LECTURE NOTES

ON

ELECTRICAL INSTALLATION AND ESTIMATING

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Th1. ELECTRICAL INSTALLATION AND ESTIMATING

Name of the Course: Diploma in Electrical Engineering			
Course code:		Semester	6th
Total Period:	60	Examination	3 hrs
Theory periods:	4P / week	Class Test:	20
Tutorial:	1 P / week	End Semester Examination:	80
Maximum marks:	100		

A. RATIONALE:

Prior to implementation of a project in the power transmission and distribution sectors, a material estimate is required in various stages: like i) transmission line construction ii) distribution line construction iii) erection of domestic installation iv) service connection to industrial installation etc. In estimating, calculation of quantity of material is estimated by the estimator. This subject 'Electrical Installation and Estimating' is meant for learning the estimation process by the final semester students

B. OBJECTIVE:

After completion of this subject the student will be able:

1. To write down detailed specification and numbers required of different materials.
2. To determine the size and material of conductor and cable from electrical and mechanical consideration. As such to prepare a detailed list of materials with complete specifications.

C. Topic wise distribution of periods:

Sl. No.	Topics	Periods
1.	Indian electricity rules	06
2.	Electrical installations	12
3.	Internal wiring	12
4.	Over head installation	12
5.	Over head service lines	12
6.	Estimating for distribution substations	06
	Total	**60**

D. COURSE CONTENTS

1. INDIAN ELECTRICITY RULES

1.1 Definitions, Ampere, Apparatus, Accessible, Bare, cable, circuit, circuit breaker, conductor voltage (low, medium, high, EH), live, dead, cut-out, conduit, system, danger, Installation, earthing system, span, volt, switch gear, etc.

1.2 General safety precautions, rule 29, 30, 31, 32, 33, 34, 35, 36, 40, 41, 43, 44, 45, 46.

1.3 General conditions relating to supply and use of energy : rule 47, 48, 49, 50, 51, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 70.

1.4 OH lines : Rule 74, 75, 76, 77, 78, 79, 80, 86, 87, 88, 89, 90, 91

2. ELECTRICAL INSTALLATIONS

2. 1 Electrical installations, domestics, industrial, Wiring System, Internal distribution of Electrical Energy. Methods of wiring, systems of wiring, wire and cable, conductor materials used in cables, insulating materials mechanical protection. Types of cables used in internal wiring, multi-stranded cables, voltage grinding of cables, general specifications of cables.

2. 2 ACCESSORIES: Main switch and distribution boards, conduits, conduit accessories and fittings, lighting accessories and fittings, fuses, important definitions, determination of size of fuse – wire, fuse units. Earthing conductor, earthing, IS specifications regarding earthing of electrical installations, points to be earthed. Determination of size of earth wire and earth plate for domestic and industrial installations. Material required for GI pipe earthing.

2. 3 LIGHTING SCHEME: Aspects of good lighting services. Types of lighting schemes, design of lighting schemes, factory lighting, public lighting installations, street lighting, general rules for wiring, determination of number of points (light, fan, socket, outlets), determination of total load, determination of Number of sub-circuits.

3. INTERNAL WIRING

3 . 1 Type of internal wiring, cleat wiring, CTS wiring, wooden casing capping, metal sheathed wiring, conduit wiring, their advantage and disadvantages comparison and applications.

3 . 2 Prepare one estimate of materials required for CTS wiring for small domestic installation of one room and one verandah within 25 m^2 with given light, fan & plug points.

3 . 3 Prepare one estimate of materials required for conduit wiring for small domestic installation of one room and one verandha within 25 m^2 with given light, fan & plug points.

3 . 4 Prepare one estimate of materials required for concealed wiring for domestic installation of two rooms and one latrine, bath, kitchen & verandah within 80m^2 with given light, fan & plug points.

3 . 5 Prepare one estimate of materials required for erection of conduct wiring to a small workshop installation about 30m^2 and load within 10 KW.

4. OVER HEAD INSTALLATION

4.1. Main components of overhead lines, line supports, factors Governing Height of pole, conductor materials, determination of size of conductor for overhead transmission line, cross arms, pole brackets and clamps, guys and stays, conductors configurations, spacing and clearances, span lengths, overhead line insulators, types of insulators, lighting arresters, danger plates, anti-climbing devices, bird guards, beads of jumpers, jumpers, tee-offs, guarding of overhead lines.

4.2. Prepare an estimate of materials required for LT distribution line within load of 100 KW maximum and standard spans involving calculation of the size of conductor (from conductor chart), current carrying capacity and voltage regulation

consideration using ACSR.

4.3. Prepare an estimate of materials required for LT distribution line within load of 100 KW maximum and standard spans involving calculation of the size of conductor (from conductor chart), current carrying capacity and voltage regulation consideration using ACSR.

4.4. Prepare an estimate of materials required for HT distribution line (11 KV) within 2 km and load of 2000 KVA maximum and standard spans involving calculation of the size of conductor (from conductor chart), current carrying capacity and voltage regulation of the size of conductor (from conductor chart), current carrying capacity and voltage regulation consider action using ACSR.

5. OVER HEAD SERVICE LINES

5. 1 Components of service lines, service line (cables and conductors), bearer wire, lacing rod. Ariel fuse, service support, energy box and meters etc.

5. 2 Prepare and estimate for providing single phase supply of load of 5 KW (light, fan, socket) to a single stored residential building.

5. 3 Prepare and estimate for providing single phase supply load of 3KW to each floor of a double stored building having separate energy meter.

5. 4 Prepare one estimate of materials required for service connection to a factory building with load within 15 KW using insulated wire.

5. 5 Prepare one estimate of materials required for service connection to a factory building with load within 15 KW using bare conductor and insulated wire combined.

6. ESTIMATING FOR DISTRIBUTION SUBSTATIONS

6. 1 Prepare one materials estimate for following types of transformer substations.

6.1.1 Pole mounted substation.

6.1.2 Plinth Mounted substation.

Syllabus coverage up to Internal assessment

Chapters: 1, 2 and 3.

Learning Resources:			
Sl.No	**Name of Authors**	**Title of the Book**	**Name of Publisher**
1	Surjit Singh	Electrical Installation and Estimating	Dhanpatrai and sons
2	J B Gupta	A course in Electrical Installation, Estimating and costing	S K Kataria and Sons
3	N. Alagappan S.Ekambaram	Electrical Estimating and Costing	TATA McGRAW HILL

Amper.

SI Unit of Coerrent.

One Amper.

1 Coleemb of Charge Per Second is called Amporе. (1C/s)

Apparatus.

The Technical Equipement or Mechinary need for a Particulare Activity or Pore Pose is called apparatus or set of equipments tools or Machine that are used for a Particular Pore Pose.

Bare

An electrical conducting having no covering or electrical insulation.

Cable.

A cable is assembly of one or more wires which is used to carrying electrical Current and having covering or electrical Insulation.

Circuit.

Circuit is a closed Path that allow electricity to flow from one Point to Another Point.

Circuit Breaker.

Circuit Breaker is Protecting device which is Make or Break circuit either Manually or Automatically during no load, full load & fault condition.

-> It is an Automatically operated electrical Switch design to Protect a electrical circuit from damaged caused by over head or electricity or Short circuit.

Conductor Voltage.

Low voltage = upto 1000V

Medium voltage = Between 1000V to 35KV.

High voltage - Between 35 KV to 230KV

Extra high voltage: Between 230 KV and Above.

Conductor is a object or a type Material in which the flow of charge is one or more.

Live:
A live wire is a wire carrying electrical current it means electrically charged conductor.

Dead:
A Dead wire is a wire through which electric current does not flow.

Pipes.
It is a rigid or flexible tube which is Mechanically Strong and fire resistance in which a cable and cables are drawn.
→ It is two type :- flexible cable.
rigid cable.

Cut-out:
The cut out (Also called the service head) is a piece of electrical equipment that links the Main/service electricity cable and the internal wires in your Property.
→ It Make sure that electricity passes safely & efficiently into your Property. It Also houses the main fuse.

Conduit:
An electrical conduit is a tube used to Protect and route electrical wiring in a building or structure.
→ Electrical conduit may be made of metal, plastic, fiber or fired clay.
→ Most conduit is rigid, but flexible conduit is used for some Purpose.

System:
It means a electrical system in which all the conductors apparatus are electrically connected to a common source of electrical supply.

Installation

It means Composite electrical unit for the Purpose of Generating, transmitting, distribution and utilization.

Switch gear:

The apparatus used for switching operation, regulation and controlling of circuit.

Ex:- Switch, fuse, Cut outs, Circuit Breaker & relay.

Earthing System.

An electrical system in which all conductor are earthed is called Earthing system.

Volt:-

SI unit of voltage or Potential difference

$$\text{Voltage} = \frac{\text{Workdone}}{\text{Charge}}$$

$$1V = \frac{1J}{1C}$$

→ It is the electrical potential which, when applied to a conductor the resistance of conductor is 1 ohm which will Produce 1 Amp of current.

Accessible:

It means with in physical reach without the use of any apply Appliances or special effort.

General Safety Precautions.

Rule-29

construction, Installation, Protection, operation Maintance of electric Supply lines and apparatus.

* The Material and apparatus used shall conform to the relevant Specification of Indian standards, where such specifications have already been mentioned.

* Human, Animal & Property safety must be maintained.

* All electric Supply lines and apparatus must have sufficient rating for power, insulation and estimated fault current and sufficient Mechanical Strength.

Rule -30

Service line and Apparatus on consumer's Premises

*. The supplier shall ensure that all electric supply lines wires, fitting and apparatus belonging to sole condition on a consumer Premises and supplier shall take above Precaution to avoid danger arranged on such permision from supply lines

*. The consumer shall, also take Precaution for the sole custody of the equipment on Premises belonging to the supplier.

Rule -31

Cut-out consumer Premises.

*. The supplier shall Provide a suitable cut-out in each line. A cut-out is a appliance which Automatically Interrupts the flow of energy through any conductor when the current rise above the Predetermined Amount.

Rule-32.

Identification of earthed and earthed neutral conductor and Position of switches and cut-outs there in.

Rule-33

Earth terminals on consumer Premises.

*. The supplier shall Provide and Maintain on the consumer Premises for the consumer use a suitable earthed terminal in an Accessible Position.

*. Consumer shall take reasonable precaution to Prevent Mechanical damage to the earthed terminal.

* The supplier may recover from the consumer the cost of installation of such earthed terminals.

Rule-34 Accessibility of Bare conductor

Where Bare conductor are used in a building Owner of such conductor shall. (a) Ensure that they are In-Accessible (b) Take necessary steps as consider By the Inspector.

Rule-35

Caution notice

There should be a clearly visible caution notice in Hindi and the local language of the district of a type approved by the Inspector on every motor, Generator, transformer & all support of lines Provided.

* If a generator, motor, transformer is within enclosure, one notice affixed to the said enclosure shall be sufficient for the purpose.

* It is also warning notice.

Rule-36

Handling of Electric Supply line apparatus.

* Before any electric conductor or apparatus is handled adquate precaution shall be taken by earthing or by other suitable means.

* No Permision shall work on any live electric supply line or apparatus and no person shall assist such person on such work unless he/she is Authorised in that Behalf and take the safety measure approved by the Inspector.

Rule-37

Supply of vehicle

Rule-38

Cable are Protable transportable or apparatus

Rule-39

Cables Protected By Bituminus materials.

Rule-40

Street Box

* Shall not curtain gas pipe. Precaution should be taken to Prevent influx of water or gas

* Supply line forming part of different system pass through Some Street Box readily distinguishable.

* All Street Box should be regularly Inspected.

* The Box can only be open by mean of key.

Rule-41: Distinction of circuit of different voltage

The owner of every generating station, Station, Sub-Station Junction Box in which there are many circuit or apparatus, intended for operation at different voltages, shall readily distinguishable from one another.

Rule-42

Instruction for Restoration of Person Scattering from electric Shock

*Instructions in English, Hindi and the local language of the districts for the restoration of Person Scattering from electric Shock, shall be affixed by the owner in a conspicuous place in every generating station, Sub-Station with the factory Act 1948.

Rule-43

Provision Applicable to Protective equipment.

*Fire Buckets filled with clean dry Sand and ready for Immediate use for extinguishing fire, in addition to fire extinguisher; Suitable for dealing with electrical fire should be all generating station, Sub-Station.

*1st Aid-Box Should be Provided and Maintained in every generating Station; Sub-Station etc.

Rule-45

Precautions to be adopted by consumers owners, Electrical contractor Electrical Workmen & Suppliers.

Rule-46

Periodical Inspection & Testing of consumer's Installation:-

* Installation Should be Periodically Inspected not exceed five years either by the Inspector or by Suppliers

* The fees for such inspection and test shall be determine By the central or the State government.

* In the event of the failure of any consumer to pay the fees on or Before the date Specified the consumer Shall be liable to disconnected under the direction of inspector.

* However such disconnection by the Supplier Shall not be Made without giving to the consumer Seven Clear day's notice in writing of his intention to do

General Conditions relating to Supply and use of energy

Rule 47 (Testing a consumer installation)

Upon receipt of an application for a new or additional supply of energy the Supplier shall ~~instruct~~ inspect and test the applicant installation.

*. If the result of inspection suggest modification to installation the applicant should make such modification to make installation safe

Rule-48

(Precaution against leakage Before connecting)

*The leakage current should not exceed $\frac{1}{5000} \times$ (load current) or (maximum current)

Rule-49

Leakage on Consumer's Premises.

If the inspector or the Supplier has reason to Belive that there is an leakage in the system which likely to cause danger, they may give the consumer reasonable notice in writting that he desire to inspect. and ~~test~~ test the consumer installation.

* The Supplier may and if directed to do so by the Inspector, shall discontinues the supply of energy to the installation But only after giving to the consumer 48 hours notice in writing of disconnection of supply and shall not commence the supply until Supplier or the inspector is satisfied that the cause of leakage has been removed.

Rule-50

Supply to Consumer.

*The Supplier shall not commence or continue to give supply of energy to consumer unless (a) Suitable linked switch or a circuit-Breaker of requisite capacity to carry & Break the current is placed as near as possible to, so as to easily operated to completely isolate the supply to the installation.

(b) A Suitable Linked Switch or a Circuit Breaker of requisite capacity to carry and Break the full load current is inserted on the Secondary side of a T/f in case of high or extra high voltage installation.

*. The supply of energy to each motor or other apparatus is controlled By a Suitable linked Switch or a circuit Breaker of requisite capacity placed on such a position as to be adjucent to the motor or other Apparatus readily Accessible to and easily operate by the Person in charge and so connected in circuit that by its means as supply of energy can be cut off from the motor or apparatus.

* All insulating material used should have sufficient mechanical Strength & maintain its insulating Property under different working condition of temp^n & moisture.

Rule-51

Provision Applicable to medium, High on extra high Voltage installation

* All conductor (other than those of Overhead line) shall be completely enclosed in mechanically strong metal casing or metallic covering which is electrically and Mechanically Protected against mechanical damage

* All metal work enclosing, supporting or Associated with installation Should be earthed.

Rule-52.

Appeal to inspector in regard to defects.

Rule-53

cost of inspection and test of consumers installation.

The cost of the first inspection and the test of consumer installation carried out in shall be Borne by the supplier and the cost of every subsequent inspection and test shall be Borne By the consumer.

Rule-54.

Declared voltage of supply to consumer.

The declared voltage should not vary more than 6% in case of low or medium voltage or more than 12 1/2 %. in the case of high or extra-high voltage.

Rule-55

Declared frequency of supply to consumer

The supply frequency should not vary more than 3%.

Rule-56

Selling of meter and cut-outs

A Supplier may affix one or more Seals to any cut-out and to any meter, Placed upon a consumer premise in accordance with Section 26, and no Person other that the supplier shall Break any such seal.

Rule-57 Meters maximum demand indicators and other apparatus on consumer Premises.

* The errors do not exceed 3% above or below the absolute Accuracy at all load

* Supplier shall examine, test and regulate all meters

* Every supplier shall maintain a register, showing the date of the last test the errors recorded at the time of the test, date of installation etc.

Rule-58.

