Building electrical installation

Level-II

Learning Guide-20

Unit of Competence: install wiring system using rigid steel metallic conduit

Module Title: Installing Wiring Systems Using Rigid Steel and Metallic Conduit

LG Code: EIS BEI2 M06 LO20-LG-20

TTLM Code: EIS BEI2 M06 TTLM 0919v1

LO 1: plan and prepare

Instruction Sheet	Plan and prepare

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Confirming existing electrical supply
- Following procedures to ensure the co-ordination of site services and the activities
- Identifying means of electrical isolation
- carrying out basic isolation procedures
- measuring and marking wiring systems, wiring enclosures, equipment and conduit
- checking planned locations for their sensitivity, visually acceptable with other site services

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, **upon completion of this Learning Guide, you will be able to**:

- Confirm existing electrical supply
- Follow procedures to ensure the co-ordination of site services and the activities
- Identify means of electrical isolation
- carry out basic isolation procedures
- measure and mark wiring systems, wiring enclosures, equipment and conduit
- check plane locations for their sensitivity, visually acceptable with other site services

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 6.
3. Read the information written in the information “Sheet 1, Sheet 2, Sheet 3 and Sheet 4 Sheet 3 and Sheet 6”.
4. Accomplish the “Self-check 1, Self-check t 2, Self-check 3 Self-check t 4, Self-check 5 and Self-check 6” **in page -7, 9, 12 and 14, 35 and 40** respectively.
5. If you earned a satisfactory evaluation from the “Self-check” proceed to Operation Sheet 1” **in page -36.**
6. Do the “LAP test” **in page – 37** (if you are ready).

Information Sheet-1	Confirming electrical supply

1.1 Introduction

Plan is typically any diagram or list of steps with details of timing and resources, used to achieve an objective to do something. It is commonly understood as a temporal set of intended actions through which one expects to achieve a goal.

Plans can be formal or informal:

- Structured and formal plans, used by multiple people, are more likely to occur in projects, diplomacy, careers, economic development, military campaigns, combat, sports, games, or in the conduct of other business. In most cases, the absence of a well-laid plan can have adverse effects: for example, a non-robust project plan can cost the organization time and money.
- Informal or ad hoc plans are created by individuals in all of their pursuits.

The most popular ways to describe plans are by their breadth, time frame, and specificity; however, these planning classifications are not independent of one another. For instance, there is a close relationship between the short- and long-term categories and the strategic and operational categories.

It is common for less formal plans to be created as abstract ideas, and remain in that form as they are maintained and put to use. More formal plans as used for business and military purposes, while initially created with and as an abstract thought, are likely to be written down, drawn up or otherwise stored in a form that is accessible to multiple people across time and space. This allows more reliable collaboration in the execution of the plan.

Prepare: - is the process of arranging people and physical resources to carry out plans and accomplish organizational objectives**.**

1.2 Confirming electrical supply

A **power supply** is an electronic device that supplies electric energy to an electrical load. The primary function of a power supply is to convert one form of electrical energy to another and, as a result, power supplies are sometimes referred to as electric power converters. Some power supplies are discrete, stand-alone devices, whereas others are built into larger

devices along with their loads. Examples of the latter include power supplies found in desktop computers and consumer electronics devices.

Every power supply must obtain the energy it supplies to its load, as well as any energy it consumes while performing that task, from an energy source. Depending on its design, a power supply may obtain energy from various types of energy sources, including electrical energy transmission systems, energy storage devices such as a batteries and fuel cells, electromechanical systems such as generators and alternators, solar power converters, or another power supply. All power supplies have a *power input*, which receives energy from the energy source, and a *power output* that delivers energy to the load. In most power supplies the power input and output consist of electrical connectors or hardwired circuit connections, though some power supplies employ wireless energy transfer in lieu of galvanic connections for the power input or output. Some power supplies have other types of inputs and outputs as well, for functions such as external monitoring and control. Checking electrical power supply is checking the power availability of system.

Types of power supply

1. Ac power supply

AC stands for alternating current, which means the electrical current frequently reverses direction. AC electricity is measured according to its cycles, with one complete cycle being counted each time a given current travels in one direction and then doubles back on itself.

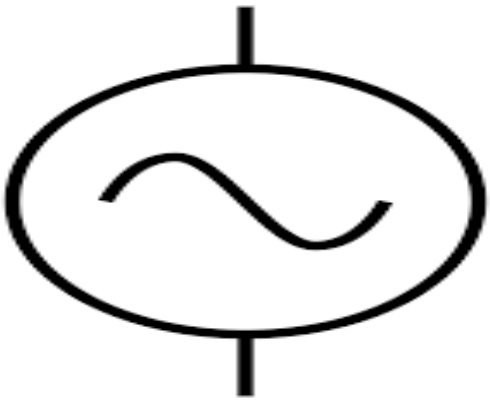


Figure 1.1 symbols AC voltage source

Colors of conductors

Color identification of bare conductors and cable cores are given by EELPA'S regulation

- Ear thing ---------- white
- Live of AC single-phase circuit ---------- Green
- Neutral of ac single or three phase ac circuit ----black
- Phase R of three-phase ac circuit ----------Green
- Phase S of three-phase ac circuit ---------- Yellow
- Phase T of three-phase ac circuit ---------- Red

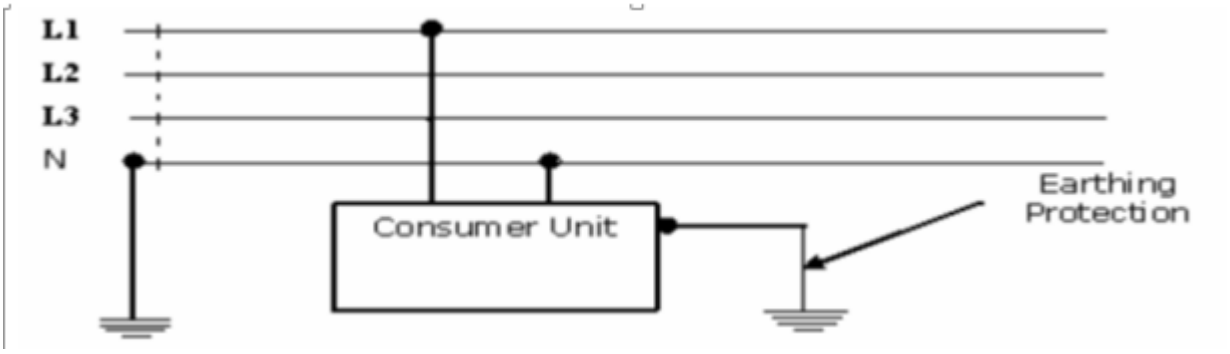


Figure 1.2 single phase

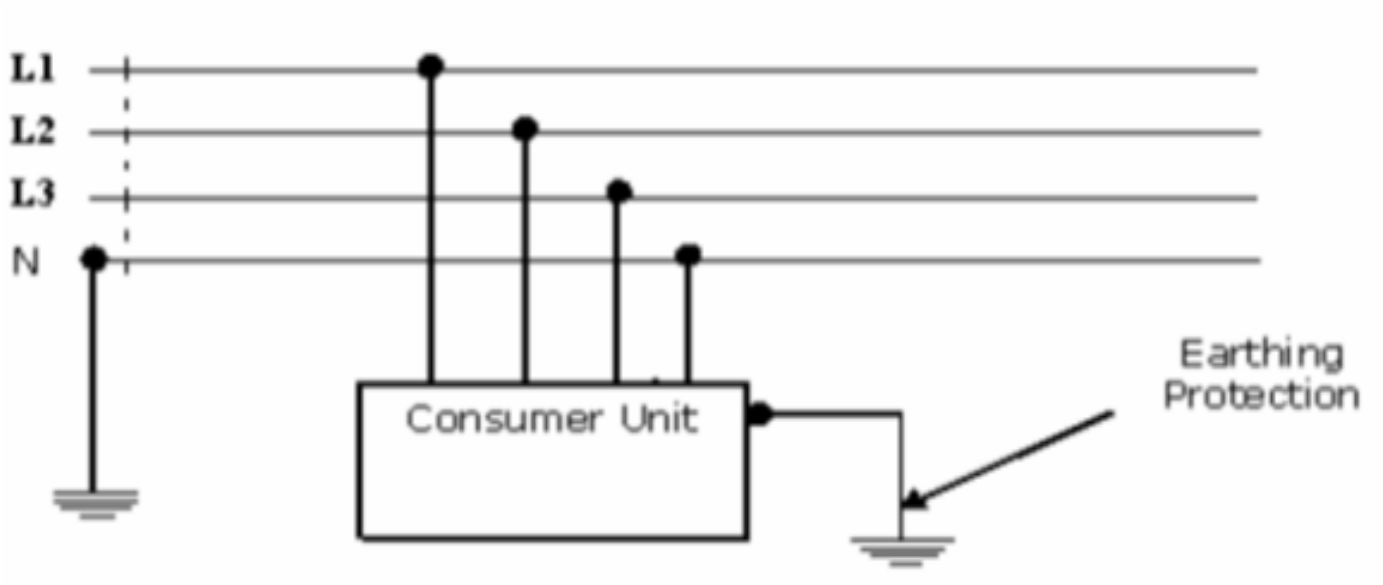
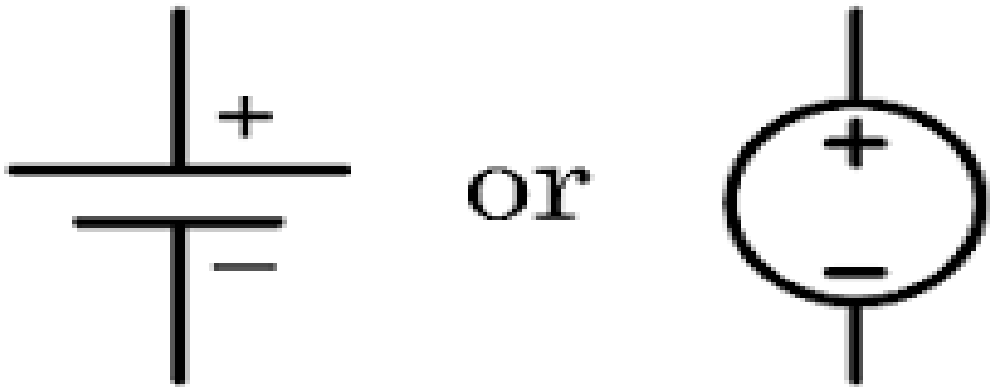


Figure 1.3 three phase

1. DC power supply

A DC power supply is one that supplies a constant DC voltage to its load. Depending on its design, a DC power supply may be powered from a DC source or from an AC source such as the power mains.

- Direct current (DC) which flows only in one direction.



Symbols of DC Voltage Source

Figure 1.4 symbols DC voltage source

Self-Check -1

Self-Check -1	Written Test

Directions: chose the best answer

1. Which is the kind of thing that is objectionable Ear thing (**1 points**)

   A) White B) green C) black D) yellow

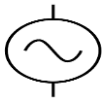
2. Which is the kind of thing that is objectionable Live of AC single-phase circuit (**1points**)

A) White B) green C) black D) yellow

3. Which is the kind of thing that is objectionable Neutral of ac single or three phase ac circuit (**1points**)

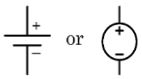
A) White B) green C) black D) yellow

4. What is the name of this symbol? (**2 points**)



A) DC B) AC C) KC D) DE

5. What is the name of this symbol? (**2 points**)



A) DC B) AC C) KC D) DE

Note: **Satisfactory rating – 10 points** **Unsatisfactory - below 5 points**

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-2	Following procedures to ensure the co-ordination of site services and the activities

2.1. Following procedures to ensure the co-ordination of site services and the activities

Determining actions means addressing multiple sets of activities that solve client's problems. Thus, determining actions to take clients from referral services are the way of deciding/providing right options which client's fill existing gaps.

The good approaches of determining actions are:

- multidisciplinary approach (team meetings to discuss the plan)
- participatory among community services worker and clients and/or relatives
- client oriented(focus client need and gaps)
- Relates directly to the assessment – numbers correspond

2.2. Process of determining actions to take clients for referral services

- Explores clients' needs and gaps
- Identify referral service providers and their services delivered
- State pros and cons about the referral services to clients
- Establish set of actions: that are relevant to client's needs and gaps to be sent for referral services
- Determine detailed action plan that fits client's capacity like:
  - ✓ Availability of resources (both financial and material)
  - ✓ Physical strengthens
  - ✓ Timeline to deliver and recovery
- Lists the expected changes of clients

Self-Check -2	Written Test

Directions: Answer all the questions listed below.

1. Describe the good approaches of determining actions to client's fill existing gaps?
2. Describe Process of determining actions to take clients for referral services?

Note: **Satisfactory rating – 10 points** **Unsatisfactory - below 5 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-3	Identifying means of electrical isolation

3.1. Electrical isolation

Electrical isolation is a method of corrosion control. Conductors are prone to corrosion from stray current that originates from dissimilar metals. Providing good isolation for these conductors manages the corrosion significantly.

Electrical isolation is achieved using a mechanical switch that isolates a section of a circuit from the main electrical power system as and when required.

Emergency switching:-Rapid cutting off of electrical energy to remove any hazard to persons, livestock or property which may occur unexpectedly.

