INDUSTRIAL ELECTRICAL MACHIN DRIVE TECHNOLOGY

LEVEL II

LEARNIG GUIDE - 16

Unit of Competence:	**Install and terminate wiring system**
Module Title:	**Installing and terminating wiring system**
LG Code:	**EEL EMD2 05 0811**
TTLM Code:	**EEL EMD2 M05 1019**

LO1: Plan and prepare

Instruction Sheet	Learning Guide #16

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

MODULE CONTENTS:

LO1 plan and prepare

- Safety requirements of equipment/tools
- Reading and interpreting electrical circuit diagrams
- Types and application of termination
- Checking Wiring system and components
- Procedure of termination
- Identifying wiring system components and accessories
- Consult work coordination
- Tools equipment and Testing Device

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

- Installation is planned and prepared
- Appropriate personnel are consulted
- Wiring systems' components are checked
- Fitting Accessories are obtained in accordance with established procedures
- Locate in which specific items of accessories, apparatus and circuits are Installed
- Materials necessary to complete the work are obtained
- Tools, equipment and testing devices needed to carry out the installation work are obtained

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instruction described blew 3 to 6
3. Read the information written in the "Information Sheet 1 up to information 8".
4. Accomplish the "Self-check 1, self-check 2, Self-check 3, Self-check 4, Self-check 5, Self-check 6, Self-check 7, Self-check 8 " in page (6,13,19,25,30,35,38 and 43) respectively.
5. If you earned a satisfactory evaluation from the "Self-check" proceed to "Operation Sheet 1, Operation 2 in page -45 and 46 respectively.
6. Do the "LAP test" in page – 47 (if you are ready.

Information Sheet-1	Safety requirements of equipment/tool

1. Introduction

Safety is the number one priority in any job. Every year, electrical accidents cause serious injury or death. Many of these casualties are young people just entering the workplace. They are involved in accidents that result from carelessness, from the pressures and distractions of a new job, or from a lack of understanding about electricity. This chapter is designed to develop an awareness of the dangers associated with electrical power and the potential dangers that can exist on the job or at a training facility.

1.1 safety equipment

Generally, safety equipment is the protection that is used by workers to avoid injuries, casualties, life threatening situations etc.. Different types of safety equipment are used by workers depending upon the nature of risk involved in the work. For example, in a welding operation the dark welding helmets are used as a piece of safety equipment. In construction operations, hard hats, foot gear and coveralls are considered safety equipment. All these types of safety equipment fall under the Personal Protective Equipment (PPE) category.

- **use equipment safely**

All businesses must ensure that their equipment is used and maintained correctly to reduce the risk of accidents or damage to health and to meet health and safety requirements. Under health and safety law, employers have a duty to minimize risks to employees.

1.2 General Safety Practices

Only tools and equipment which are in good condition may be used. Tools shall only be used for the purpose for which they were designed. Employees shall make frequent inspections of tools and equipment, and immediately remove from service any items found defective.

When using hand tools, the employee shall place himself in such a position that he will avoid injury if the tool slips.

Only soft faced hammers (brass, plastic, rubber, or similar materials) shall be used on highly tempered steel tools such as cold chisels, star drills, etc. Proper eye protection must be worn when performing such an operation.

Files, rasps, and other tools having sharp tangs shall be equipped with approved handles.

Tools which are not in use shall be placed where they will not present a tripping or stumbling hazard.

Pointed tools shall never be carried edge or point up in pockets.

Tools shall not be thrown from one worker to another, or to another working location.

Extensions shall not be used on wrenches to gain leverage unless the wrench is designed to be used in such a fashion.

When cutting wire or any other material under tension, the material being cut shall be secured to prevent the ends from snapping free. Hooks, brushes, vacuums, or special tools shall be used to remove dust or chips. Compressed air shall not be used.

All machinery must be turned off when unattended. Maintenance, repairs, adjustments, and measurements must not be made while saws, lathes, grinders, and similar equipment are in operation.
Compressed air shall never be used to dust off clothing, or be directed toward another person.
Saw blades, gears, sprockets, chains, shafts, pulleys, belts, and similar apparatus shall not be operated without the proper guarding. Safety glasses, goggles, or face shields shall be worn when operating power tools.
Electrical termination is the practice of ending a transmission line with a device that matches the characteristic impedance of the line.
An electrical connector is an electro-mechanical device used to join electrical terminations and create an electrical circuit. Electrical connectors consist of plugs (male-ended) and jacks (female-ended). The connection may be temporary, as for portable equipment, require a tool for assembly and removal, or serve as a permanent electrical joint between two wires or devices
Safety practices to be observed for work on electrical equipment. The following general safety practices should be observed for work on electrical equipment:

- **Check before Act**

The scope of work and relevant circuit should be checked before starting any electrical work. Suitable lighting and adequate illumination should be provided for the workplace. The condition of tools and instruments should also be checked before carrying out electrical work.

- **Isolate and Lockout**

The circuit / equipment under maintenance should be isolated as far as practicable. The relevant isolator should be locked out. A suitable warning notice should be placed close to the isolator.

- **De-energize**

The circuit/equipment to be worked on should be checked to ensure that it is dead.

- **Others**
  - ✓ The workplace should be kept clean and tidy.
  - ✓ Keep hands away from any circuit or equipment or extraneous conductive parts that are not being worked on.
  - ✓ Unauthorized people should not stay in the work place.
  - ✓ The requirements stated in any related safety procedures and checklists should be followed.
  - ✓ Electrical installations, including but not limited to those newly installed, maintained, repaired or tripped under fault conditions, should be properly inspected and tested prior to en enegization.
  - ✓ Hooks, brushes, vacuums, or special tools shall be used to remove dust or chips.
  - ✓ Compressed air shall not be used.
  - ✓ All machinery must be turned off when unattended.

- ✓ Compressed air shall never be used to dust off clothing, or be directed toward another person.

Saw blades, gears, sprockets, chains, shafts, pulleys, belts, and similar apparatus shall not be operated without the proper guarding.
Safety glasses, goggles, or face shields shall be worn when operating power tools.
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An electrical connector, is an electro-mechanical device used to join electrical terminations and create an electrical circuit

1.3 POWER TOOLS

There are a few other precautions to follow when working with machinery. Some of the precautions are as follows:

- Never operate a machine with a guard or cover removed.
- Never operate mechanical or powered equipment unless you know how to operate them. When in doubt, consult the appropriate instruction or ask someone who knows.
- Always make sure that everyone is clear before starting or operating mechanical equipment.
- Cut off the source of power before trying to clear jammed machinery.
- Always keep everyone clear when hoisting heavy machinery or equipment by a chain fall. Guide the hoist with lines attached to the equipment.
- Never plug in electric machinery without knowing that the source voltage is the same as that called for on the nameplate of the machine.