Point of Commencement of supply.

* At the outgoing terminal of the cut-out inserted By the Supplier on each conductor of every service line other than earthed or earthed neutral.

Rule-59

Precaution against failure of Supply (Notice of failure)

Supplier shall take all responsible precaution to avoid any accidental interruption of supply and also to avoid danger to the Public or to any employee when engaged on any operation during installation or repair work.

Rule-60

Test for the resistance of insulation.

Where any electrical supply line for use at low or medium voltage has been disconnected from a system for the purpose of addition or repair such electric supply line shall not be reconnected to the system until the supplier or the owner has applied the test prescribe under Rule-48.

Rule-61

Connection with earth.

The neutral Conductor of a three phase four-wire system shall be earthed by not less than two separate and distinct connections with the earth both at the generating station and at the substation.

*. Cables External conductor shall be earthed by two separate and dist connection with earth.

*. The connection with earth may include a link by means of which the connection may be temporarily interrupted for the purpose of testing or for locating a fault.

* In a direct current three-wire system the middle conductor shall be earthed at the generating station only. and the current from middle conductor to earth shall be continuously recorded By means of a recording Ammeter and if at any time the current exceed one thousand part of the maximum supply current immediate steps shall be taken to improve the insulation of the system.

*. The medium Conductor is earthed by means of a CB with a resistance connected in parallel the resistance shall not exceed 100Ω and on opening of the CB immediate steps shall be taken to improve the insulation of the system, and the CB shall be reclosed as soon as possible

* The resistance shall be used as a protection for the Ammeter.

* In case of A.C system there shall not be inserted on the connection with earth any impedance cut-out or CB.

* The frame of every generator / stationary motor / metalic parts of all transformer shall be earthed by the owner by two separate & distinct connection with earth

* All earthing system belongs to the supplier shall be tested for resistance on dry day during the dry season not less than once every two years.

Rule-62

System at medium voltage: where a medium voltage system is employ the voltage between earth & any conductor forming part of the system shall not, under normal condition exceed five voltage

Electric supply lines systems and apparatus for high & Extra-high voltages

Rule-63 Approval by the Inspector.

Before supply of extra high voltage to a person the supplier shall ensure that the high or extra-high voltage electric supply lines or apparatus belonging to high and placed in position properly joined and duty completed and examined.

* The owner of any high or extra high voltage installation who make any addition or alternation to his installation shall not connect to the supply his apparatus or electric supply line unless approved by the inspector.

Rule-64 use of energy at high & extra high voltage:

All conductor and apparatus intended for use at high or extra-high voltage and situated on the premises of the consumer are inaccessible except to an Authorised person and all operation in connection with the said conductor and apparatus are carried out only by authorised person.

* The consumer has provided and agree main line a separate Building or a locked wather-Proof and fire Proof enclosed of agreed design and location to which the Supplier shall at all time have Access for the Purpose of Housing high or extra-high voltage apparatus & metering equipment

* All pole type sub-station are constructed and maintain in Accordance with rule 69

* Cable inside Sub-Station and Switch-Station containing Cable shall be filled with Sand or inflamable, non-explosable materials.

Rule-65 Voltage Tests.

* High or extra-high Voltage electric supply lines and apparatus of the Supplier shall not be connected unless the tests provided by the Indian Standard Institution is performed.

* If the normal working Voltage doesn't exceed 1000V, the testing Voltage shall be 2000 volts.

* If the normal working voltage exceed 1000 volt but doesn't exceed 11,000 Volt the testing Voltage shall be double the normal working voltage

* If the normal working voltage exceed 11,000 volt, the testing voltage shall be normal working Voltage plus 10,000 volt.

* The Supplier shall duly record the result of every test made under this rule.

Rule-66

Metal Sheathed electric supply lines: Precaution against excess leakage

* conductor shall be enclosed in metal sheathing which shall be electrically continuous and connected with earth.

* In the event of failure of insulation occuring between one conductor & the metal sheathing at any point along an electric supply line as a fore said, the impedance of the relevant ckt shall be such that current resulting from such failure shall not be less than twice the value of the current for which a suitable cut-out of adequate capacity or other suitable overhead protection device has been set to operate.

Rule-67

Connection with earth.

The neutral point shall be earthed by not less than two separate and distinct connection with earth each having its own electrode at the generating station and at the sub-station

* In the event of appreciable harmonic current in the neutral connection so as to cause interference with communication circuit the generator or transformer neutral shall be earthed through a suitable Impedance

* In the case of system comprising electric supply lines having concentric cables, the external conductor shall be the one to be connected with earth.

Rule-68

General condition as to transformation & control of energy.

Sub-Station & Switch-Station shall preferable be ground, but where necessary constructed underground. due Provision for ventilation & drainage shall be made.

* Sub-Station be effectively protected by fencing not less than 8 ft in highest so as to prevent Access to the electrical Supply lines and apparatus therein by an unauthorised Person.

Rule-69

Pole type Substation.

Where Platform type construction is used for a Pole type Sub-Station & sufficient space for a Personal to Stand on the Platform is Provided.

Rule-70

Condensers.

Suitable Provision shall be made for immediate & automatic discharge of every static condenser on disconnection of supply.

Over Head line (OH lines)

Rule-74

Material & Strength.

All conductor of over-head lines shall have a breaking strength of not less than 317.51 kg (700 lbs)

Rule-75

Joints: Joint shall be Mechanically and electrically secure under the condition of operation. The ultimate strength of joint set less than 95% of that of the conductor and electrical conductivity not less than Conductor.

Rule-75

Maximum Stress: factor of safety.

factor of safety expressed how much stronger a system is than it needs to be for an intended load.

Many systems are internally built much stronger than needed for normal usage to allow for emergency situation unexpected load, Misused etc

Building commonly use a factor of safety of 2 for each structural Building, Pressure vessels use 3.5 to 4 Automobile use 3' x aircraft → 1.2 to 3.0

The Minimum factor of safety for supports Based on crippling load
(1) metal supports → 2.0
(2) ~~Concrete~~ Concrete support → 2.5
(3) Wood supports → 3.5

→ Joints Between Conductor on over-head line shall be mechanically & electrically secure under the condition of operation.
→ The ultimate strength of the joint shall not be less than 95% of that the conductor & the electrical conductivity not less than that of the conductor.
→ Provided that no conductor of an overhead line shall have more than two joints in a span.

Rule-76 Maximum Stresses — factors of safety.

The owner of every overhead line shall ensure that it has the following minimum factors of safety

1. for ~~so~~ metal support → 1.5
2. for mechanically Processed concrete support - 2.0
3. for hand-moulded concrete support - 2.5
4. for wood support → 3.0

The minimum factor of safety for stay-wires; guard-wire ~~or~~ shall 2.5 based on the ultimate tensile strength ~~in this behalf~~ of the wire.

→ The minimum factor of safety for conductor shall be 2. Based on their ultimate tensile Strength.

1. Initail unloaded tension - 35%.
2. final unloaded tension - 25%.

Rule-77 Clearance above ground of the lowest conductor.

1. Low or medium voltage line → 19ft (5.791m)
2. High voltage line → 20ft (6.096m)

Service line erected across street line

1. low and medium voltage → 18ft
2. High voltage line → 19ft

Erected along a street line

Rule-78

Clearance Betn conductor & trolley wires.

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 and medium voltage → 4ft
(b) High voltage upto 11,000 volt → 6ft
(c) above 11,000 → 8ft
(d) Extra high voltage → 10ft

* Insulated conductor → 2ft.

Rule-79 Clearance from building of low and medium voltage lines and service line

*. vertical ~~clearance~~ clearance of 2.5 meters or 8 feet from the highest of point

* when the line passes adjacent to the building a horizontal clearance of 4 feet from a nearest point.

Rule-80

Clearance from Building of High and Extra-high voltage lines

Vertical Clearance

(a) ~~under~~ upto 33 KV → 12ft
(b) for extra high voltage line 12ft - plus 1 foot for every additional 33 KV.

Horizontal Clearance.

upto 11KV → 4ft
above 11 KV → 6ft
upto 33KV

for extra-high voltage line 6ft plus 1 foot for every addition 33 KV.

Rule-81

Conductors at different voltage on Same Supports

method of construction and the clearance between the conductor shall be approved by the inspector.

Rule-82 maximum interval Between Supports

Overhead lines carrying low or medium voltage conductor the interval shall ~~be~~ not exceed 67 meters.

Rule-~~83~~ 86 line crossing or approaching each other

The owner of the line which was last ~~ear~~ erected shall so protected it as to guard against the possibility of its coming into contact with the other overhead line.

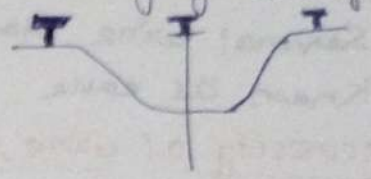
Rule-88 Guarding Guarding

Line Crossing Every guard wire shall be connected to earth at every point at which its electrical continuity is break.

* Every guard wire shall have an Actual Breaking Strength of not less than 635 kg and it made of iron or steel, shall be galvanised.

* Every guard wire shall be have Current Carrying Capacity

* where there is only one trolley wire, two guard-wire shall be erected



Rule-89

No service line shall be taken off from an overhead line except at a point of support

Rule-90 Earthing.

All metal supports of overhead lines and metalic fittings attached shall be Permanently & efficiently earthed.

* Each stay wire shall be similarly earthed unless an insulator has been Placed in it at height not less than 3.048 meter (10ft) from the ground.

Rule-91 Safety & Protected device.

use of guard wire & protection from unauthorised Person ascending using a ladder or special appliance.

Rule-92 Protection Against Lightening.

By using lightening arrester to divert lightning to ground.

ELECTRICAL INSTALLATION

WIRE:- single core strand may be bare or cover with insulations known as wire.
CABLE:-Several wire stranded together is known as cable. (Cover with insulation)

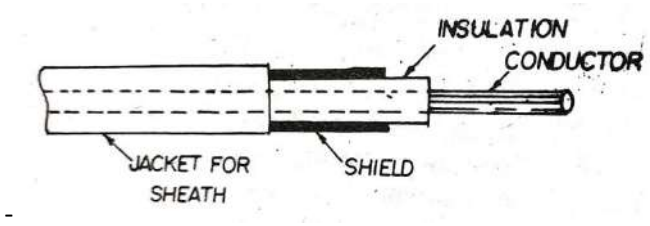
NECESSITY IN A CONDUCTOR/WIRE/CORE:

- Good conductor of electricity (low resistivity)
- Cheaper in cost.
- Safety (not provide leakage current)
- Easily available.
- High mechanical strength, durable.
- Melting point should be high.
- High resistivity to corrosion, oxidation, withstand dampness.
- High resistivity towards chemical reaction.

PARTS OF CABLE:

Cable consists of three parts

a) Conductor/Wire/Core
b) Insulation/Dielectric
c) Cable jacket



a) Conductor/core:-It carries current.
b) Insulation/Dielectric:-covering part is used to avoid leakage current from the conductor.
c) Cable jacket;-The protective covering for protection of insulation from mechanical damage.

CONDUCTOR MATERIAL USED IN CABLES:-

1. COPPER
2. ALUMINIUM
3. SILVER
4. GOLD
5. LEAD & TIN
6. STEEL
7. GALVANISED STEEL

1.COPPER:-

- It has high conductivity.
- Less resistivity, durable and ductile.
- Mechanically strong, hard
- High resistivity to corrosion, oxidation, high temperature.
- Welded easily, soldered.
- Cheaper in cost.

2.ALUMINIUM

- Cheaper in cost
- Long distance power distribution (use in place of copper for bare electric cable)

Aluminium	copper
1. Less conductivity than copper (60% of copper). 2. required Aluminium is 1.61times that of copper in volume.	1. More conductivity than aluminium.

INSULATING MATERIALS:- It is used to prevent the leakage current from conductor.

Properties of insulating material:-

- High resistivity.
- High flexibility.
- High dielectric strength.
- Non-inflammable (not catching fire easily/not inflammable).
- Non-hygroscopic (it does not absorb water and moisture from atmosphere).
- High resistive to moisture, acid, or alkalis.
- Capabilities to withstand high rupturing voltage and high temperature.
- Capability withstand wind, force, Iceland.

TYPES OF INSULATING MATERIALS:-

1.RUBBER

Advantages:-

- It has good dielectric strength(30KV/MM)
- It has high insulating properties.
- High relative permittivity.

Disadvantages:-

- It absorbed moisture.
- Often when heated to a temperature of 60 to 70℃
- Ages when expose to light.
- Deform when warm and brittle when cold.
- It is sticky in nature.
- So, hat pure rubber is not used for insulation.

2. VIR (VULCANISED INDIAN RUBBER)

Advantages:-

- It has great mechanical strength.
- It has good dielectric strength (60KV/MM)
- It has good insulating properties.
- It does not absorb moisture from atmosphere.
- It is Durable

VULCANISATION

- It is a chemical process for converting natural rubber to more durable material by adding of sulphur.

- Sulphur reacts with copper and corroded the copper surface. So this can be avoided by providing a tinned layers over the copper surface.
- It may be used in internal wiring and other low voltage insulation. (decoration)

3. SILK& COTTON:-

- This is used in low voltage cable.
- Conductors may have a single layer or double layer covering depending upon the requirements of service.
- Silk of cotton covered wires are usually used for instruments and motor windings

4. IMPREGNATED PAPER

Advantages:-

- It has high dielectric strength. (30 kv/ mm)
- It has good insulation resistance.
- It has low cost.

Disadvantages:-

- It absorbed moisture (hygroscopic in nature).So that it always provided with some protective covering and never left unshield.
- To make it noninflammable paper, impregnated with some compound like paraffin, napthenic and resin.

5. POLYVINYLE CHLORIDE (PVC)

- It has good dielectric strength.
- It has good insulating properties.
- Good mechanical strength.
- It does not absorb moisture.
- It does not reacts with acid & alkali (used in house wiring ,cable factories)
- It is used for low & medium voltage domestic & industrial light and power installation.
- It is low cost.

MECHANICAL PROTECTION

- Insulating materials are mechanically weak so protection against mechanical injury is required.
- Protection is provided by steel, aluminium on PVC covering.
- **Protection against damage & moisture.**

TYPES OF CABLES USED IN INTERNAL WIRING

The wire employed for internal wiring of building may be divided into different groups according to:-

1. Conductors used (according to the conductors material used in cable:-

a) Copper conductor
b) Aluminium conductor

2. According to the numbers of core in cables:-

a) Single core cable
b) Twin core cable
c) Three core cable
d) Four core cable

3. According to voltage grading, the cables are 2 types:-

a) 250/500 volt cable
b) 660/1100 volt cable

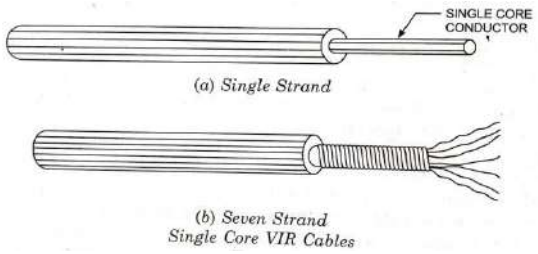
4. According to types of insulation the cables are:-

a) VIR insulated cables
b) TRS/CTS cables
c) Lead sheath cable
d) PVC Cable
e) Waterproof cable/weather proof
f) Flexible cord & cables

TRS-Tough rubber sheath
CTS-Cab tyre sheath

1. VIR INSULATED CABLE

- The cables are available in 250/500 volt and 660/1100 volt.
- It consists of tin & copper conductor covered with a layer of VIR Insulation.
- Over the rubber insulation cotton tap sheath covering with moisture resistance compound bitumen wax to make the cable moisture proof.
- Conductor reacts with VIR insulation therefore to prevent the reaction a tin layer is given in the conductor.
- VIR is used to protect the conductor from mechanical injury.
- Bitumen & cotton tap are used to protect the insulation from weather & moisture.