Isolation Cutting off an electrical installation, a circuit or an item of equipment from every source of electrical energy.

Mechanical maintenance: - The replacement, refurbishment or cleaning of lamps and non-electrical parts of equipment, plant and machinery.

Switch: - A mechanical switching device capable of making, carrying and breaking current under normal circuit conditions, which may include specified overload conditions, and also of carrying, for a specified time, currents under specified abnormal conditions such as those of short circuit.

Electrical isolation is a method of corrosion control. Conductors are prone to corrosion from stray current that originates from dissimilar metals. Providing good isolation for these conductors manages the corrosion significantly.

Various electrical isolators can be used, depending on the requirements of the system. Some of types of isolators are:

1. **Single break isolators** - This type is divided into male and female contacts. The rotation of the post insulator moves the contact arms. Where both insulator stacks are rotated in opposite directions, the isolator is closed with the contact arm. Counter-rotation of both stacks causes the contact arm to open, and hence the isolator is turned off.
2. **Double break isolators** - Their constructional features are three post stacks where the central post is a tubular male contact that rotates horizontally. The rotation can be done manually using a lever at the base of the post, or by a motor that rotates the contact using a tie rod.

3. **Pantograph isolators** - This type of electrical isolation allows installation of modern switch gear with the least space required. It is comprised of an operating insulator and a post insulator.

Electrical isolators can be categorized differently, based on the position of the power system. The categorizations are:

Line side isolator - This type of isolator is fixed at the line of a feeder.

Bus side isolator - This kind of isolator is attached directly to the main bus.

Transfer bus side isolator - This type of isolator is attached directly to the transfer bus.

There is no arc-quenching technique used in an isolator, hence it must be operated when the circuit is free from any current. Opening or closing any live circuit by isolator is dangerous because there can be huge arcing between the contacts. A hand isolator can operate voltages that are up to 145kV, while higher voltages that are over 245kV require motorized isolators.

Identification of Equipment and Isolation Points: - The electrical equipment to be worked on, all of its energy sources and the appropriate points of isolation must be positively identified by an electrical worker. It is not uncommon for electrical enclosures to have more than one power source supplied into the enclosure. The safety of the electrical tradespersons relies on identifying and isolating all electrical power sources that are normally present.

E.g. two electrical control panels, each with their own power supply, interconnected with low voltage control circuits – a control circuit in one of the control panels is powered from the second control panel. In this instance, both control panels would be electrically isolated.

Isolation of Electrical Equipment: - All electrical equipment and electrical circuits must be isolated from all sources of electrical supply before any work is started on the equipment and circuits. This will be achieved by operating the appropriate controlling device(s) and include:

- Opening switches;
- Opening circuit breakers; or
- Removal of circuit connections, after the power supply to the circuit connections has been isolated;
- Disconnection of battery

Batteries: Where a battery isolation device is installed, the device should be switched off and locked in the open position to isolate the battery power source before working on the circuits. When disconnecting a battery where one leg is earthed, always disconnect the earthed lead first then the un-earthed lead.

Self-check Test -3

Self-check Test -3	Identifying means of electrical isolation

Directions:

I choose the best and write the letter of your choice on the space provided. ***(2pts each)***

_____1. The replacement, refurbishment or cleaning of lamps and non-electrical parts of equipment, plant and machinery.

A. Mechanical maintenance B. Single break isolators C. Emergency switching D. none

_____2. Rapid cutting off of electrical energy to remove any hazard to persons.

A. Batteries B. Electrical Equipment C. Isolation D. Emergency switching

_____3. Is a method of corrosion control?

A. Electrical isolation B. Pantograph isolators C. Pantograph isolators D. Nene

_____4. This type is divided into male and female contacts.

A. Single break isolators B. Batteries C. Electrical Equipment D. Isolation

_____5. Mechanical switching device capable of making, carrying and breaking current under normal circuit conditions

A. Switch B. Electrical isolation C. Pantograph isolators D. Pantograph isolators

II. Directions: Answer all the questions in the blank space *(3pts each)*

1. _____ is type of isolator is fixed at the line of a feeder.
2. _____ is kind of isolator is attached directly to the main bus.
3. _____ is type of isolator is attached directly to the transfer bus

Note: **Satisfactory rating – 19 points** **Unsatisfactory - below 10 points**

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-4	carrying out basic isolation procedures

4.1. Basic isolation procedure

1 There must be an isolation procedure for each item of plant, including the application of isolation devices, locks and tags, as practicable. While isolation procedures may vary in detail because of differences in plant, power sources, hazards and processes, they must include the following steps.

Safe isolation procedures are in place to ensure that workers on site are not exposed to danger when working on or near live electrical systems. There are many reports where these procedures have not been followed correctly and sadly this has resulted in needless loss of life.

The isolation procedures are:

1. Identify the plant involved and the corresponding energy sources.
2. Identify all other hazards.
3. Shut the plant down.
4. De-energize all stored energy sources.
5. Isolate and lock out all energy sources.
6. Tag plant controls, energy sources and other potential hazards.
7. Control other potential hazards.
8. Test by ‘trying’ to re-activate the plant, without exposing the tester or others to risk, to ensure isolation procedures have been effective, before commencing any maintenance, cleaning, inspection or repairs on the plant.
9. Carry out the work on the plant.
10. Once remedial work is complete, the people who tagged the controls are to remove the tags before the plant is returned to operational status.

Self-check Test 4

Self-check Test 4	Carrying out basic isolation procedures

Instructions:

I. Answer To The Following Questions Accordingly (5*pts. Each*)

1. What is isolation?
2. Write at list fife isolation procedures

Note: **Satisfactory rating – 15 points** **Unsatisfactory - below 8 points**

If you have can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-5	measuring and marking wiring systems, wiring enclosures, equipment and conduit

5.1. Measuring and marking wiring systems

Measuring means:-

- to determine the exact dimensions, capacity, quantity, or force of; measure
- To appraise, estimate, or judge.
- To make conformable to a standard.
- To mark or measure off; delineate.
- To prepare or mix (plaster) with a definite proportion of plaster of Paris and mortar.
- To chip or rub (bricks or stones) to a uniform size or shape.

Marking is putting a point for measuring is not re measuring.

Checking location for sensitivity: -It is used to determine the sensitivity location.

What is a Multi meter?

Melt meters are commonly used to measure current, resistance, or voltage. Originally termed analog Volt-Ohm-Milliam meter (VOM), some models are referred to as Volt-Ohm Meters (VM). Digital Volt Meters (DVMs) measure voltage (certain oscilloscope models have this capability, as well).

Figure 1.5 Digital Volt Meters

Meg ohm meters/Insulation Test

An insulation tester is an ohmmeter that measures the electrical resistance of insulating components. The tester outputs a high DC voltage to generate a current through and over the tested insulation. Readings indicate the amount of current escaping from the insulating

material. Since meter resistance values can be displayed in mega ohms, devices are also called mega ohmmeters

Figure 1.6 **Meg** ohm meters

Ammeter

An ammeter (from Ampere Meter) is a measuring instrument used to measure the current in a circuit. Electric currents are measured in amperes (A), hence the name. Instruments used to measure smaller currents, in the mille ampere or microampere range, are designated as mille ammeters or micro ammeters. Early ammeters were laboratory instruments which relied on the Earth's magnetic field for operation. By the late 19th century, improved instruments were designed which could be mounted in any position and allowed accurate measurements in electric power systems.

Figure 1.7 Ammeter

A voltmeter

Is an instrument used for measuring electrical potential difference between two points in an electric circuit. Analog voltmeters move a pointer across a scale in proportion to the voltage of the circuit; digital voltmeters give a numerical display of voltage by use of an analog to digital converter.

A voltmeter in a circuit diagram is represented by the letter V in a circle.

In electrical and electronic engineering, a current clamp or current probe is an electrical device with jaws which open to allow clamping around an electrical conductor. This allows measurement of the current in a conductor without the need to make physical contact with it, or to disconnect it for insertion through the probe. Current clamps are typically used to read the magnitude of alternating current (AC) and, with additional instrumentation, the **phase and** waveform can also be measured. Some clamps meters can measure currents of 1000 A and more. Hall Effect and vane type clamps can also measure direct current (DC).

Figure 1.8 **voltmeter**

5.2. Wiring enclosures

In general, ordinary corrosion, accidental contact with live parts, and a limited amount of falling dirt. Some devices have been investigated for use in other operating environments

When unmated and when mated with other devices in the same manufacturer's line of products. They are marked with one of the type designations 2 through 6, 12 and 13 indicated in Electrical Equipment for Use in Ordinary Locations (AALZ). All outdoor types provide a degree of protection against rain, snow, and sleet. Outdoor types are also suitable for use indoors if they meet the environmental conditions present. A device that complies with the requirements for more than one type of enclosure may be marked with multiple designations. Complete use and mating information is provided in the installation instructions provided with each device.

Devices having integral enclosures or installed as intended have been investigated for use indoors, in dry locations. All such listed products provide a degree of protection against

5.3. Equipment and tools

5.3.1 Tools

Tape Measure

A standard tape measure is used for all kinds of field measurements, such as setting heights for switches and outlets, centering lighting fixture boxes, and marking surfaces for cutouts.

Hammer

Is used to secure electrical boxes equipped with nail-on brackets to wall studs and other framing members in a home. You'll also need one to drive wire staples when anchoring new electrical cable to framing members.

Utility knife, or *box cutter*,

Is handy for cutting sheathing from non-metallic (Romex) cable, to cut off electrical tape, and to open cardboard boxes.

Phillips Screwdrivers

Electricians keep screwdrivers with them at all times, for removing and installing cover plates, outlets, switches, and many other devices. It's best to have a few different lengths of Phillips screwdrivers, as well as #1, #2, and #3 tip sizes.

Straight-Blade Screwdrivers

Screwdrivers with insulating rubber jackets covering the handles are designed for better safety when doing

As with Phillips screwdrivers, you will likely need more than one size of straight-blade screwdrivers. If you have to choose just one, pick a medium blade; it will suit most projects.

Straight-blade screwdrivers are also available with insulated handles for better safety when doing electrical work.

Wire Strippers

Another essential electrical specialty tool for homeowners is a good pair of wire strippers. Wire strippers are used to cut and strip insulation from electrical wires. A wire stripper tool has a row of gauged holes for stripping wires of different sizes, and it usually includes cutting jaws for trimming the wire ends. Some types are combination tools that can also be used to crimp wires and to strip the vinyl jacket off NM cable.

Needle-Nose Pliers

Another essential specialty electrical tool is a pair of needle-nose pliers (also called *long-nose pliers*). It will be used for bending and twisting wires whenever you are making screw-terminal connections. The long, narrow tip makes this a great tool for detailed work. Most needle-nose pliers also include cutting jaws for trimming wires.

Linesman Pliers

A pair of linesman pliers is an electrician's do-it-all tool. It has a squared-off end that is great for twisting wires together, a center cutting blade for trimming wire, and a grip area between the handles for pulling wire. Diagonal cutting pliers, sometimes called *side snips* or *dikes,* are used to cut wires. They are specially designed with a cutting edge that goes down to the tip of the jaws, allowing you to get into tight areas to trim wires. Some types can also have a built-in voltage detector to sense live wires. You can also find combination tools that include wire-stripping slots built into the handles.

5.3.2 Equipment

The idea of equipment represents all sorts of machinery, functional devices or accessories which serve an individual, household or a community purpose. Usually, a set of tools that are designated for a specific task is known as equipment. This could be a small set of functional items in a finished product. For example, equipment

Electrical Conduit

An **electrical conduit** is an electrical piping system used for protection and routing of electrical wiring. Electrical conduit may be made of metal, plastic, fiber, or fired clay. Flexible conduit is available for special purposes.

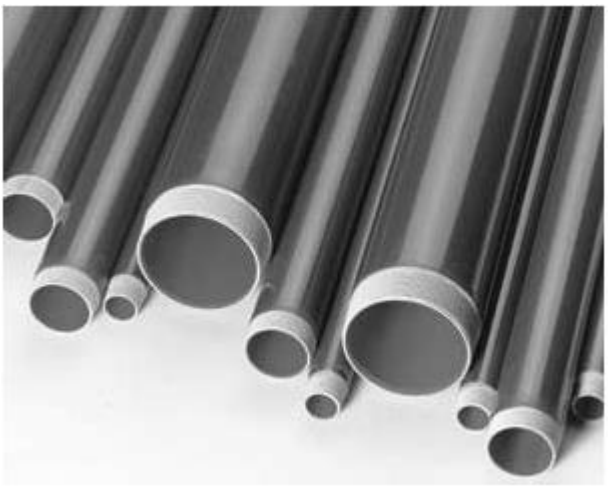
Conduit is generally installed by electricians at the site of installation of electrical equipment. Its use, form, and installation details are often specified by wiring regulations, such as the US National Electrical Code (NEC) or other national or local code. The term "conduit" is commonly used by electricians to describe any system that contains electrical conductors, but the term has a more restrictive definition when used in wiring regulations.

