	37/2.50	209	12.3	11.2	146	18.4
225.0	37/2.80	240	13.5	11.7	169	19.1

Selection of size of conduit---

The selection of conduit pipes depends upon no. of cables of different sizes that are to be accommodated.

Table 5.4. Table showing number of cables that can be accommodated in the conduit of size as shown against each for cables of VIR or PVC insulated both copper and Al. conductors.

No. and diameter of wire in mm	Nominal X sectional area in mm ²	Material of conductor	No. of cables that can be accommodated in conduit of size													
			20 mm		25 mm		30 mm		38 mm		50 mm		60 mm			
			S	B	S	B	S	B	S	B	S	B	S	B		
1/1.12	1.0	Copper	7	5	13	10	20	14	-	-	-	-	-	-	-	-
3/0.736	1.25	Copper	7	5	12	10	20	14	-	-	-	-	-	-	-	-
1/1.40	1.5	Al	7	5	12	10	18	12	-	-	-	-	-	-	-	-
3/0.925	2.0	Copper	5	4	10	8	18	12	-	-	-	-	-	-	-	-
1/1.80	2.5	Al	6	5	10	8	16	10	-	-	-	-	-	-	-	-
7/0.736	3.0	Copper	5	4	8	6	12	10	-	-	-	-	-	-	-	-
1/2.24	4.0	Al	4	3	7	6	12	10	-	-	-	-	-	-	-	-
7/0.925	4.5	Copper	3	2	6	5	10	8	-	-	-	-	-	-	-	-
1/2.80	6.0	Al	3	2	6	5	10	8	-	-	-	-	-	-	-	-
7/1.12	6.75	Copper	2	-	5	4	8	7	-	-	-	-	-	-	-	-
1/3.55	10	Al	2	-	5	4	8	7	-	-	-	-	-	-	-	-
7/1.32	12	Copper	-	-	4	3	6	5	8	6	-	-	-	-	-	-
7/1.626	14	Copper	-	-	3	2	4	4	7	6	-	-	-	-	-	-
7/1.70	16	Al	-	-	2	-	4	3	7	6	-	-	-	-	-	-
19/1.12	18	Copper	-	-	-	-	4	3	6	5	10	7	12	8	-	-
7/2.24	25	Al	-	-	-	-	3	2	5	4	8	6	9	7	-	-
19/1.32	30	Copper	-	-	-	-	3	2	5	4	8	6	9	7	-	-
7/2.50	35	Al	-	-	-	-	2	-	4	3	7	5	8	6	-	-
19/1.626	40	Copper	-	-	-	-	-	-	3	3	6	5	8	6	-	-
7/3.00	50	Al	-	-	-	-	-	-	4	3	6	4	6	5	-	-
19/1.80	50	Copper	-	-	-	-	-	-	2	-	5	4	6	5	-	-

Selection & rating of main switch---

Selection of main switch is depends upon starting current of motor Selection & rating of distribution board---

It depends upon no. of ckt (for motors & other loads)

PROBLEM-1

Prepare estimates & material table to install power connection of 3-phase 5HP induction motor for an agriculture tube well in the room size 3m x 3m x 3m. The motor is 1 m away from two nearest walls.

- Electrical wiring plan
- Single line diagram, showing earth wires also.
- Decide the rating & specification of important materials and calculate the length of wire, conduit, earth wire & prepare a complete list of materials required.

Ans-

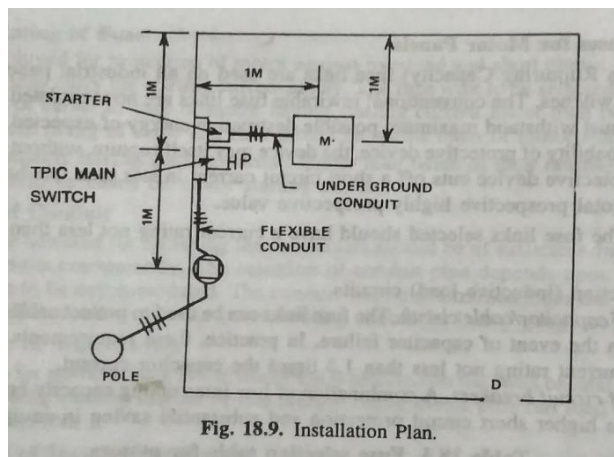


Fig. 18.9. Installation Plan.

