# BUILDING ELECTRICAL INSTALLATION LEVEL-I

**Based on March 2022, Curriculum Version 1**



## Module Title: Installations of PVC Conduit and Wiring Systems

**Module code: EIS BEI1 M07 0822**

**Nominal duration: 80Hour**

**Prepared by: Ministry of Labour and Skill**

**August, 2022**

**Addis Ababa, Ethiopia**

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# Acknowledgment

**Ministry of Labor and Skills** wish to extend thanks and appreciation to the many representatives of TVET instructors and respective industry experts who donated their time and expertise to the development of this Teaching, Training and Learning Materials (TTLM).

# Acronym

LAP – Learning Activity Performance

EEPCOS – Ethiopian Electric Power Corporation

EBCS- Ethiopian Building Code & Standard

AC- Alternative Current

DC – Direct current

ISO -International Organization for Standard

RD - Requirements Document

PVC - Polyvinyl Chloride

NM- Non Metalic

HVAC – High Voltage alternative current

CTS - Cabtyre Sheathed Wire

TRS - Tough Rubber Sheathed Wire

MCB – Miniature circuit Breaker

# Introduction to the Module

The Installation of PVC, Conduit and Wiring Systems helps to know plan & prepare installations, how to install wiring system & inspection & notification of completion of work in building electrical installation field .

This module is designed to meet the industry requirement under the Building Electrical Installation occupational standard, particularly for the unit of competency: Installation of PVC, Conduit and Wiring Systems

**This module covers the units**:

- Plan & prepare
- Wiring system Installation
- Inspection & Notification completion of work

**Learning Objective of the Module**

- Plan and prepare
- Install wiring system
- Inspect and notify completion of work

**Module Instruction**

For effective use this modules trainees are expected to follow the following module instruction:

1. Read the information written in each unit
2. Accomplish the Self-checks at the end of each unit
3. Perform Operation Sheets which were provided at the end of units
4. Do the “LAP test” giver at the end of each unit.
5. Read the identified reference book & website.

# UNIT ONE: PLAN AND PREPARE

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

- Confirmations of existing electrical supply
- Procedures for co-ordination of site services
- Electrical isolation & procedures
- Wiring systems location measurement & marking
- locations plan

This unit will also assist you to attain the learning outcomes stated in the in the above unit. Specifically, upon completion of this learning guide, you will be able to:

- Confirm the existing electrical supply in accordance with laid down procedure
- Follow agreed procedures to ensure the co-ordination of site services and the activities of other trades
- Identify the means of electrical isolation accurately prior to commencing installation when required
- Isolation procedures are carried out to ensure a safe installation in accordance with electrical regulations and approved procedures
- Measure and mark all locations out for wiring systems, wiring enclosures, ***tools and equipment*** in accordance with electrical regulations and to meet an agreed specification
- Check the planned locations for their sensitivity, visually acceptable and are in accordance with other site services.

## 1.1. Confirmation of electricity supply

Every power supply must obtain the power it supplies to its installation system. Depending on its design, a power supply may obtain power from various types of sources such as electric transmission line; generator, solar system etc. therefore check the availability of the source of power.

❑ **Types and sources of supply**

There are only two types of electricity supply

- DC (direct current):- obtained from cells or batteries.
- AC (alternating current):- Obtained from hydroelectric, nuclear, solar, diesel & wind

❑ **Electricity Supply Specifications**

Electricity supply for domestic consumers, according to EEPCOS/EBCS-10 standards, meets the following specifications: -

- 220V, ± 2.5% Single phase supply with nominal
- 380V, ± 4% Three phase supply with nominal
- Permitted frequency is 50Hz

❑ **Electricity supply Confirmation:**

The Electrical Wiring Systems are mostly standardized with several rules, regulations and laws. Residential Wiring must be installed correctly and safely in accordance with electrical regulations and standards. If the electrical wiring is carried out incorrectly or without confirming to any standard, then it may lead to incidents like short circuits, electric shocks, damage of device.

Consider the following factors before the actual installation work to be done in residential, commercial or industrial wiring:

- Type of building construction,
- type of ceiling,
- wall and floor construction,
- wiring methods,
- Installation requirements, etc.

## 1.2. Procedures for co-ordination of site services

- **Site Services:** the places that the electrical installation (electrical plan) is performed.
- **Co-ordination:** the process of organising workers, work activities & time is coordinator. It consider the improve efficiency & effectiveness. Procedures of coordination's of site services are:
  - Identify clear schedule, quality of residential wirings work.
  - Clarify any limitations on the existing site.
  - Involve all workers from the very beginning, setting the benefits of the project.
  - Create clear roles & responsibilities of all workers.
  - Align project plans with on-going site plan.
  - Establish a timeline for routine follow-ups, site visits and updates to ensure that the project is implemented as planned and that challenges are addressed as soon as they occur.
  - Coordinate with adjacent ongoing work in order to achieve greater impacts and reduce future reconstruction or repair.

## 1.3. Electrical isolation & procedures

- ***Isolation*:** It means disconnect or separate the electrical sources from the wiring system.
- ***Isolator:*** mechanical switching devices that used to isolation purposes in order to protect the user, workers & appliance or equipment from electrical accidents.

### 1.3.1. Isolation and Switching:

**A. General installation**: - **It** must be provided with a main switch or circuit breaker and a means of isolation to cut off all voltages. These two functions may be incorporated in a single device. The main switch or circuit breaker should interrupt all live conductors & be capable of cutting off the full load current of the installation from supply. Circuit breaker may be arranged to disconnect the phase conductors only.

For standby generator; Use electrically & mechanically interlocked 4-pole changeover devices for interconnection between the normal and standby sources to ensure that any neutral unbalance and fault current return to the correct source of supply.

**B. Switching off for maintenance.**

- It must be provided where maintenance may involve injuries from mechanical movement. These include every circuit supplying:
  - Electric appliances
  - Electrical heating equipment.
  - Electrical wiring devices.
  - Luminaires.

**C. Requirements of Isolation and Switching Devices**

General a common device is used to perform one or more of the following functions:

- Means of isolation;
- means of switching off for mechanical maintenance;
- Means of emergency switching.

**I. Isolating devices**

- It should be capable of: Off & ON all installation systems & carrying the normal circuit current
- Its position contact should be either externally visible.
- Should be designed & installed to prevent unintentional or inadvertent closure.

Examples of isolating devices are:

- isolators (disconnectors),
- fuse switches and switch-fuses,
- links, including fuse-links and fuse cut-outs,
- plugs and socket outlets,
- cable couplers
- circuit breakers

- It should be clearly placed.