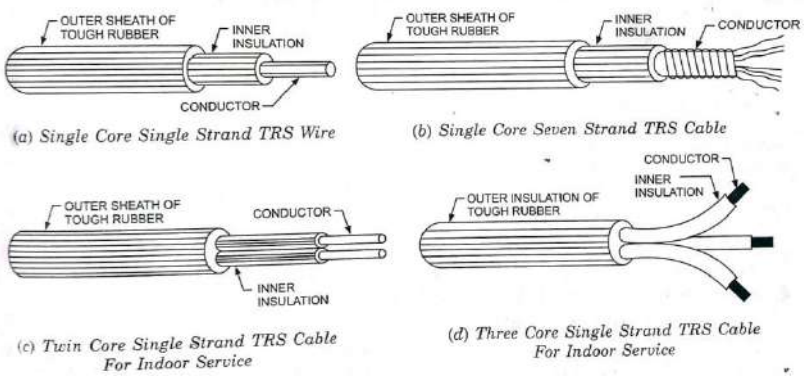


(a) Single Strand

(b) Seven Strand
Single Core VIR Cables

2. TRS/CTS CABLE

- These cables are available in 250/500 volt and 660/1100.
- TRS/CTS cable is vulcanized rubber, insulated conductor with an outer protective covering of tough rubber which provides additional insulation and protection against wear & tear.
- These cables are water proof and hence can be used in wet condition.
- This cable is available in single core, twin core, three cores etc.
- The cores are insulated from each other and covered with a common sheathing.



(a) Single Core Single Strand TRS Wire

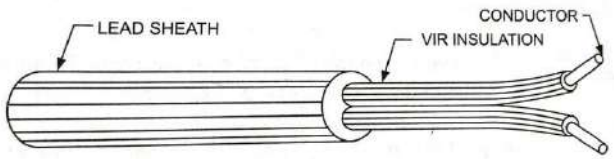
(b) Single Core Seven Strand TRS Cable

(c) Twin Core Single Strand TRS Cable For Indoor Service

(d) Three Core Single Strand TRS Cable For Indoor Service

3. LEAD SHEATH CABLE

- This cable is available in 250/500 volt.
- It consists of vulcanized rubber insulated conductors cover with a sheath of lead.
- The lead sheath provides a very good protection against the moisture and mechanical injury. So this can be used without casing or conduit system.
- This cable is available in single core, twin core, three cores etc.



2-Core Lead Sheathed Cable

4. POLYVINYL CABLE (PVC)

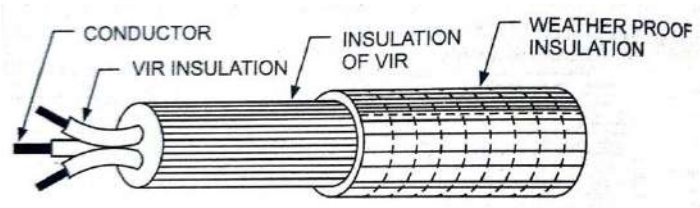
- These cables are available in 250/500 volt & 660/1100 volt grade.
- It is used incasing-capping, batten& conduit wiring system.
- Since PVC is harder than rubber it does not require cotton tapping over it for mechanical and moisture protection.
- These type cable conductors are insulated with PVC insulation.

ADVANTAGES

- Better insulating properties.
- Low cost
- Better flexibilities.
- No chemical effect on metal of the wire.

5. WEATHER PROOF CABLE

- These cables are available in 250/600 volt and 660/1100 volt grade.
- These cables are either PVC or VIR insulated conductors and then compounded with weather resisting material.
- These cables are not affected by heat, sunlight, rain.
- It is used for outdoor wiring, power supply or industrial supply.



3-Core Weather Proof Cable

6. FLEXIBLE CORD & CABLE

- It consist of wire silk, cotton, plastic covering.
- Flexible cord have tin-copper conductor.
- Flexibilities and strength is obtained by using conductors having large no. of strand.
- This wire or cable are used as connecting wires for such purpose as from ceiling rose to lamp holder ,socket outlet to portable apparatus such as fan ,lamp, heater ,etc.

MULTISTRAND CABLE

- Advantages of multi strand cables w.r.t single solid conductors.
- Multi strand cables are more flexible and durable and therefore can be handle conveniently.
- The surface area of multi strand cable is more as compare to the surface area of equivalent single solid conductor .so heat radiating capacity is more in multi strand cable because of its large area.
- Skin effect is better as conductors are tubular, specially in case of high frequency.
- The no. of strand is stranded cable must be 3,7, 19, 37, 61, 91 etc.

VOLTAGE GRADING OF CABLES:-

- This specifies the safe voltage which the insulation of the cable can withstand.
- The cables employed for domestic wiring are graded as 250/500 volt & 660/1100 volt grade.

GENERAL SPECIFICATION OF CABLES:-

1. SIZE OF CABLE:
   19/24
   19-No. of strand in cable 24-diameter of each strand in mm
2. Types of conductors used in cable (co & Al)
3. The no.of core that cable consists of (single core, twin core ,three core ,four core)
4. Voltage grading (250/500 volt & 660/1100 volt grade)
5. Types of cable with clear description regarding insulation, shielding etc.(PVC etc.)

<u>LIGHTING ACCESSORIES AND FITTINGS</u>

1. SWITCH
2. CEILING ROSE
3. SOCKET OUTLET
4. PLUGS
5. LAMP HOLDER

1. SWITCHES

- A switch is used in an electric circuit as a device for making or breaking the electric ckt in a convenient i.eis by the simple motion of handle or knob to connect together or disconnect two terminal to switch cables or wires are connected.

2. TYPES OF SWITCH:-

a) ACCORDING TO THE TYPE OF BASE MATERIAL:-

- Porcelain switch(high rating)
- Bakelite switch(low rating)

b) ACCORDING TO THE COLOUR

- black
- white
- Brown

c) ACCORDING TO OPERATION

- One way switch
- 2 way switch
- 2 way centre off switch
- Double pole main switch
- Single pole single throw

- Single pole double throw
- Double pole double throw
- Double pole main switch
- Single pole main switch

1. **ONE WAY SWITCH**
   - 6 amp,250 volt --------light load (fan, tube light)
   - 16 amp,250 volt -------heavy load(washing machine, heater, AC etc)

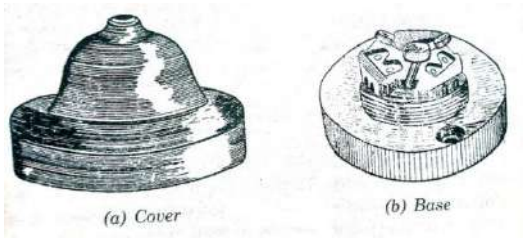
2. **TWO WAY SWITCH**
   - The switch of this type consist of 3 or 4 terminals
   - The switch of this type is usually used for staircase wiring orckt where one point is to be controlled from two different places.
   - 6 amp, 250volt -------(light load)

Connection diagram of 2 way switch

3. **2 WAY CENTRE OFF SWITCH**
   - 6 amp ,250 volt

4. **SINGLE POLE MAIN SWITCH**
5. **DOUBLE POLE MAIN SWITCH**
6. **SINGLE POLE SINGLE THROW**
7. **SINGLE POLE DOUBLE THROW**
8. **DOUBLE POLE DOUBLE THROW**

<u>CEILING ROSE</u>



- The ceiling rose is used to connect the pendent lamp, fan and fluorescent tube to install through flexible wire.
- It consists of 2 parts

1. Base 2.cover

It is made of bakelite, porcelain

TYPES OF CEILING ROSES

1. 2-way ceiling rose:-
   It is fitted with two terminal plate.
2. 3-way ceiling rose:-
   It is fitted with 3 terminal plates. Rating 6A, 250 volt

SOCKET OUTLET:-

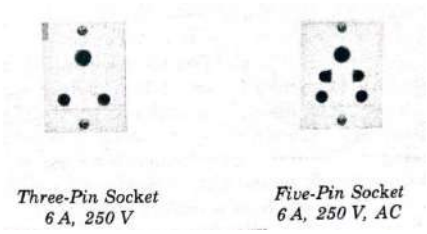
The socket outlet are used to supply outlet connection when ever required for electrical appliances such as TV, iron table fan.

TYPES OF SOCKETS

1 PIN SOCKETS

3 PINSOCKETS

5 PIN SOCKETS



Three-Pin Socket 6 A, 250 V

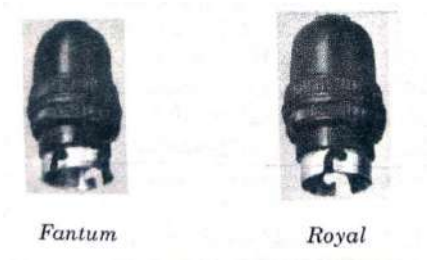
Five-Pin Socket 6 A, 250 V, AC

LAMP HOLDER:-

- It is used to support the lamp and also to connect of electricity.
- These are design for quick removal,replacement. Of the lamp.
- It is made of Bakelite with porcelain interiar.

TYPES OF LAMP HOLDER:-

1. Pandent holder
2. Angle holder
3. Slanting holder



Fantum

Royal

PLUG:- Plugs are use to connect the supply from the socket outletfor electrical appliances such as TV, Iron

2pin plug

3pin plug

PARALLEL OPERATION ADVANTAGES

- The supply voltage is uniform in each load.
- In case the light or same other equivalent goes out of order, it will not affect the supply of current to other light etc as each one of them is individually connected to line.
- The voltage in the ckt will be uniform and every will glow with full brightness.

SERIES CONNECTION

- The ckt useful for decorative lighting for marriage and other places where groups of lamps are tobe control by switch instead of placing separate switch for each light.
- The major disadvantages areof one light goes out of order , light and other equipments in that ckt will go off . As the flowof current from one point to other is stop.

SERIESPARALLEL CONNECTION

2 way centre off switch

Series parallel ckt are used either to provide deam light or full bright light through the same lamp by using special switch such as two way centre off switch .

To operate either both lamp in series or parallel by wing two pole double throw switch

FUSE

It is a simple and cheapest device used for interupturing and electrical ckt under short ckt or over load condition.

- The action of a fuse is based upon the heating effect of the electric current.

ADVANTAGES

- It is cheaper form of protection available.
- It needs no maintenance.
- Its operation is completely automatic.
- It interrupt huge short ckt current without noise, gas, smoke.

DISADVANTAGE

- Considerable time is lost in running or replacing a fuse after operation.

FUNCTION OF WIRE

- To carry the current working current flow without heating.
- To break the ckt when the current exceed the limiting current.

FUSE ELEMENT MATERIAL

- The material used fuse elements must be of low rating point ,high conductivity , low cost and from deterioration.
- The material commonly use for fuse elements are tin, lead ,copper, zinc, aluminium and alloy of lead and tin(60+40)
- Fuse element is a low melting point material such as tin, lead and zinc.
- The alloy of lead and tin is used for small current for fuse (up to 15 amp)

Metals	Melting point
silver	980
tin	240
zinc	419
lead	328

copper	1090
aluminium	665

- Beyond 15 amp rating ckt copper wire fuse are used.
- Either copper or lead tin alloy is mostly used as an ordinary use wire.

TYPES OF FUSE:-

- Supply main fuse

This fuse is provided by the supplier and is fixed just before the service meter .The rating of supply main fuse will be as from bad current of the consumers.

- Consumers main fuse

  This is another fuse of rating slightly less than that of supply main fuse and placed after the consumers main switch.

3.SUB CKT:-

The total wiring system is divided in to no. of sub ckt or branch. A separate fuse is provided for each branch ckt and is known as sub. Ckt or branch ckt fuse.

POINT FUSE :-

In good quality indoor wiring in building light and plug point is provided with its individual fuse known as point fuse.

IMPORTANT DEFINATION (2 MARK)

FUSE:-

Fuse is a current interrupting device which break or open the ckt by fusing the elements when the current in the ckt exceed a certain voltage.

FUSE ELEMENTS OR FUSE WIRE:-

It is that point of the fuse which actually melt when an excessive current flow in the cktr and thus isolate the faulty device from the supply.

CURRENT RATING:-

It is define as the rms value of current which the fuse wire can carry continuously without deterioration and with temperature rise with in specific limit.

FUSING CURRENT;-

It is define as the minimum value of current at which the fused elements or fuse wire melt. Its value will be more than current rating of the fuse element for a round wire the appropriate value of fusing is given by

$$I=Kd^{\frac{3}{2}}$$

Where k= fuse constant, depend upon the metal of the fuse elements

d =diameter of the wire

The fusing current depends upon various factor such as

1. Types of metal used.
2. The cross sectional area i.e whether round or regular section
3. Diameter of the wire
4. Types enclose employed
5. Type of surface (stranded)

The fusing current for stranded fuse will be less than the product of the fusing current one strand and the no. of strand.

DETERMINATION OF SIZE OF FUSE WIRE

1. Factors responsible for deteriorating the size of the fuse wire in an installation are:-
    - Maximum current rating of the circuit.
    - Current rating of the smallest cable in the ckt protect by the fuse.

EARTHING CONDUCTOR:-

- Earthing conductor is of v high conductivity material specially we i. E copper & G.I wire.
- I should be protect against mechanical injuries in corrosion.

WHAT IS EARTHING;-

Connection of non-current carrying part of electrical apparatus such as metallic frame, metallic covering of cables, earth terminals of sockets outlet, stay wire etc to the general mass of earth in such a manner that at all time an immediate discharge of electric energy taken place without danger.

EARTHING IS PROVIDED

- To avoid electric shock to the human beings
- To avoid risk of fire due to earth leakage current through unwanted path.

IS SPECIFICATION REGARDING EARTHHING OF ELETRIC INSTALLATION:-

Distance of earth from building

An earthing electrode shall not situated with in a distance of 1.5 mt from the based where installation system is being earthed.

SIZE OF EARTH CONTINUITY CONDUCTOR (ECC)

The conductor which is used to connect the body of an equivalent or connected to the earth is known as earth continuity conductor. It should not be less than 2.9 mm2 or half of installation conductor size.

RESISTANCE OF EARTH:-

- The earth resistance should be low enough to cause flow of current.
- The value of earth resistance does not remain constant but change with the weather at its depend upon the moisture contain of the soil and is maximum during dry season.
  For large power station =0.5 Ω
  Major power station=1.0 Ω
  Small substation=2.0 Ω
  In all other cases=5 Ω maximum
- The earth wire and earth electrode shall be of same material:-
  The earth wire shall be taken through G.I pipe of 13mm diameter for at least 30 cm length below ground surface to the earth electrode to protect it against mechanical damage.
- The earth electrode shall always be placed in vertical position inside earth or pit so that it may be in contact with all the different earth layers.

It is made of bakellite , porcelain

SOCKET OUTLET:-

The socket outlet are used to supply outlet connection when ever required for electrical appliances such as TV, iron table fan.

LAMP HOLDER:-

- It is used to support the lamp and also to connect of electricity.

- These are design for quick removal, replacement. Of the lamp.
- It is made of Bakelite with porcelain interiar.

TYPES OF LAMP HOLDER:-

4. Pandent holder
5. Angle holder
6. Slanting holder

CONNECTION

1. PARALLEL CONNECTION:-

NO. OF WIRE	1	2	3	4	7
FUSING CURRENT	1	1.667	1.25	2.75	4

FUSING FACTORS:-

It is the ratio between minimum fusing current to the current rating of fusing elements is known as fusing factor and it is always greater than unity.

$$\text{Fusing factor}=\frac{minimum\ fusing\ current}{current\ rating\ of\ fusing\ element}$$

DETERMINATION OF SIZE OF FUSE WIRE:-

Factor responsible for determining the size of fuse wire in an installation are

1. Maximum current rating of the circuit.
2. Current rating of the smallest cable in the circuit protected by the fuse.

EARTHING CONDUCTOR:-

- Earthing conductor is of high conductivity material specially we use copper and G.I wire.
- It should be protected against mechanical injury and corrosion.

EARTHING:-

Connection of non-current carrying part of electrical apparatus such as metallic frame ,metallic covering of cables ,earth terminals of socket outlet, stay wire etc to the general mass of earth in such a manner that at all times an immediate discharge of electric energy takes place without danger.

Earthing is provided

- To provide electric shock to the human beings.
- To avoid risk of fire due to earth leakage current through unwanted path.