Assumption-

- Height of main board from floor = 1.5m
- Two earth wires enclosed of 15mm dia G.I pipe
- Motor is installed 0.25m above floor on a suitable foundation. full

$$\text{load current} = \frac{5 \times 735.5}{(\sqrt{3} \times \text{p.f.} \times \text{voltage} \times \text{efficiency})}$$

$$= \frac{5 \times 735.5}{(\sqrt{3} \times 0.85 \times 400 \times 0.75)}$$

$$= 8 \text{ amp}$$

SELECTION & RATING OF MS-

$$\text{Assume total current drawn by motor} = 8 + (50\% \text{ of } 8) = 12 \text{ amp}$$

It is very close to 16 amp, then next higher rating main switch 32 amp available in market. So specification is TPIC 32A, 500v grade MS.

SELECTION&RATINGOFWIRE-

Wereferaboveratingofcabletable,itsuggestedthatpvcinsulatedAlconductorsize 6mm^2 Or $1/2.80$ mm dia.

CALCULATIONOFHEAVYGAUGECONDUITPIPE,25MMDIA---

Frommainboardtotopofmotorfoundation= $1.5+0.25(\text{depthoftrench})+1.0(\text{along trench})+0.25+0.25=3.25\text{m}$

Totallengthofconduit= $3.25+10\%\text{wastage}=3.57\text{m}$ nearlysay4m

CALCULATIONFORLENGTHHEAVYGAUGECONDUITPIPE,15mmDIAFOREARTHWIRE---

Frommainboardtotopofmotorfoundation= $3.25 \times 2\text{pipe}=6.5\text{m}$ For

10% wastage so, total length= $6.5+0.6=7.1\text{m}$ or 7m

CALCULATIONFORLENGTHOFFLEXIBLECONDUITOF SIZE25mmDIA---

fromenergymetertomainboard= 1.0m

from main switch to starter= 0.5m

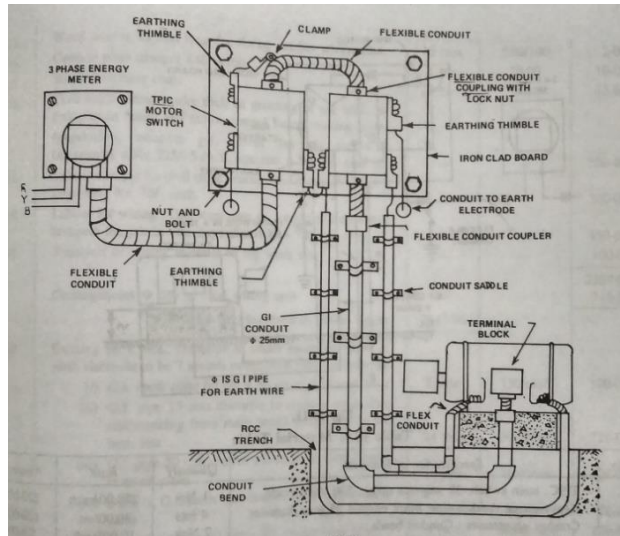
fromstartertoconduitmouth= 0.25m

frommotorfoundationtomotorterminalblock= 0.25m

total length of flexible conduit= $1.0+0.5+0.25+0.25=2\text{m}$

for 10% of wastage

so totalis= $2+0.2=2.2\text{m}$ say2.5m



CALCULATION FOR LENGTH OF WIRE OF 6mm² OR 2.80mm DIA---

Conduit has 3 wires for 3-phase DOL starter, so

Total length of wire = length of conduit (rigid + flexible) × 3 wires