Carefully inspect all portable power tools to be sure they are clean, well-oiled, and in working order before you use them. The switches should operate normally, and the cords should be clean and free of defects. Ground the casings of all electrically driven tools. Do not use sparking portable electric tools in any place where flammable vapors, gases, liquids, or exposed explosives are present.
Check to make sure that power cords do not come in contact with sharp objects. Don't let cords kink. Don't leave them where they might be run over. Don't let cords contact oil, grease, hot surfaces, or chemicals. When damaged, replace power cords. When unplugging power tools from receptacles, you should grasp the plug, not the cord.

Self-Check 1	Written Test

Name: _____ Date: _____

I. Direction: Answer the following questions.

1. What is safety of equipment?

2. What are the general safety practices should be observed for work on electrical equipment?

3. Why is it important to use equipment safely?

4. Write the precautions to follow when working with machinery?

Note: **Satisfactory rating - 4 points** **Unsatisfactory - below 4 points**

Information Sheet-2	Reading and interpreting electrical circuit diagrams

2.1 Electrical diagrams

There are a number ways to show electrical circuits. They are wiring, schematic, pictorial and layout diagrams.

There are several different types of electrical wiring diagrams. They all do essentially the same thing, which is to show you how circuits are wired. However, the variation in these diagrams shows how circuits are mapped out in different ways to accomplish different ends. The type of electrical wiring diagram you use depends on what you want to achieve with it.

An electrical wiring diagram will use different symbols depending on the type, but the components remain the same. Diagrams will show receptacles, lighting, interconnecting wire routes, and electrical services within a home. This includes circuit breaker boxes and any alarms that are wired into the system. Different switches and different types of outlets all have different symbols, and you'll need to know these symbols in order to be able to read an electrical wiring diagram. Everything within a home electrical system will be shown on one of these diagrams. This is to make sure that everything will operate correctly if the diagram is adhered to and all components are functional.

2.1.1 Electrical symbols

Electrical symbols or electronic circuits are virtually represented by circuit diagrams. There are some standard symbols to represent the components in circuits. This article gives some of the frequently used symbols for drawing the circuits. There are many electrical and electronic schematic symbols are used to signify basic electronic or electrical device. These are mostly we used for draw circuit diagrams.

Below are different kind of symbols we mentioned category wise.

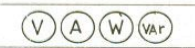
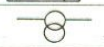
- Wires
- Switches
- Sources
- Ground
- Resistor
- Variable Resistor
- Capacitor
- Inductors
- Diodes
- Transistor
- Logic Gates
- Amplifiers
- Antenna
- Transformer

Table 1 Electrical symbols

SYMBOL	DESCRIPTION
Line Systems	
	Conductor, general
	Flexible conductor
Identification of Installation Method	
	Underground line
	Overhead line
	Surface line
	In/Under surfaceline
Identification of Intended Application	
	Protective Conductor (PE)
	Signal line
	Telephone line
	Radio line
Supply Lines	
	Wiring going upward
	Wiring going down
	Wiring passing through vertically
	Junction of conductors for flush installation

Table 2 Electrical symbols

Table 26.1 Graphical symbols for electrical installations (conte'd)

SYMBOL	DESCRIPTION
Luminaires(conte'd)	
	Florescent luminaire double lamp
	Row of florescent luminaire
	Exterior luminaire (post top)
Indicating Instruments and Transformers	
	Indicating instruments
	Metre (kilowatthour-metre)
	Current transformer
	Voltage transformer
Power Supply Units	
	Convertor General Symbol
	Rectifier
	Battery (Cell)
	Inverter
Electrical Appliances (Power)	
	Electrical appliance, General symbol
	Kitchen appliance
	Electric range, general symbol
	Microwave cooker
	Baking oven
	Hotplate
	Water heater
	Washing machine

Note: Darkened symbols indicate flush [recessed] installations.

Table 3 Electrical symbols

Table 26.1 Graphical symbols for electrical installations (conte'd)

SYMBOL	DESCRIPTION
Electrical Appliances(conte'd)	
	Clothes dryer
	Dish washer
	fan
	Air conditioning
	Freezer
	Deep freezer
M	Motor
G	Generator
Communication appliances	
	Intercom
	Telephone exchange, general symbol
	Automatic Telephone exchange
Signalling Devices	
	Bell
	Horn
	Siren
	Call indicator panel (Number indicates call stations, for example 9 stations)
	Electric Clock
	Master Clock
	Non-automatic fire alarm device (manual fire call point)
	Fire alarm control & indicating panel
	Smoke detector

Note: Darkened symbols indicate flush [recessed] installations.

2.1.2 Types of electrical circuit

1 Schematic Diagram

The system flow is shown by a series of horizontal and vertical lines, much like a normal electrical wiring diagram. However, in this case, the lines show the flow of the system rather than the wires in the system. It's an electrical wiring diagram that's aimed more at designers and electricians who work with the theory of the circuit. Schematics will not be ideal for anyone who plans on working on the circuit as it is in the house.

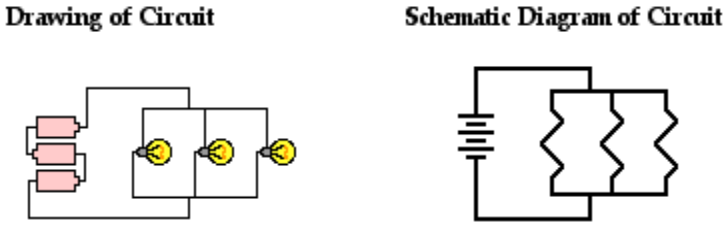


Figure 1: Schematic Diagrams

2 Wiring Diagram

A wiring diagram is the most common form of electrical wiring diagram. Unlike a schematic, it's concerned with the connections between the different parts of a circuit or parts of an entire electrical system. Wiring and equipment on the wiring diagram is carefully laid out to show the approximate location of equipment in the circuit and thus, within the home. This makes it far more useful as a reference and guide for anyone wanting to work on a home's electrical.

The components within the circuit are represented by a series of pictorials and these accurately resemble the components within the system so they can be easily identified. While the horizontal and vertical lines of a schematic show the circuit's flow, lines in a wiring diagram instead represent the physical wiring of the circuit.