IS SPECIFICATION REGARDING EARTHING OF ELECTRICAL INSTALLATION

1. Distance of earth from Building

   An earth electrode shall not be situated within a distance of1.5m from the building whose installation is being earthed.

2. Size of earthed continuity conductor
   - The conductor which is used to connect the metal body of an equipments or appliances to the earth is known as earth continuity conductors (ECC).
   - It should not be less than 2.9mm^2 or half of installation conductor size.
3. Resistance of earth
   - The earth resistance should be low enough to cause flow of current.

- The value of earth resistance does not remain constant but change with the weather as it depends upon the moisture contents of the soil and is maximum during dry season.
  Large power station =0.5Ω
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  Small sub-station=2Ω
  In other all cases=5Ωmaximum
- The earth wire and earth electrode shall be of same material.
- The earth wire shall be taken through G.I pipe of 13 mm diameter for atleast30 cm length below ground surface to the earth electrode to protect it against mechanical damage.
- The earth electrode shall always be placed in vertical position inside the earth or pit so that it may be in contact with all the different earth layer.
- All the earth wire run along the various sub circuit shall be terminated and looped firmly at the main board and from main board, the main earth shall be taken to the electrode.

POINT TO BE EARTH

- Earth pin of 3- pin& 5- pin socket should be permanently and efficiently earth.
- All metallic covering containing or protecting any electric supply line or apparatus such as iron clad switches ,iron clad distribution fuse board, G.I pipes and conduit enclosing VIR or PVC cable etc should be connected to earth.
- The frame of energy generator, stationary motor ,portable motor and the metallic part of all transformer and any other apparatus used for regulating and controlling energy and all medium voltage energy consuming apparatus should be a earth by two separate different connection with earth.
- Fabricating steel ,transformer line tower, tubular steel or rail poles carrying overhead conductor should be earthed.
- Stay wire provide for overhead lines should be connected to earth buy connecting at least one strand of the earth wire .
- The neutral conductor of a 3phase, 4 wire system and the middle conductor of a 2pjase ,3 wire system should be earthed by two separate and different connection in earth at the generating station and at the substation.

DETRMINATION OF SIZE OF EARTH WIRE AND EARTH PLATE FOR DOMESTIC OF MOTOR INSTALLATION

CONDUITS ACCESSORIES& FITTINGS

1. CONDUIT COUPLER
   It is used to joint two length of conduit. The length of screw conduits are always threated at both end on outer side.
2. GRIP COUPLER

In grip coupler, no extra labour is required for making threads. The ends of conduits are placed in the grip coupler and screw it tightly.
It is covered above two conductor and the screw is used to make it tight.

2. FLEXIBLE CONDUIT COUPLER

For coupling a flexible conduit to the rigid conduit a combine coupling is used.

3. BENDS ,ELBOW, & TEES

BEND:- Bends are usually used for change in direction of conduit.

ELBOW:

Elbows are of shorter radius, are only used where sudden right turn is required.`

TEES

CONDUIT BUSHINGS

This are used when the rigid conduit enter the conduit box or a hole which is not threaded.

This are used to prevent cable from being cut by the edges.

It is up two types.

a) Male -outer threads
b) Female-inner threads

CONDUIT REDUCER

Conduit reducers are used when the size of conduit change.

Conduit reducer have both male & female threads.

FIXING OF CONDUIT

It is used to fix the conduit over the wall.

CLIP:- Clip are used for fixing the conduit on rough brick walls and in concealed wiring.

SADDLE:

Saddle are used for fixing the conduit where clips cannot provide a firm enough hold or a single screw cannot be dependent upon for fixing.

LOCKNUTS/CHECK NUTS:

This are used when rigid conduit enter a conduit box.

CONDUIT NIPPLES

This serve the same purpose as conduit bushing.

This are rarely used due to their higher cost.

CONDUIT BOXES

The conduit boxes are used in surface conduit wiring as well as concealed conduit wiring. It serve the following purpose.

It is used to provide connection to rigid fan and other point.

For pulling of cable into the conduit. Boxes serving this purpose are known as inspection box . this are provided after every 30 cm length straight run.

For housing junction of cables, the conduit boxes serving this purpose are known as junction box.

WIRING SYSTEM

A network of wires connecting various accessories for distribution of electrical energy from the supply meter board to the numerous electrical energy consuming device such as lamps & fan and other domestic appliances through controlling & safety device is known as wiring system.

TYPICAL HOUSE WIRING SYSTEM

SYSTEM OF DISTRIBUTION OF ELCTRICAL ENERGY

As per recommendation of Indian standard, the maximum number of points of light, fan and 5A sockets outlet that can be connected in one circuit is 10and the maximum load that can be connected in such circuit is 800 watt, in case more load or points are required to be connected to the supply, then it is to be done by having more than one circuit.

The system of distribution of electrical energy is two types

1. Distribution board system
2. Tee system

DISTRIBUTION BOARD SYSTEM

TEE SYSTEM

METHODS OF WIRING

Therearetwo methods of wirings known as joints box system (tee system)and loop in system wiring.

JOINTS BOX/ TEE SYSTEM

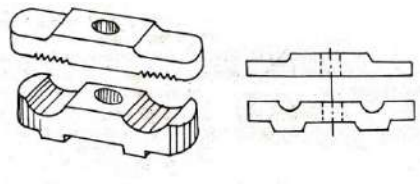
CHAPTER-3 INTERNAL WIRING

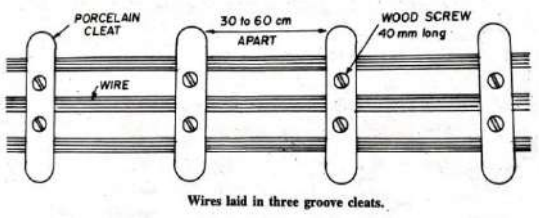
TYPES OFINTERBNAL WIRING

Following are the type of internal wiring usually employed in industries and house wiring;-

1. Cleat wiring
2. Wooden casing & capping wiring
3. C.T.S/T.R.S or batten wiring
4. Lead sheathed or metal sheathed wiring
5. Conduit wiring

1. CLEAT WIRIG





Wires laid in three groove cleats.

- In this type of internal wiring the cable used are either VIR or PVC.
- The cables are held by porcelain, cleat above wall or ceiling.
- The cleats are made in two halves one is base and other is cap.
- The base is groove to accommodate the cable and the cap is put over it and a whole of it then screwed on wooden plug (guttis) over the wall or ceiling.
- The cleat are up three types
    - One groove-one cable
    - Two groove-two cable
    - Three groove-three cable

- The cleat should be usually used at interval of 30 cm and in no case at more than 60 cm.

ADVANTAGES

- It is cheapest system of internal wiring.
- It's installation and dismantlement is easy and quick.
- Inspection, alternation and addition can be easily made.
- Skill required is little.

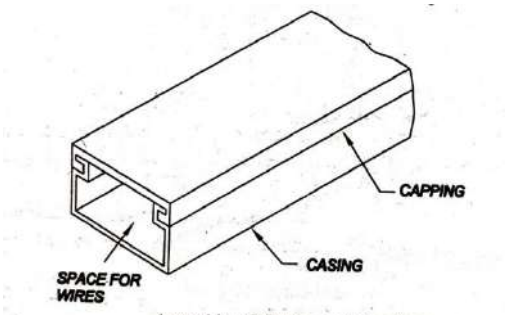
DISADVANTAGES

- It is not good looking.
- It is quite temporary & destroy quickly.
- The insulation dampness from the atmosphere hence this system of wiring can be used in damp place.
- Oil& smoke are injurious to VIR insulation.

FIELD APPLICATION

- The wiring of this type is very suitable for temporary installation in dry places, where appearance is not so important and cost is the main consideration.

2. WOODEN CASING & CAPING WIRING



Assembly of Casing and Capping.

- This is one of the earliest systems of wiring.
- The cables used in this type of wirings are either VIR or PVC.
- It has two halves, one is casing and another is capping.
- The casing consist of V – shaped grooves and is covered at the top buy means of rectangular strip of wood known as capping.
- The varnished is used to protect wood from white ants.

ADVANTAGES

- Cheaper in cost as compare to lead sheath wiring.
- Easy to install and rewire.
- It provides good insulation as conductors are at a good distance apart.
- Easy to inspect by opening the capping.

DISADVANTAGES

- This type of wiring is also coated with pain to varnish to protect from dampness. So it can be used in damp place.
- Since there is a risk of fire. It cannot be used where there is a possibility of fire hazard.
- This type of wiring can be used only on surface and can be concealed in plaster.
- Since it require better work skills, the labour cost is higher.

FIELD APPLICATION

- This type of wiring is suitable for low voltage domestic installation in dry places and where there is no risk of fire.

PVC CASING & CAPING WIRING

- Due to increased cost of teak wood, the wooden casing & capping are becoming absolute and PVC casing &capping are being used.
- This type of wiring is achieved by using hollow channel made of PVC plastic.

3. C.T.S/ T.R.S OR BATTEN WIRING

T.R.S-Tough rubber sheathed wiring
C.T.S-Cab Tyre sheathed wiring

- In this type of wiring the cables used may be single core, twin core or three core T.R.S cable with a circular shape.
- T.R.S cables are sufficiently chemical proof, water proof, steam proof but are slightly affected by lubricating oil.
- T.R.S cables are run on perfectly straight and well varnished teak wood batten.
- The width of batten depends upon number and size of cables to be carried by it.
- The wood battens are screw to wood by plugs at an interval not exceeding 75 cm.
- The cables are held on the wood batten by means of tin-brass links clips at an interval of 10 cm or 15cm.

ADVANTAGES

- Its installation is easy and quick.
- Its life is sufficiently long.
- Within certain limits it is fire proof.
- It can withstand the action of most chemical such as acids &alkalis.
- It is cheaper than other types of wiring excepts cleat wiring.
- If the job is carried out with a care it gives a nice appearance.

DISADVANTAGES

- Good workmanships is required forth is type of wiring.
- This type of wiring cannot be recommended for use in situation open to sun & rain

FIELD APPLICATION

- The T.R.S wiring is suitable for low voltage installation in domestic & commercial building.
- It cannot be used in damp places.

4 .LEADSHEATHED / METAL SHEATHED WIRING

- In this type of wiring the cables used are T.R.S or P.V.C with an outer covering of sheath of lead aluminium alloy containing about 95% of lead.
- This metal sheath protection to the cables from mechanical injuries, dampness and atmospheric corrosion.
- The whole lead covering is made electrically continuous and is connected to earth at the point of entry to protect against leakage current.

ADVANTAGES

- It provides protection against mechanical injuries better than that of T.R.S wiring.
- It is easy to fix and look nice.
- Its life is long if proper earth continuity is maintain throughout.
- It can be used in damp situation provided protection against moisture.
- It can be used in situation exposed to rain & sun.

DISADVANTAGES

- It is costlier than T.R.S wiring.
- In case of damage of insulation the metal sheath becomes alive and gives shock.

- Skilled labour & proper supervision is required.

5.CONDUIT WIRING

- In this system of wiring al wires are enclosed in steel pipe known as conduit (PVC or VIR).
- There are3types of conduit wiring
    1. Concealed conduit wiring.
    2. Surface conduit wiring
    3. Flexible conduit wiring

1. CONCEALED CONDUIT WIRING

- The conduit are embedded along wall or ceiling in plaster at the time of construction.
- The conduit should be electrically& mechanically continuous and connected to earth at suitable place through earth wire.
- The conduit used for this purposes is up two types.
    1. Light gauge conduit
    2. Heavy gauge conduit
- PVC conduit pipes are also available now and are increasing being employed in place of steel conduit.
- PVC. Conduits are cheaper in cost. It required less time to install. Such conduits are resist to acids, alkalis, oil & moisture.

2.SURFACED CONDUIT WIRING

- The conduit in surface conduit wiring is placed on the surface of the wall and hold with the of conduit saddle.
- This system of wiring is applied in the industrial wiring.

3.FLEXIBLE CONDUIT WIRING

- The flexible conduit pipe is a pipe which can bend or twist without the change in its diameter.
- The flexible conduits are not used for general electrical wiring system. it is used for connecting rigid conduit with machine terminal box in case of motor wiring, energy meter and main switch in case industrial & domestic wiring system.

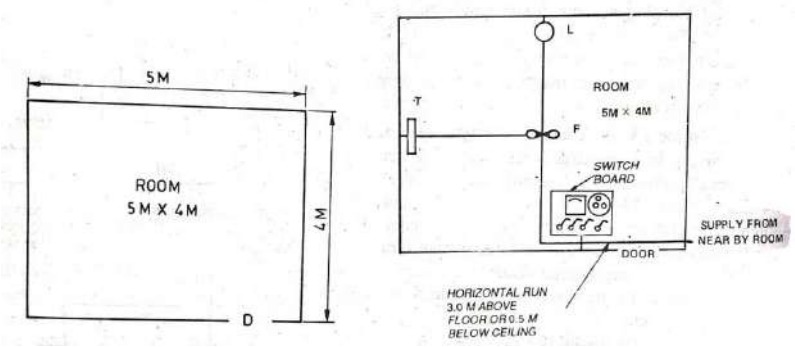
ADVANTAGES

- It provides protection against mechanical damage.
- The whole system is water proof.
- Replacement and alternation of defective wiring is easy.
- Its life is long if the work is properly executed.
- It is shock proof if earthing &bonding is properly done.

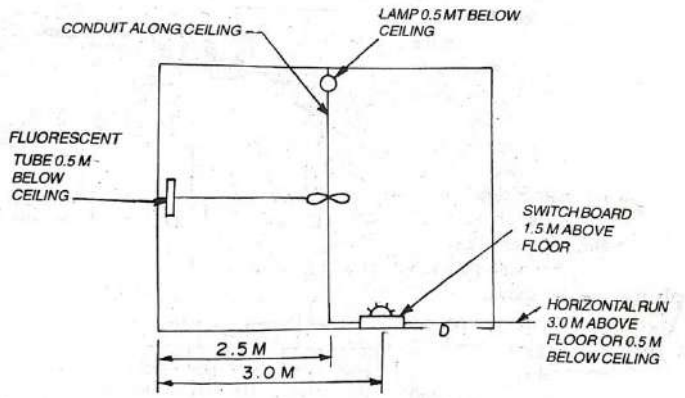
DISADVANTAGES

- It is a very costly system of wiring.
- Experience & highly skilled labour needed for carrying out the job.

Q.1 The plan of a single room of size 5mtsX4mts is given below .The room is required to be provided with one lamp, one fan, fluorescent tube and one 5 Amp socket –outlet. Each of the points is controlled by its individual switch. Mark the location of the electrical points suitably and draw the installation plan. Also draw the wiring diagram. Calculate the total length of wire and other materials and prepare complete list of materials required for wiring the room in concealed steel conduit system of wiring .No main switch is to be provided as the entry of the sub-circuit is from adjoining room.