Electrical conduit provides very good protection to enclosed conductors from impact, moisture, and chemical vapors. Varying numbers, sizes, and types of conductors can be pulled into a conduit, which simplifies design and construction compared to multiple runs of cables or the expense of customised composite cable. Wiring systems in buildings may be subject to frequent alterations. Frequent wiring changes are made simpler and safer through the use of electrical conduit, as existing conductors can be withdrawn and new conductors installed, with little disruption along the path of the conduit. A conduit system can be made waterproof or submersible. Metal conduit can be used to shield sensitive circuits from electromagnetic interference, and also can prevent emission of such interference from enclosed power cables.

When installed with proper sealing fittings, a conduit will not permit the flow of flammable gases and vapors, which provides protection from fire and explosion hazard in areas handling volatile substances.

Some types of conduit are approved for direct encasement in concrete. This is commonly used in commercial buildings to allow electrical and communication outlets to be installed in the middle of large open areas. For example, retail display cases and open-office areas use floor-mounted conduit boxes to connect power and communications cables.

Both metal and plastic conduit can be bent at the job site to allow a neat installation without excessive numbers of manufactured fittings. This is particularly advantageous when following irregular or curved building profiles.



The cost of conduit installation is higher than other wiring methods due to the cost of materials and labor. In applications such as residential construction, the high degree of physical damage protection is not required so the expense of conduit is not warranted. Conductors installed within conduit cannot dissipate heat as readily as those installed in open wiring, so the current capacity of each conductor must be reduced if many are installed in one conduit. It is impractical, and prohibited by wiring regulations, to have more than 360 degrees of total bends in a run of conduit, so special outlet fittings must be provided to allow conductors to be installed without damage in such runs. Some types of metal conduit offer a useful bonding conductor for grounding (earthing), but wiring regulations may also dictate workmanship standards or supplemental means of grounding for certain types. While metal conduit can be used as a grounding conductor, the circuit length is limited.

Types of Conduits

1. ***Rigid Metal Conduit*** **(RMC)** - is a thick threaded tubing, usually made of coated steel, stainless steel or aluminum.

   The installation of Rigid Steel Conduit (RSC) is covered by Article 344 of the National Electrical Code (NEC). This article is entitled "Rigid Metal Conduit (RMC) and includes all requirements for all rigid metal conduits, including steel, stainless steel, aluminum, and red brass. You will often see the following acronyms used: RSC (Rigid Steel Conduit), ERSC (Electrical Rigid Steel Conduit), or GRC (Galvanized Rigid Conduit) in place of RMC (Rigid Metal Conduit) in order to differentiate the type of metal used.

Rigid steel conduit (RSC) is a listed threaded metal raceway of circular cross section with a coupling which can be either a standard straight tapped conduit coupling or the integral type. Threads on the uncoupled end are covered by industry color-coded thread protectors which protect the threads, keep them clean and sharp, and aid in trade size recognition. Rigid metal conduit is available in trade sizes 1/2 through 6. Thread protectors for trade sizes 1, 2, 3, 4, 5, and 6 are color-coded blue, trade sizes 1/2, 1 1/2, 2 1/2, 3 1/2 are black, and trade sizes 3/4 and 1-1/4 are red. The nominal finished length of RMC with couplings is 10 feet. Twenty foot lengths are available in some trade sizes.

There are different processes used to provide corrosion protection to rigid steel conduit. Rigid steel conduit can have a primary coating of zinc, a combination of zinc and organic coatings, or a non-metallic coating (such as PVC). Supplementary coatings can be applied to all three where additional corrosion protection is needed.

Rigid steel conduit is the heaviest-weight and thickest wall conduit. Where galvanized by the hot-dip process, it has a coating of zinc on both the inside and outside. Electro-galvanized rigid conduit has a coating of zinc on the exterior only, with approved corrosion resistant organic coatings on the interior. Rigid conduit with "alternate corrosion protection coatings" generally has organic coatings on both the exterior and the interior surfaces. Galvanized rigid metal conduit (GRC) is non-combustible and can be used indoors, outdoors, underground, concealed or exposed. Rigid steel conduit with coatings that are not zinc-based may have temperature limitations which will be noted on the manufacturer's product label and may not be listed for use in environmental air spaces; consult manufacturers' listings and markings.

2. ***Galvanized Rigid Conduit*** **(GRC)** - is galvanized steel tubing, with a tubing wall that is thick enough to allow it to be threaded. Its common applications are in commercial and industrial construction.

3. ***Intermediate Metal Conduit*** **(IMC)** -. Intermediate metal conduit, or IMC for short, is a rigid steel electrical conduit that is lighter in weight than another rigid conduit. It was designed specifically to protect insulated electrical conductors and cables. It does the work of a similar conduit, galvanized rigid conduit (GRC), but with much less weight and thickness size. By utilizing IMC in areas allowed, you can all but eliminate the need for a heavier wall conduit.

   IMC has other advantages over GRC. It has a larger interior diameter than Galvanized Rigid Conduit and the smoother interior of the pipe allows for easier wire pulling through the conduit. It is also coated in a hot galvanized coating on the exterior and a special corrosive-resistant coating on the inside to extend the conduit's lifespan for reliability. Common conduit sizes range from ½" to 4".

4. ***Electrical Metallic Tubing*** **(EMT)**, sometimes called thin-wall, is commonly used instead of galvanized rigid conduit (GRC), as it is less costly and lighter than GRC. EMT itself may not be threaded, but can be used with threaded fittings that clamp to it. Lengths of conduit are connected to each other and to equipment with clamp-type fittings. Like GRC, EMT is more common in commercial and industrial buildings than in residential applications. EMT is generally made of coated steel, though it may be aluminum.

   Electrical Metallic Tubing is light gauge steel raceway used to protect wiring from physical damage and fire. It shields electrical fields emitted by the wiring and acts as a ground. The thick coating of zinc galvanization on the interior and exterior of the conduit provides excellent corrosion resistance from environmental, chemical and mechanical

degradation. Power steel Products provides UL-listed ANSI C80.3 EMT conduit in hex bundles according to the detailed specifications in the chart below. Standard length is 10 feet but other lengths are available. Each piece comes with a UL label and is closely monitored and tested during all phases of production to guarantee the highest quality.

5. **Aluminum conduit**, similar to galvanized steel conduit, is a rigid conduit, generally used in commercial and industrial applications, where a higher resistance to corrosion is needed. Such locations would include food processing plants, where large amounts of water and cleaning chemicals would make galvanized conduit unsuitable. Aluminum cannot be directly embedded in concrete, since the metal reacts with the alkalis in cement. The conduit may be coated to prevent corrosion by incidental contact with concrete. The extra cost of aluminum is somewhat offset by the lower labor cost to install, since a length of aluminum conduit will have about one-third the weight of an equally-sized rigid steel conduit. In extreme corrosion environments where plastic coating of the tubing is insufficient, conduits may be made from stainless steel, bronze, or brass.

6. **Flexible conduits** are used to connect to motors or other devices where isolation from vibration is useful, or where an excess number of fittings would be needed to use rigid connections. Electrical codes may restrict the length of a run of some types of flexible conduit. Flexible metallic conduit used in an underground parking facility.

7. ***Flexible Metallic Conduit*** (FMC, often informally called **greenfield** or **flex**) is made by the helical coiling of a self-interlocked ribbed strip of aluminum or steel, forming a hollow tube through which wires can be pulled. FMC is used primarily in dry areas where it would be impractical to install EMT or other non-flexible conduit, yet where metallic strength to protect conductors is still required. The flexible tubing does not maintain any permanent bend.

FMC may be used as an equipment grounding conductor if specific provisions are met regarding the trade size and length of FMC used in addition to the amperage of the circuits contained in the conduit. In general an equipment grounding conductor must be pulled through the FMC with an ampacity suitable to carry the fault current likely imposed on the largest circuit contained within the FMC.

8. ***Liquidtight Flexible Metal Conduit*** **(LFMC)** is a metallic flexible conduit covered by a waterproof plastic coating. The interior is similar to FMC.

9. ***Flexible Metallic Tubing (FMT)*** is not the same as Flexible Metallic Conduit (FMC) which is described in National Electrical Code (NEC) Article 348. FMT is a raceway, but not a conduit and is described in a separate NEC Article 360. It only comes in 1/2" & 3/4" trade sizes, whereas FMC is sized 1/2" ~ 4" trade sizes. NEC 360.2 describes it as: "A raceway that is circular in cross section, flexible, metallic and liquidtight without a nonmetallic jacket."

10. ***Liquidtight Flexible Nonmetallic Conduit*** **(LFNC)** refers to several types of flame-resistant non-metallic tubing. Interior surfaces may be smooth or corrugated. There may be integral reinforcement within the conduit wall. It is also known as FNMC.

Non-metallic conduit (Polyvinyl Chloride – PVC)

PVC conduit is especially suitable for installation systems in light-industrial premises or offices where surface wiring is required. The fittings are identical to those used for metal conduit with the exception that the system is connected not by screwing but by the use of an adhesive. PVC conduit may be bent by hand using a bending spring. This spring, the same diameter as the inside of the conduit, is pushed inside the conduit. The conduit may now be bent by hand, the spring ensuring that the conduit keeps its shape. In cold weather a little warmth may need to be applied to achieve a successful bend.

Properties of Polyvinyl Chloride (PVC)

1. high tensile strength;
2. it can be bent by hand if warmed;
3. it has high electrical resistance;
4. it is weather resistant;
5. it does not crack under stress at normal temperatures;
6. it has a low flammability;
7. it is self-extinguishing when the source of heat is removed;
8. It must be used with special saddles and expansion couplers when used in fluctuating temperatures, as its expansion is five times that of steel.

5.4 Measuring and marking wiring systems, wiring enclosures and equipment

To prepare the conduit for an electrical installation, you first of all have to determine the installation run between the components or fittings. This installation run very often represents a change of directions, which means that conduit fittings or components are necessary irregularities in the wall.

Therefore measuring conduit is one of the most important parts in any electrical installation.

Before you prepare the conduit for a particular installation, make sure that you select the correct size of the required conduit. Check that the conduit end is straight and square before using any measuring instruments.

To measure the size of a conduit with a rule, place the rule across the conduit in such a way that the edge of the scale is in line with the center line of the conduit. Measure the outside diameter of the conduit, line up the first main graduation of the scale with the outer edge of the conduit on one side and gently move the other end of the scale up and down to find the maximum reading.

To measure the inside diameter of a conduit, place the front edge of the ruler against the inner edge of the conduit and proceed in the same manner described above to find the maximum reading.

Before you cut or bend a conduit, exact measurements must be taken. Flexible rules or folding rules are normally used for linear measurements. This rule extend to n overall length of 1 to 3 meters and in some cases 8 meters.

Before you measure and mark out the length of a conduit, you have to distinguish between conduit which is threaded at the ends or unthreaded.

Measuring unthreaded conduit

To measure the exact conduit depends on the type of fitting used:

a. Fitting without socket
b. Fitting with sockets

There are three most common methods of measuring unthreaded conduit.

1. The fitting used sockets, measure the distance from face to face of fitting
2. The without sockets, measure the distance from the face of one fitting to the face of the other fitting for terminating the conduit to the box.
3. One of the fittings is with a socket and one without socket, measure the distance from the face of one fitting to the face of the other, and add 3 mm to the measured length for terminating the conduit to the box without a socket.

Measuring conduit with threaded ends

To measure conduit which includes threaded conduit fittings, you must learn how to measure the fitting allowance.

Measurement of conduit fittings

1. Center to face the socket
2. Engagement of thread or depth to which the conduit screws into the fitting.
3. Center of fitting to end conduit.

Conduit with threaded ends can only be measured with an allowance for the fittings. This allowance includes the conduits fitting and the thread of the conduit to be connected as shown in the figure.

Conduit lengths are generally measured by one of the following methods:

1. End of conduit thread to face of fitting
2. Face of fitting to face of fitting
3. End to end of the conduit

The other method, the conduit is terminated inside the box by sing a locknut and female bush.

1. Female bush
2. Locknut
3. Conduit

Electrical installation run very often represents exchange of direction. Therefore, it must often be bent to suit any curve or angle between the different fittings.

To make the required bend at the correct position, it is most important to measure the exact distance between one of the fittings and the change of direction.