II. **Switching devices:** it should be:-

- Require manual operation.
- Have visible indicated open and closed positions of the contacts.
- Be designed & installed in such a way to prevent accidental switching on.

- Be capable of cutting off the full load current of the relevant part of the installation.
- Be readily accessible for operation.

Examples of isolating devices are:

- switches
- circuit breakers
- control switches operating contactors
- Plugs and socket outlets.

**D. Reasons for Electrical Isolation**

a) To protect the operator by blocking the transfer of hazardous or high voltages.
b) To prevent ground loops.
c) For voltage level shifting.
d) To protect electrical equipment from surges, and lightning strikes, which can lead to electrical faults and fires?
e) To protect electrical circuits from transient noise.

### 1.3.2. Safe isolation procedure:

All steps of electrical isolation are similar for low voltage and for high voltage installations systems.

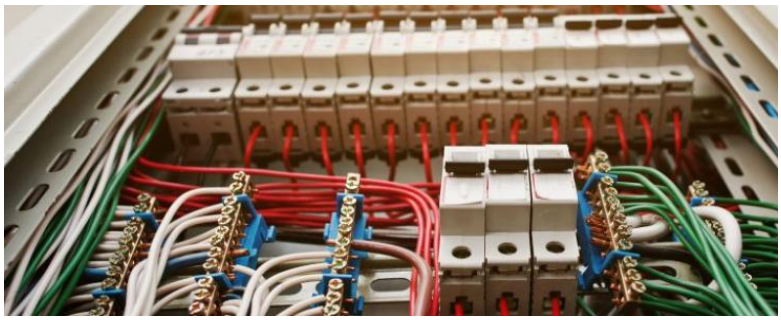


Fig 1.1: safe isolating

❑ **Isolate the voltage: safe isolation procedures are:**

1. **Identify correct isolation point or device** - it is important to ensure that the correct point of isolation is identified. When isolating the main source of energy, it is also essential to isolate any secondary source.

2. **Check condition of voltage indicating device** - such as a test lamp or two-pole voltage detector.
3. **Switch off installation/circuit to be isolated** - it should never be assumed that equipment is dead because a particular isolation device has been placed in the OFF position.
4. **Verify with voltage indicating device that no voltage is present** - It is important to ensure that the correct point of isolation is identified before showing dead.
5. **Re-confirm that voltage indicating device functions correctly on proving unit** - Use proving unit to confirm that the voltage on the indicating device is functioning correctly.
6. **Lock-off device used to isolate installation circuit** - It is preferable for an appropriate locking-off device be used on the point of isolation.
7. **Post warning notices** - Suitable labeling of the disconnected conductors using a caution notice is vital to prevent the supply being reinstated.

## 1.4. Tools & equipments, locations of Wiring systems &wiring enclosure

### 1.4.1. Tools & equipments:

**a) Hand tools**: - the tools that holds in the hand or hands to assist a person in doing manual work.

✓ **Pliers**: - They are main essential hand **tools** for electricians. They are mainly used to cut wire, grip, twist, bend or straighten wires. Every professional technician puts a bunch of pliers in its toolbox or truck, including crimping pliers and stripping pliers which are used to tighten locks, fittings, and caps.




Fig 1.2: Different Types of Pliers

✓ **Screw drivers:** Electricians keep screwdrivers with them at all times, for loosen and fasten various pieces such as 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.




Fig 1.3: Different Types of screw drivers

✓ **Wrenches**: it is a tool used to provide a mechanical advantage when torque is applied to hold and turn bolts, nuts, screws, and pipes. They are divided into two categories:




Fig 1.4: Different Types of wrenches

✓ **Wire insulation Removers**: they are used to remove the insulation part of the wire. It is suitable type, if used correctly.




Fig 1.5: Insulation removing tools

- ✓ **Hacksaw**: a fine-tooth hand saw with a blade held under tension in a frame, used for cutting materials such as metal or plastics.



Fig 1.6: Hacsaw

- ✓ **Fish tape**: A fish tape is used to pull stranded or solid wire conductors through metal or PVC conduit. Cable lube is available to assist you in pulling the wires through the conduit. A fish tape can also be helpful when you are pulling NM cable through wall cavities.




Fig 1.7: Fish tape

- ✓ **Hammer:** It is a tool used to deliver an impact to an object. They are mostly used to drive nails, fit parts, or break up objects. There are many types of hammers designed for specific uses, which vary in shape and structure. Most hammers include a handle and a head, with most of the weight in the head. The two main types of hammers are claw and ball peen.



Fig 1.8: Claw hammer

- ✓ **Tap-meter:** 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.




Fig 1.9: Tap-meter

**b) Power Tools:** A power tool is a tool that is actuated by an additional power source and mechanism other than the solely manual labor used with hand tools. The most common types of power tools use electric motors. Internal combustion engines and compressed air are also commonly used.



Cordless ( Rechargeble) drill




Corded drill

Fig 1.10: Power driller

**c) Testing instruments**: - They are instruments which test & measure the functionalities & measure the values of electrical quantities of wiring systems. Those instruments are used to test continuity (short circuit & open circuit) & measure currents, voltages, resistances, insulation resistance, wattages and other important elements in electrical works. Some of Testing instruments are:

- ***Multi-meters***:- The name implies, a multimeter is designed to perform a variety of measuring tasks. With multiple inputs, settings and read the results can give accurate readings in most situations. It is either analogue or digital. Nowadays digital multi-metre is more referable than analogue. Because it's reading result is more accurate. It is used to measure electrical quantities such as voltage, current, resistance, continuity, transistor values & capacitance by rotating the knob to the labelled mark of the quantity that is to be measured.




Digital Multi-meter



Amalogue Meter

Fig 1.11: Different types of multi-metres

- ***Megger or Digital insulation tester***: - use a high voltage, low current DC charge to measure the insulation resistance of the wires to identify current leakage and faulty or damaged insulation, which can lead to arc faults, blown circuits, and risk of electrical shock or fire.



Fig 1.12: Digital insulation tester

- **High potential tester**: It is a term used for electrical safety testing instruments used to verify electrical insulation in finished appliances, cables or other wired assemblies, printed circuit boards, electric motors, and transformers. It is the opposite of a continuity test. Continuity Test checks surety of current flows easily from one point to another point while Hi.pot Test checks surety of current would not flow from one point to another point.



Fig 1.13: High potential testor

- **Earth resistance tester**: is used to measure the resistance of the earth is called Earth Resistance Tester. All the equipment of the system is grounded through the earth electrode. Unhindered earthing protects electrical equipment and personnel from the fault current.