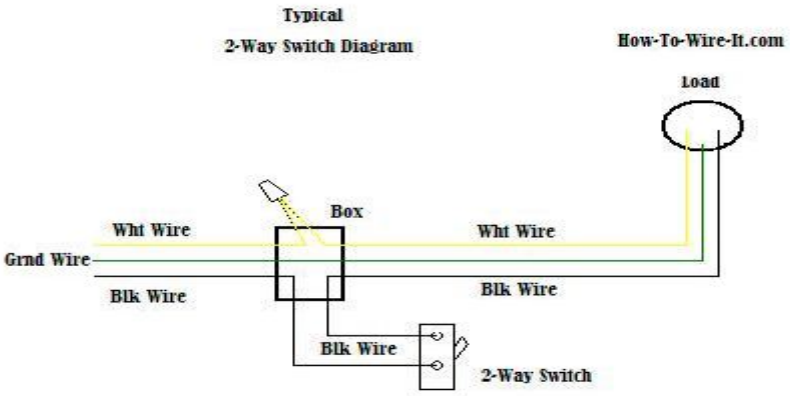


Figure 2: Wiring Diagram

3 Pictorial Diagram

The least useful of the main electrical wiring diagrams is the pictorial diagram and for this reason alone, it's not commonly used. It makes no attempt to be an accurate representation of the circuit but concentrates on the components in the circuit. Without precise knowledge, the average homeowner wouldn't be able to use it effectively.

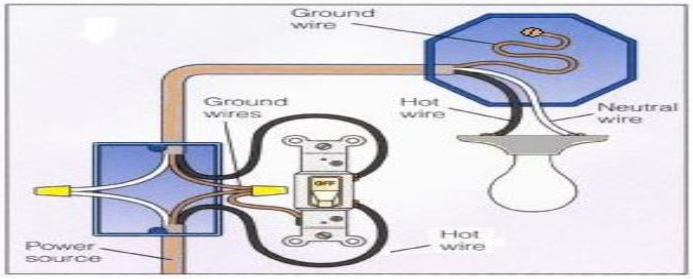


Figure 3 Pictorial Diagram

4 Layout diagram

It is an exact graphical representation of the layout of the various fixtures, equipment, utilities, and buildings of the plant

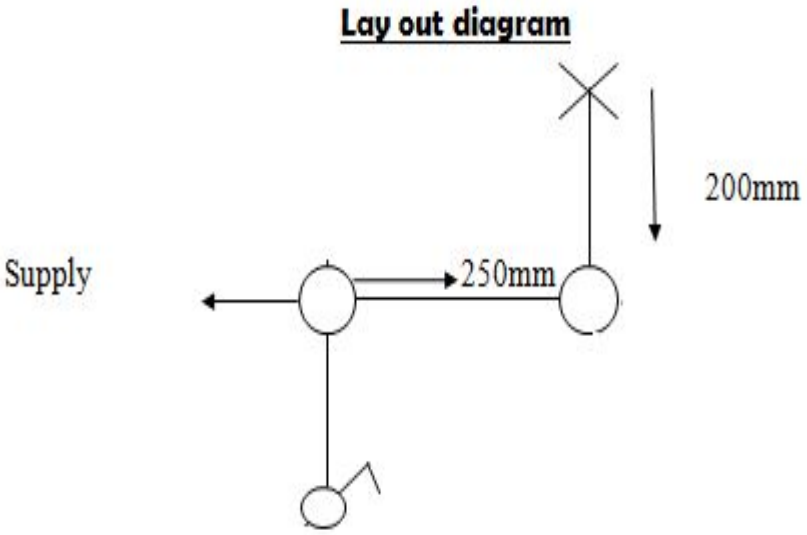


Figure 4: Layout diagram

Self-Check 2	Written Test

Name: _____ Date: _____

I. Direction: Answer the following questions.

1. What do we mean by electrical symbols?

2. What are the four electrical diagrams differentiate with example?

Note: **Satisfactory rating - 2 points** **Unsatisfactory - below 2 points**

Information sheet 3	Types and application of termination

3.1 Splicing

A splice may be considered as two or more conductors joined with a suitable connector reinsulated, re shielded and re jacketed with compatible materials... applied over a properly prepared surface. Whenever possible, splicing is normally avoided. However splicing is often an economic necessity. There can be many reasons for building splices such as:

The supplied length of cable is not sufficient to perform the intended job... only so much cable can be wound on a reel (reel ends) only so much cable can be pulled through so much conduit, around so many bends, etc.

- Cable failures
- Cables damaged after installation
- A tap into an existing cable (tee or wye splices)

In all the above cases, the option is to either splice the cable or replace the entire length. The economy of modern splicing products in many cases makes splicing an optimal choice. Whatever the reason to splice, good practice dictates that splices have the same rating as the cable. In this way the splice does not de rate the cable and become the weak link in the system.

3.1.1 Splicing steps

The previously quoted definition accurately develops five common steps in building a splice:

1. Prepare the surface The preferred method of removing insulation is with a wire-stripping tool, if available. Asharp knife mayalso be used.

Hand Wire Stripper

The procedure for stripping wire with the hand wire stripper is as follows

- ✓ Insert the wire into the center of the correct cutting slot for the wire size to be stripped. Thewire sizes are listed on the cutting jaws of the hand wire strippers beneath each slot.
- ✓ After inserting the wire into the proper slot, close the handles together as far as they will go.
- ✓ Slowly release the pressure on the handles so as not to allow the cutting blades to make contact with the stripped conductor. On some of the newer

style hand wire strippers, the cutting jaws have a safety lock that helps prevent this from happening. Continue to release pressure untilthe gripper jaws release the stripped wire, then remove.

- **Knife Stripping**

A sharp knife may be used to strip the insulation from a conductor. The procedure is much the same as for sharpening a pencil. The knife should be held at approximately a 60º angle to the conductor. Use extreme care when cutting through the insulation to avoid nicking or cutting theconductor. This procedure produces a taper on the cut insulation as shown in figure 5.

Figure 5

2. Join conductors with connector(s) After the cables are completely prepared, the rebuilding process begins. If a cold shrink or premolded splice is being installed,the appropriate splice components must be slid onto the cable(s) before the connection is made. The first step is reconstructing the conductor with a suitable connector. A suitable connector for medium/high voltage cable splicesis a compression or shearbolt connector.Do not use mechanical type connectors (such as split-bolt connectors.). Connector selectionis based on conductor material: aluminum or copper.

3. Re-insulate recognized method for reinsulating is the traditional tape method. Tape has a history of dependable service and is generally available. Since tape does not depend on cable types and dimensions, it is themost versatile approach. However, wrapping tape on a medium/high voltage cable can be time consuming and error prone since the careful build-up of tape requiresaccurate half-lapping and constant tension in order to reduce built-in air voids. Linerless splicing tapes reduce both application time and error.Studies have shown time savings of 30-to-50 percent since there is no need to stop during taping to tear off liner. This also allows the installer to maintain a constant tape tension, reducing the possibility of taped-in voids. Tape splice kits can be useful since they contain all the necessary tapes along with proper instructions. They ensure the propermaterials are available on the job,which is ideal in an emergency.Another method for reinsulating utilizes molded rubber

technology. These factory-made splices are engineered for the convenience of the installer. In many cases, these splices are also factory tested and designed to be installed without theuse of special installation tools.