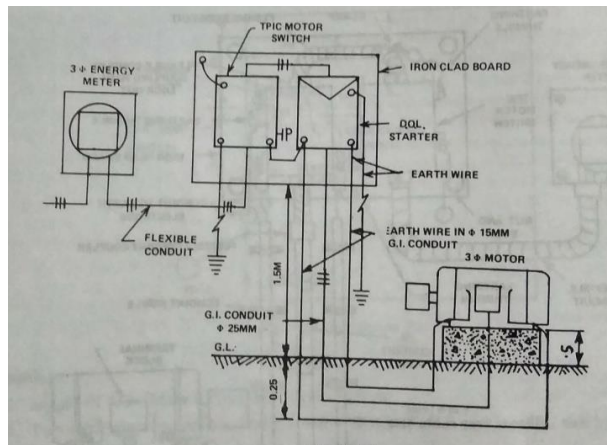
$$= (3.25 + 2.0) \times 3 = 15.75 + 2.5 \text{m (15\% wastage)} = 18.25 \text{m say } 19 \text{m}$$

CALCULATION FOR LENGTH OF 8SWG, G.I. EARTH WIRE---

Length of earth wire = length of conduit × 2 wires

$$= 3.25 \times 2 \text{ wires} = 6.5 \text{m} + 2 \text{m around main board}$$

$$= 8.5 \text{m} = 9 \text{m}$$



Material table—

Sino	Description	specification	Quantity
01	Mainswitch(TPIC)	32amp,500v	01no
02	Ironcladboardfabricatedwith angleiron&MSsheetwithfitting accessories	30cm×30cm	1set
03	Heavygaugeconduitpipewithit's fitting accessories	25mmdia	4m
04	G.lconduitpipewithfitting accessories	15mmdia	7m
05	Flexibleconduitpipewithit's fitting accessories	25mmdia	2.5m
06	PvcinsulatedAlconductor	Singlecore,6mm ² or1/2.80mmdia	18m
07	Earthwirewithit'sfitting accessories	G.ltype8swg	9m
08	MSsheetfixwithwallfitting accessories	---	1set
09	Conduitbend,saddle	---	Asperrequired
10	Dangerplate	440v	01
11	Sundriestocompletethewholejob	----	Asperrequired

DOMESTIC WIRING—

SEQUENCE TO BE FOLLOWED IN CARRYING OUT THE ESTIMATE---

- 1- Drawing installation plan
- 2- Calculation for total connected load in amperes
- 3- Selection & rating of mains switch and sub mains switch
- 4- Selection of main distribution board
- 5- Calculation for conduit pipe or batten
- 6- Calculation of length of phase & neutral wire
- 7- Calculation of length of earth wire
- 8- Preparing material table

ARRANGEMENT OF APPARATUS-

Energymeter---to---DPIC mains switch-----to----main DB----to---subcircuits (switchboard)

- Every subcircuit contains light, fan, & 5-amp socket loads

- **each subcircuit is having not exceeding 10 no of points or 800 watts**

SELECTION OF WIRE—

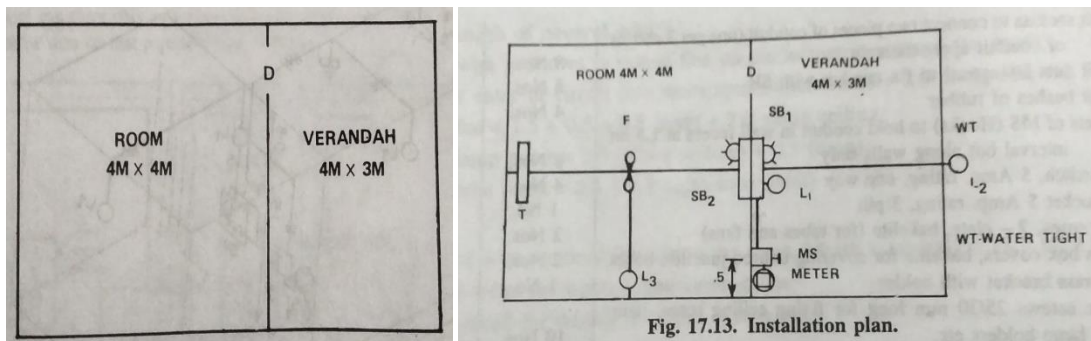
It depends upon specified load in which considered as