Solution



Installation plan

Assume

a) Total height from floor to ceiling=3.5 mts
b) Height of H.R from floor=3.0 mts
c) Height of switch board from floor=1.5mts
d) Light and tube points from ceiling=0.5 mts

Calculation for length of conduits pipe of 20 mm diameter

from SB to HR=1.5 mts
from entry of circuit into room upto take off points=2.0+0.5=2.5mts
from HR to lamp point=0.5mt+4+0.5=5mts
from fan to tube points=2.5+0.5=3 mts
total length of conduit pipe=(1.5+2.5+5+3)mts=12mts
taking 10% for wastage=1.2 mts
total length of conduit pipe required for wiring the room=13.2 mts

Calculation for length of phase wire

from point of entry of circuit into room upto SB= 2(HR)+1.5(VR)=3.5 mts
from SB to fan =1.5(VR)+0.5(HR)+0.5+2=4.5mts

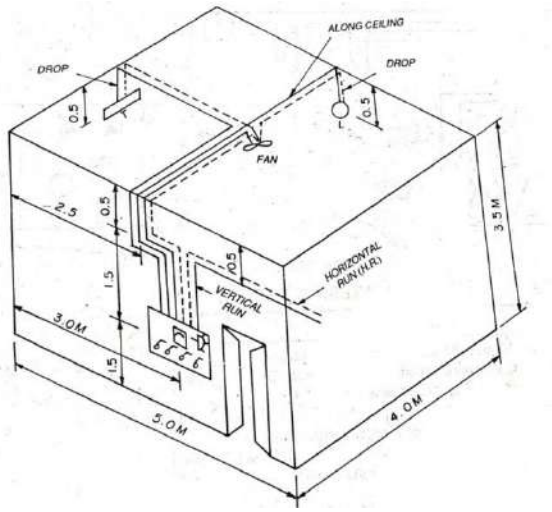
from SB to lamp=4.5+2+0.5=7 mts
from SB to tube point=4.5+2.5+0.5=7.5 mts
total length of phase wire=(3.5+4.5+7+7.5)mts=22.5mts
taking 15% for wastage=3.37mts
total length of phase wire required for wiring the room=22.5+3.37=25.075mts

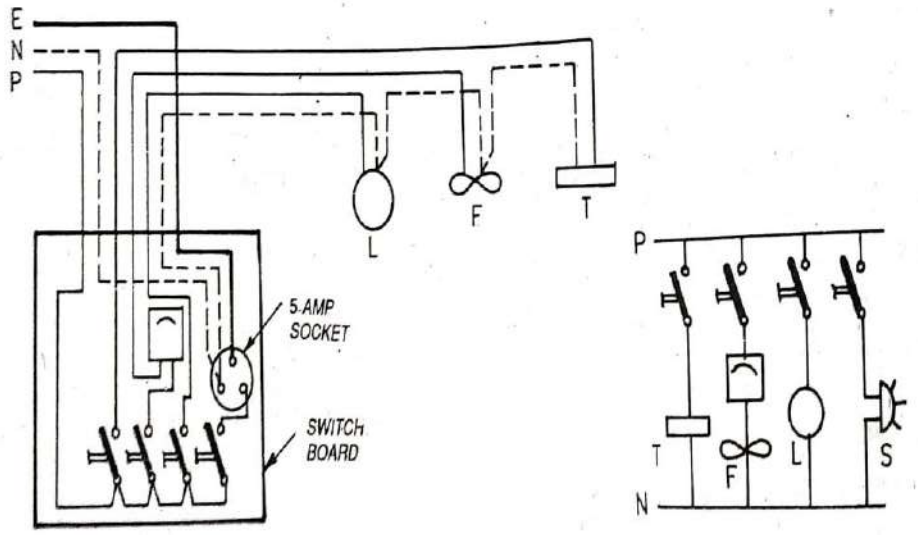
Calculation for length of neutral wire

from point of entry of circuit into room up to SB= 2(HR)+1.5(VR)=3.5 mts
from SB to fan =1.5(VR)+0.5(HR)+0.5+2=4.5mts
from fan to lamp points=2+0.5=2.5mts
from fan to tube point=2.5+0.5=3mts
total length of neutral wire=(3.5+4.5+2.5+3)mts=13.5mts
taking 15% for wastage=2.02
total length of neutral wire required for wiring the room=13.5 +2.02=15.52mts

calculation for length of earth wire (14 SWG)

length of earth wire=0.25 mt.

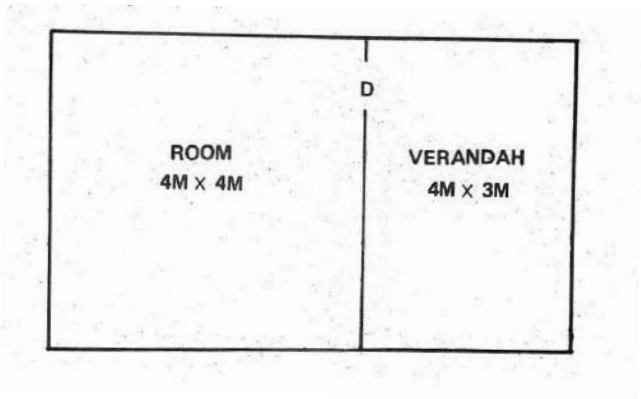




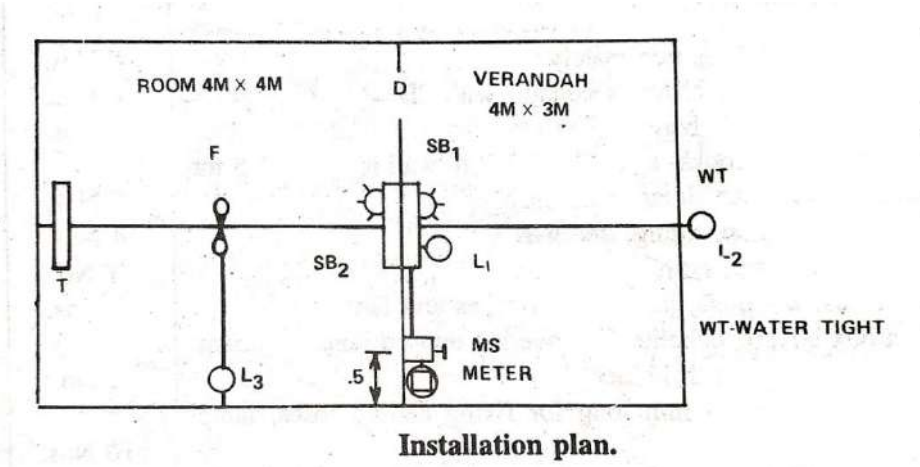
Material Table

Si no.	description of materials with specifications	Quantity
1	total length of conduit pipe (20 mm dia)	13.2 mts
2	total length of phase wire (1 mm^2)	25.075mts
3	total length of neutral wire(0.5 mm^2)	15.52mts
4	total length of earth wire(14 SWG ,G.I)	0.25 mt.
5	Conduit pipe accessories for 20 mm dia a. 1-way junction box b. 2-way junction box c. 3-way junction box d. Conduit bends	 2 nos 1no. 2nos. 3nos.
6	One way switch,5 amp ,rating	4nos.
7	Socket,5 amp rating, 3 pin	1nos.
8	Ceiling rose, 2-plate,bakelite	2nos.
9	Lamp brass bracket with holder	1nos.

Q.2 A room and a verandah ,the plan of which is given below is required to be provided with electrical wiring. Mark the location of energy meter, main switch and switch board and electrical points suitably and draw the installation plan showing supply path to each points and wiring diagram .calculate the total length of wire required for wiring the room and verandah in batten system of wiring. Prepare a list of materials with complete specification of each item with approximate cost.



Solution



Installation plan.

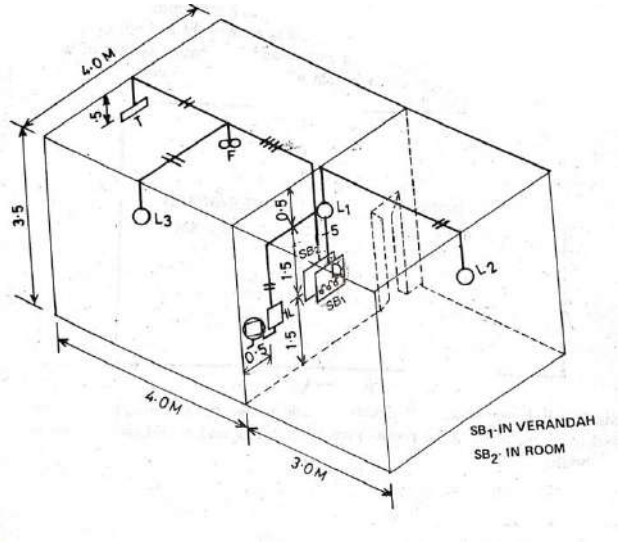
Assume

a) Total height from floor to ceiling=3.5 mts
b) Height of H.R from floor=3.0 mts
c) Height of switch board from floor=1.5mts
d) Light and tube points from ceiling=0.5 mts

e) Location of energy meter and main switch board=0.5 mt. inside verandah on room wall

Calculation of load

Lamps= 3X60 W=180W
Fan=1X60W=60W
Socket outlet 5 amp.=2X100W=200W
Fluorescent tube=1X40W=40W
Total connected load=480W
Load in ampere=480W/230V=2.1 amp



Selection and rating of main switch

Rating of DPIC , Main switch =5 ampere ,250 volt grade

Selection and rating of Distribution board

There are only seven light/fan/socket points, hence no distribution board will be used

Calculation for length of batten

from main board to HR=1.5 mts =13mm X13mm (2 wire)
from SB_1 to HR =1.5mts=31mm X13mm (5wire)
from SB_2 to HR=1.5mts=25mm X13mm (4wire)
from HR above main board to L_1=1.5mts=13mm X13mm (2 wire)
from L_1 to L_2=0.5+3+0.5=4mt=13mm X13mm (2 wire)
from HR above SB_2 to fan =0.5+2=2.5 mts=25mm X13mm (4wire)
from fan to L_3=2+0.5=2.5mt=13mm X13mm (2 wire)
from fan to tube point=2+0.5=2.5mt=13mm X13mm (2 wire)

total length of batten of size
13mm X13mm=1.5+1.5+4+2.5+2.5=12mt
25mm X13mm=1.5+2.5=4mt
31mm X13mm=1.5mt

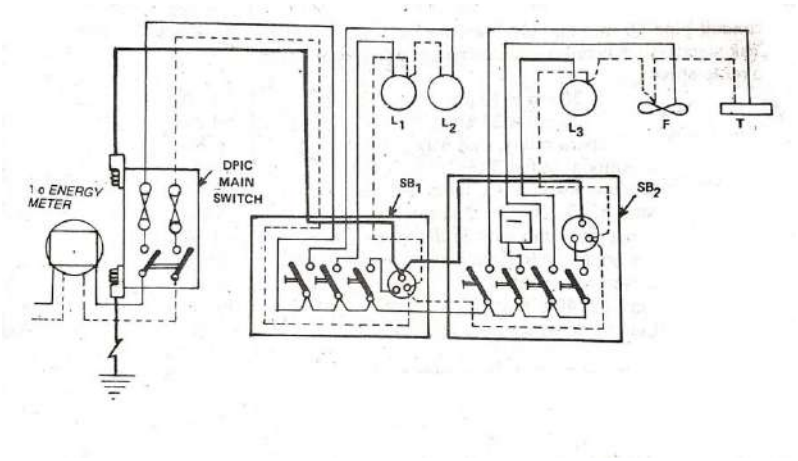
taking 10% for wastage which is required for wiring the room
13mm X13mm=12mt +1.2=13.2 say 13mt
25mm X13mm=4mt+0.4=4.4mt say 4.5 mt
31mm X13mm=1.5mt+0.15=1.65 mt say 2mt

Calculation for length of aluminium conductor VIR wire of size 1.5 mm^2

13mm X13mm=12mtX 2 wire=24 mts
25mm X13mm=4mt X 4 wire=16 mts
31mm X13mm=1.5mt X 5 wire=7.5 mts

total length of wire on batten=47.5mts
taking 15% for wastage=7.2mts
total length of phase wire required for wiring the room=47.5+7.2=55.7mts say 56mts

calculation for length of earth wire (14 SWG)
from MS to SB_2 through SB_1=1.5+1.5+1.5+0.25(thickness of wall)=4.75mts
taking 15% for wastage=0.47mt
taking 10% for wastage which is required for wiring the room=4.75+0.47=5.2 mts say 5.5 mts



Material Table

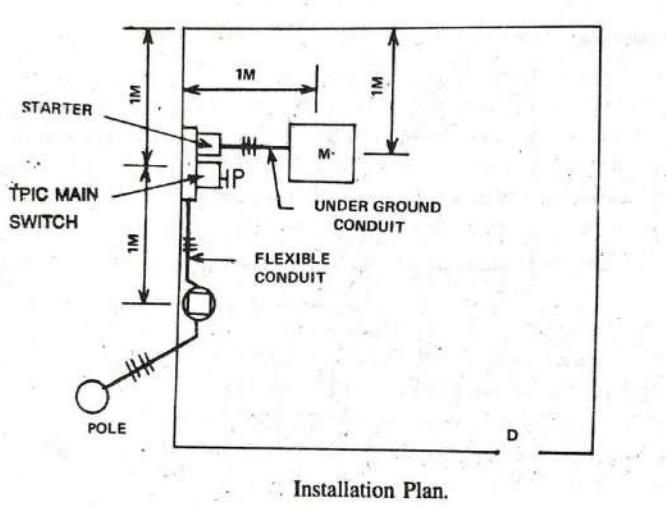
Si no.	description of materials with specifications	Quantity
	DPIC main switch 5 amp rating,250 volt grade with fuse and NL	1no.
1	total length of Different size of Batten 13mm X13mm 25mm X13mm	 13mt 4.5 mt

	31mm X13mm	2mt
2	total length of phase & neutral wire (1.5 mm^2)	56mt
4	total length of earth wire(14 SWG ,G.I)	5.5 mts
5	Conduit pipe accessories for 20 mm dia a. 1-way junction box b. 2-way junction box c. 3-way junction box d. Conduit bends	 2 nos 1no. 2nos. 3nos.
6	One way switch,5 amp ,rating	6nos.
7	Socket,5 amp rating, 3 pin	2nos.
8	Ceiling rose, 2-plate,bakelite	2nos.
9	Lamp brass bracket with holder	2nos.
9	Link clip,aluminium 40 mm long (10 cm apart)	300 nos
9	Black enamel nails to fix clips with batten	100 gms
9	Teak wood plugs (guttis) at 0.75 mt interval	30nos.
9	Earthing thimbles 5 amp rating for fixing earth wire to main switch	2nos.
9	Earthing set complete with pipe,earth wire,charcoal,salt,thimbles,nuts & bolts etc	1 set.

Q.3 It is proposed to install a power connection of 3 phase 5 HP induction motor for an agriculture tube-well in the room of size 3MX3MX3M high. The motor is one metre away from two nearest walls. Prepare the estimate in the following order.

a) **Draw installation plan showing location of MB and motor etc. Also mark path of wiring by a thick line.**
b) **Single line diagram. Showing earth wires also.**
c) **Wiring diagram.**
d) **Decide the rating and specification of important materials and calculate of wire ,conduits,earth wire etc. and prepare a complete list of materials required for wiring the room with complte specification of each item. Also calculate the approximate cost for the power wiring.**

Solution



Installation Plan.