4. Re-shield The cable's two shielding systems (strand shield and insulation shield) must be rebuilt when constructingasplice.The sametwo methods are used as outlined in there insulation process: tape and molded rubber.Foratapesplice, the cable strand shield in gisre placed by asemi-conductive tape. This tape is wrapped over the connector area to smooth the crimp indents and connector edges.The insulation shielding system is replaced by acombination of tapes. Semi-con is replaced with the same semi-conducting tape used to replace thes trand shield. The cable's metallic shield is generally replaced with a flexible wav enmesh of tin-plated copper braid. This braid is for electrostatic shielding only and is not designed to carry shield currents. For conducting shield currents, a jumper braid is installed to connect the cables' metallic shields. This jumper must have an ampacit rating equal to tha to fthe cables'shields.

5.Re-jackete is accomplished in a tape splice by using a combination of the rubber splicing tape overwrapped with a vinyl tape In molded rubber splice, re-jacketing is accomplished by proper design of theoutersemi-conductiverubber,effectively resulting in a semi- conductive jacket.

3.2.1 Types of splices

Western Union Splice

The Western Union splice joins small, solid conductors.

Figure 5 shows the steps in making a Western Union splices.

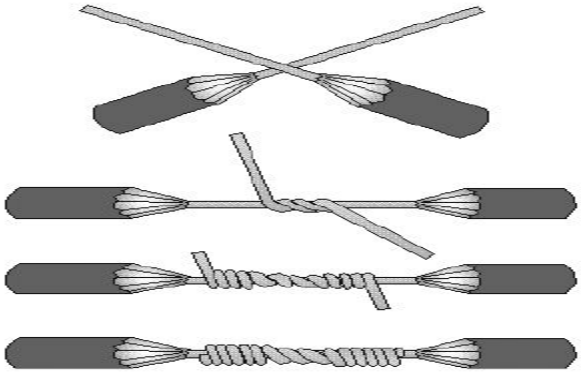


Figure 5 Western Union splices.

1. Prepare the wires for splicing. Enough insulation is removed to make the splice. The conductor is cleaned.
2. Bring the wires to a crossed position and make a long twist or bend in each wire.
3. Wrap one end of the wire and then the other end four or five times around the straight portion of each wire.
4. Press the ends of the wires down as close as possible to the straight portion of the wire. This prevents the sharp ends from puncturing the tape covering that is wrapped over the splice. The various types of tape and their uses are discussed later in this chapter.

3.2.2 Staggering Splices

Joining small multi conductor cables often presents a problem. Each conductor must be spliced and taped. If the splices are directly opposite each other, the overall size of the joint becomes large and bulky.

A smoother and less bulky joint can be made by staggering the splices. Care should be taken to ensure that a short wire from one side of the cable is spliced to a long wire, from the other side of the cable. The sharp ends are then clamped firmly down on the conductor. The figure shows a Western Union splice, but other types of splices work just as well.

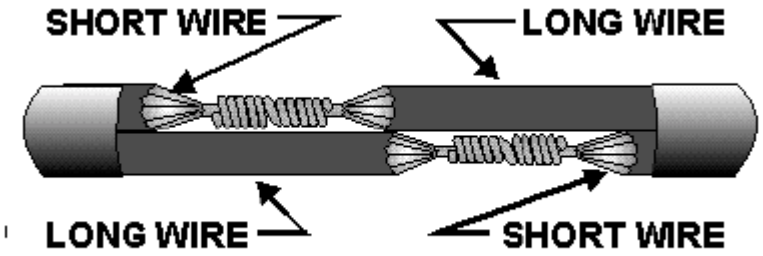


Figure 6

- **Rattail Joint**

A splice that is used in a junction box and for connecting branch circuits is the rattail joint fig 7

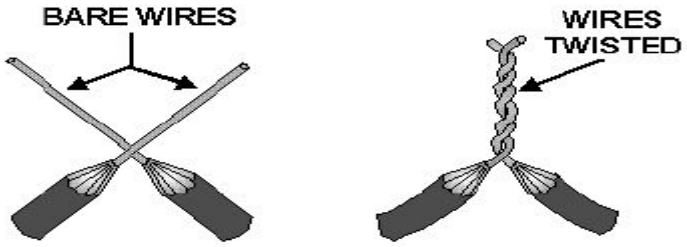


Figure 7

- **Fixture Joint**

The fixture joint is used to connect a small-diameter wire, such as in a lighting fixture, to a larger diameter wire used in a branch circuit. Like the rattail joint, the fixture joint will not stand much strain. As shows the steps in making a fixture joint. The first step is to remove the insulation and clean the wires to be joined. After the wires are prepared, the fixture wire is wrapped a few times aroundthe branch wire. The end of the branch wire is then bent over the completed turns. The remainder of the bare fixture wire is then wrapped over the bent branch wire. Soldering and taping completes the job.

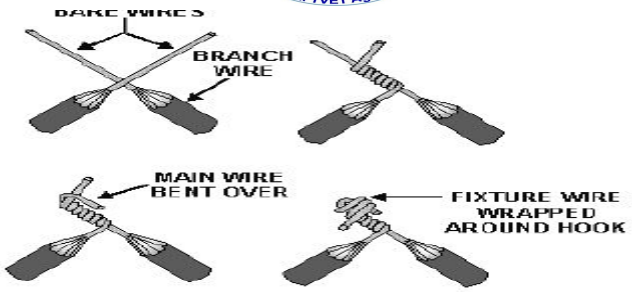


Figure **8**

- **Knotted Tap Joint**

All the splices discussed up to this point are known as butted splices. Each was made by joining the free ends of the conductors together. Sometimes, however, it is necessary to join a branch conductor to a continuous wire called the main wire. Such a junction is called a tap joint. The main wire, to which the branch wire is to be tapped, has about 1 inch of insulation removed. The branch wire is stripped of about 3 inches of insulation.