Measuring for a for a 90^0 bend

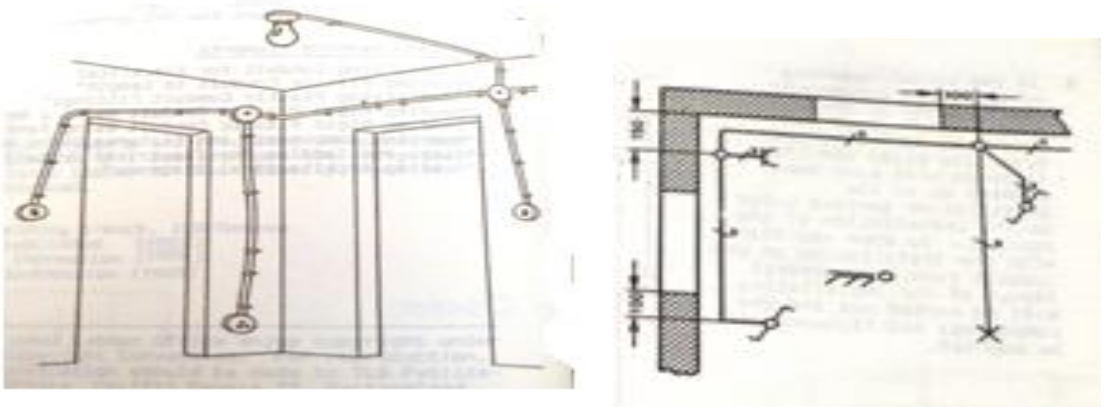


Figure 1.9 conduit bend

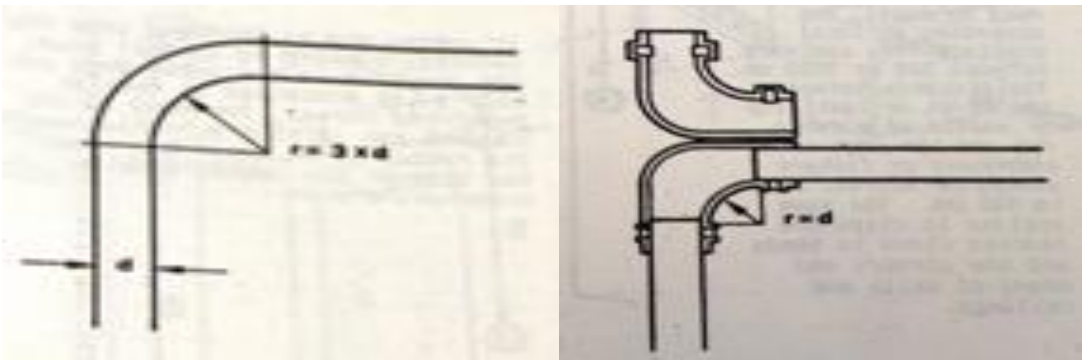


Figure 1.20 conduit bend

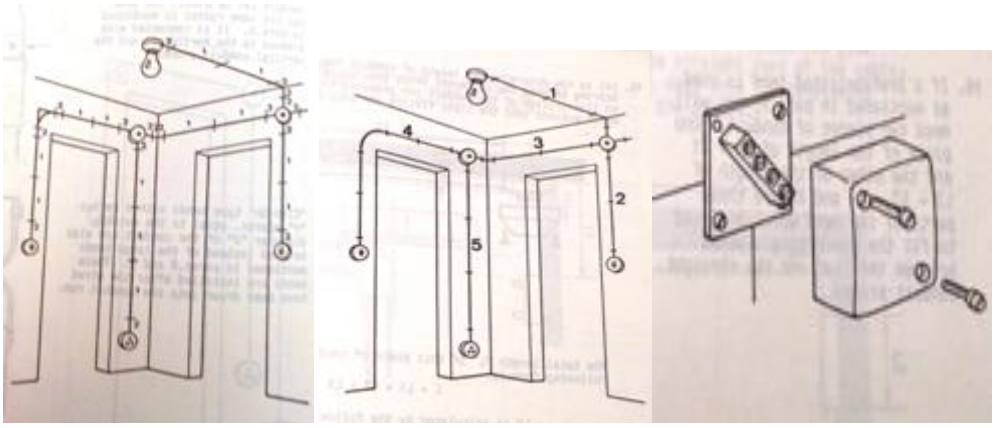


Figure 1.21 conduit bend

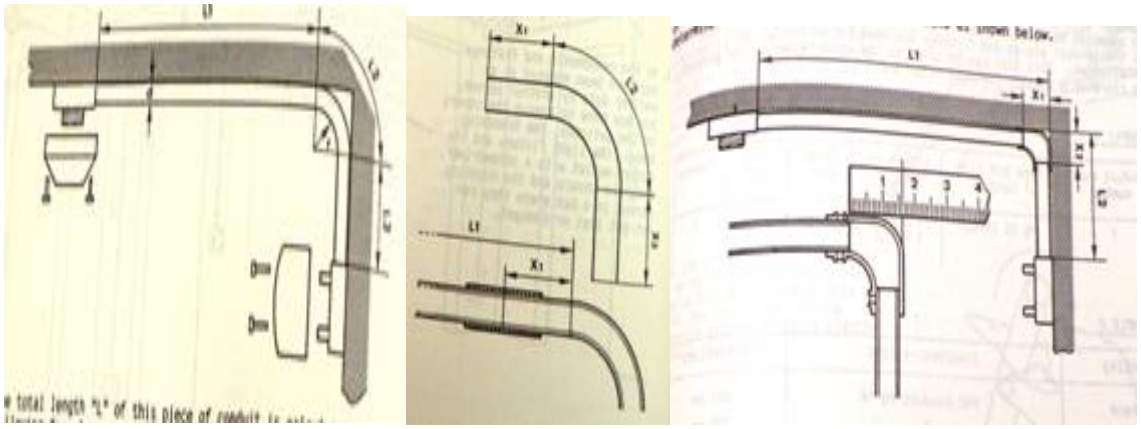
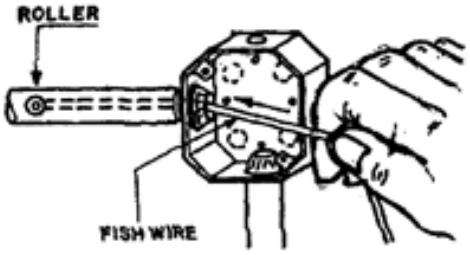
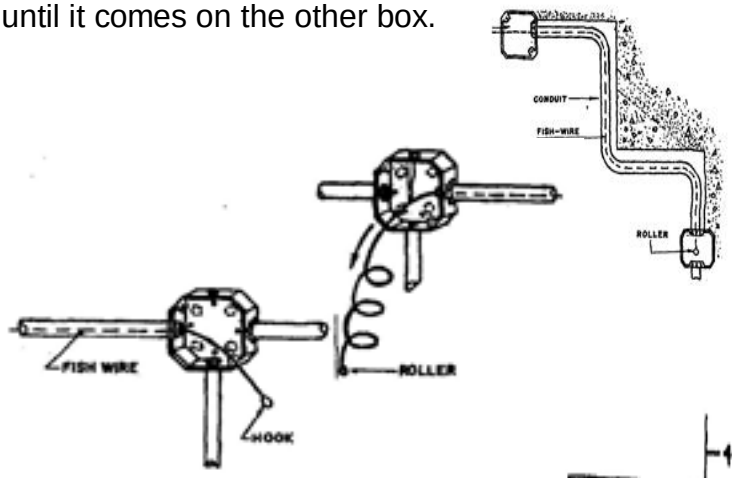


Figure 1.22 conduit bend

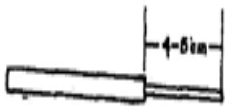
Feeding-in wires/cables into conduit is done after performing roughing in activities. A GI wire is fed in the conduit either by pushing through the conduit or by pulling it with a fish wire. The procedure in feeding in wires into conduit are discussed and illustrated below and on succeeding pages of this learning guide.



1. Insert the GI wire from one electrical box to another through conduit and their fittings.
2. Push the GI wire along the installation until it comes on the other box.



3. Pull the GI wire until the hook end is one meter from electrical box as shown.



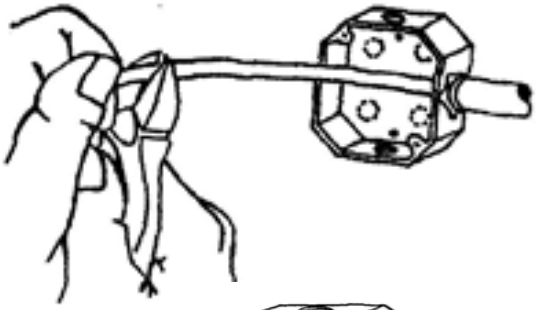
4. Tie the electric wire/cables to the hook by:

- Stripping the insulation of the wire of about 50 mm long from the ends
- Bending the ends as shown

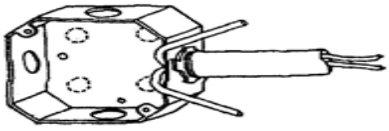
5. Tie all the electrical conductor to the GI wire hook and
   - Bind them with bare wire tightly as shown.

6. Feed-in the electrical conductors into the conduit with somebody pushing at one point while you are pulling at another point as shown.

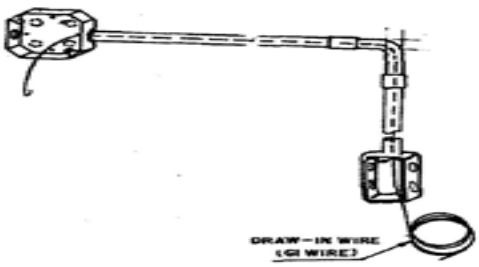
7. Pull the GI wire until the tied ends of the electrical conductor comes out. Cut the wires from the hook leaving enough free ends at the box

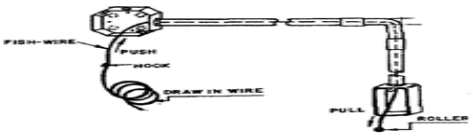


8. Bend the free ends of the wires at the box to prevent from being pulled out from the conduit.

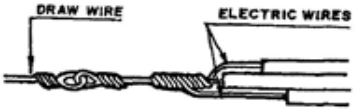


9. When electric wires are not immediately fed-in into a conduits after their installation, a draw-in (G. I. wire) are usually fed-in into the conduit between boxes.





10. In feeding-in wires into the conduit, tie them to the draw wires as shown.



Self-Check -5

Self-Check -5	Written Test

Instructions:

Read carefully the statement and select the best answer from the

1. An electrical piping system used for protection and routing of electrical wiring.

a. Electrical Metallic Tubing
b. Electrical Conduit
c. Flexible Metal Conduit
d. All of the above

2. A metallic flexible conduit covered by a waterproof plastic coating. The interior is similar to FMC.

a. Electrical Metallic Tubing
b. Flexible Metallic Conduit
c. Liquidtight flexible Metal Conduit
d. Polyvinyl Chloride

3. A metal conduit made by a helical coiling of a self-interlocked ribbed strip of aluminum or steel, forming a hollow tube through which wires can be pulled.

a. Electrical Metallic Tubing
b. Flexible Metallic Conduit
c. Liquidtight flexible Metal Conduit
d. Aluminum Conduit

4. A light gauge steel raceway used to protect wiring from physical damage and fire. It shields electrical fields emitted by the wiring and acts as a ground.

a. Electrical Metallic Tubing
b. Flexible Metallic Conduit
c. Liquidtight flexible Metal Conduit
d. Polyvinyl Chloride

5. A conduit coated in a hot galvanized coating on the exterior and a special corrosive-resistant coating on the inside to extend the conduit's lifespan for reliability.

a. Intermediate Metal Conduit
b. Galvanized Rigid Conduit
c. Electrical Metallic Tubing
d. Electrical Metal Tubing

6. Common Intermediate Metal Conduit sizes range from;

a. ½" to 4"
b. 1" to 4"
c. 2" to 4"
d. ¾ to 4"

7. A conduit having a tubing wall that is thick enough to allow it to be threaded. Its common applications are in commercial and industrial construction

a. Intermediate Metal Conduit
b. Galvanized Rigid Conduit
c. Electrical Metallic Tubing
d. Electrical Metal Tubing

8. Rigid steel conduit is the heaviest-weight and thickest wall conduit.

a. Rigid Steel Conduit
b. Electrical Conduit
c. Galvanized Metal Conduit
d. Flexible Metal Tubing

9. A conduit use for a raceway that is circular in cross section, flexible, metallic and liquid tight without a nonmetallic jacket.

a. Rigid Steel Conduit
b. Electrical Conduit
c. Aluminum Conduit
d. Flexible Metallic Tubing

10. A conduit which refers to several types of flame-resistant non-metallic tubing of which the interior surfaces may be smooth or corrugated.

a. Electrical Metallic Tubing
b. Flexible Metallic Conduit
c. Liquidtight flexible Metal Conduit
d. Liquidtight Flexible Nonmetallic Conduit

Note: **Satisfactory rating – 10 points** **Unsatisfactory - below 5 points**

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Name: _____ Date: _____

Operation Sheet-1	Electrical Wiring using Rigid Steel and Metallic Conduit

I. **Topic:** Installation of Electrical Wiring using Rigid Steel and Metallic Conduit.

II. CONDITIONS/SITUATIONS

You are given a task to install electrical wiring using Electrical Metallic Tubing (EMT conduit). The supplies and materials for this task are given below.

III. PROCEDURES

Step 1: Insert the GI wire from one electrical box to another through conduit and their fittings

Step 2: Push the GI wire along the installation until it comes on the other box.

Step 3: Pull the GI wire until the hook end is one meter from electrical box as shown.

Step 4: Tie the electric wire/cables to the hook by:

Step 5: Tie all the electrical conductor to the GI wire hook and

Step 6: Feed-in the electrical conductors into the conduit with somebody pushing at one point while you are pulling at another point as shown.

Step 7: Pull the GI wire until the tied ends of the electrical conductor comes out. Cut the wires from the hook leaving enough free ends at the box

Step 8: Bend the free ends of the wires at the box to prevent from being pulled out from the conduit.

Step 9: When electric wires are not immediately fed-in into a conduits after their installation, a draw-in (G. I. wire) are usually fed-in into the conduit between boxes.

Step 10: In feeding-in wires into the conduit, tie them to the draw wires as shown.