- (1) Insulated wire for mechanical reason
- (2) Voltage drop
- (3) Current carrying capacity
- (4) Types of insulation is used i.e. VIR, PVC, TRS etc
- (5) Grade i.e. 250v, 500v, 660v etc
- (6)

PROBLEM-2

A room & a verandah, the plan of to be provided with electrical wiring. Mark the location of energy meter, main switch & switch board & electrical points suitable & draw the installation plan showing supply path to each point & wiring diagram. Calculate the total length of wire required for wiring the room & verandah in batten system of wiring. prepare a list of materials with complete specification of each item.

Ans-



From this plan we required

- Room contain—two light points, one fan & 5 amp socket load
- Verandah contain—two light points, 5 amp socket load

ASSUMPTION-

- (a) Total height of ceiling = 3.5m
- (b) Height of HR from floor = 3.0m
- (c) Height of SB from floor = 1.5m

(d) Location of energy meter & main switch board = 0.5 m inside verandah on room wall.

(e) All dimension in meter

Calculation of load-

Lamps = $3 \times 60 = 180\text{w}$

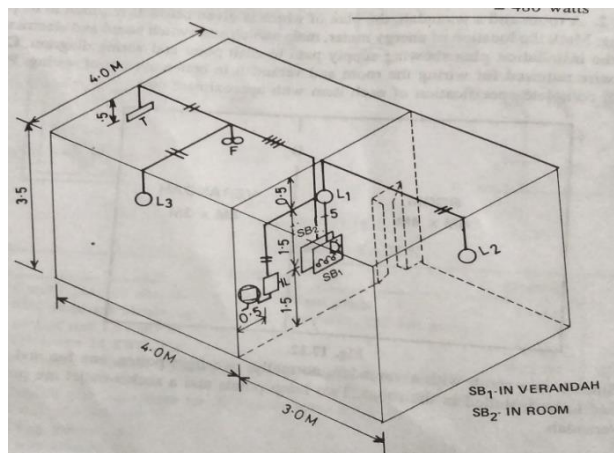
Fan = $1 \times 60 = 60\text{w}$

Socket outlet 5amp = $2 \times 100 = 200\text{w}$

Fluorescent tube = $1 \times 40 = 40\text{w}$

Total load = 480w

Load in amp = $\text{watt/volt} = 480/230 = 2.1\text{amp}$



SELECTION & RATING OF MAIN SWITCH—

D.P.I.C. Main switch of 5 amp rating 250V grade is selected

SELECTION & RATING OF DB—

Total points are 7 points, so no distribution board is required.