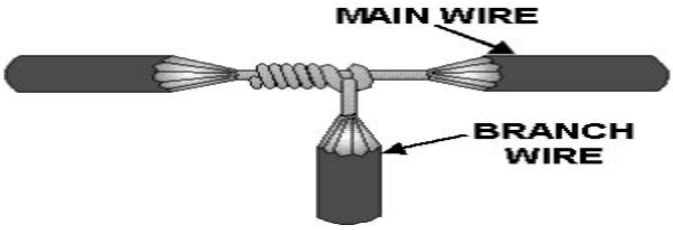


Figure **9**

3.2 Termination Types

3.3.1 Solder Type

A solder type connection allows for a strong, solid mechanical and electrical connection. Clean the connection well. For electrical circuits you must use a rosin type flux to clean all connections. Do not use acid flux that is commonly used for plumbing installation. The acid based flux will cause corrosion and inherently cause intermittent problems with the electrical signal. The choice of solder is also important. Using a solder standard60/40 formula will meet the majority of your soldering needs. However, lead-free and high-grade silver solder is available for special applications. Also, use a soldering iron of the proper wattage. If the soldering iron is not hot enough, you may not be able heat the connection enough to get a good solder joint. This may cause what is known as a "cold" solder joint and can cause intermittent problems like opens to occur. However, if the soldering iron is too hot, you can cause damage to the components of the system near the connection. This can also cause the insulation to possibly melt causing the bare primaries to make contact with each other resulting in a short.

3.3.2 Crimp Type

A crimp type connection allows for quick and simple installation while still maintaining a mechanical and electrical connection fairly close to a solder type termination. Solid or stranded wire can be used in this type of termination.

Some of the key points to remember for a good clean connection are as follows:

1. Make sure you use the proper size connector for the type of cable you are using.
2. Make sure all of your cuts and stripping are clean.
3. Avoid nicks as much as possible.
4. Use the proper crimp tool; don't try to improvise with pliers, etc.

The most common crimp method involves two crimps, one on the insulation for a stronger mechanical connection and one on the conductor or shield for a good electrical connection. A crimp tool is designed specifically for this type of termination for the type of connector you are using. This allows for good connections both mechanical and electrical.

Self-Check 3	Written Test

Name: _____ Date: _____

I. Direction: Answer the following questions.

1. What is splicing

……

……

2. Write the steps of splicing

……..

……..

……

……..

3. Types of splices are ……and ……..

4. Types of Termination are……., and ,, ……..

Note: **Satisfactory rating - 4 points** **Unsatisfactory - below 4 points**

Information sheet 4	Procedure of Termination

4. Introductions

Cable Termination is the connection of the wire or fiber to a device, such as equipment, panels or a wall outlet, which allows for connecting the cable to other cables or devices. The three main areas we will discuss are termination used in Telecom,

A wire termination is the work performed to the end of a wire that allows it to connect to a device (connector, switch, terminal, etc.). There are many types of terminations in the aircraft industry, but we can boil them down into two basic categories: crimp and solder.

A crimp termination is performed when the device requires a contact or terminal. The wire insulation is stripped, and the contact or terminal is attached to the wire using a crimp tool. The tool crimps the contact or terminal onto the wire conductor. This type of termination is most often used on the aircraft wiring harnesses and circuit breaker panels

A solder termination is performed when the wire conductors attach directly to the device. This requires stripping off the wire insulation and applying flux and solder to connect the wire to the device. (Requirements for Soldered Electrical and Electronic Assemblies) gives the specific details on how to properly solder.

4.1 Procedure of termination

- **Soldering method and technique**

The following information will aid you in learning basic soldering skills. It should enable you to solder wires to electrical connectors, splices, and terminal lugs that we have discussed earlier in the chapter. Special skills and schooling are required for the soldering techniques used in printed circuit boards and micro-miniature component repair.

- **Soldering process**

Cleanliness is essential for efficient, effective soldering. Solder will not adhere to dirty, greasy, or oxidized surfaces. Heated metals tend to oxidize rapidly. This is the reason the oxides, scale, and dirt must be removed by chemical or mechanical means. Grease or oil films can be removed with a suitable solvent. Connections to be soldered should be cleaned just prior to the actual soldering operation. Items to be soldered should normally be "tinned" before making a mechanical connection. Tinning is the coating of the material to be soldered with a light coat of solder. When the surface has been properly cleaned, a thin, even coating of flux should be placed over the surface to be tinned. This will prevent oxidation while the part is being heated to soldering temperature. Rosin-core solder is usually preferred in electrical work. However, a separate rosin flux may be used instead. Separate rosin flux is frequently used when wires in cable fabrication are tinned.

- **Soldering the joint**

✓ Clean the iron tip on the damp sponge.
✓ Melt a little solder on the tip of the iron. This helps to transfer the heat to the joint.
✓ Touch both parts to be soldered
✓ Wire and pin.
✓ Feed the solder in from the opposite side. It will melt and quickly flow around the joint.
✓ Remove the solder *before* the iron.
✓ It should take about three seconds to heat, melt

- **Insulating**

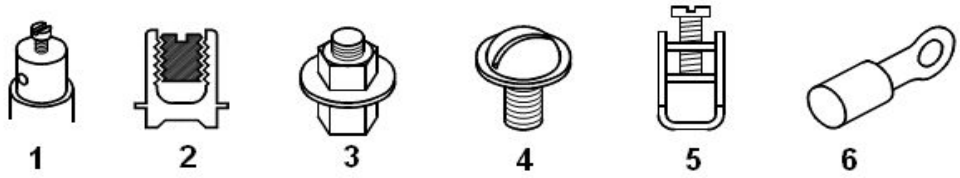
An **insulator** on the other hand is a material which does not allow an electric current to flow. Rubber and most plastics are insulators.

- **Insulation materials**

Wires and cables (conductors) are insulated and protected by a variety of materials (insulators) each one having its own particular properties. The type of material used will be determined by the designer who will take into account the environment in which a control panel or installation is expected to operate as well as the application of individual wires within the panel. As part of the insulating function, a material may have to withstand without failing:

Figure Terminals, Clamps and Lugs

There are a wide variety of conductor terminals. Typical type sare asshown in Figure below



1. The screw terminal will be found in various accessories such as, lamp holders, batten holders and plug to psused in domestic premises. Ashrouded version of this terminal is probably the most commonly used type.It will be found in switches,sockets,ceiling roses and consumer units.
2. Thes plit terminal will be used in joint boxes to enable joints to be made with out having to cut conductors.
3. The post terminal will be used mainly to make connections to earth and also in such placesas the mains connection to an electric cooker or an electric motor.
4. The screw head terminal will also be mainly used to make connections to earth,and is also very popular inolder fuse boards.
5. The clamp terminal is now in common use inmain switches, MCB's, RCD's and RCBO's.
6. The lug terminal comes in an extremely wide variety of shapes and sizes.They may be bare or insulated. Methods of connecting to the cable vary as follows:
   - Ferrules,whichareusedonflexiblecablestopreventthestrandsfromspreadingoutandarethen connected using a screw or clamp terminal.
   - Large power cables where the lug is compressed on to the cable using a hydraulic type crimptool. The lug is then connected to a post or screwhead terminal.