LAP Test	Practical Demonstration

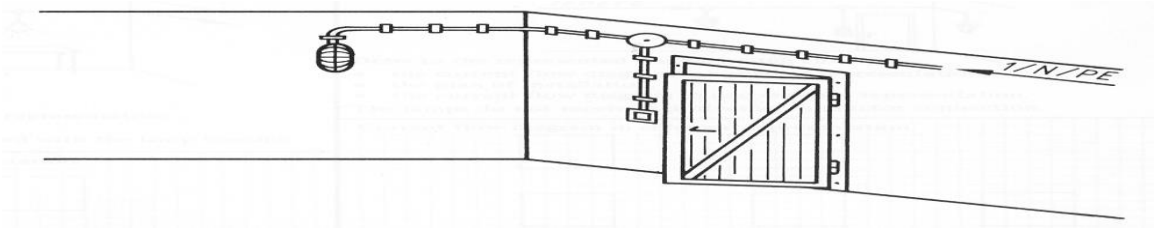
Name: _____ Date: _____

Time started: _____ Time finished: _____

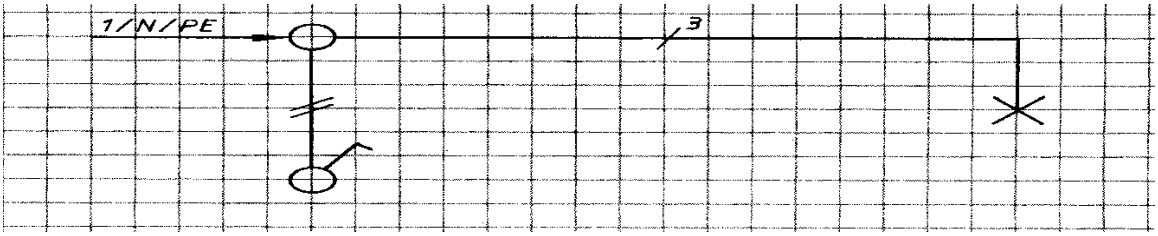
Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 3 hours.

Task 1: install electrical wiring using Electrical Metallic Tubing

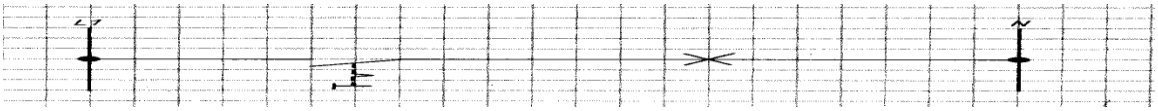
Task 2: ***Lighting circuit, 1-way switch: one lamp, on-off***



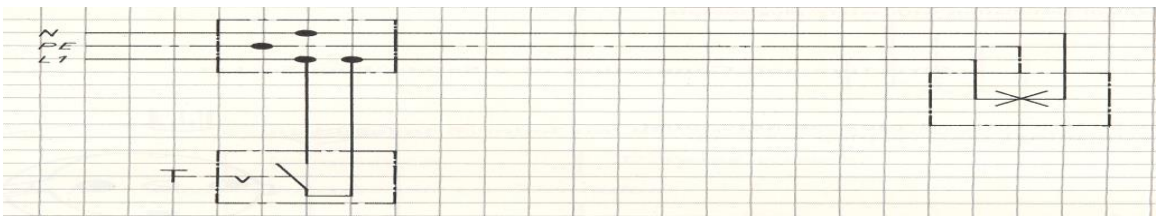
Lining/Layout Diagram



Function Diagram



Wiring Diagram



Information Sheet-6	The checking planned locations for their sensitivity, visually acceptable with other site services

6.1 checking planned locations install wiring system

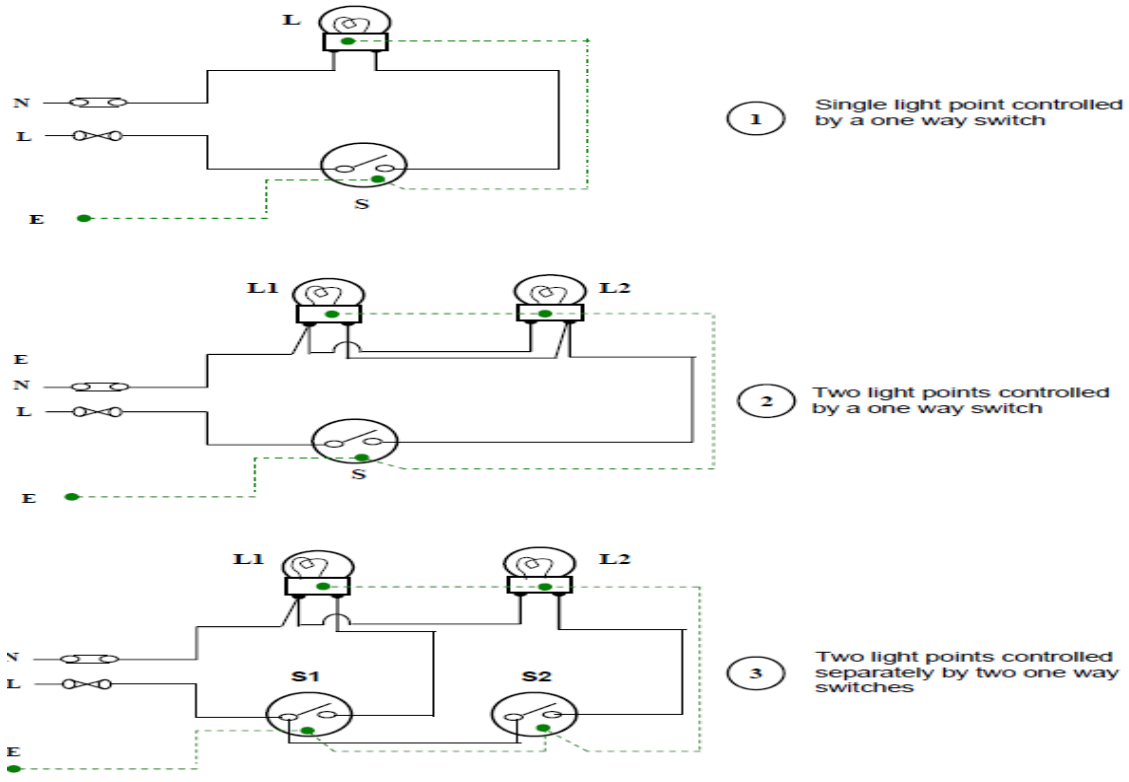
TESTING OF ELECTRICAL WIRING SYSTEM

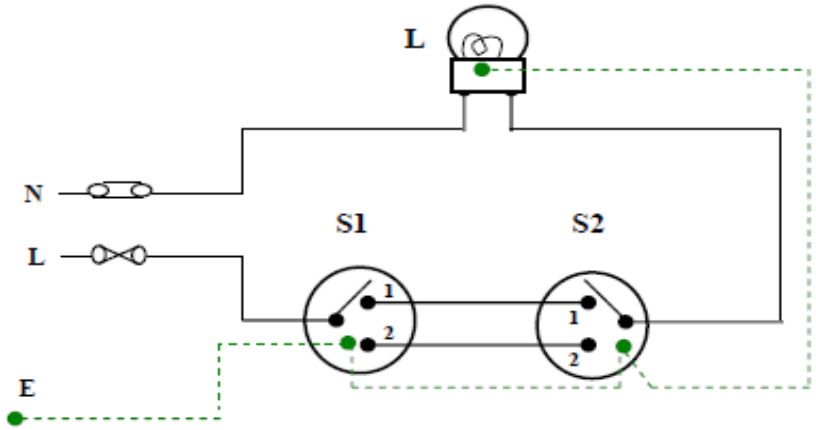
The entire installation shall be tested in accordance with IEE regulations for:

1. Insulation resistance.

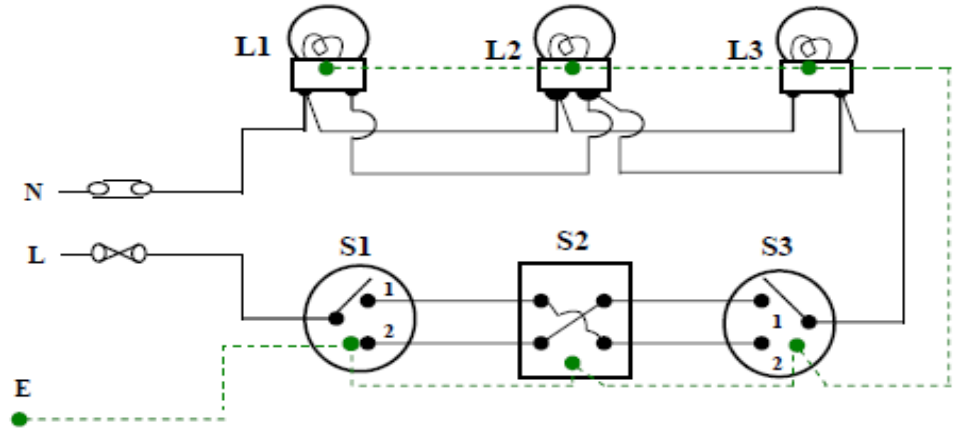
2. Earth continuity.

3. Polarity of single pole switches.

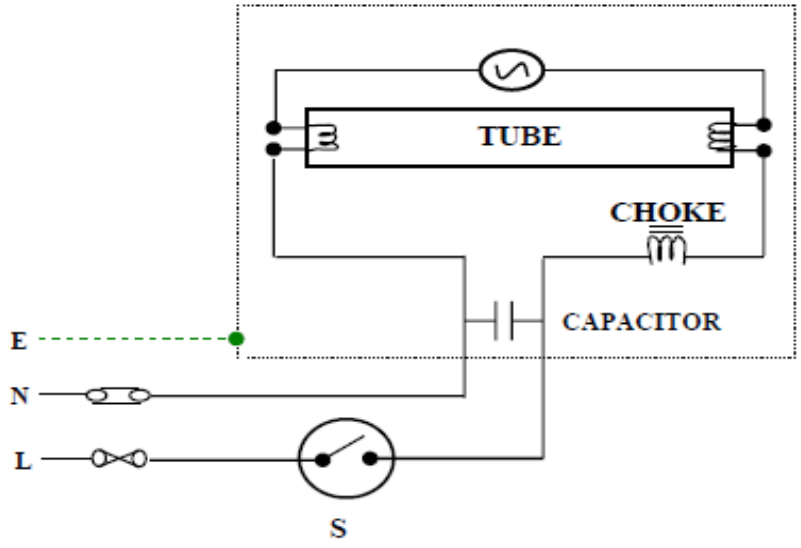




4 Single light point controlled by a two way switch



5 Three light points controlled by two way switches and intermediate switch

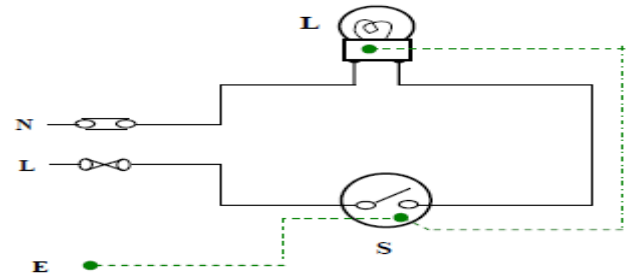


6 Single fluorescent light point controlled by a one way switch

Self-check Test -6

Self-check Test -6	The checking planned locations for their sensitivity, visually acceptable with other site services

Directions: write the name of lighting circuit schematic wiring



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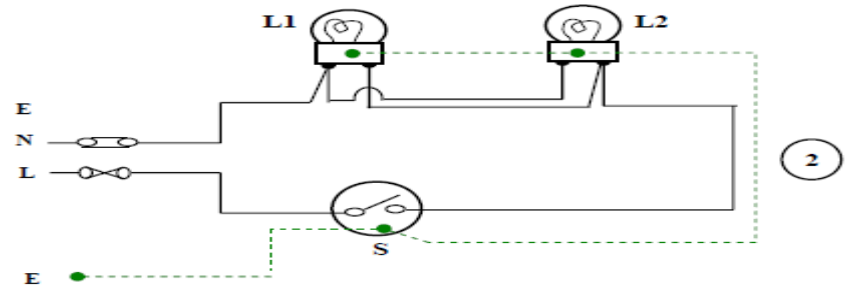

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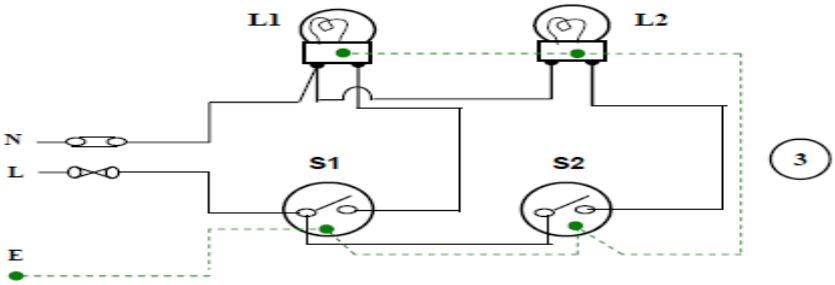

3

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List of Reference Materials

1. Information Gathering.
2. **https://www.youtube.com/watch?v=XOdPJDSTvjM**
3. **Google**

Building electrical installation

Level-II

Learning Guide- 21

Unit of Competence: install wiring system using rigid steel metallic conduit

Module Title: Installing Wiring Systems Using Rigid Steel and Metallic Conduit

LG Code: EIS BEI2 M06 LO21-LG-21

TTLM Code: EIS BEI2 M06 TTLM 0919v1

LO2. Install wiring system

Instruction Sheet	Install wiring system

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Fixing the wiring systems, wiring enclosures and equipment safely with relevant regulations and manufacturers' instructions
- . Recording test data by the job specifications and quality assurance procedures

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, **upon completion of this Learning Guide, you will be able to**:

- Fix the wiring systems, wiring enclosures and equipment safely with relevant regulations and manufacturers' instructions
- . Record test data by the job specifications and quality assurance procedures

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 44 to 47.
3. Read the information written in the information "Sheet 1, Sheet 2,"
4. Accomplish the "Self-check 1, Self-check t 2," **in page -48, and 59** respectively.
5. If you earned a satisfactory evaluation from the "Self-check" proceed to "Operation Sheet 1" **in page 60.**
6. Do the "LAP test" **in page – 60** (if you are ready).