❑ **How to use it?**

The used method is a four-point method. The required pieces of equipment for the precise measurement are:

- Earth Tester (4 terminal).
- 4 electrodes.
- 4 insulated wires.
- A hammer.
- Measuring tape

**How to connect? Procedure**

1. Take the grounding electrode and isolate it from the rest of the system for measurement.
2. Mark the current terminals of Earth Resistance Tester as C1 and C1 and potential centers as P1 and P2.
3. Colorize the leads as per the standards as: C1=Black, C2=Red, P1=Green, P2=Yellow
4. Drive four small-sized electrodes into the soil at the same depth and equal distances from each other.
5. The earth electrode is connected to the C1 terminal of the Earth Resistance Tester.
6. The electrode is connected to the rest of Earth Resistance Testers terminal and potential terminals as per the rules of the Four Point Method.

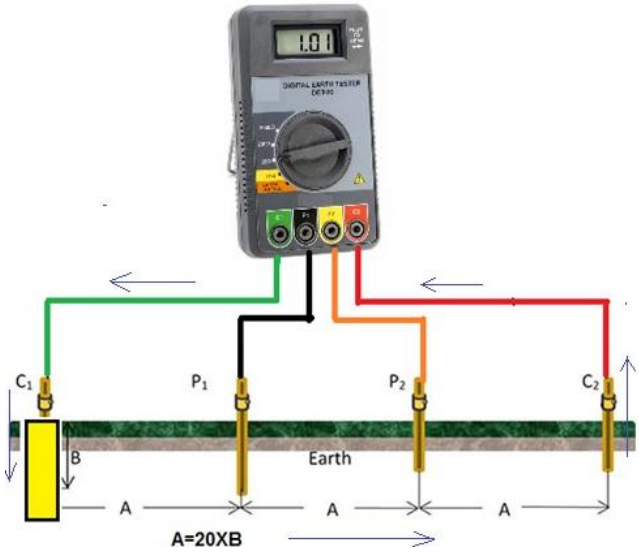



Fig 1.14: Earth resistance tester

**Table 1.1: The difference between megger & Earth resistance tester**

| No. | Earth Resistance Tester | Megger |
|---|---|---|
| 1 | It measures low resistance. | It measures high resistance. |
| 2 | Cannot be used to test the quality of insulation. | Can be used to test the quality of insulation. |
| 3 | Cannot function above its specified voltage. | Can function at or above its voltage. |
| 4 | It is used to measure the resistance of earthing pit. | It is used for measuring the insulation resistance of the motor winding cable, etc. |
| 5 | Its measurements are in Ohms. | Its measurements are in Mega Ohms. |

- **Ladder:** is a piece of tools used for climbing up or down something. It consists of two long side pieces of wood, metal or rope with steps fixed between them.



Fig 1.15 ladder

### 1.4.2. Wiring system measurement and marking

- **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 means: -** putting points or any sign to ensure the correct locations of amounts of wiring systems.

- **Marking Process means**: - Transferring paper drawings or plans (directly to the site plan, such as walls, floor and ceiling) for putting cable & wire routes, mounting outlets, fixtures, switches and junction boxes.
- **Layout and Installation Drawing**

1) The electrical layout should be considered after proper locations of all outlets for lamps, fans, appliances - both fixed and transportable, motors, etc, have been selected and best methods of wiring determined.
2) All runs of wiring and exact positions of all points of switch-boxes and other outlets shall be first marked on the plans of the building and approved by the engineer in charge or the owner before the actual commencement of the work.

**How is the marking performed during wiring**

- Detailed electrical circuits for each room and the entire building as a whole, developed on the basis of already working standard solutions;
- Electrical installation drawings indicating the location of each element of the wiring.
- If you neglect this rule, relying on the rich life experience of the owner or the great practice of performing electrical work by a visiting electrician, then there is a high probability of making mistakes that will have to be corrected in the future.
- In the extreme case, when there is already no time for design, for reference and guidance, you can use the simple recommendations for the placement of electrical wiring regarding building structures shown in the picture, although it is still better to refer to building codes and rules.

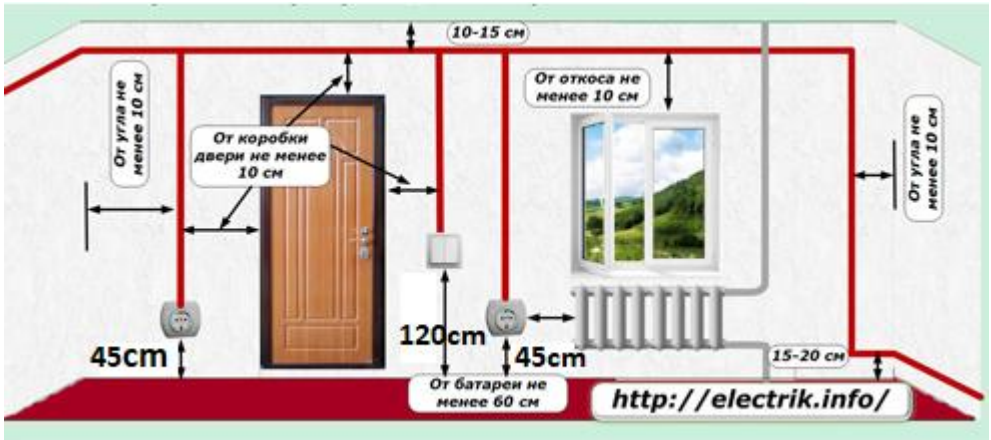



Fig 1.16 measurement

All wires and cable channels here have only with horizontal and vertical direction at right angles. It is not possible to arbitrarily mark tracks at an angle to save distance. In the course of operation, after a few years there is a possibility that when fastening to the walls of furniture, hanging pictures..

- **Height of sockets and switches** it is not strictly regulated, but is selected according to the habits and preferences of the owners of the apartment. When wiring relative to the door, window, heating battery, gas stove, adjacent walls and ceiling, one must be guided by the requirements of regulatory documentation.
- Electrical wiring is the process of drawing lines on the walls and ceiling. For its implementation, it is necessary to use at least simple drawing devices:
  - ruler or tape measure for measuring distances;
  - marker, pencil or ballpoint pen to indicate lines;
  - Plumb and level to determine the horizon and verticals.