CALCULATIONFORLENGTHOFBATTEN---

FrommainboardtoL₁—(13mm×13mm)2wires=1.5+1.5=3m

L₁to SB₁ --(31mm×13mm) 5wires=1.5m

L₁to L₂ --(13mm×13mm)2wires=0.5+3+0.5=4m

SB₂tofan ---(25mm×13mm) 4 wires =2+2=4m

FantoL₃ ---(13mm×13mm)2wires=2+0.5=2.5m

Fan to tube point --- (13mm×13mm)2 wires =2.5 m

TOTALLENGTHOFBATTENOF SIZE---

13mm×13mm=3+4+2.5+2.5=12m+(10%wastage)=13.2m=13m

25mm×13mm =4m+((10%wastage)=4.4m=4.5m

31mm×13mm =1.5m+(10% wastage)=1.6m=2m

CALCULATIONSOFLNGTHOFALCONDUCTORVIRWIREOFSIZE1.5mmsq—

Lengthofwirecalculatedfromlengthofbattenofvarioussizes 13mm×13mm=

12m × 2wires = 24m

25mm×13mm = 4m× 4wires= 16m

31mm×13mm =1.5m× 5wires=7.5m

.....
 Totallengthofwiresonbatten= 47.5m

Totallengthofwires=47.5m+1m(wallcrossing)+15%wastage=55.7msays56m CALCULATION

OF LENGTH OF EARTH WIRE OF SIZE 14 SWGGALVANISED STEEL---

FromMS—to-SB₂throughSB₁=1.5+1.5+1.5+0.25=4.75m

Totallength=4.75+0.47=5.2msay5m

Material table—

Sino	Description	specification	Quantity
01	DPIC mains switch	5amp, 250v grade	01
02	Teakwood main box for enclosing MS&DB	30cm×30cm	01
03	Teakwood battensize	13mm×13mm 25mm×13mm 31mm×13mm	13m 4.5m 2m
04	VIRAL conductor	1.5mmsq, 250v grade	56m
05	Earth wire	14SWG, G.I type	5m
06	Conduit pipe for wall crossing	20mm dia	0.25m
07	Switchboard with fitting accessories	20cm×10cm 20cm×25cm	01no 01no
08	Flush switch	5amp, oneway	06no
09	Socket	5amp, 3-pin	02no
10	Ceiling rose	2plate, backlite	02no
11	Teakwood round block	10mm dia	04no
12	Teakwood plugs (gutties) at 0.75m interval	----	30no
13	Holder	---	02no
14	Link clips, aluminium 40mm long (one clip on two wires 10cm apart (length of wire+2×10 clips)	----	300no or 3 boxes
15	Woodscrews 25mm long to fix batten with gutties at 0.75m interval	----	30no
16	Woodscrews 15mm long	----	15nos
17	Sundries to complete the whole jobs	----	As per required

PROBLEM-3

A room & a varandah, the plan of to be provided with electrical wiring. Mark the location of energy meter, main switch & switch board & electrical points suitable & draw the installation plan showing supply path to each point & wiring diagram. Calculate the total length of wire required for wiring the room & varandah in conduit wiring. prepare a list of materials with complete specification of each item .

Ans

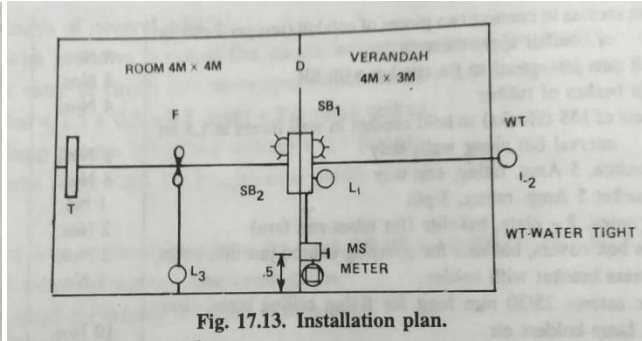
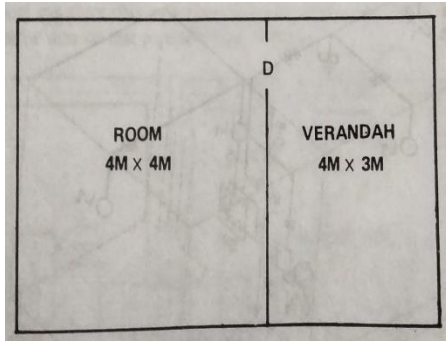


Fig. 17.13. Installation plan.

From this plan were required

- Room contain—two light points, one fan & 5 amp socket load
- Verandah contain—two light points, 5 amp socket load

ASSUMPTION-

- (f) Total height of ceiling = 3.5m
- (g) Height of HR from floor = 3.0m
- (h) Height of SB from floor = 1.5m
- (i) Location of energy meter & main switch board = 0.5m inside verandah on room wall.
- (j) All dimension in meter

Calculation of load-

Lamps=	3×60=180w
Fan=	1×60=60w
Socket outlet 5amp=	2×100=200w
Fluorescent tube=	1×40=40w

Total load= 480w

Load in amp = watt/volt = 480/230 = 2.1 amp

SELECTION&RATINGOFMAINSWITH—

D.P.I.C Mainswitch of 5amp rating 250v grade is selected

SELECTION & RATING OF DB—

Total points are 7 points, so no distribution board is required.