Information Sheet-1	Fixing the wiring systems, wiring enclosures and equipment safely with relevant regulations and manufacturers' instructions

1.1. Fixing the wiring systems

What is Electrical Wiring?

Electrical Wiring is a process of connecting cables and wires to the related devices such as fuse, switches, sockets, lights, fans etc. to the main distribution board is a specific structure to the utility pole for continues power supply.

Methods of Electrical Wiring Systems w.r.t Taking Connection

Wiring (a process of connecting various accessories for distribution of electrical energy from supplier's meter board to home appliances such as lamps, fans and other domestic appliances is known as Electrical Wiring) can be done using two methods which are

- **Joint box system or Tee system**
- **Loop – in system**

They are discussed as follows:

Joint Box or Tee or Jointing System

In this method of wiring, connections to appliances are made through joints. These joints are made in joint boxes by means of suitable connectors or joints cutouts. This method of wiring doesn't consume too much cables size.

You might think because this method of wiring doesn't require too much cable it is therefore cheaper. It is of course but the money you saved from buying cables will be used in buying joint boxes, thus equation is balanced. This method is suitable for temporary installations and it is cheap.

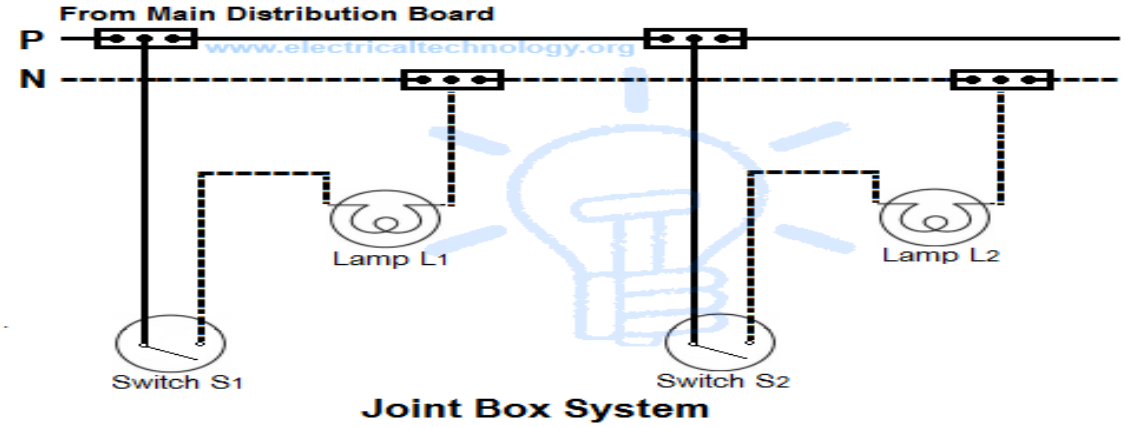


Figure 2.1 joint box system

Loop-in or Looping System

This method of wiring is universally used in wiring. Lamps and other appliances are connected in parallel so that each of the appliances can be controlled individually. When a connection is required at a light or switch, the feed conductor is looped in by bringing it directly to the terminal and then carrying it forward again to the next point to be fed.

The switch and light feeds are carried round the circuit in a series of loops from one point to another until the last on the circuit is reached. The phase or line conductors are looped either in switchboard or box and neutrals are looped either in switchboard or from light or fan. Line or phase should never be looped from light or fan.

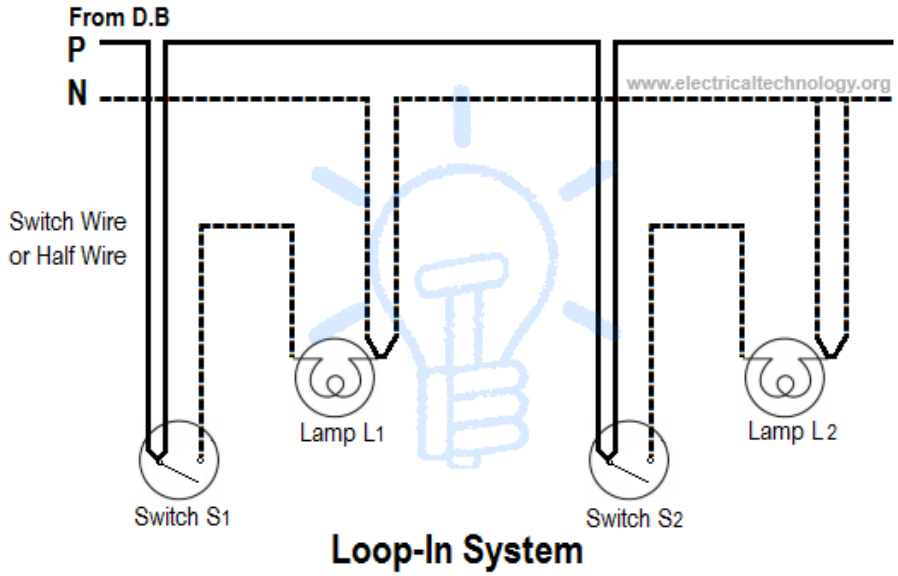


Figure 2.2 loop in system

Advantages of Loop-In Method of Wiring

- It doesn't require joint boxes and so money is saved
- In loop – in systems, no joint is concealed beneath floors or in roof spaces.
- Fault location is made easy as the points are made only at outlets so that they are accessible.

Disadvantages of Loop-In Method of Wiring

- Length of wire or cables required is more and voltage drop and copper losses are therefore more
- Looping – in switches and lamp holders is usually difficult.

1.2. Fixing wiring enclosures safely with relevant regulations and manufacturers' instructions

An electrical enclosure

Is a cabinet for electrical or electronic equipment to mount switches, knobs and displays and to prevent electrical shock to equipment users and protect the contents from the environment? The enclosure is the only part of the equipment which is seen by users; in many cases it is designed not only for its utilitarian requirements, but also to be pleasing to the eye. Regulations may dictate the features and performance of enclosures for electrical equipment in hazardous areas, such as petrochemical plants or coal mines.

Electrical enclosures are usually made from rigid plastics, metals, particularly stainless steel, carbon steel, and aluminum. Steel cabinets may be painted or galvanized. Mass-produced equipment will generally have a customized enclosure, but standardized enclosures are made for custom-built or small production runs of equipment

20" Enclosure with Screw-On Cover

This 20 Inch enclosure features universal On-Q bay-style mounting holes that are compatible with...

Allen Bradley PLC installed in an electrical enclosure

Figure 2.3 enclosure

1.3. Fixing equipment safely with relevant regulations and manufacturers' instructions

Electrical Equipment

An electrical equipment is an electricity consuming device or apparatus (including the cable) that is connected to the electrical installation

Electrical equipment can be classified into one of the following categories:

• **Hand-held / Portable:** appliance which is hand-held while in operation or can be moved easily while connected to the supply, intended to be held in the hand during normal use and the electrical motor forms an integral part of the equipment. (Excludes battery operated equipment). Examples: floor polisher, power tools, power leads, multi-outlet power board, jug, toaster, laboratory stirrer/heater, heat gun, heating mantle, etc.

• **Movable:** an appliance that can be moved readily from one place to another by unplugging from a general purpose outlet, but that is not moved during operation. Examples: cathode ray oscilloscope, electronic balance, personal computer, printer, portable power generating equipment, etc.

• **Fixed/stationary:** an appliance which in normal use is fastened to a support or otherwise secured in a specific position or is of such a size or function as to be difficult or unlikely to be moved from one place to another. Examples: large workshop machinery (lathe, band saw, etc.), oven, refrigerator, fixed power generating equipment, etc.

• **Experimental:** an appliance, constructed by a School/Section that does not fit into any of the other categories. Examples: immersion heater elements, furnaces, distillation control systems, laser sources, UV light sources, heater controls, etc.

Self-check Test 1

Self-check Test -1	Fixing the wiring systems, wiring enclosures and equipment safely with relevant regulations and manufacturers' instructions

Directions:

I. Directions: Answer all the questions (*5pts each)*

1. What is the advantage and disadvantage of loop –in method of wiring?
2. What is Electrical Wiring?
3. What is electrical enclosure?
4. Write the Methods of Electrical Wiring Systems?

Note: **Satisfactory rating – 20 points** **Unsatisfactory - below 10 points**

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-2	Recording test data by the job specifications and quality assurance procedures

1.1 Recording test data by the job specifications

1.1.1 continuity test

2. In electronics, a **continuity test** is the checking of an electric circuit to see if current flows (that it is in fact a complete circuit). A continuity test is performed by placing a small voltage (wired in series with an LED or noise-producing component such as a piezoelectric speaker) across the chosen path. If electron flow is inhibited by broken conductors, damaged components, or excessive resistance, the circuit is "open".
3. Devices that can be used to perform continuity tests include multi meters which measure current and specialized continuity testers which are cheaper, more basic devices, generally with a simple light bulb that lights up when current flows.
4. An important application is the continuity test of a bundle of wires so as to find the two ends belonging to a particular one of these wires; there will be a negligible resistance between the "right" ends, and only between the "right" ends.

How to test for continuity

1. Turn the dial to Continuity Test mode ( ). It will likely share a spot on the dial with one or more functions, usually resistance (Ω). With the test probes separated, the multi meter's display may show OL and Ω.
2. If required, press the continuity button.
3. First insert the black test lead into the COM jack.
4. Then insert the red lead into the VΩ jack. When finished, remove the leads in reverse order: red first, then black.
5. With the circuit de-energized, connect the test leads across the component being tested. The position of the test leads is arbitrary. Note that the component may need to be isolated from other components in the circuit.
6. The digital multi meter (DMM) beeps if a complete path (continuity) is detected. If the circuit is open (the switch is in the OFF position), the DMM will not beep.
7. When finished, turn the multi meter OFF to preserve battery life.

Figure 2.4 continuity test

Continuity testing overview

- Continuity is the presence of a complete path for current flow. A circuit is complete when its switch is closed.
- A digital multi meter's Continuity Test mode can be used to test switches, fuses, electrical connections, conductors and other components. A good fuse, for example, should have continuity.
- A DMM emits an audible response (a beep) when it detects a complete path.
- The beep, an audible indicator, permits technicians to focus on testing procedures without looking at the multi meter display.
- When testing for continuity, a multi meter beeps based on the resistance of the component being tested. That resistance is determined by the range setting of the multi meter. Examples:
    - If the range is set to 400.0 Ω, a multi meter typically beeps if the component has a resistance of 40 Ω or less.

- If the range is set 4.000 kΩ, a multi meter typically beeps if the component has a resistance of 200 Ω or less.

- The lowest range setting should be used when testing circuit components that should have low-resistance value such as electrical connections or switch contacts.

What is a Multimeter?

A digital multimeter or DMM is a useful instrument for measuring voltage, current and resistance, and some meters have a facility for testing transistors and capacitors. You can also use it for checking continuity of wires and fuses. If you like to DIY, do car maintenance or troubleshoot electronic or electrical equipment, a multimeter is a handy accessory to have in your home toolkit.

If you have any questions, just leave a comment at the end of this "how to" guide. Also if you find this article useful, please share it on Facebook, Pinterest or other social media using the easy share buttons.

Thanks!