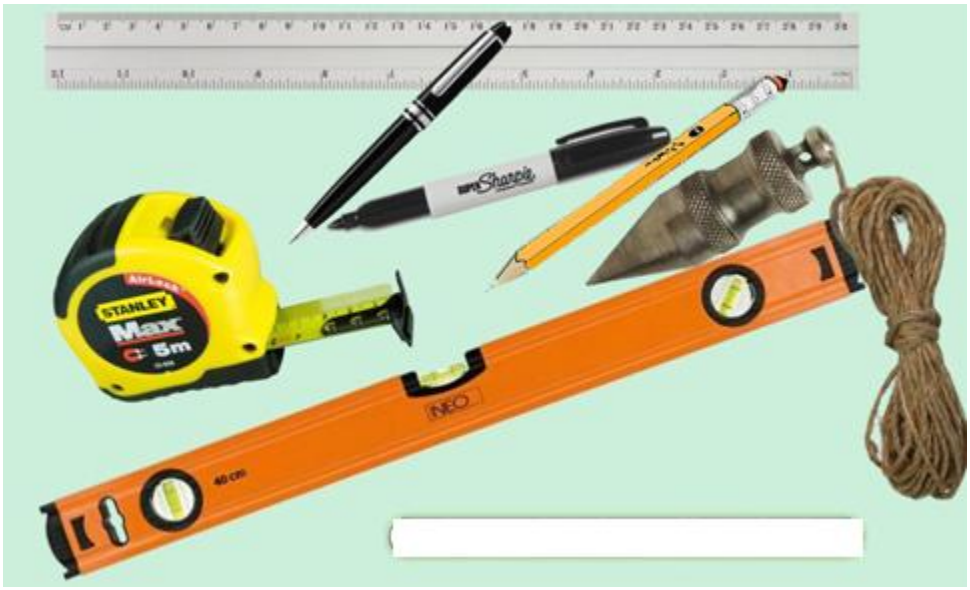



Fig 1.17 Marking tools

- **Marking work**

During repair, expansion or initial electrical installation of electrical wiring, the marking begins with the designation on the walls and ceiling of the places for the future location of lamps, switches, sockets, junction boxes and the apartment panel. That is, at first, from the project drawings, the dimensions of all terminal devices of the apartment's electrical equipment, which must be connected by cables and wires, are transferred to the building structures of the room elements in real scale.

To place these items in hidden wiring it is necessary to draw the boundaries of the places of deepening of the installation boxes.

It should be borne in mind that:

- The walls of apartments can be leveled, coated with a layer of stucco or with construction finishing sheets;
- Suspended or suspended structures can be mounted on the base ceiling;
- The height of the floor can be raised due to additional flooring from parquet, laminate or other floor coverings.

- **Ceiling marking methods**

To perform the work you will need to climb a small height. For this purpose, it is convenient to use an ordinary building stepladder. To prevent falls, it must be stably installed and the locking strips and screws securely fixed.

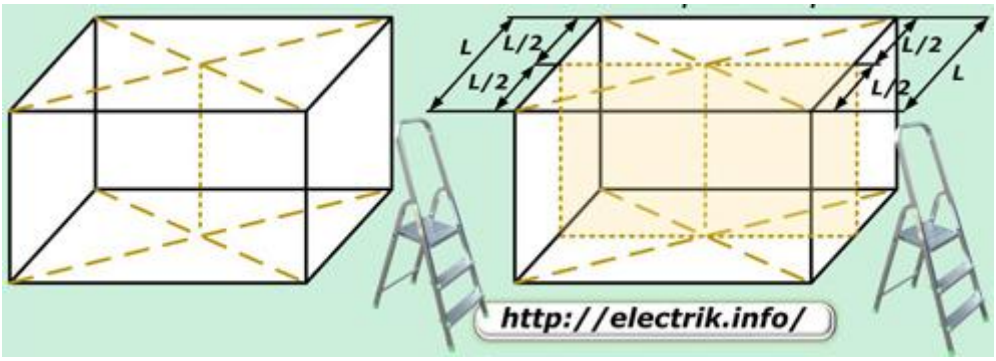



Fig 1.18: Ceiling Marking

**Attention!** When laying electrical wiring on the ceiling, it is impossible to weaken its supporting structure. For this purpose, gating of ceiling slabs is prohibited because of the possibility of their collapse.

- **Methods for drawing straight lines on the ceiling**

To conduct diagonals and axes connecting points on the ceiling, there are several technical methods.

1. **First way** based on the use of a construction chipping cord impregnated with coloring powder. For its use, it is advisable to work with an assistant who stands on the stepladder and rigidly sets the beginning of the cord at the first intended point for drawing the line.



Fig 1.19: measure ceilings

2. **Second way** drawing lines on the ceiling is based on the use of modern laser pointers or levels that use them in their design. The relatively low cost of these devices makes them affordable for the home master. The laser beam is clearly visible on any surface. It is very easy to orient and fix in space.




Fig 1.20: Sprit level

- **Wall marking methods**

The methods for drawing lines on walls using flashing threads or using a laser beam work the same way as on the ceiling. Only here it is necessary to take into account the level of their location in horizontal and vertical planes. To do this, use plumb lines and levels.

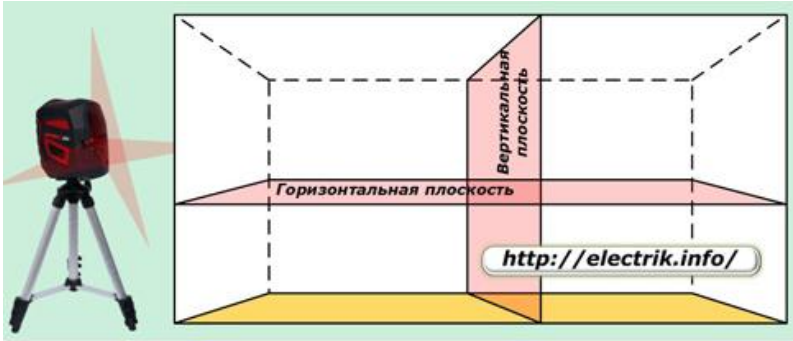



Fig 1.21: wall marking

- **The sequence of marking work for cable lines**

It is advisable to start this operation after the marking of all the other elements of the wiring is completed, since the cables must connect them along the optimal path.

Cable locations in future gates are immediately drawn so that the required width is clearly defined. On such lines, it is easier to drive a chamfer or cut grooves in other available ways.

The marking of cable channels starts from a floor, apartment or entrance panel into the house. First of all, it is always necessary to determine the method of supplying voltage to the switchboard, from which all the mains will stretch. This will facilitate the rest of the installation and the selection of optimal paths.

After the power supply path to the switchboard is indicated, the mains of the power circuits are sequentially drawn, diverging in all rooms. In this case, questions may arise related to the problems of the project. They need to be timely clarified and resolved.

When the location of the cable routes to all rooms is drawn, you can gradually start marking the wiring inside each room. It is carried out according to the above rules and ends when all the lines for connecting sockets, switches and all terminal devices are drawn.

In some cases, a space under the floor is used to lay electrical circuits. With such a project, hidden cable routing is performed and places of their intersection with each other are quite possible, which will be further protected from damage.