CALCULATION FOR LENGTH OF CONDUIT PIPE 25mm dia --- From

main board to L₁— =1.5+1.5=3m

L₁ to SB₁ -- =1.5m

L₁ to L₂ --=0.5+3+0.5=4m

SB₂ to fan ---=2+2=4m

Fan to L₃ ---=2+0.5=2.5m

Fan to tube point ---=2.5m

TOTAL LENGTH OF CONDUIT PIPE = 3+1.5+4+4+2.5+2.5=17.5+(10% wastage)=19.2m say 20m

OF LENGTH OF PHASE WIRE—

From main board to L₁—=1.5+1.5=3m

L₁ to SB₁ -- =1.5m×3wire=4.5M

L₁ to L₂ --=0.5+3+0.5=4m

SB₂ to fan ---=2+2=4m×3wire=12M

Fan to L₃ ---=2+0.5=2.5m

Fan to tube point ---=2.5m

Total length of phase wire = 3+4.5+4+12+2.5+2.5=28.5+0.25(wall crossing)+(10% wastage)=32.3m say 32.5m

CALCULATIONS OF LENGTH OF NEUTRAL WIRE—

From main board to L₁—=1.5+1.5=3m

L₁ to SB₁ -- =1.5m×2wire=3.0M

L₁ to L₂ --=0.5+3+0.5=4m

SB₂ to fan ---=2+2=4m=4M

Fant to L₃ ---=2+0.5=2.5m

Fant to tube point ---=2.5m

Total length neutral wire = 3+3+4+4+2.5+2.5=19+0.25(wall crossing)+(10% wastage)=21

CALCULATION OF LENGTH OF EARTH WIRE OF SIZE 14 SWG GALVANISED STEEL---

From MS to SB₂ through SB₁ = 1.5+1.5+1.5+0.25=4.75m

Total length = 4.75+0.47=5.2m say 5m

Material table—

Sino	Description	Specification	Quantity
01	DPIC mains switch	5amp, 250v grade	01
02	Phase wire	1.5mmsq, 250v grade	32.5m
03	Neutral wire	1.5mmsq, 250v grade	21m
04	Earth wire	14SWG, G.I type	5m
05	Conduit pipe	25mm dia	20m
06	Switchboard with fitting accessories	20cm×10cm 20cm×25cm	01no 01no
07	Flush switch	5amp, oneway	06no
08	Socket	5amp, 3-pin	02no
09	Ceiling rose	2plate, backlite	02no
10	Conduit pipe accessories for 25mm dia 1 way junction box 3 way junction box	---	03no 01no
11	Conduit bend	---	06no
12	Holder	---	02no
13	Conduit socket accessories	---	As per required
14	Crampets of MS hook to hold conduit in wall at 1.5m interval		11no
15	Sundries to complete the whole jobs	----	As per required

Problem-4

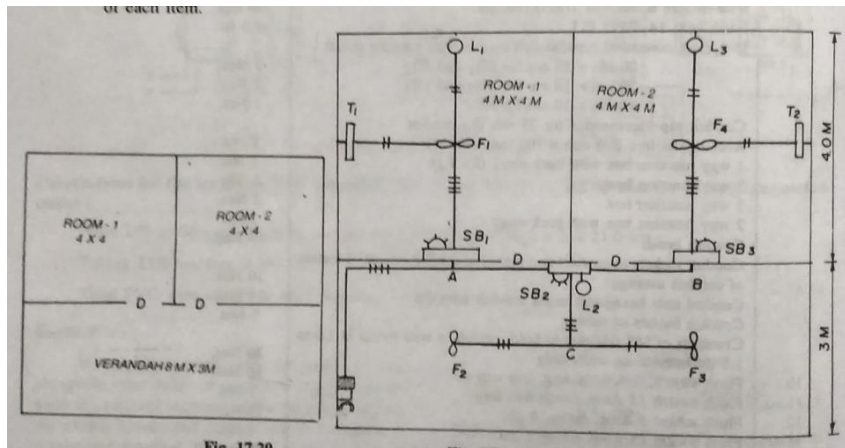
The plan of two rooms, one verandah office building is given below, the building is required to be provided with electrical conduit wiring at 230 v single phase, suggest electrical points suitable in rooms & verandah. solve the estimate in the following sequence.