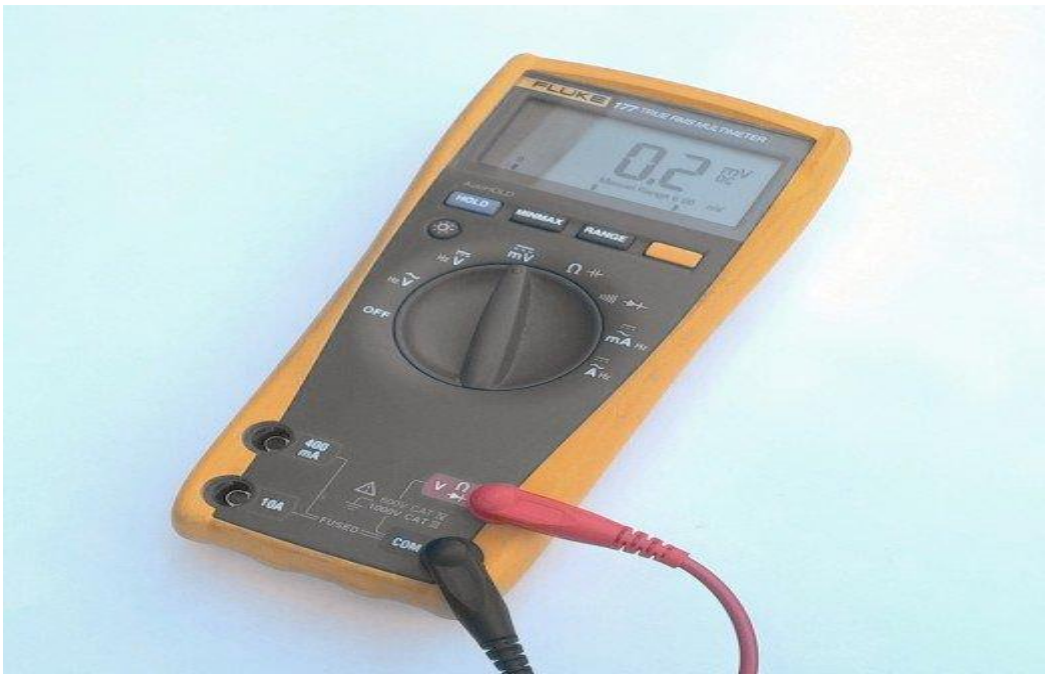


Figure 2.4 multi meter

Volts, Amps, Ohms - What does it All Mean?

Volts

This is the pressure in an electrical circuit

Amps

This is a measure of the current flowing in an electrical circuit

Ohms

A measure of the resistance to flow in a circuit

Voltage Source

This produces a current flow in a circuit. It could be a battery, portable generator, mains supply to a home, alternator on your car engine or bench power supply in a lab or workshop

Load

A device or component which draws power from a voltage source. This could be an electronic resistor, bulb, electric heater, motor or any electrical appliance

Ground

This is usually the point in a circuit to which the negative terminal of a battery or power supply is connected

DC

Direct current. Current flows only one way from a DC source, an example of which is a battery

AC

Alternating Current. Current flows one way from a source, reverses, and then flows the other way. This happens many times a second at a rate determined by the *frequency* which is typically 50 or 60 hertz. The mains supply in a home is AC

Polarity

A term used to describe the direction of flow of current in a circuit or which points are positive and which are negative wrt a reference point

Volts, Watts, Amps, Kilowatt Hours, What does it All Mean? - The Basics of Electricity

What Does a Multi meter Measure?

A basic multi meter facilitates the measurement of the following quantities:

- DC voltage
- DC current
- AC voltage
- AC current (not all basic meters have this function)
- Resistance
- Continuity - indicated by a buzzer or tone

In addition meters may have the following functions:

- Capacitance measurement
- Transistor HFE or DC current gain
- Temperature with an additional probe
- Diode test
- Frequency

The value measured by the instrument is indicated on an LCD display or scale. Laboratory bench DMMs sometimes have seven segment LED displays.

How Do I Setup a Multi meter to Measure Volts, Amps or Ohms?

Voltage, current and resistance ranges are usually set by turning a rotary selection dial. This is set to the quantity being measured, e.g. AC volts, DC volts, Amps(current) or Ohms (resistance).

Voltage, Current and Resistance Ranges

Figure 2.5 multi meter

How to Measure Voltage

1. Power off the circuit/wiring under test if there is a danger of shorting out closely spaced adjacent wires, terminals or other points which have differing voltages.
2. Plug the black ground probe lead into the COM socket on the meter (see photo below).
3. Plug the red positive probe lead into the socket marked V (usually also marked with the Greek letter "omega" Ω and possibly a diode symbol).

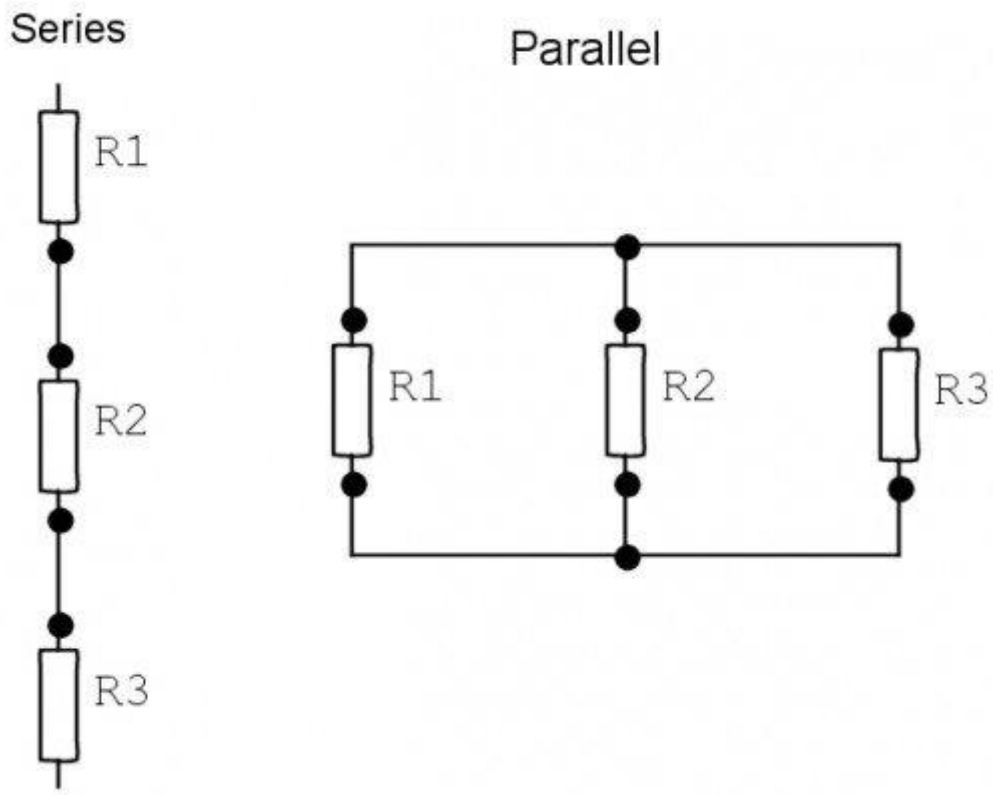
4. If the meter has has a manual range setting dial, turn this to select AC or DC volts and pick a range to give the required accuracy. So for instance measuring 12 volts on the 20 volt range will give more decimal places than on the 200 volt range.
   If the meter is auto ranging, turn the dial to the 'V' setting with the symbol for AC or DC (see "What Do the Symbols on the Range Dial Mean?" below).
5. A multi meter must be connected in parallel in a circuit (see diagram below) in order to measure voltage. So this means the two test probes should be connected in parallel with the voltage source, load or any other two points across which voltage needs to be measured.
6. Touch the black probe against the first point of the circuitry/wiring.
7. Power up the equipment.
8. Touch the other red probe against the second point of test. Ensure you don't bridge the gap between the point being tested and adjacent wiring, terminals or tracks on a PCB.
9. Take the reading on the LCD display.

Note: A lead with a 4mm banana plug on one end and a crocodile clip on the other end is very handy. The croc clip can be connected to ground in the circuit, freeing up one of your hands.

Connecting Probe Leads to Measure Voltage

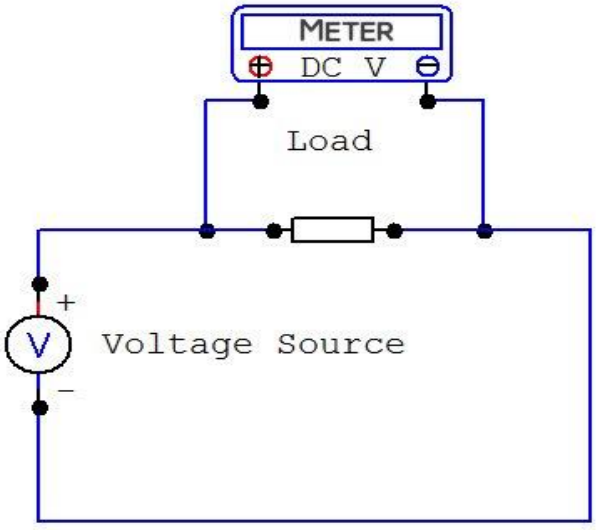
Test leads and 4mm sockets on a DMM, setup to measure voltage | Source

Series and Parallel Connections



Explaining series and parallel connections (R1, R2 and R3 are resistors) | Source

Measuring Voltage - Meter in Parallel with Load



2.2 **Recording test data by quality assurance procedures**

ELECTRICAL INSTALLATION TESTNG RECORD SHEET

Client:	
Project:	**Date of Test:**
Address:	**Tester:**
Area:	**Supervisor:**

				Continuity			IR		CCC	Polarity	Fault Loop Impedance			RCD
Test Point/ Circuit Number	Conductor Sizes (mm²) Actives/Earths		MCB (Rating & Type)	Active Conductor Ω (Rph)	Earth Conductor Ω (Re)	Pass/ Fail	Insulation Resistance (MΩ)	Pass/ Fail	Correct Circuit Connections Pass/Fail	Polarity Pass/Fail	Measured Loop Value R (Ω)	Maximum Permitted Loop Value R (Ω)	Pass/ Fail	RCD Pass/Fail
Main Earth														

To the requirements of AS3000

ELECTRICAL INSPECTION AND TEST PLAN

Client	**Project:**	**Date:** ____/_____/_____
Site address:		

Ref	Operation or Stage of Work		Stage/ Frequency	Records	Requirement Standard/ specification	Acceptance Criteria	Inspection/test procedure	Inspection: What/Who		
	Description	Characteristics						Employee	Service Provider	Customer
1	Incoming materials inspection	Conform to order	Each delivery	Delivery Dockets	Orders as placed	Specification and codes	Check against orders	H	S	
2	Storage and protection	As specified	Each week	Visual	Protected from weather	Safe, secure/adequate protection	Visual	X	S	S
3	Preliminary activities	Task completion	Each work area	Hazard Assessment procedure	Specification, as attached	All tasks completed	Visual	H	W	S
4	Pre-start	Ready to commence work	Each work area	Fencing / signage/ Protective clothing	As per site specific procedure	To authority requirements	Checked	H	W	S
5	Carry out work	To trade codes & authority requirements	Each sequence	Checklist	Specification as per SWMS attached	Checklist and test panel	Checked	H (A)	W	S
5a	Conduit installation	To trade codes & authority requirements	Each sequence	Checklist	SWMS002	Checklist	Checked	X	W	S
5b	Cable installation	To trade codes & authority requirements	Each sequence	Checklist	SWMS012	Checklist Earth test report	Checked	X	W	S
5c	Cable connections	To trade codes & authority requirements	Each Sequence	Checklist	SWMS013	Checklist HV test report	Checked	X	W	S
6.	Pre-handover activities	All matters finalised, clean and tidy	Each work area	Wiring diagrams/ checklist	Specification, as attached	All items completed to specification	Final inspection	H	H	H

Key

W =	Witness Point	A 'witness point provides a party (such as the customer, service provider and regulatory authority) with the opportunity to witness the inspection or test or aspect of the work, at their discretion.
H =	Hold Point	A 'hold' point defines a point beyond which work may not proceed without the authorisation of a designated service provider or authority. This '*designated service provider or authority*' might be an agency or other customer's representative/ authorised person, or a regulatory authority (such as Integral Energy, Sydney Water, Council and/or WorkCover etc.) representative, or it may be the service provider inspecting its service provider or employee.
H (A) =	Inspection/test by authority	
S =	Surveillance or monitoring by supervisor	
X =	Self inspection by employee performing the work	

Electrical work to AS3000 and the NSW Installation and Wiring Rules unless otherwise required.

Self-check Test -2

Self-check Test -2	Recording test data by the job specifications and quality assurance procedures

Directions:

I Choose the one that best suitable the statement and write the letter of your choice on the space provided. *(2pts each)*

_____1. This is the pressure in an electrical circuit

A. DC B. AC C. voltage D. Volts

_____2. This is a measure of the current flowing in an electrical circuit

A. Batteries B. Ohms C. Amps D. current

_____3. A measure of the resistance to flow in a circuit

A. voltage B. Ohms C. Volts D. Nene

_____4. Direct current. Flows only one way from a DC source, an example of which is a battery

A. DC B. Batteries C. Electrical Equipment D. Isolation

_____5. Alternating Current. Current flows one way from a source, reverses, and then flows the other way.

A. DC B. AC C. GB D. all

II. Directions: Answer all the questions *(3pts each)*

What Does a Multi meter Measure?

What is a Multi meter?

What is continuity test?

Note: **Satisfactory rating – 19 points** **Unsatisfactory - below 10 points**

If you have can ask you teacher for the copy of the correct answers.

Score = _____

Rating:

Name: _____ Date: _____

Operation Sheet-1	Electrical Wiring using Rigid Steel and Metallic Conduit

Topic: testing continuity

Procedures:

Step 1: Turn the dial to Continuity Test mode ( ). It will likely share a spot on the dial with one or more functions, usually resistance (Ω). With the test probes separated, the multi meter's display may show OL and Ω.