Fig 1.21: wall marking

Under the floor covering, the cables must run entirely without creating switching points and connections.

In conclusion of the article, it should be emphasized once again that the fully completed wiring layout serves as the basis for creating an executive power plan for the apartment and house, which during the operation of the building greatly facilitates the planning and execution of any subsequent work.

### 1.4.3. Wiring enclosure measurement and marking

An electrical enclosure is housing for electrical or electronic equipment. Its purpose is to protect that equipment from the environment (especially in the case of external electrical enclosures) and also to protect people from the equipment (e.g. to prevent electric shock or the propagation of an explosion).

## 1.5. Locations plan:

**Planning of Electrical Wiring Work**

Prior to carrying out wiring work, the wireman/contractor should plan and determine the tasks to be undertaken so that the work carried out is tidy, neat and safe to be used. The wireman/contractor shall: -

- Undertake a site visit;
- Determine the consumer load requirements;
- Calculate the maximum load demand; and
- Submit the plans, drawings and specifications.

❑ **Site Visit**

The purpose of the site visit is to determine: -

- Electrical equipment suitable for use;
- Maximum load demand;
- Single or three phase incoming supply;
- Type of wiring; and
- Equipment arrangement.

❑ **Determining Consumer Load Requirements**

With the aid of the building floor plans, the installation requirements such as the proposed load, placement of electrical equipment and installation design plans can be determined.

❑ **Calculating Maximum Load Demand**

The estimate of the maximum load demand is for determining the specifications of the wiring equipment such as the cables and accessories and subsequently to prepare the electrical installation plans.

According to clause 311 of MS IEC 60364 Part 1, to determine the maximum demand for each circuit while ensuring an economic and reliable design within the permitted voltage drop limits. Diversity factors may be taken into account.

The maximum current demand calculations for each circuit must be prepared. These details will show the current requirements, in amperes, for each phase and also assist in determining the cable sizes.

❑ **Submission of the Plans, Drawings and Specifications**

Regulation 65 of the Electricity Regulations 1994 states that the eligibility to submit plans is as follows: -

- Wireman with Single Phase Restriction Low voltage single phase up to 60 amperes.
- Wireman with Three Phase Restriction Low voltage up to 60 amperes.

**Self-check #1**

## I. Choose the correct answer from the give alterative

1) To verify or prove a successful electrical isolation you would use a:
   a) *voltage indicator b )* set of GS 38 test leads c) voltage proving unit d) small padlock
2) To secure an electrical isolation you would use a:
   a) voltage indicator b) set of GS 38 test leads c) voltage proving unit d)*small padlock*
3) Where a test instrument or voltage indicator is used to prove a supply dead, the same device must be tested to show that it still works using a:
   a) voltage indicator b) set of GS 38 test leads c) voltage proving unit d)*small padlock*
4) To give adequate protection to the person carrying out a safe isolation procedure, the test instrument must incorporate a:
   a) voltage indicator b) set of GS 38 test leads c) voltage proving unit d)*small padlock*
5) Which one is not categorized under had tools to measure DC current?

   A. power driller B. test light C. hacksaw D. pliers

## II. Mach column "B" to column "A"

| A | B |
|---|---|
| _____ 1: Isolation devices | A. putting sign |
| _____ 2: high potential tester | B. Breaker |
| _____ 3: marking | C. Preferable Supply in Residential wiring |
| _____4. AC | D. Use opposite to continuity |

## III. Give short ad precise answers for the following questions

1. _____ Process of organising workers, work activities & time?
2. List at least 5 electrical isolation procedures?
3. What are isolation requirements?
4. List why electrical isolation is needed?
5. Writ the difference between megger & Earth Resistance Tester

Note: Satisfactory rating – above 60% Unsatisfactory - below 60%

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

# Operation sheet #1

**Operation Title:** Plan and Prepare

**Instruction:** to confirm existing electrical supply, visit your work shop or your college compound with your teacher or Trainer where the electrical supply distribution boards found and:

**Purpose:** to confirm the supply of electrical installation

**Required tools and equipment:** unit one of this module, tools from workshops like screw drivers, pliers, measuring tools neon tester,

**Precautions:**

- use safety precaution while confirm electric supply
- Properly handle the tools

**Procedures:**

**Step 1**: Observe the electrical supply from Energy meter to Distribution board (main and sub) to final circuit.

**Step 2:** Identify Sources electrical power supply (AC and DC)

**Step 3:** Identify the types electrical power supply system (single phase and three phase supply)

**Step 4:** Observe and Identify Electricity Supply Specifications (single phase Nominal voltage, three phase nominal voltage, TT supply system)

**Step 3:** Observe and identify how the electrical supply system where distributed to each building found in your college and the TT supply systems.

**Quality criteria:**

# Operation sheet #2

**Operation Title:** Plan and Prepare

**Instruction:** To identify the means of electrical isolation, visit your work shop or your college compound with your teacher or Trainer where the electrical supply distribution boards, sub distribution boards and final circuits found and:

**Purpose:** to confirm the supply of electrical installation

**Required tools and equipment:** unit one of this module, tools from workshops like screw drivers, pliers, measuring tools neon tester,

**Precautions:**

- use safety precaution while confirm electric supply
- Properly handle the tools

**Procedures:**

**Step 1:** Check with the duty holder/authorized person that it is acceptable to isolate the circuit/equipment.

**Step 2:** Ensure that there is a 'Permit to Work' in place.

**Step 3:** Identify the type of supply system

**Step 4:** Locate and identify the circuit/equipment to be isolated including any alternative sources

**Step 5:** Select an approved voltage indicator device

**Step 6:** Verify the circuit/equipment is functional.

**Step 7:** Identify suitable means of isolation.

**Step 8:** Isolate circuit / equipment by:

**Step 9:** Fit appropriate lock off device and locks.

**Step 10:** Verify the circuit/equipment is isolated. Use the approved voltage indicator device to verify circuit is dead.