Assumption

a) Total height of main board from floor =1.5 mts
b) Two earth wires enclosed in their respective 15 mm dia. G.I pipe installed side by side for earthing the motor.
c) The Motor with pumping set is installed 0.25 mt above floor on a suitable foundation

Calculation of load

Running current =$\frac{5\times746}{\sqrt{3}\times400\times0.85\times0.8}$ = 9.1 amp say 8 amp

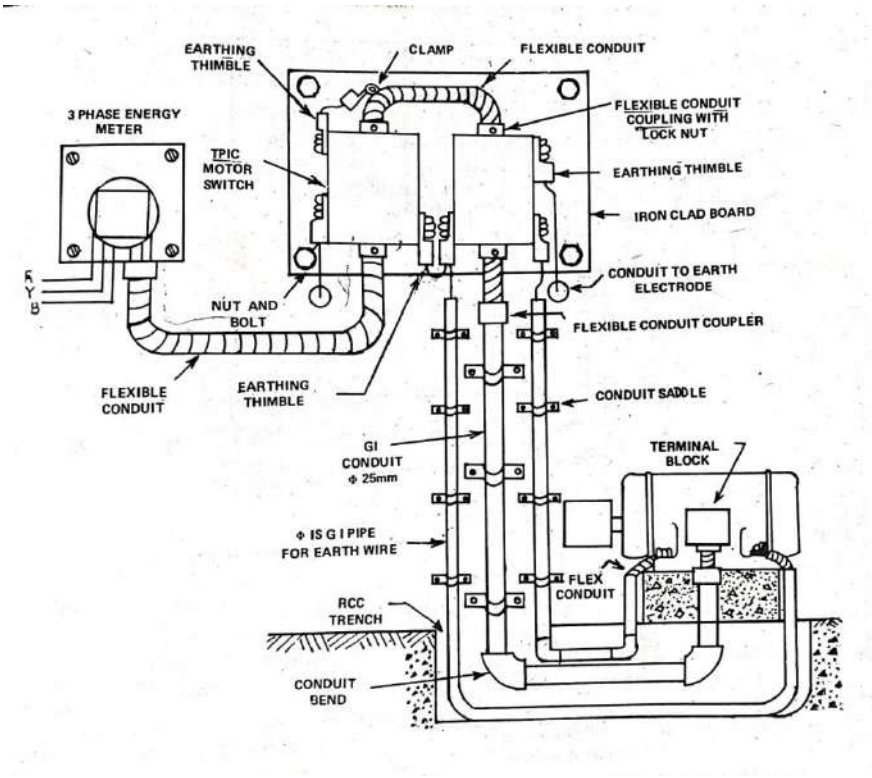
Starting current=1.5$\times$ 8 = 12 amp

Selection and rating of MS

It is suggested that a TPIC, Main switch=32 amp,500 volt grade

Selection and rating of wire

It is suggested that a PVC Insulated aluminium conductor, single core ,660 volts grade of size 6 mm^2 or 1/2.80 mm diameter, should be used for power wiring



Calculation for length of heavy gauge conduits of 25 mm diameter

From TPIC to motor foundation=1.5+0.25+1+o.25+0.25=3.25 mts
Taking 10% wastage=0.325mt
Total length of conduit required for wiring the motor =3.25+0.325=3.57 mts say 4 mts

Calculation for length of heavy gauge conduits of 15 mm diameter

From starter to motor foundation=(1.5+0.25+1+o.25+0.25)X2=3.25 mts X 2=6.5 mts
Taking 10% wastage=0.65mt
Total length of conduit required for wiring the motor =6.5+0.65=7.1 mts say 7.5 mts

Calculation for length of flexible conduits of 25 mm diameter

From energy meter to main board=1.0 mt
From main switch to starter=0.5 mt
From starter to conduit mouth=0.25mt
From motor foundation to motor terminal block=0.25mt
Total length of conduit=(1.0+0.5+0.25+0.25)mt=2mt
Taking 10% wastage=0.2mt
Total length of flexible conduit required for wiring the motor =2+0.2=2.2mts say 3.25 mts

Calculation for length of phase wire of 6 mm^2 or 1/2/80 mm dia

From TPIC to motor foundation=(rigid conduit +flexible conduit)X3

=(3.25+2)mts X 3

=15.75 mts

Taking 15% wastage=2.5mt

Total length of phase wire required for wiring the motor=(15.75+2.5)mts=18.25 mt=18.5 mts

Calculation for length of 8 SWG , G.I , earth wire

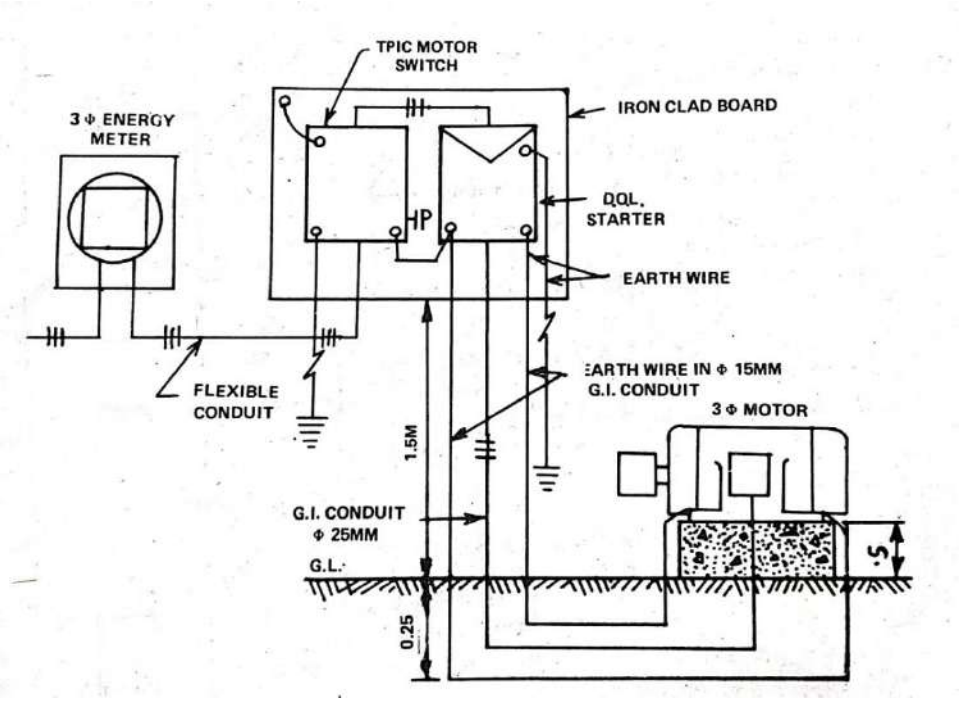
From starter to motor foundation = length of conduit X 2 earth wires

=3.25 X 2 Wires

=6.5 mts

Taking 10% wastage=0.65mt

So total earth wire required for wiring the motor=6.5 +0.65=7.15mt say 7.5 mts



Material Table

Si no.	description of materials with specifications	Quantity
1	TPIC main switch 32 amp rating,500 volt	1no.

2	Total length of rigid conduit (25mm dia)	4 mt
3	Total length of flexible conduit (25 mm dia)	2.5 mt
4	Total length of rigid conduit (15mm dia)	7.5
5	Total length of phase wire(6 mm^2)	19 mt.
6	Earth wire (14 SWG)	8 mt
7	Saddle	1 pkt
8	Nuts & bolts	1 pkt
9	Wooden screw 20 mm long	30 nos.
10	PVC tape	1 pkt.
11	Bend	30 gms
12	Earthing thimbles 5 amp rating for fixing earth wire to main switch	2nos.
13	Earthing set complete with pipe,earth wire,charcoal,salt,thimbles,nuts & bolts etc	1 set.

CHAPTER-4 OVERHEAD INSTALLATION

Q.1 In a city locality, an overhead distribution line of 400 volts, 3 phase ,50 cycle/sec. is to be erected along a straight route on steel tubular poles. The length of the line is 500 metres and the line terminates at the ends. The span between adjacent poles is 50 mts. The street light conductors are also supported on the same poles.Make a neat sketch of the last 2-3 poles and estimate the quantity of material required for installing the distribution line with full specification of each items. Other details of the line are suggested as under.

ACSR conductors are phase lines, neutral and street light conductor of size 6/1$\times$ 2.11 (squirrel conductor). Earth wire 8 SWG , Galvanised iron

Solution

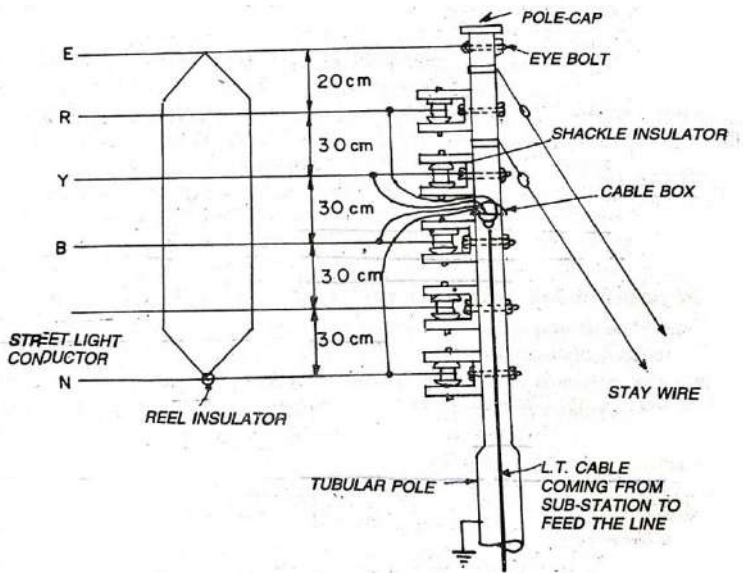
Assuming that the connection is taken for the line from an existing sub-station of 11/0.4 KV.
Length of line =500 metres
Average span=50 mts.
No. of tubular poles required=$\frac{500}{50}$+1=11 nos.
Length of squirrel ACSR conductor of size(6/1$\times$ 2.11 mm)=(500 mts$\times$ 5)+2% for sag
=2500+50
=2550 mts

In weight=85 kg/km=216.75 kg say 217kg

Length of 8 SWG, galvanized iron= 500+2% for sag

=510 mts

In weight =10 mts/kg=51 kg

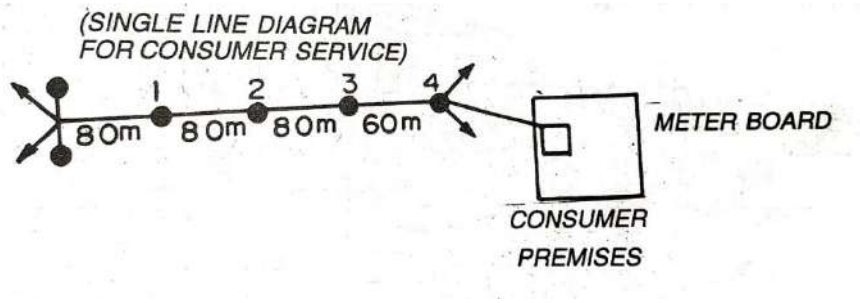


Material Table

Si no.	description of materials with specifications	Quantity
1	Steel tubular poles (9 mts long)	11 nos
2	ACSR squirrel conductors of size(6/1× 2.11 mm)	2550 mts(218 kg)
3	E arth conductors 8 SWG GI	510 mts (51kg)
4	shackle Insulators with 'D' straps i.e 5 on each pole	55 nos.
5	Nuts and Bolts 15 mm dia ,200 mm long with washers for fixing 'D' straps with pole,one for each straps	55 nos.
6	Nuts and Bolts 15 mm dia ,125 mm long with washers for fixing insulators with 'D' straps	55 nos.
7	Earth wire pole clamp one on each end pole	2nos.
8	Eye bolts,15 mm dia ,200 mm long for holding earth wire on intermediate pole	9 nos.
9	Guard wire of size 7/16 SWG ,for guarding at approximate 15 places	45 mts
10	Reel insulator	15 nos.
11	Pole caps for steel tubular poles	11 nos.

12	Stay wire set complete i.e 2 sets on each terminals poles	2+2=4 nos
13	Earthing sets complete for earting(one at each terminal pole and one central pole)	3 sets
14	Street light fitting complete with tube and clamps	11nos.
15	Number plates with clamps	11nos.
16	Pole foundation for each pole	11nos.
17	To complete the job miscellaneous items such as cement ,sand, concrete etc	-
18	14 SWG ,galvanized steel wire as binding wire	5kg

Q.2 A tube well owner wants 3 phase,4 wire power connection to his 10 BHP motor from an over head double pole structure having of 25 KVA ,11/0.4 KV . The double pole structure is 300 metres away from tube well. Estimate the quantity of materials required for erecting a line and for giving a service connection to the tube well motor. Also draw neat sketch of the same.



Solution

Total connected load =10BHP

Starting current=$\frac{10\times746}{\sqrt{3}\times400\times0.85\times0.9}$ = 14.07 amp

Starting current=1.5× $14.07 = 21.10$ amp

To meet the present load requirement and Provision for future requirement in the event expansion of building and any other electrical points in the existing building =(50% × 21.10)+21.10=31.65 amp

It is therefore suggested that

- L.T 4 core ,aluminium conductor weather proof cable of size =6 mm^2 (from distribution transformer to pole and from last pole to the meter box)
- A.A.C of minimum size =3/3.00 mm mantis stranded conductor (from fifst pole to last pole)

Average span=50 mts.

No. of Concrete pole required(9 mt. long) =$\frac{300}{50}$=6 nos.

Length of mantis AAC conductor of size(3/3.00 mm)=(300 mts× 4)+2% for sag

=1200+24

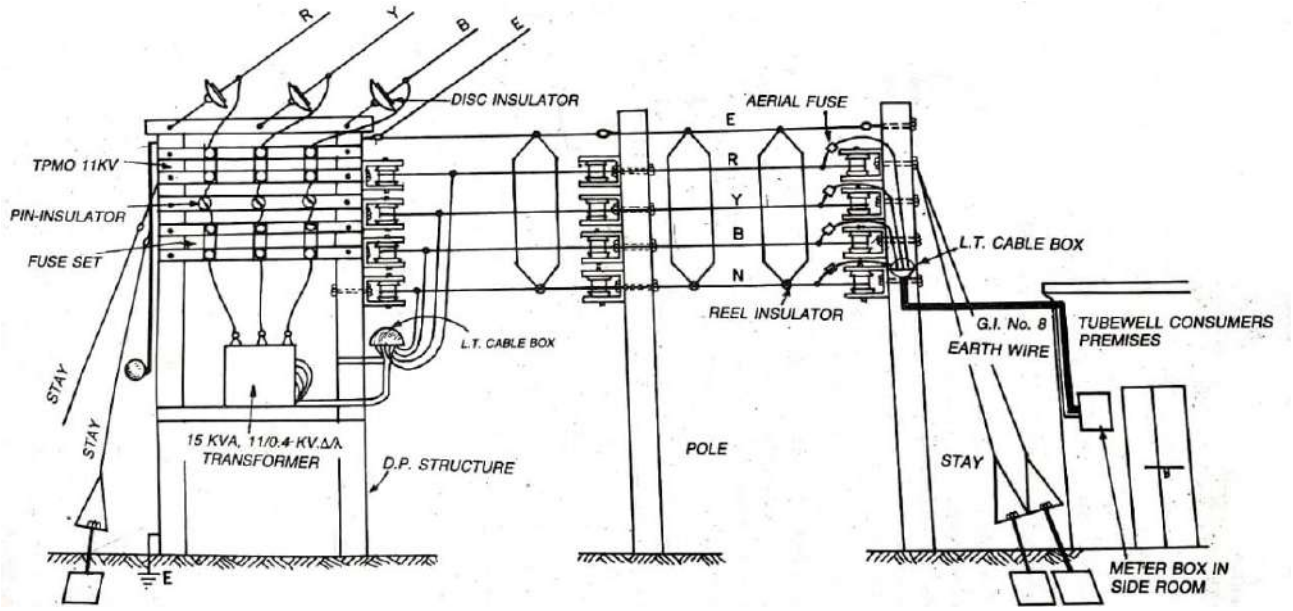
=1224 mts

In weight=58 kg/km=70 kg

Length of 8 SWG, galvanized iron= 300+2% for sag

=306mts

In weight =10 mts/kg=30.6kg



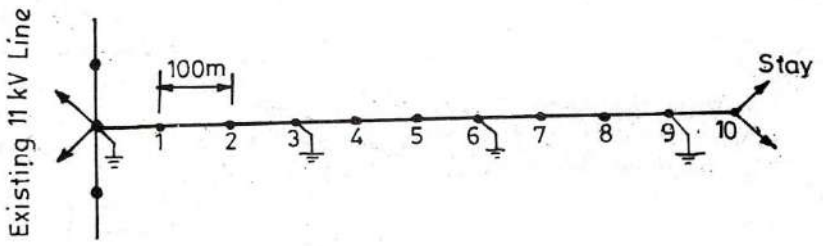
Material Table

Si no.	description of materials with specifications	Quantity
1	RCC poles (9 mts long)	6 nos
2	AAC, mantis conductors of size(3/3.00mm)	1224 mts(70kg)
3	E arth conductors 8 SWG GI	306 mts (30.6kg)
4	Shackle Insulators with 'D' straps i.e 4 on each pole	24+4=28 nos
5	Nuts and Bolts 15 mm dia ,200 mm long with washers for fixing 'D' straps with pole,one for each straps	28nos.
6	Nuts and Bolts 15 mm dia ,125 mm long with washers for fixing insulators with 'D' straps	28 nos.
7	Eye bolts,15 mm dia ,200 mm long for holding earth wire on intermediate pole	4 nos.
8	Earth wire pole clamp one on each end pole	2 nos.
9	Guard wire of size 7/16 SWG ,for guarding at	30 mts

	approximate 15 places	
10	Aerial fuse,32 amp rating on last pole	3 nos.
11	L.T outdoor cable box, complete with clamps	2 nos.
12	Reel insulator	10 nos.
13	Pole caps for steel tubular poles	6 nos.
14	Stay wire set complete i.e 2 sets on each terminals poles	2+2=4 nos
15	Earthing sets complete for earting(one at each terminal pole and one central pole)	1 sets
16	Number plates with clamps	6 nos.
17	Pole foundation for each pole	6 nos.
18	To complete the job miscellaneous items such as cement ,sand, concrete etc	-
19	14 SWG ,galvanized steel wire as binding wire	2kg

Q.3 Estimate the quantity of material required for the construction of 1 kilometre overhead line. The line is tapped from the existing 11 KV line to feed a particular locality. The particulars of the important materials to be used for the line to be erected are as follows.

a) Size of conductor : ACSR 6/1× 2.59 mm
b) Tubular pole or supports of 11 metres length
c) Size of earth wire : G.S (galvanized steel) 8 SWG
d) Average span length=100 mts.
e) No. of earthing sets to be installed:3 nos.