- **terminating models**

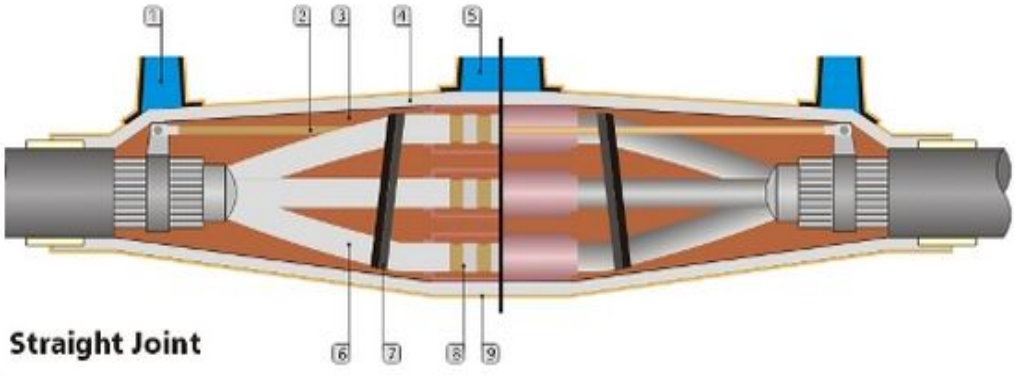


Figure terminating models

1. Riser
2. Earth continuity connection
3. C.J compound
4. Plastinet
5. Pouring gate
6. Core Insulation
7. PVC (NA) Tape
8. Ferrule
9. BOPP Tape two layers each half overlapped over plastinet

- **conductor splices and terminal connections**

Conductor splices and connections are an essential part of any electrical circuit. When conductors join each other or connect to a load, splices or terminals must be used. Therefore, it isimportant that they be properly made. Any electrical circuit is only as good as its weakest link. The basic requirement of any splice or connection is that it be both mechanically and electrically as sound as the conductor or device with which it is used. Quality workmanship and materials must be used to ensure lasting electrical contact, physical strength, and insulation.

Figure. samples of splices and terminals

- **General Wire-Stripping Instructions**

When stripping wire with any of the tools mentioned, observe the following precautions:
1. Do not attempt to use a hot-blade stripper on wiring with glass braid or asbestos insulation. These insulators are highly heat resistant.
2. When using the hot-blade stripper, make sure the blades are clean. Clean the blades with abrass wire brush as necessary.
3. Make sure all stripping blades are sharp and free from nicks, dents, and so forth.
4. When using any type of wire stripper, hold the wire perpendicular to the cutting blades.
5. Make sure the insulation is clean-cut with no frayed or ragged edges; trim if necessary.
6. Make sure all insulation is removed from the stripped area. Some types of wire are supplied with a transparent layer between the conductor and the primary insulation. If this is present, removeit.
7. When the hand strippers are used to remove lengths of insulation longer than 3/4 inch,

the stripping procedure must be done in two or more operations. The strippers will only strip about 3/4 inch at one time.

8. Retwist strands by hand, if necessary, to restore the natural lay and tightness of the strands.

9. Strip aluminum wires with a knife as described earlier. Aluminum wire should be stripped very carefully. Care should be taken not to nick the aluminum wire as the strands break very easily when nicked.

Self-Check 4	Written Test

Name: _____ Date: _____

Direction: Write/List down the following

1. Different types of termination
   a) _____
   b) _____
   c) _____
   d) _____
2. General Wire-Stripping Instructions are

   _____
   _____
   _____
   _____
   _____

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

Information sheet 5	Checking Wiring system and components

5. Introduction

Electrical wiring is the electrical power distribution through the wires in a perfect manner for economic use of wiring conductors inside a room or building with better load control. Electrical wiring system is classified into five categories: Cleat wiring. Casing wiring

Perform an Electrical Safety Components Check Home electrical fires are more common than you would think.

The problems that cause electrical fires can often be detected during a home electrical inspection. Electrical Safety Foundation International recommends you conduct an electrical system inspection any time here's what we recommend you look for.

Outlets and switches

It's best to check all your outlets and switches prior to moving in any furniture, which may block problem spots. Check first to make sure all outlets are three-pronged and that all outlets and switches have plate covers. If you have babies or toddlers, count the number of outlets as well — you'll need to buy outlet plugs for all of them.

Note any looseness or signs of damage. Loose outlets or switches and cracked plates pose electrocution and fires risks. Discoloration around an outlet or switch or warmth to the touch suggests a dangerous buildup of heat, and that switch or outlet shouldn't be used until an electrician checks it out. If you hear strange sounds such as buzzing or crackling coming from an outlet or switch, it could indicate an issue with the wiring and should be investigated by an electrician.

Light fixtures

Check all the light fixtures. Make sure any ceiling- or wall-mounted fixtures are secure. Also, check the wattage and bulbs in every light fixture. If the previous installed a bulb with a greater wattage than the fixture was designed to handle, it could overheat and ignite nearby combustible material such as a cloth or paper lamp shade.

Electrical panel

The fuses or circuit breakers in electrical panel protect you against fires by preventing electrical system from being overloaded. Make sure each fuse or circuit breaker is the right size for its circuit. The wrong size could result in overheated wiring creating a fire hazard.

Check also to see if there are Arc Fault Circuit Interrupters (AFCIs) installed in your panel. These are special circuit breakers that monitor for dangerous electrical arcs that can cause fires and trip the circuit when one is detected.

5.1 Wire /Conductor/

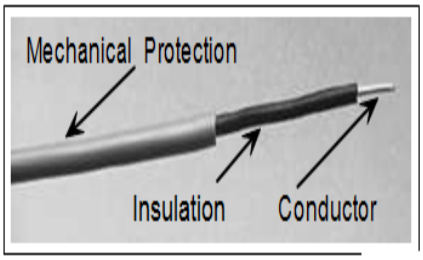
Conductor is the current carrying components are made of copper or aluminum. (Aluminum is less expensive but less efficient, requiring a larger conductor diameter to carry an equal electrical load when compared to a copper conductor.)

- A conductor should have a current carrying capacity not less than the maximum current demand it normally carries, be capable of withstanding the prospective fault current, and suitable for operation in the environment and at the design voltage of the installation.
- Factors to be considered in sizing of cable conductors In general, sizing of cable conductors should take into account the following factors:
    - ✓ the conductor material;
    - ✓the insulating material;
    - ✓the ambient temperature in which the cable is installed;
    - ✓the method of installation;
    - ✓whether or not the cable is affected by thermal insulating material;
    - ✓the use and type of protective device;
    - ✓the voltage drop from the origin of the circuit to the load;
- Method of sizing cable conductors In determining the size of cable conductors to be used, the steps employed, in general, are as follows:
    - ✓ Determine the design current of the circuit under consideration.
    - ✓ Choose a suitable over current protective device
    - ✓ Choose suitable size of the conductors according to the current carrying capacity required.
    - ✓ the ambient temperature does not exceed 35°C;
    - ✓ the protective device is not a semi-enclosed fuse; and
    - ✓ the cables are not in contact with any thermal insulation.