**Step 11:** Re-check the approved voltage indicator device is still functional

**Step 12:** Circuit/equipment should be safe to carry out the work.

**Quality criteria:**

**LAP Test # 1**

Name: _____ Date: _____

Time started: _____ Time finished: _____

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

**Task 1:** Observe and Confirm existing electrical supply. (**6hrs)**

**Task 2:** Observe and identify the means of electrical isolation. **(4hrs)**

**Task 3:** observe and Carry out isolation procedures. **(4hrs)**

**Task 4:** observe and demonstrate how to Measure and mark out all locations for wiring system and enclosures. (**6hrs)**

# UNIT TWO: WIRING SYSTEM INSTALLATION

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

- Fix wiring systems, using PVC and Flexible Conduits
- Recording test data
  - ✓ Job specifications
  - ✓ Quality assurance procedures

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

- Fix the wiring systems using PVC & Flexible Conduits safely and in accordance with relevant regulations and manufacturers' instructions
- Record test data in the format required by the job specifications and quality assurance procedures

## 2.1. Fix wiring systems, using PVC and Flexible Conduits

### ❑ Introduction

PVC conduit & wiring System Installation is mostly standardized with several rules, regulations and laws. These must be installed correctly and safely in accordance with electrical regulations and standards. If the electrical wiring is carried out incorrectly or without confirming to any standard, then it may lead to incidents like short circuits, electric shocks, damage the device / appliance or leads to the malfunctioning of device which further causes for the reduction of device life.

Factors that you should be considered before the actual PVC conduit & wiring System installation work to be done for residential, commercial or industrial wiring. These factors include type of building construction, type of ceiling, wall and floor construction, wiring methods, installation requirements, etc.

### ❑ Electrical Safety

Before starting any electrical installation work, the first & foremost thing is the concern of safety. Follow the following safety steps at the workplace.



Fig 2.1: Electrical safety sign

- Always use safety equipment like goggles, gloves, shoes, etc. and avoid any direct contact with live or energized circuits.
- Have the skills and techniques to distinguish the exposed live parts of the electrical equipment.
- Disconnect the source supply while installing or connecting wires.
- The power supplied to the installation must be controlled on the main switchboard, which should consist of circuit breaker.
- Conductive tools and materials must be kept at a safe distance from live parts of the circuit or equipment.

- Use non-conductive hand tools for which they are rated to perform electrical work. If they are used for voltage (or current) rating other than rated, the insulation strength of the tool will breakdown and causes electric shock.

### 2.1.1. PVC conduit & wiring System

- **Distribution of Electricity**

The EEPCO provides the electric supply up to the outside of the consumer's premises (residential, commercial or industrial). The consumer has to take the connection from that point to the main distribution board / switchboard at home.

From the main switchboard / distribution board, various types of electrical loads such as fans, lights, room coolers, and refrigerators are connected through respective circuits and electrical wiring.

### 2.1.2. Wiring systems

**I.** **Wire** is a type of conductor which conducts electricity. In the case of household wiring, the conductor itself is usually copper or aluminum (or copper-sheathed aluminum) and is either a solid metal conductor or stranded wire.

**II.** **Wiring system**: A network of wires connecting various accessories for distribution of electrical power from the supplier meter board to the numerous electrical power consuming devices such as lamps, fans and other domestic appliances through controlling and safety devices is known as a wiring system.

**III.** **Types of Electrical Wiring Systems**

Electrical Wiring is an important part of a building, be it a residential building (individual houses or apartments), large commercial spaces (office buildings) or industries (factories).

There are several methods and systems of Electrical Wiring, which are used for lighting and other power circuits.

The type of Electrical Wiring plays a major role in the overall cost of the installation. So, it is very important to understand what type of electrical wiring systems is suitable for a particular job.

Some common factors to be considered while choosing a particular electrical wiring system are:

- Cost of the Wiring System

- Type of Wires / Cables used
- Quality of the Wires
- Type of load (light, HVAC, motors etc.)
- Safety of the Wiring System
- Possibility of future modifications / extensions
- Life of installation
- Fire safety

Irrespective of the type of Wiring and the choice of Wire, the Electrical Wiring System should be able to protect against regular mechanical wear and tear under normal operating conditions.

Usually, the type of wire determines the Electrical Wiring Systems. Some of the commonly used Electrical Wiring Systems in Residential, Commercial, Industrial, Auditoriums, etc. are:

a) Cleat Wiring
b) Casing and Capping Wiring
c) Batten Wiring (CTS or TRS)
d) Lead Sheathed Wiring
e) Conduit Wiring (Surface or Concealed)

**B) Cleat Wiring**

In this, porcelain, wood or plastic cleats are fixed to walls or ceilings at regular intervals, i.e., 0.6 m between each cleat. PVC insulated cables are taken through the holes of each cleat and hence, the cleat supports and holds the wire. This is an inexpensive method of wiring and is used for temporary installations. Therefore, it is not suitable for home electrical wiring and also it is an outdated method.




Fig 2.2: Cleat wiring in conduit

- **Advantages cleat wiring.**
  - Cheap and easy wiring
  - Easy to fault detection
  - Easy to repair
  - Alteration and addition is easy.
- **Disadvantages of Cleat Wiring**
  - Bad appearance
  - Exposed to weather to be affected by humidity, rain, smoke, sunlight etc
  - Chances for shock or fire
  - Used in only 220V in low ambient temperature.
  - Not long lasting
  - Sag happens

### C) Casing and Capping Wiring

In this, wiring types the wire run through a truck casing having channels. The truck casing is prepared in such a way that it is of a required fixed length with parallel channels that accommodates the cables. The truck casing is fixed to the walls or ceiling with screws. After placing the cables inside the channels of casing, a truck cap with grooves is placed on it to cover the cables. This is also a cheap wiring system, but there is a high risk of fire in case of short circuits.



Fig 2.3: Casing and Capping Wiring

- ***Advantages of Casing Wiring***
  - Cheap and easy to install

- Strong and durable wiring
- Customization can be done easily
- Safe from smoke, dust, rain and steam etc.
- Due to casing and capping no risk of shock.

❑ ***Disadvantages of Casing Wiring***

- Very costly
- Not suitable for weather with high humidity and acidic conditions.
- Insect like termites or ants can damage wooden casing and capping.
- High risk of fire.

**D) Batten Wiring:**

In this, insulated wires are run through the straight teak wooden battens. The wooden battens are fixed on the ceilings or walls by plugs and screws. The cables are fitted onto the battens by using tinned brass link clips. These clips are fixed to the battens with rust-resistant nails. This wiring installation is simple and cheap as compared to other electrical wiring systems also takes less time to install. These are mainly used for indoor installations. In this type of wiring, Cabtyre Sheathed Wire (CTS) or Tough Rubber Sheathed Wire (TRS) is generally used as the electrical conductor.