- Installation plan on the plan of building starting from energy meter
- Wiring diagram

- (c) Calculate the total materials
- (d) Prepare the list of materials

ASSUMPTION-

- (a) Total height of ceiling = 3.5m
- (b) Height of HR from floor = 3.0m
- (c) Height of SB from floor = 1.5m
- (d) Location of energy meter & main switch board = 0.5m inside verandah on room wall.
- (e) All dimension in meter



CALCULATION OF LOADS-

Lamps = $3 \times 60 = 180w$

Fans = $4 \times 60 = 240w$

Fluorescent tube = $2 \times 40 = 80w$

Socket 5amp = $3 \times 100 = 300w$

Total load = $800w$

Current in amp = $watt/volt = 800/230 = 3.5amp$

SELECTION & RATING OF MAIN SWITCH---

DPI main switch 15amp rating, 250v grade is selected

SELECTION & RATING OF DISTRIBUTION BOARD---

There are 12 points so two sub-circuits are selected Sub

circuit 1-----points controlled from SB₁

Sub-circuits 2----points controlled from SB₂ & SB₃

It is suggested that a two-way MCB, each 5A rating along with double pole MCB with neutral link should be used.

CALCULATION OF LENGTH OF CONDUIT PIPE OF 25MM DIA—

Main board to L₂ = 1.5 + 2.5 + 4 = 8m

L₂ to junction 'c' = 0.5 + 1.5 = 2m 'c' to fan

2 = 2m

'c' to fan 3 = 2m

L₂ to SB₂ = 1.5m

L₂ to HR above SB₃ = 2m

SB₃ to fan 4 = 1.5 + 0.5 + 2 = 4m

Fan 4 to tube light 2 = 2 + 0.5 = 2.5m

Fan 4 to L₃ = 2 + 0.5 = 2.5m

SB₁ to fan 1 = 1.5 + 0.5 + 2 = 4m

Fan 1 to L₁ = 2 + 0.5 = 2.5m

Fan 1 to tube light 1 (T₁) = 2 + 0.5 = 2.5m

Total length = 35.5m

Total length of pipe = 35.5 + (0.25 + 0.25) wall crossing + 10% of wastage = 39.6 say 40m CALCULATION

PHASE WIRE---

Main board to junction A = 1.5 + 2.5 + 2 = 6m × 2 wire = 12m

Junction A to L₂ = 2m

L₂ to junction 'c' = 0.5 + 1.5 = 2m × 2 wire = 4m

'c'tofan2 =2m
 c'tofan3 =2m
 L₂toSB₂ =1.5m×4wire =6m
 L₂tojunctionB =2m
 SB₃toHR above the SB₃ =1.5m×4wire=6m
 HR above the SB₃to fan 4 =0.5+2=2.5m×3wire=7.5m
 Fan4totubelight2 =2+0.5 =2.5m
 Fan4toL₃ =2+0.5 =2.5m
 SB₁toHRaboveSB₁ =1.5m×4wire =6m
 HR above SB₁to fan1 =0.5+2=2.5m×3wire =7.5m
 Fan1toL₁ =2+0.5 =2.5m
 Fan1totubelight1(T₁)=2+0.5 =2.5m