5.2 Cables and Flexible Cords

Cable Definition One or more conductors provided with insulation. The insulated conductor (s) may be provided with an overall covering to give mechanical protection. A cable consists of three parts.

1. Conductor
2. Insulation
3. Sheath (Mechanical Protection)



The most common conductor material used is copper.Aluminium is used for larger cables and its use is not permitted in domestic installations. The most common insulation used is PVC.Other materials are used as insulation depending on what the cable is being used for and where it is being installed.

The most common mechanical protection used is PVC .Further protection is provided by installing cables in locations where they are unlikely to be damaged. Where this is not possible, cables must be installed inconduit, trunking or ducting. Otherwise a suitably armoured cable must be used. When cables are installed in conduit o rtrunking they need not have any other for mechanical protection.

The following is a list of the standard sizes used in domestic installations.

Cross sectional area is the surface area of a section of conductor.

1.5 mm^2–2.5 mm^2–4 mm^2–6 mm^2–10 mm^2–16 mm^2

The cable insulation is colour coded asfollows:

Phase (Live)–Brown

Neutral–Blue

Earth–Green/Yellow

Table: color identification

Colour identification of cores of flexible cables and cords

Number of cores	Function of core	Colour(s) of core
1	Phase	Brown
	Neutral	Blue
	Protective	Green-and-yellow
2	Phase	Brown
	Neutral	Blue
3	Phase	Brown
	Neutral	Blue
	Protective	Green-and-yellow
4 or 5	Phase	Brown or black
	Neutral	Blue
	Protective	Green-and-yellow

5.3 Over current Protective Devices

Over current protection for circuit every circuit must be protected by one or more devices for automatic interruption of the supply in the event of over current resulting from: overload, or fault. Examples of over current protective devices The following devices are acceptable as protective devices against over current:

- Miniature Circuit Breakers (MCB)
- Moulded Case Circuit Breakers (MCCB)
- High Breaking Capacity (HBC) Fuses
- Semi-enclosed Fuses
- Circuit Breakers incorporating over current release, or in conjunction with fuse.

Self-Check 5	Written Test

Name: _____ Date: _____

Direction: Write/List down the following

1 We conduct an electrical system inspection any time on

_____

_____

_____

_____

2 A cable consists of three parts.

_____

_____

_____

3. the most common mechanical protection used is……

4 what devices are acceptable as protective devices against over current:

_____

_____

_____

_____

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

Information sheet 6	Identifying wiring system components and accessories

6 Introductions

Electricity requires an electric path to flow and there are many conducting materials used for this purpose. There are many semi conducting materials which are used to reduce the voltage and also drop the current flow. There are non-conducting materials which are used as insulation during working on live-lines. In this unit we will study how the household or industrial wiring is done and what materials are essential for household or industrial wiring. We will also study the different types of wiring and how they is done.

6.1 Wiring materials

Electrical wire is made of materials like copper, aluminum and silver. As silver is expensive, mostly copper and aluminum are used in wiring. Materials are classified into three types according to their properties:

1. Conducting materials
2. Insulating materials
3. Semiconductor material

Conducting Material

- ***Copper***

It is a good conductor of electricity. It is used in wiring materials in cables. Its has low resistance and is used for conduction of electricity at high,medium and low voltage. It is used in wiring and cable making.

- ***Aluminium***

It is light weight and cheaper in comparison to copper. Therefore,this type of conducting materialis mostly used in electrical wiring. It is silvery–white in colour and it has as oft texture.It is often used in wiring and making cable.

- **Insulating Materials**

Insulating materials are used for insulating purpose.These types of materials are bad conductors of current. For example rubber,paper,mica,wood,glass and cotton nature and number of conductors:

6.2 Wiring Accessories

Wiringaccessoriesareusedforconnectingappliances

- ***Switch***

A switch is used to make or break an electrical circuit.It is used to switch‘on’ or‘off’ the supply of electricity to an appliance.There are various switches such as

- ✓ surfaceswitch
- ✓ flushswitch
- ✓ ceilingswitch
- ✓ pullswitch
- ✓ pushbuttonswitch
- ✓ bedswitch

Surface switch :It is mounted on wooden boards fixed on the surface of a wall.It is of three types

1.One-way switch

2.Two-way switch

3.Intermediate switch

One-way switch: It is used to control single circuits and lamp

Two-way switch: It is used to divert the flowof current to either of two directions.

The two-way switch can also be used to control one lamp from two different places as in the case of stair case wiring

I**ntermediate switch**: It is used to control a lamp from more than two locations.

Flush switch*:* It used for decorative purpose. *Bed switch:* As the name indicates, it is used to switch‘on ’the light from any place, other than switch board or from near the bed.This switch is connected through a flexible wire.

- **Lamp holder**
  Is of two types
  - ✓ Pendantholder
  - ✓ Batten holder

Pendant holder

It is used to provide a tapping to the pendant lamp–holder through the flexible wire or a connection to a fluorescent tube

Socketoutlet/plug

The socket outlet has an insulated base with the moulded or socket base having three terminal sleeves.

- **Main switch**

To control the electrical circuit a main switch is used. Through the main switch,the power in a building is controlled completely.

Fig. 3.9 Bed switch

Fig. 3.11 Batten holder

Fig. 3.12 Ceiling rose

Fig. 3.14 Main switch/ Main MCB

Fig. 3.9 Bed switch

Fig. 3.11 Batten holder

Fig. 3.12 Ceiling rose

Fig. 3.14 Main switch/ Main MCB

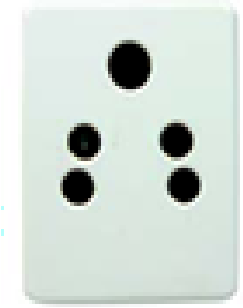


Fig. 3.13 Socket

Fig. 3.5 One-way switch

Fig. 3.6 Two-way switch

Fig 3.7 Intermediate switch

Fig. 3.8 Flush Switch

Fig. 3.10 Pendant holder

Self-Check 6	Written Test

Name: _____ Date: _____

I. Direction: Answer the following questions.

1 Wiring. Materials are classified into three
…… .,
……..and
……

2 Lamp holder is of two types
……..,
……

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

Information sheet 7	Consulting work coordination

7 work coordination process

Team coordination is a process that involves the use of strategies and patterns of behavior aimed to integrate actions, knowledge and. goals of interdependent members, in order to achieve common goals

7.1 coordination in an organization

Co-ordination is the unification, integration, synchronization of the efforts of group members so as to provide unity of action in the pursuit of common goals.