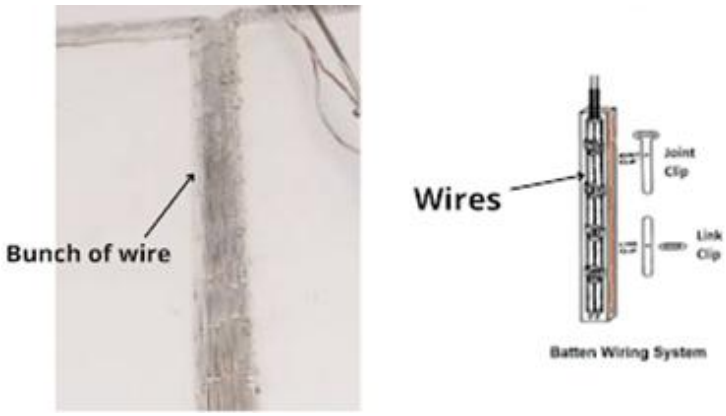



Fig 2.4: Batten Wiring

❑ ***Advantages of Batten Wiring***

- Easy installation
- Cheap in material cost
- Appearance is better.
- Customization is easy

- Less chance of leakage current

❑ Disadvantages of batten wiring are

- Not suitable for outdoor wiring
- Humidity, smoke, steam etc directly affect on wires.
- Heavy wires are not recommended for this wiring scheme.
- Only suitable for below 250 V.
- High risk of fire.

**E) Conduit Wiring**:

In this wiring system, wires or cables are taken through either PVC conduit pipes or through steel conduit pipes. It can be either surface conduit wiring or concealed conduit wiring. If the conduit pipes are run on surface of the walls and ceilings, it is called a surface conduit wiring. If the conduits are run inside the surface of the walls and ceilings and are covered with plastering, it is called as concealed conduit wiring

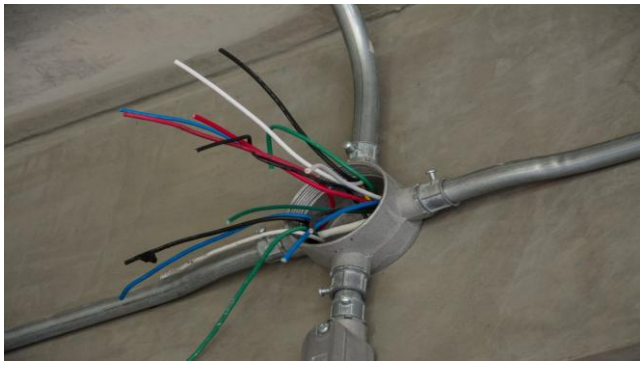


Fig 2.5: Conduit Wiring

Surface conduit wiring system is used in industries to connect the heavy motors. On the other hand, concealed wiring is the most popular and common method of wiring the residential buildings. The conduit wiring system is the safest method of wiring and also looks beautiful. Among different types of conduit (i.e. Metalic, Non-Metalic & flexible) mostly residential electrical installation is a use Nom-Metalic or PVC conduit because:

- It has high tensile strength;
- it can be bent by hand if warmed;
- it has high electrical resistance;
- it is weather resistant;
- it does not crack under stress at normal temperatures;

- it has a low flammability;
- It has light weight
- Its accessibility & cheapest than other conduits

❑ **Advantages of Conduit Wiring**

- The safest wiring
- Appearance is better
- No risk of fire or mechanical wear and tear.
- No risk of damage of cable insulation
- Safe from humidity, smoke, steam etc.
- No risk of shock
- Long lasting

❑ **Disadvantages of Conduit Wiring**

- Very expensive
- Installation is not easy
- Not easy to customize for future
- Hard to detect the faults.

### F) Lead Sheathed Wiring

This wiring method is also similar the CTS / TRS Wiring except for the type of wire / cable. In this, the electrical conductor is first insulated with Vulcanized Indian Rubber and then it is covered with a sheath of Lead-Aluminum alloy (95% Lead and 5% Aluminum). Similar to the Batten Wiring, this wiring is also run on wooden batten and are fixed with tinned clips.

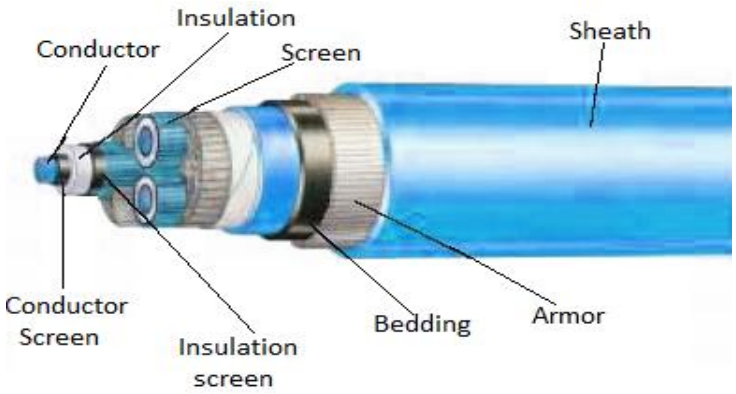



Fig 2.6: Lead sheathed wiring

## IV. Wiring Preparation

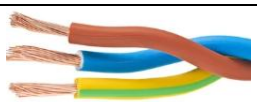
As we are discussing the sequence of steps in wiring like understanding the safety, knowing types of wiring systems, understanding the difference among various electrical drawings and symbols, the next step of electrical wiring process is the preparation of wires or cables and electrical tools.

The wiring preparation includes the following considerations.

- ❑ Identify types of conductors.
  - ⌖ Based on the numbers of cores wires is categorized in to:
    - Solid (rigid) wire
    - Stranded/standard (flexible)wire
    - Semi-stranded wires
  - ⌖ Mostly Solid (rigid) conductors are preferred for electrical residential electrical installations.
- ❑ Select wires based on their specifications. Factors to select wire are number of strands in the conductor, insulation type, cross section area of the wire, diameter of the strands, etc.
  - ⌖ Based on EEPCO standard the cross section area of the wire:
    - For extra low voltage electrical installation is ***0.5mm$^2$ – 1mm$^2$***
    - For luminaire electrical installation is ***1.5mm$^2$ – 2.5mm$^2$***
    - For receptacles (socket outlet) electrical installation is ***2.5mm$^2$ & above.*** it depends on the appliances using in the outlets.
- ❑ Choose the wires depends on the color code:

Table 2.1: EEPCO wire/ cable color standards

| ➢ **Solid (Rigid) wire** | | |
|---|---|---|
| Function | Color code (for 50/220/380 V) | Color code |
| Single phase Line | Red |  |
| Three phase Line (L1) | Red/blue/ yellow/green |  |
| Three phase Line (L2) | Red/blue/ yellow/green |  |
| Three phase Line (L3) | Red/blue/ yellow/green |  |
| Single or three phase Neutral line | Black |  |

| ➢ **Stranded (Flexible) wire /cables** | | |
|---|---|---|
| Single phase Line | Brown/ Black |  |
| Single Neutral Line | Blue | |
| Three phase Line (L1) | Brown/Black/green/yellow | |
| Three phase Line (L2) | Brown/Black/green/yellow | |
| Three phase Line (L3) | Brown/Black/green/yellow | |
| three phase Neutral line | Blue | |
| Earthing line | Yellow with green strip | |

**Note**: in all electrical installation system the color code of the stranded conductor is depending on the number of cores. i.e. The number of core of the standard wire or cable is above three; we can use black wire/cables as a phase line.