Single line diagram of the line

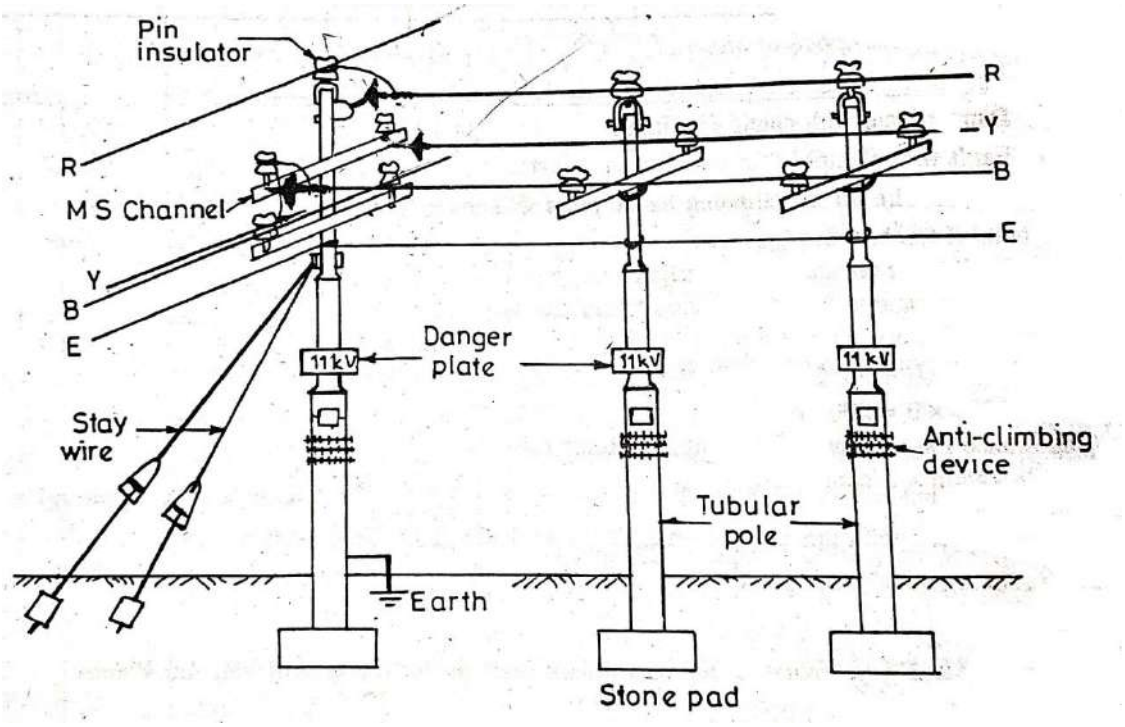
Solution

Total Length of conductors (ACSR weasel conductor 6/1 X 2.59 mm)= (1000X3)+2% for sag

=3000+60=3060 mts

Total length of G.I. earth wire of size 8 SWG =1000+2% for sag

=1000+20=1020 mts



Material Table

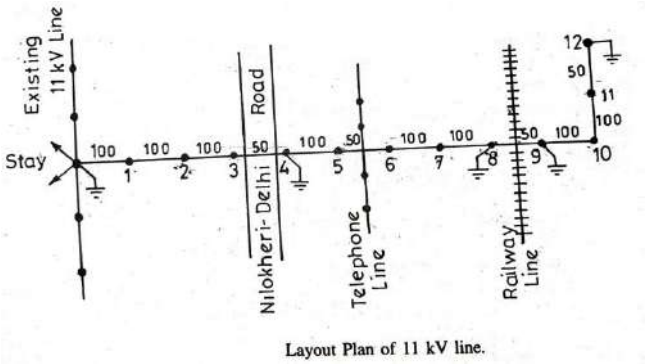
Si no.	description of materials with specifications	Quantity
1	Tubular line supports (11 mts long)	10 nos
2	Material required for connection with existing line of 11 KV line 1. M.S channel for cross arm (10 cmX5 cmX1.5mts) 2. H.T ,11 KV Disc insulator with complete fittings 3. H.T ,11 KV ,pin type insulators with nuts and bolts 4. Stay complete sets (clamps ,stay wire, egg insulators ,stay rod stay bow, stay plates) 5. Earth wire clamp 6. Binding wires 7. Clamps for M.S channel 8. Concreting for stay rod	 1no. 3nos. 2 nos. 2nos. 1no. 1 kg 1 no. 2nos.

3	Fitting for new line supports 1. Stone pads for poles 2. Angle iron cross arms, 1 for each pole 3. clamps for fixing cross arm with poles 4. 11 KV ,pin type insulators with nuts and bolts 5. No. plates with clamps for fixing 6. Danger plates with clamps for fixing 7. Earth wire clamp 8. Barbed wire for anti climbing for 10 poles @ 1 kg for each pole 9. Binding wires (for fixing conductors over insulators)	 10 nos. 10 nos. 10 nos. 30 nos. 10 nos. 10 nos. 10 nos. 10kg 6kg
4	ACSR weasel conductors of size 6/1 X 2.59 mm	3060 mts
5	G.I earth wire of size 8 SWG	1020 mts.
6	Earthing complete sets (G.I pipe, charcoal ,salt etc)	3 nos.
7	Painting for poles	10 nos.

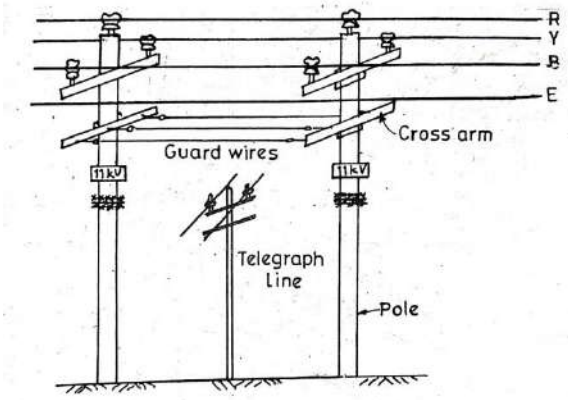
Q.4 Estimate the material and cost for the construction of 1 kilometre overhead line. The line is tapped from the existing 11 KV overhead line. Assuming that the line is passing over the main road, telegraph line and railway line. Given data:

a) Size of conductor : ACSR 6/1× 2.36 mm gopher
b) Type of pole : R.S (Rolled steel) joist 10 mts and 11.5 metres long.
c) Size of earth wire : G.S (galvanized steel) 8 SWG
d) Type of cross arm : mode of angle iron
e) No. of earthing : plate eathing

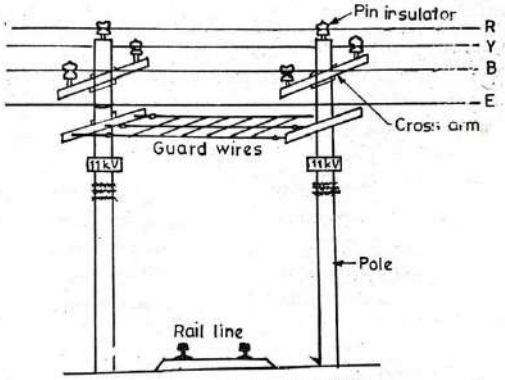
Solution



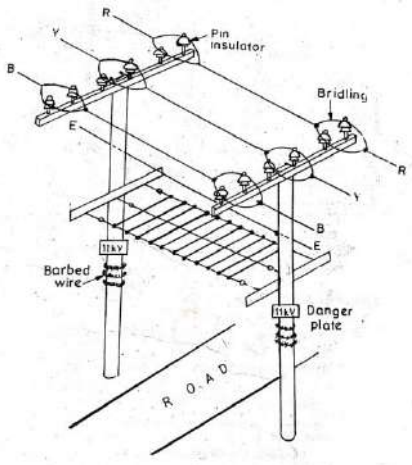
Layout Plan of 11 kV line.



Guarding for telegraph line.



Guarding for rail line



Bridling on road crossing.

Total Length of conductors (ACSR gopher conductor 6/1 X 2.36 mm)= (1000X3)+2% for sag

=3000+60=3060 mts

Total length of G.I. earth wire of size 8 SWG =1000+2% for sag

=1000+20=1020 mts

Material Table

Si no.	description of materials with specifications	Quantity
1	a) R.S joist poles 15cm diameter 10 mt long b) R.S joist poles 15cm diameter 11.5 mt long	6 nos. 6 nos.

2	Material required for connection with existing line of 11 KV a) M.S channel for cross arm (10 cmX5 cmX1.5mts) b) H.T ,11 KV Disc insulator with complete fittings c) H.T ,11 KV ,pin type insulators with nuts and bolts d) Stay complete sets (clamps ,stay wire, egg insulators ,stay rod stay bow, stay plates) e) Earth wire clamp f) Binding wires g) Clamps for M.S channel h) Concreting for stay rod	 1no. 3nos. 2 nos. 2nos. 1no. 1 kg 1no. 2nos.
3	Fittings for new line supports a) Stone pads for poles b) Angle iron cross arms, 1 for each pole c) clamps for fixing cross arm with poles d) 11 KV ,pin type insulators with nuts and bolts e) No. plates with clamps for fixing f) Danger plates with clamps for fixing g) Earth wire clamp h) Barbed wire for anti climbing for 10 poles @ 1 kg for each pole i)Binding wires (for fixing conductors over insulators)	 12 nos. 12 nos. 12nos. 42 nos. 12 nos. 12 nos. 12 nos. 12 kg 8 kg
4	Extra material for poles at road crossing a) Brindling cross arm b) Cross arm clamps c) Guard wire	 2 nos. 2nos. 10 kg
5	Extra material for telegraph line crossing a) Cross arm b) Clamps for cross arm c) Guard wire d) Eye bolts for holding guard wire	 2nos. 2 nos. 20 kg. 6 nos
6	Extra material for rail way line crossing a) Cross arm b) Clamps for cross arm c) Guard wire d) Eye bolts for holding guard wire	 2nos. 2 nos. 20 kg. 6 nos
7	ACSR gopher conductors of size 6/1 X 2.36 mm	3060 mts
8	G.I earth wire of size 8 SWG	1020 mts.
9	Earthing complete sets (G.I pipe, charcoal ,salt etc)	4 nos.
10	Painting for poles	12 nos.

CHAPTER -5 OVERHEAD SERVICE LINE

PREPARE AND ESTIMATE FOR PROVIDING SINGLE PHASE SUPPLY LOAD OF 5KW (LIGHT,FAN,SOCKET) TO A SINGLE STORED RESIDENTIAL BUILDING

Q.1 A newly constructed single storeyed house is to be provided with single phase 230 volts,50 HZ having a load of 5 KW(light,fan,socket). The supply is to be given from overhead line 20 mt. away from the building. Prepare a list of the material,for giving sevice connection and also estimate the cost of the service connection. A G.I pipe is to be raised along the roof to receive bare conductor on its cross arm fitted with insulators. Also draw sketch of service connection.

Solution

Assumptions

1. Height of ground floor=3.5 mts.
2. Service connection received at the height of 6 mts. from ground.

Selection and rating of weatherproof ,twin core, aluminium conductor cable and line conductor

Total connected load=5 KW

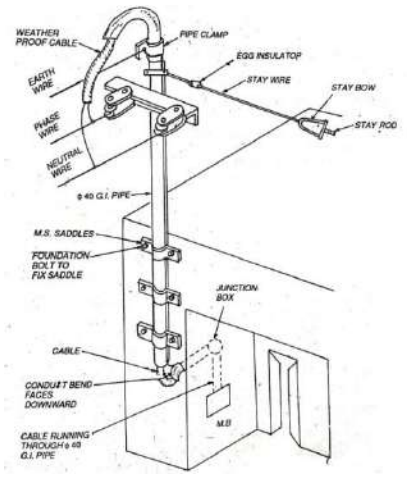
Total load in ampere=5000/230=21.7 amp

Diversity factor=60%X21.7=13 amp

To meet the present load requirement and Provision for future requirement in the event expansion of building and any other electrical points in the existing building =(50% X13)+13=19.5 amp

It is therefore suggested that

- Rating of weatherproof cable =6 mm^2 or 1/2.80 mm ,twin core, PVC insulated cable to carry a load current of 27 amp.
- Rating of bare conductor for installation between distribution pole upto insulators=10 mm^2 ,AAC
- Rating of earth wire=8 SWG



Material Table

Si no.	Specification	Quantity

1	PVC weatherproof cable of size 6mm^2 or 1/2.80 mm twin core including wastage	10mts
2	AAC for phase and neutral connection (10 mm^2)	42 mts
3	8 SWG GI earth wire(from pole to meter board)	20+1+10=31 mts
4	G I pipe (50 mm diameter)	8mt.
5	Conduit bends	3 nos
6	GI pipe Saddles	10 nos.
7	Earthing Thimble (to fix earth wire and stay wire)	2 nos.
8	LT shackle insulators	4 nos.
9	Angle iron bracket insulator of size(50mmX50mmx6mmx60mm) long	2 nos.
10	Stay insulator	1no.
11	Stay wire	7mt.
12	Stay bow	1 nos
13	Stay rod	1 nos
14	Cement	1 bag
15	Sand	3 bag
16	Concrete	2 bag
17	2 Way junction box	2 nos.
18	Nuts & bolts	2 pkt

Q.2 A newly constructed single storeyed house is to be provided with single phase 230 volts,50 HZ having a load of 4 KW. The supply is to be given from overhead line 30 mt. away from the building.

Prepare a list of the material,for giving sevice connection and also estimate the cost of the service connection.