Management seeks to achieve co-ordination through its basic functions of planning, organizing, staffing, directing and controlling

7.2 Important Elements of Coordination | Benefits

- Balancing: Efforts, jobs and activities of all departments must be balanced. ...
- Timing: Timing involves scheduling of operations in a suitable order. ...
- Integration: Integration refer to the unification of all unrelated and diverse activities in such a manner as to accomplish the job efficiently

- **need for coordination**

Coordination helps to bring together the human and material resources of the organization. It helps to make optimum utilization of resources. These resources are used to achieve the objectives of the organization. **Coordination** also minimizes the wastage of resources in the organization

The **four** common **elements** of an organization include

- ✓ common purpose,
- ✓ coordinated effort,
- ✓ division of labor, and
- ✓ hierarchy of authority

- **Role of Consultant.**

The consultant's primary role is to assist your work with certain areas of your inclusiveness work. While the consultant may act as an educator, a catalyst for deeper change, a resource, or a facilitator, the leadership of the process remains within your organization

- **Consulting effectively**

Eight Steps to Consultancy Success

1. Build a balanced relationship. ...
2. Clarify the role. ...
3. Define direction. ...
4. Practice scope control. ...
5. Get them up and running quickly. ...
6. Cement trust with the team. ...
7. Provide feedback. ...
8. Be vigilant

Key skills Consulting Firms Look For

- Academic Success. Academic success is a hygiene factor for a job in Consulting. ...
- Work Experience. ...
- Leadership and Initiative. ...
- Perfect Presentation. ...
- Consulting Fit. ...
- Commercial Awareness. ...
- A Natural Communicator. ...
- Self-awareness

Self-Check 7	Written Test

Name: _____ Date: _____

I. Direction: Answer the following questions.

1. Why do we need for coordination?

2 The four common elements of an organization include

_____

_____

_____

_____

3 Eight Steps to Consultancy Success are

_____

_____

_____

_____

_____

_____

_____

_____

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

Information sheet 8	Tools equipment and Testing Device

8.1 basic electrical tools and their uses

- **Pliers**

Pliers are available in different types, shape, and sizes.They are also available in both insulatedand uninsulated handles.An insulated handle should be used when working on or near hot wires.It isalso used for cutting big and small wires

- **Screw Drivers**

A screwdriver comes in various sizes and with several tip shapes.Screwdriversused byelectricians should have insulated handles.Using a screwdriver for a particular job, the width of thescrewdriver tip should match the width of the screw slot.

- **DrillingEquipment**

Drilling equipment is needed to make holes in building structure passages ofconduits andwires

- **Sawing and Cutting Tools**

Saws commonly used by electricians include the crosscut, keyhole, andHacksaw

- **Soldering Equipment**

In doing electric wiring, splices and taps (connections made to wire) should be soldered,unless you use solderless connectors.Typical equipments available for soldering are shown below.

- **Hammers**

Hammers are used with chisels and for nailing and fitting.Below are examples of carpenter'sclaw hammer,lineman's hammer, and machinist'sball-peen hammer.

- **Measuring Tools**

To measure wire length and other items, the electrician finds considerable use for measuringtools such as the extension or zigzag rule, push-pull rule and a steel tape as shown below.

8.2 Testing device

- **using a multimeter**

A multimeter is a device used to measure voltage, resistance and current in electronics & electrical equipment. It is also used to test continuity b/n two points to verify if there is any break in circuit or line. There are two types of multimeter: analogue and digital.

- ✓ Analogue has needle style gauge
- ✓ Digital has LCD display

Test equipment is necessary for determining proper set-up, adjustment, operation, and maintenance of electrical systems and control panels.

Hand-held DMM

Portable Analog Multimeter

Voltmeters: For measuring differences of potential (voltage) between two points in an electrical circuit. The instrument is connected in parallel with the circuit being measured. Ranges vary from a few tenths volt to a few thousand volts. Instruments are capable of measuring both A.C .and D.C voltage.

Ohmmeters: For measuring the electrical D.C. ohm resistance of a circuit, circuit part, or component. Calibrated from zero ohms to infinite.Measures either series or parallel resistance.

Ammeters: Measure magnitude of electrical current flow in an electrical circuit. When measuring D.C. currents, some types must be inserted in series with the circuit. A.C. ammeters are of two types. One requires that it be connected in series with the circuit; the other needs only to be clamped around the current carrying conductor.

PhaseTester which doubles as a small terminal screw driver. It is a very useful tool when checking if a circuitis “live” or not.It is very important to ensure that it is not used in a dampor wet condition.When in use, current flows through the body of the user.Dampness may increase this operating current to a dangerous level.

Self-Check 8	Written Test

Name: _____ Date: _____

I. Direction: Answer the following questions.

1 What are basic electrical tools

2 What are the basic Testing device

3 The two types of multimeter……..and ……..

4 Multimeter is a device used to measure ……,…… And …….

Note: **Satisfactory rating - 4 points** **Unsatisfactory - below 4 points**

Operation Sheet 1	Safety requirements of equipment/tools

1.1 Safety requirements of equipment/tools;

Step 1- wear PPE.
Step 2- select required testing instrument /digital multimeter/.
Steps 3- adjust on zero reading.
Step 4- observe 0.00 reading, if not go to step 2
Step 5- clean the area.

Operation Sheet 2	Procedure of termination

1.5 **Procedure of termination;**

Step 1- wear PPE.
Step 2- select required materials, tools and instruments.
Step 3- prepare the wire for splicing
Step 4 removes insulation of conductor
Step 5 Bring the wires to a crossed
Step 6 splices the two terminals
Step 7 solders the joints
Step 8 terminate the joints with connector
Step 9 clean work areas

❖ By using the above procedure do the following LAP test

LAP Test	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, workshop, tools and materials you are required to perform the following tasks within 8 hours.

Task 1: Safety requirements of equipment/tools

. Task2: Procedure of termination

List of Reference Materials

Book

- **Ethiopian Building code standards electrical installation of building**

Internet

- https://www.nibusinessinfo.co.uk/content/safety-workplace-machinery-equipment-and-tools
- https://media.distributordatasolutions.com/3M/2018q1/5a9ec41a8b4865eb70059fe3670116e4d63a4078.pdf
- https://wisconsindot.gov/dtsdManuals/traffic-ops/programs/training/slights/03-slights-electrical-wiring.pdf