Step 2: If required, press the continuity button

Step 3: First insert the black test lead into the COM jack.

Step 4: Then insert the red lead into the VΩ jack. When finished, remove the leads in reverse order: red first, then black.

Step 5: With the circuit de-energized, connect the test leads across the component being tested. The position of the test leads is arbitrary. Note that the component may need to be isolated from other components in the circuit.

Step 6: The digital multi meter (DMM) beeps if a complete path (continuity) is detected. If the circuit is open (the switch is in the OFF position), the DMM will not beep.

Step 7: When finished, turn the multi meter OFF to preserve battery life.

LAP Test	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 30 mints.

Task 1: test continuity

Task 2: test voltage

Task 3: test current

Task 4: test voltage

Task 5: test current

List of Reference Materials

1. Information Gathering.
2. https://www.youtube.com/watch?v=XOdPJDSTvjM
3. Google

Building electrical installation

Level-II

Learning Guide- 22

Unit of Competence: install wiring system using rigid steel metallic conduit

Module Title: Installing Wiring Systems Using Rigid Steel and Metallic Conduit

LG Code: EIS BEI2 M06 LO22-LG-22

TTLM Code: EIS BEI2 M06 TTLM 0919v1

LO3. Inspect and notify completion of work

Instruction Sheet	Inspect and notify completion of work

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Reporting to relevant people those variations to the planned work
- The appropriate action is sought from the relevant people

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, **upon completion of this Learning Guide, you will be able to**:

- Report to relevant people those variations to the planned work
- The appropriate action is sought from the relevant people

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 64 to 71.
3. Read the information written in the information “Sheet 1 and Sheet 2,”
4. Accomplish the “Self-check 1, Self-check t 2,” **in page -68 and 72** respectively.
5. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1,” **in page -73.**
6. Do the “LAP test” **in page – 73** (if you are ready).

Information Sheet-1	Reporting to relevant people those variations to the planned work

1. **Preparing Report**

- Report is done to relevant people those necessary variations to the planned programmed of work

The appropriate action is sought from the relevant people.

- Installing electrical wiring systems, wiring enclosures and equipment . The most effective methods of measuring, cutting to length and installing wiring systems and wiring enclosures. The most effective methods of fabricating wiring enclosures. The authority issuing procedures for co-coordinating data on site services

Interpret diagrams and drawings to find site services and the planned location of the wiring systems, wiring enclosures and equipment

THE PURPOSE OF A CONDITION REPORT

Are your electrics Safe?

An electrical Condition Report is a periodic test and inspection of an electrical installation. The purpose of the report is to check the condition of an installation, detecting and recording any factors that might affect safety. One of the reasons a report of this kind is necessary is to determine that the installation has not deteriorated or been damaged over time. An electrical condition report will determine the following aspects:

- how safe the installation is for the protection of people against electric shocks and burns
- The potential for fire and heat damage arising from electrical defects.
- check that the installation has not become unsafe through deterioration or damage
- check for defects or evidence of non- compliance with current regulations which may be dangerous

What is the purpose of an electrical installation condition report?

The Purpose of a Condition Report. An electrical Condition Report is a periodic test and inspection of an electrical installation. The purpose of the report is to check the condition of an installation, detecting and recording any factors that might affect safety

Many homeowners ignore the precautionary measures that have been detailed in different governmental policies, for different electrical installations. There will be times when you will be boggled as to why the inspector has failed your electrical inspection. There are many reasons for a failed inspection, which are very common and generally ignored by the house owners.

To understand the various electrical loopholes that are left by contractors, it is extremely important and necessary to learn about electrical inspection in general.

What is an Electrical Inspection?

An electrical inspection refers to the thorough checkup of the electrical connections and wiring installed in your home.

Who is an Electrical Inspector?

An electrical inspector is an authorized person from the government and municipality who is responsible for checking the electrical connections to ensure they comply with the law codes and requirements in the area.

Why is Electrical Inspection Important?

There are many reasons behind the necessity of getting an electrical inspection done. Some of the most common ones are:

- **Protection against possible surges:** This is a common phenomenon in different regions, especially when there is a storm. Electrical surges can not only ruin your appliances, but can also create short circuits in your house. When the inspection is being done, the inspector will check for different points in the wiring that can cause this type of mishap.
- **Fire:** Many a times it has been seen that an electrical short circuit has been the reason behind a fire breakout in a house. These short circuits are caused by different loose wires in the meter or in the cabling itself. During the inspection, the inspector can easily recognize these faults and ask you to rectify them.
- **Shocks:** Imagine touching an electronic appliance and immediately experiencing a surging electric current in your body. Although the impact may not be that disastrous; however, this could lead to other mishaps easily. Apart from this, the body current in

an electronic appliance can easily hamper its performance or can render it completely non-workable. An electrical inspector can catch these faults in the wiring in time to rectify them.

How to Prevent Different Problems during Electrical Inspection?

Your mind just might be full of questions as to why you failed an electrical inspection. While the reasons may vary, it is always better to know what to do before an inspection to avoid failure. Some of the main points are:

- **Research:** Check all the possible norms and procedures that you might need to follow while installing different wires and cables. Apart from this, a proper research will also help in ensuring that you do not stand clueless, while the inspector does the inspection.
- **Proper equipment:** The electric wires and cables in your house should be authentic in nature. They should be made as per the norms and requirements of the state laws.
- **The right technician:** It is imperative that you get the right electrical technician to work in your house. A novice or amateur might just damage the electrical connections that could lead to different types of disasters, apart from you failing the inspection.
- **The costs involved:** It is advisable to check the charges involved in getting an inspection done. While some places will not charge you at all, some others may charge, especially if it is a repeat visit. You would also need to know the necessary paperwork you would need before and during the inspection. Getting the paperwork done beforehand will help save a lot of time.

Introduction Supervisor

A Person in the first-line management who monitors and regulates employees in their performance of assigned or delegated tasks. Supervisors are usually authorized to recommend and/or effect hiring, disciplining, promoting, punishing, rewarding, and other associated activities regarding the employees in their departments.

2.2 Job Description:

1) Supervises and coordinates activities of electric-meter installer I and electric-meter repairer engaged in installing, testing, adjusting, and repairing meters for recording electric current consumption: Reviews work orders to verify specifications of wire sizes and metering equipment according to National Electric Code and company requirements.

2) Visits installation sites and inspects installed meters and other electrical appliances for conformance to specifications and safety standards.

3) Consults with customers, electric-wiring contractors, and commercial department representatives to determine space requirements, availability of customer-service outlets, and types of metering equipment for special installations.

4) Issues meter test or repair orders to workers.

5) Examines meters, instruments, and phase transformers to verify accuracy of tests and completion of repairs or adjustments.

6) Performs other duties as described under supervisor Master Title.

Self-check Test -1

Self-check Test -1	**Reporting to relevant people those variations to the planned work**

Directions:

I. Directions: Answer all the questions *(3pts each)*

1) What is the purpose of an electrical installation condition report?
2) What is an Electrical Inspection?
3) Who is an Electrical Inspector?
4) Why is Electrical Inspection Important?

Note: **Satisfactory rating – 15 points** **Unsatisfactory - below 8 points**

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-2	The appropriate action is sought from the relevant people

Electrical Installation Testing Record Sheet

What's the difference between an "electrician" and a "Quality electrician"? Planning, execution and evidence.

Although electrical contractors are only required to issue customers with a certificate of test, documented inspection and test procedures, and inspection and test records provide evidence of the actual test results which support the certificate. They also provide workers with a visual reminder of the step by step testing process. Workers can easily review the completed test record and identify if any steps have been missed

Install a Concealed Electrical Wiring System

A Step by Step Guide

Concealed conduit electrical wiring systems are a popular choice in domestic premises as they are aesthetically appealing. They are the most commonly used house electrical wiring system as it protects the wires from external damage and increases their longevity.

The wires are installed in 4 steps.

- Laying the electrical conduits in the slab
- Laying the electrical conduits in the wall
- Installation of Switch Boards Back Boxes
- Installation of Distribution Boards

Let us look at the step-by-step installation procedure of a concealed conduit electrical wiring system.

Laying of Electrical Conduits in Slab

- The slab conduits for house wiring should be 2 mm thick and 25 mm in size for PVC conduits. Lay the slab conduits between the top and bottom reinforcement.
- Use only deep junction boxes in slabs. Properly bind the PVC conduits using the binding wire.
- It would be ideal to follow the color coding for conduits for electrical wires and data such as LAN and telephone wire. Use grey PVC pipes for data, black PVC pipes for electrical wires and PVC solvent for joining the accessories
- Check the wall drops carefully and determine the concrete thickness.
- Check the conducting as per the service drawings and see where the switchboards are located and how many points need to be installed at each location
- Take special precautions while concreting the slab
- Replace all the broken pipes
- Ensure that all the joints are watertight
- Once the slab and beam are de-shuttered, pass the GI wiring immediately. Document any choke up or alternate route for future references
- Provide all the necessary sleeve in beams, columns prior to slab casting as per electrical & air-conditioning
- Provide the pull boxes at suitable locations
- Don't cluster the pull and junction boxes at one place. Arrange them so that they can't be seen easily from heavy movement areas as per the electrical drawings

Laying of Electrical Conduits in Wall

- Carry out the concealed conduit work after the construction of masonry walls but before the plastering work starts
- Once the curing of brickwork is completed, carry out the chasing work. Ideally, maintain a gap of 7 days between the two activities
- Do the wall chasing with wall cutters only as this would avoid damage to the walls
- Fix the electrical conduits with the approved clips to ensure proper routing and wiring
- Once the conduits, boxes and accessories are fixed, fill the chiseled surface with cement mortar and chick mesh wrapped around the conduits
- Start the wall conducting activity with level marking on the wall, keeping the height above FFL(Finished floor level) in mind
- Limit the width of chasing as per the number of conduits
- The depth of chasing should be at least 10 mm from the masonry wall to have the conduit recess

- Make sure that all the horizontal conduit runs are straight at the box level. The light point conduit should run straight vertically to the switch box. Make sure no wall conduit is taken haphazardly
- Don't use any elbows or bends. Use a spring to bend if you want to change the direction of the pipe.
- Don't run power conduits near any communication line
- Run the conduits above the false ceiling with proper support. Don't rest them on the false ceiling in any case. Seal the vertical runs with open ends at the top if you have false ceiling work

Installation of Switch Boards Back Boxes

- Fix the concealed switchboard properly in level based on the architect's design, for example, distance and height from the finished floor level (FFL)
- Ensure that the gap between the concealed switchboards is uniform. Maintain the same uniformity across all the installations.
- The switchboards must be readymade modular type metal boxes of the approved make. Fix the concealed box 3 mm below the plastered surface.
- Finish the box fixing before the plastering work while doing the wall conduiting. Fill the boxes with thermocol while the plastering work is being done.

4: Installation of Distribution Boards

- Conceal the distribution board before the plasterwork
- Fix the DB box in a proper line and level the recess provided in the brickwork
- Ready the box as per the design such as fixing the number of conduits entering the distribution box
- Place the PVC pipes from the given entry holes only

Self-check Test -1

Self-check Test -1	**Reporting to relevant people those variations to the planned work**

I. Directions: Answer all the questions *(3pts each)*

1) What's the difference between an "electrician" and a "Quality electrician"?
2) *How to install The wires write steps*

Note: **Satisfactory rating – 15 points** **Unsatisfactory - below 8 points**

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Name: _____ Date: _____

Operation Sheet-1	**Electrical Wiring using Rigid Steel and Metallic Conduit**

Topic: Installation of Distribution Boards

Procedures:

Step 1: Conceal the distribution board before the plasterwork

Step 2: Fix the DB box in a proper line and level the recess provided in the brickwork

Step 3: Ready the box as per the design such as fixing the number of conduits entering the distribution box

Step 4: Place the PVC pipes from the given entry holes only

LAP Test	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 1 hours.

Task 1: Install Distribution Boards

List of Reference Materials

1. Information Gathering.
2. https://www.youtube.com/watch?v=XOdPJDSTvjM
3. Google

No	Name of trainer	Qualification	Region	E-mail	Phone no.
1	Rehma Muluneh	Electrical control engineering	Addis Abeba	rehmamuluneh@gmail.com	0948723755
2	Salahadin Hussien	Electrical control and automation	Addis Abeba	Salahadinethio@gmail.com	0923067374
3	Elias Getachew	MSc Electrical control and automation	Addis Abeba	get.elias19@gmail.com	0913811386
4	Mesfin Bekele	Electrical control automation	Addis Abeba	Mesfin8430@gmail.com	0916843021
5	Rahel Ouma	MSc electrical electronics	Somalia	rahelouma@yahoo.com	0913343840
6	Getinet Melkie	Electrical electronics	Somalia		0911802534
7	Zenebe Shiferawu	BSc constriction technology	Dire Dewa	zeadeshiferaw@gmail.com	0913959294
8	Tewodros Yossef	Electrical engineering	Benshangule	Tedyo05@yahoo.com	0917422873
	Zelalem taye	M.A in lender ship	Amhara	Tayezelalem22@gmail.com	0918021238
	Addisu wodajo	M.A in vocational management	Amhara	addalvy2010@gmail.com	0935439185