Solution

Assumptions

3. Height of ground floor=3.5 mts.
4. Service connection received at the height of 6 mts. from ground.

Selection and rating of weatherproof ,twin core, aluminium conductor cable

Total connected load=4 KW

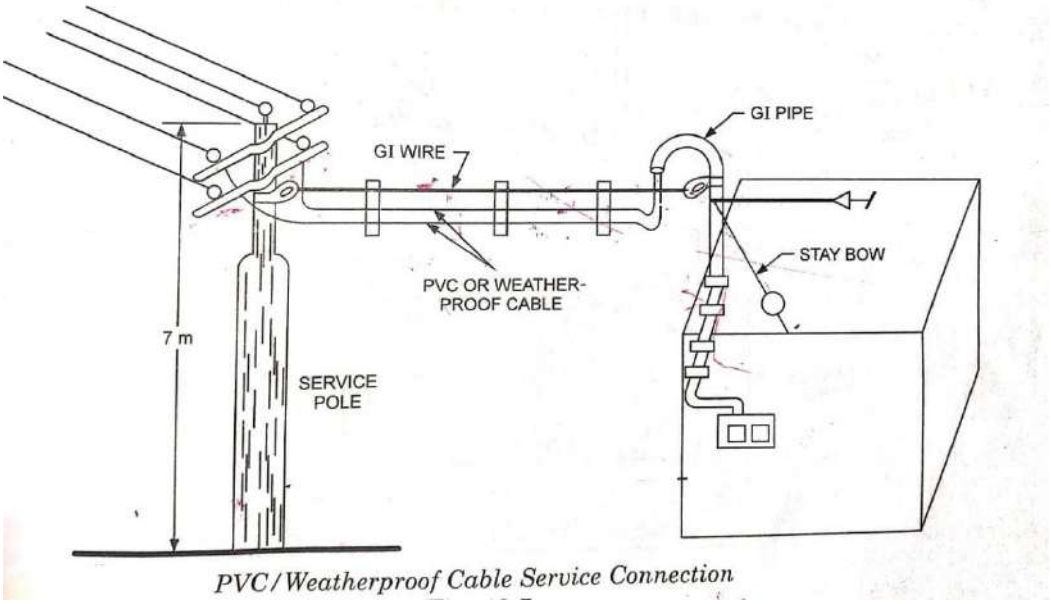
Total load in ampere=4000/230=17.29 amp

Diversity factor=60%X17.29=10.43 amp

To meet the present load requirement and Provision for future requirement in the event expansion of building and any other electrical points in the existing building =(50% X10.43)+10.43=15.21 amp

It is therefore suggested that

- Rating of weatherproof cable =4 mm^2 or 1/2.24 mm ,twin core, PVC insulated cable
- Rating of G.I wire=8 SWG



PVC/Weatherproof Cable Service Connection

Material Table

Si no.	specification	quantity
1	PVC weatherproof cable(from pole to EM with wastage)	30+2+15=47 mt
2	8 SWG GI wire	32 mt.
3	G I pipe (50 mm diameter)	8mt.
4	Conduit bends	3 nos
5	GI pipe Saddles	10 nos.
6	Earthing Thimble	2 nos.
7	Stay wire	7mt.
8	Stay insulator	1 nos
9	Stay bow	1 nos
10	Stay rod	1 nos
11	Cement	1 bag
12	Sand	3 bag
13	Concrete	2 bag
14	2 Way junction box	2 nos.
15	Nuts & bolts	2 pkt
16	Binding wire	2 mts

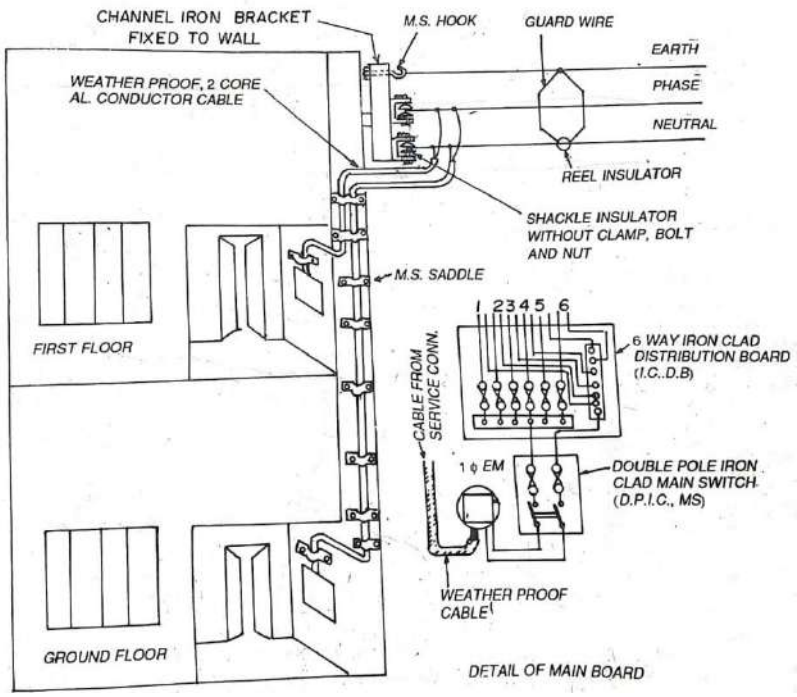
PREPARE AND ESTIMATE FOR PROVIDING SINGLE PHASE SUPPLY LOAD OF 3KW TO EACH FLOOR OF A TO DOUBLE STORED RESIDENTIAL BUILDING HAVING SEPARATE ENERGY METER

Q.3 Prepare a list of material and estimate the cost for giving service connection to a double storeyed building having two energy meters.The supply is to be given at 230 volt single phase having a load of 4 sub-cicuit (light,fan)and two 15 amp socket points on each floor .The supply is to be given from overhead line 20 metres away from the building .Also draw diagram of service connection.

Solution

Assumptions

1. Height of ground floor=3.5 mts.
2. Total height of first floor from ground=7mts.
3. Service connection received at the height of 6 mt. from ground.
4. Height of ground floor meter board from floor=1.5mts.



Selection and rating of weatherproof ,twin core, aluminium conductor cable and Line conductor

Total connected load for 4 sub-circuit=4X800=3200 watts

2-15 amp sockets=2X1000=2000watts

So total load of a single building storeyed=3200+2000=5200 watt

Total load in ampere=5200/230=22.6amp (for single storeyed)

Total connected load for both floor=22.6+22.6=45.2 amp

Diversity factor=60%X45.2=27.12amp

To meet the present load requirement and Provision for future requirement in the event expansion of building and any other electrical points in the existing building .It is therefore a better suggestion that a weather proof cable of higher rating may be used=(50% X27.12)+27.12=40.68amp

It is therefore suggested that

- Rating of weatherproof cable =16 mm^2 or 7/1.70 mm ,twin core, PVC insulated cable
- Rating of bare conductor for installation between distribution pole upto insulators=16 mm^2 ACSR Conductor
- Rating of G.I wire=8 SWG

Material Table

Si no.	Specification	Quantity
1	Shackle insulators with U clamps,nuts & bolts	2+2=4 nos.
2	Mild steel channel or hook	2 nos.
3	ACSR conductor for phase and neutral connection ($16mm^2$) including wastage	20+20+2=42mts
4	8 SWG GI earth wire(from pole to meter boa)	20+1+15=36mts
5	MS angle iron bracket of sze(50mmX50mmx6mmx1mt) long	2 nos.
6	PVC Weather proof cable	15 mt
7	MS Saddles	15 nos.
8	Earthing Thimble (to fix earth wire)	2 nos.
9	Reel insulator	1no.
10	Guard wire	7mt.
11	Cement	1 bag
12	Sand	3 bag
13	2 Way junction box	2 nos.
14	Nuts & bolts	2 pkt

PREPARE ONE ESTIMATE OF MATERIAL REQUIRED FOR SERVICE CONNECTION TO A FACTORY BUILDING WITH LOAD WITHIN 15KW USING INSULATED WIRE

Q.1 A workshop required to connect a 3-phase 15 KW ,415 V ,50 HZ motor to a 3-phase ,4-wire,415/240 volt ,50 HZ overhead line .The distance of the service line from the workshop structure having motor is 15 mt. The motor has an efficiency of 85% and a power factor of 0.8 . Estimate the quantity and cost of material required.

Solution

Assumptions

1. Height of ground floor=6 mts.
2. Service connection received at the height of 7 mts. from ground.

Selection and rating of weatherproof ,twin core, aluminium conductor cable

Total connected load =15KW

Running current=$\frac{15\times1000}{\sqrt{3}\times415\times0.85\times0.8}$ =30 amp

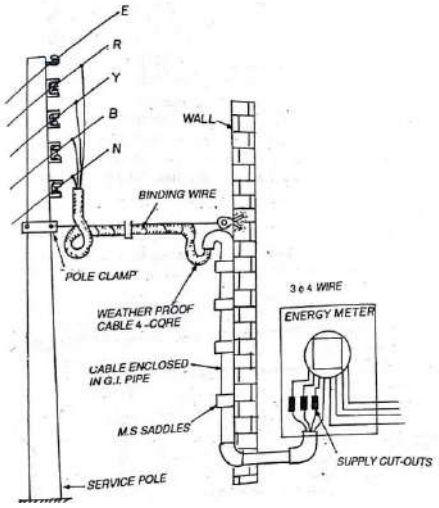
Starting current=1.5$\times$ $30 = 45$ amp

Diversity factor =60%$\times$ $45 = 27$

To meet the present load requirement and Provision for future requirement in the event expansion of building and any other electrical points in the existing building =(50% $\times$ 27)+27=40.5 amp

It is therefore suggested that

- Rating of weatherproof cable =10mm^2 or 1/3.55 mm ,4 core, PVC insulated aluminium conductor
- Rating of G.I wire=8 SWG



Material Table

Si no.	specification	quantity
1	PVC weatherproof cable(from pole to EM with wastage)	15+2+5+10=32 mt
2	8 SWG GI wire	17 mt.
3	G I pipe (50 mm diameter)	7mt.
4	Conduit bends	3 nos
5	GI pipe Saddles	15 nos.
6	Pole clamp	1 nos
7	Cement	1 bag
8	Sand	3 bag
9	Concrete	2 bag
10	2 Way junction box	2 nos.
11	Nuts & bolts	2 pkt
12	Binding wire	2 mts
13	M S hook	1 no.

Q.2 A workshop owner wants 3-phase ,4 wire power connection to his 10 HP motor from the pole of 400v ,3 phase 50 HZ overhead line at a distance of 200mt. from the workshop. Make a sketch showing the arrangement of supply and estimate the quantity and cost of the material required.

-

Solution

Assumptions

1. Height of ground floor=6 mts.
2. Service connection received at the height of 7 mts. from ground.

Selection and rating of weatherproof ,twin core, aluminium conductor cable

Total connected load =10HP

Running current =$\frac{10\times746}{\sqrt{3}\times400\times0.85\times0.8}$ = 15.8 amp

Starting current=1.5× $15.8 = 23.7$amp

To meet the present load requirement and Provision for future requirement in the event expansion of building and any other electrical points in the existing building =(50% × 23.7)+23.7=35.55 amp

It is therefore suggested that

- Rating of weatherproof cable =6 mm^2 or 1/2.80 mm ,4 core, PVC insulated aluminium conductor
- Rating of bare conductor for installation between distribution pole upto insulators=10 mm^2 ACSR Conductor
- Rating of G.I wire=8 SWG

Material Table

Si no.	specification	quantity
1	PVC weatherproof cable	15 mts
2	Bare conductors	808 mts
3	Shackle insulator	8 nos.
4	8 SWG GI wire	202 mt.
5	G I pipe (50 mm diameter)	6 mt.
6	Conduit bends	3 nos
7	GI pipe Saddles	15 nos.
8	Earthing Thimble	2 nos.
9	Cement	1 bag
10	Stay insulator	1no.
11	Stay wire	7mt.

12	Stay rod	1 nos
13	Stay bow	1 nos
14	Reel insulator	2no.
15	Guard wire	8mt.
16	Sand	3 bag
17	Concrete	2 bag
18	2 Way junction box	2 nos.
19	Nuts & bolts	2 pkt
20	Binding wire	2 mts

CHAPTER -6 ESTIMATING FOR DISTRIBUTION SUBSTATION

Q.1 Estimate the cost of a pole mounted sub-station of capacity 50 KVA transformer of rating 11/0.5 KV. The H.T line is available about 50 metres from the proposed site.Also make a neat sketch of the pole mounted sub-station.

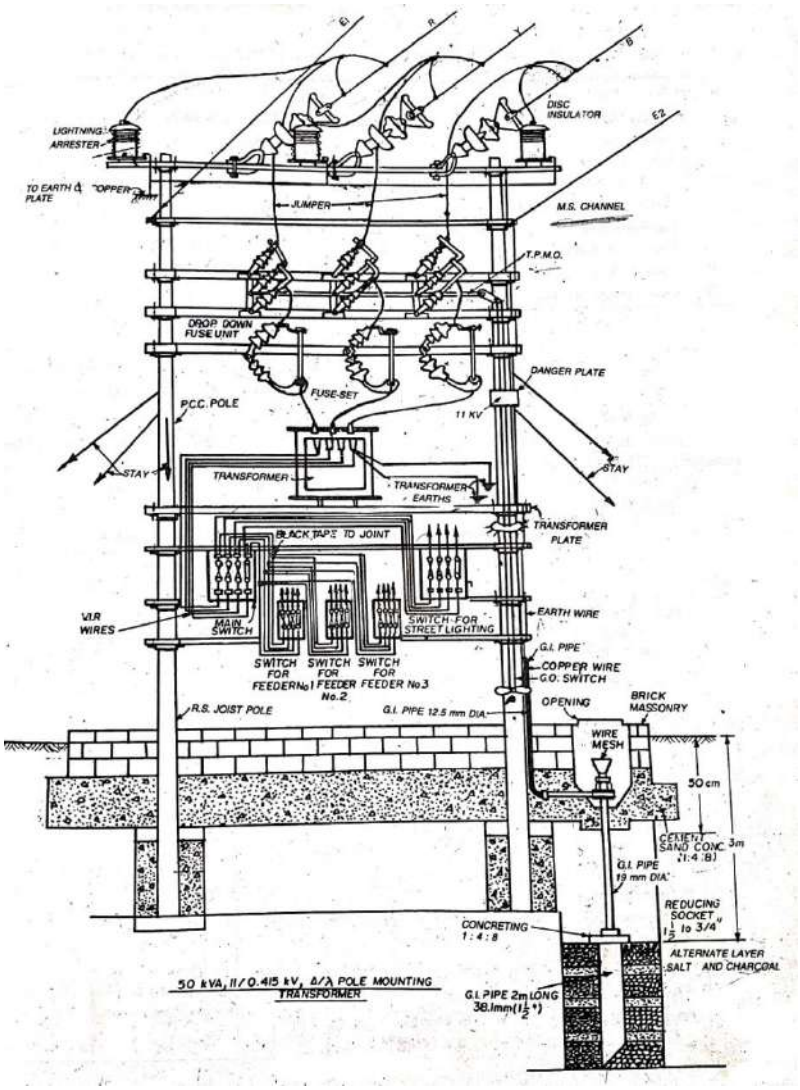
Solution

Total Length of conductors (ACSR gopher conductor 6/1 X 2.36 mm)= (50X3)+2% for sag

=150+3=153 mts

Total length of G.I. earth wire of size 8 SWG =50+2% for sag

=50+1=51 mts.



Material Table

Si no.	description of materials with specifications	Quantity
1	Material for H.T connection with main line	
	1. M.S channel cross arm 10 cm× 5cm ×1.5 mt long	1no.
	2. H.T H.T ,11 KV Disc insulator with complete fittings	3nos.
	3. Stay complete sets (clamps ,stay wire, egg insulators ,stay rod stay bow, stay plates)	2 nos.
	4. Earth wire clamp	2nos.
	5. Binding wires	500 gms
	6. Clamps for M.S channel	1 no.
	7. Concreting for stay rod	2nos.
2	Conductor ACSR gopher 6/1×2.36 mm diameter	153 mts.
3	Earth conductors 8 SWG GI	51 mts.
4	R .S joist 175 mm× 100mm ×2 mt long	2 nos.
5	Fittings on H.T double pole structure for pole mounted sub-station.	
	1. Stone pad	2 nos.
	2. Sub-station plate	1 no.
	3. M.S channel cross arm 100 mm× 50mm × 8mm ×2.65mt long	1no.
	4. Eye bolt	3 nos.
	5. Dropper angle iron 75 mm× 75mm × 8mm ×2mt long	1no.
	6. Stay complete sets	2 nos.
	7. 11 KV ,Disc type insulators with nuts and bolts	3nos.
	8. 11 KV ,pin type insulators with nuts and bolts	3nos.
	9. Binding wires	500 gms
	10. No. plates with clamps for fixing	1no.
	11. Danger plates with clamps for fixing	1no.
	12. Earth wire clamp	1no.
	13. Barbed wire for anti climbing for 10 poles @ 1 kg for each pole	5kg.
	14. Earthing complete	1set
	15. Jumper wire for jumping	11mts
	16. Nuts and bolts of size as required.	18nos.
	17. Concreting poles	2 nos
	18. T.P.M.O switch	1no.
	19. Painting of pole and other attachments	2 litres
	20. Fuse sets	1set
6	Transformer 50 KVA ,11/0.4 KV	1no.
7	TPICN(triple pole iron clad with neutral) main switch 100 ampere rating	1no.
8	Earthing for transformer	1no.
9	Lighting arresters one set of three	1set