 Totallength = 67m

Totalphasewire=67+(0.25+0.25)wallcrossing+10%wastage=74m

CALCULATIONOF NEUTRAL WIRE—

Totallengthofneutralwire=lengthofconduitpipe=36m+10%wastage=39.6=40m

CALCULATION FOR LENGTH OF EARTH WIRE OF SIZE 14 SWG OF GALVANISED STEEL---

FromMBtoSB₃=1.5+2.5+6+0.25(wallthickness)+1.5=11.75m

From HR to SB₁=0.25 +1.5=1.75m

FromHRtoSB₂=1.5m

Totallengthofearthwire=11.75+1.5+1.5=15m+10%wastage=16.5m=17m

MATERIAL TABLE—

Sino	Description	Specification	Quantity
01	DPIC mains switch	15amp, 250v grade	01
02	Phase wire	1.5mmsq, 250v grade	74m
03	Neutral wire	1.5mmsq, 250v grade	40m
04	Earth wire	14SWG, G.I type	17m
05	Conduit pipe	25mmdia	40m
06	Switchboard with fitting accessories SB ₁ SB ₂ &SB ₃	30cm×30cm 20cm×25cm	01no 02no
07	Flush switch	5amp, oneway	11no
08	Socket	5amp, 3-pin	03no
09	Ceiling rose	2plate, backlite	06no
10	Conduit pipe accessories for 25mmdia 1 way junction box 2 way junction box 3 way junction box	---	04 no 05no 02no
11	Conduit bend	---	06no
12	Holder	---	03no
13	Conduit socket accessories	---	As per required
14	Crampets of M hook to hold conduit in wall at 1.5m interval		27no
15	Sundries to complete the whole jobs	----	As per required

Short questions-

workshop

Q.1-what is the maximum load that can be connected in a power sub ckt.

Ans- the maximum load that can be connected in a power sub ckt is 3000w

Q.2-what is the maximum no of outlet that can be connected in power sub ckt Ans-2

—what is minimum size of all minimum size that can be used for wiring of a power

ckt Ans—2.5 mm dia

Q.4-what type of starter can be used for 5kw 1- ϕ .M Ans-

push button DOL starter

Q.5-what type of starter you recommend for a 20kw squirrel cage I.M

Ans- auto transfer starter

Domestic

Q.6-according to rural electrification (RE) & I. Erule each ckt contains how many points & power rating Ans-800

watt

Q.7-what is the size of batten for carrying 10 single core cable Ans-

(63mm \times 13mm)

Q.8-what is permissible voltage of internal house wiring-

Ans- +/- 2%

Q.9-what is full form of PILC

Ans-pvc insulated line conductor

Q.10-why fuse is not provided on neutral of AC supply

Ans-neutral wire is the returning path of AC, in case of any fault, the heavy fault current passes through the electrical apparatus before melt of fuse, so apparatus are damaged.

Q.11-

what is the full form of AAC, ACSR, TRS, VIR Ans--

AAC- all aluminium conductor

ACSR- aluminium conductor steel reinforced

TRS- tough rubber sheath

VIR- vulcanised indian rubber

Q.12-why concealed conduit wiring is not suitable on workshop-

Ans-in this wiring fault finding & repairing is very difficult so concealed conduit wiring is not suitable on workshop

Q.13-what is full form of CTS

Ans- CTS- cab type sheathed

Long questions—

Workshop-

Q.1-Estimate the list of materials required for connecting a 20HP, 3-phase, 50HZ squirrel cage. Motor as an irrigation pump from existing main switch in the pump house 6m distance.

Q.2-list out materials required to provide internal connection with small workshop having a work floor of 4m×6m & consist of

- (i) A 415v, 3-phase, 10kw welding T/F
- (ii) a 230v l.M operated lathe m/c
- (iv) 230v 50HZ 1.5HP bench grinder
- (v) Provide required fan & light point

Q.3 a 37kw connection is to be given to an agriculture field at 415v, 3-phase, 50hz. the connection is to be given from a 3-phase 11kv O.H distribution line which is at a distance of 40m. The motor has a full load efficiency of 85% & p.f 0.8 .make a neat sketch & estimate the quantity of material required.

Domestic wiring

Q.4-discuss conduit type of wiring briefly

Q.5-estimate the material required to provide internal wiring for a building whose plan (8m×3m) size of floor is having room size (4m×3m) & varandah (4m×3m), using conduit wiring . draw electrical wiring diagram & prepare list of material

Q.6-what are the different types of wiring explain about conduits system of wiring

Q.7-estimate the material required to provide internal wiring for a building whose plan given below, use batten wiring , draw electrical wiring & prepare list of materials