- ❑ Electrical tools that mentioned with this module in unit one of 1.4.1 are required to do the installation work.
- ❑ Choose the components such as electrical boxes, switches, receptacles, etc.

### V. Types of Electrical Wiring connections

We know that electrical circuit is a closed path through which electricity flows from phase or hot wire to the device or apparatus and then back the source though neutral wire.

Along the way, the electricity path may consist of fixtures, switches, receptacles, junction boxes, etc. So, the wiring may be routed through these elements before actually making connections with apparatus or device.

Mainly, the wiring connection is divided into two types depending on the way the devices are powered or connected to the supply. They are:

1. Series Wiring connections
2. Series Wiring connections

1. **Series wiring connections:** It is the rarely used wiring in which hot wire is routed through the several devices and then last device terminal is connected to the neutral wire.

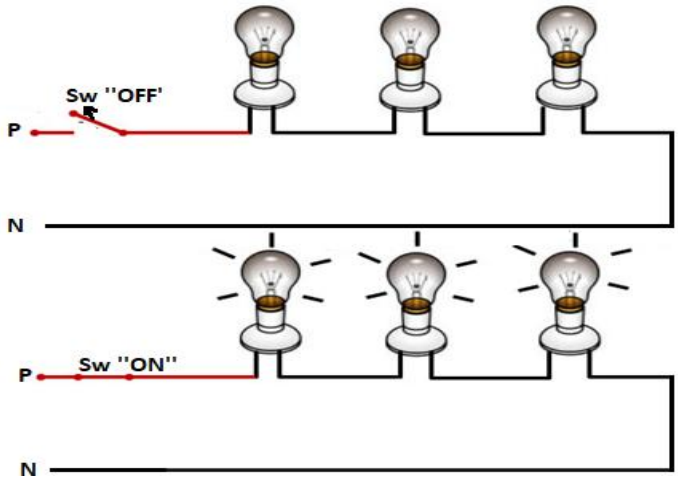



Fig 2.7: Series connection

2. **Parallel wiring connections:** In this wiring connecting system, several devices on the installation are powered on a single circuit. It is the most accepted wiring in homes and industries, in which devices are connected in parallel with the supply source.

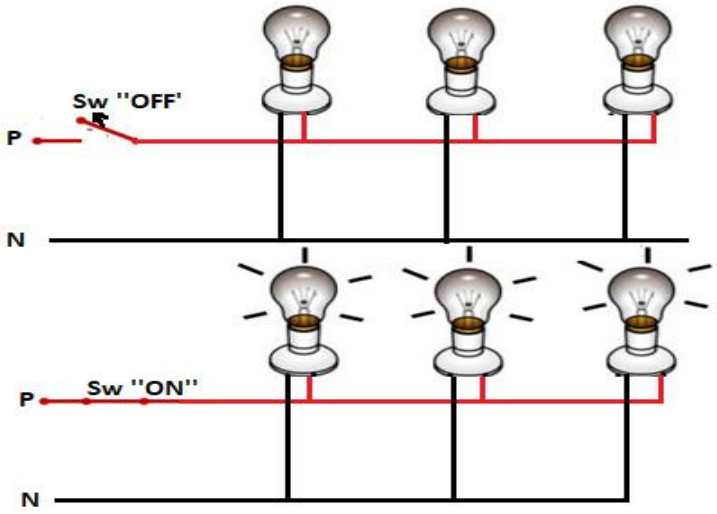



Fig 2.8: Parallel connection

In this, both phase (or hot) and neutral cables are routed through the electrical boxes (junction boxes) from which individual receptacles, fixtures, and devices are branched.

**Examples of Electrical Wiring**

- **Single Bulb (or any other load) Controlled by a One Way Switch**

In this, hot wire is connected to the one terminal of the switch and other terminal of the switch is connected to the bulb positive terminal, then bulb negative terminal is connected to the neutral wire as shown in figure.

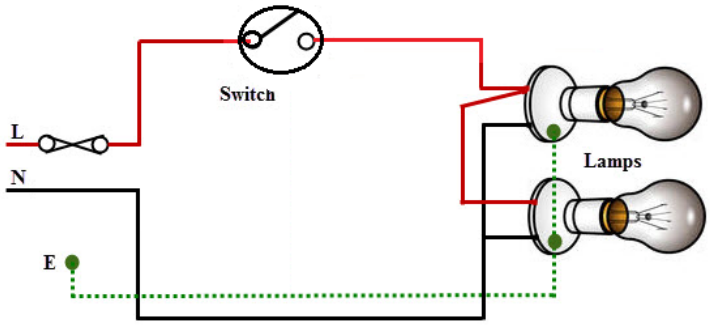



Fig 2.9: control two lamps in one place

In this, two bulbs are connected in parallel with the supply wires (phase and neutrals), which are routed by single one-way switch as shown in figure.

- **Single Blub Controlled by Two Way Switches**

This wiring is also called as bed room Wiring. In this, a light bulb / lamp is controlled from two different places / sources by using two **two-way switches**. This type of wiringnis used in bed rooms to switch ON/OFF the lamp from two sources (at the bed side and at switchboard). The connection of switches with the lamp is shown below.

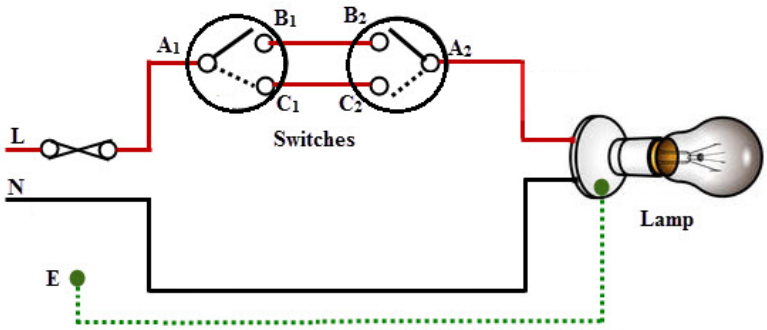



Fig 2.10: control two lamps in one place

❑ **Double Blub Controlled by intermediate Switches**

This wiring is also called as Salon Wiring. In this, a light bulb / lamp is controlled from three different places / sources by using two **two-way** & one intermediate (four way) switches. This type of wiring is used in sallon to switch ON/OFF the lamp from three sources. The connection of switches with the lamp is shown below.

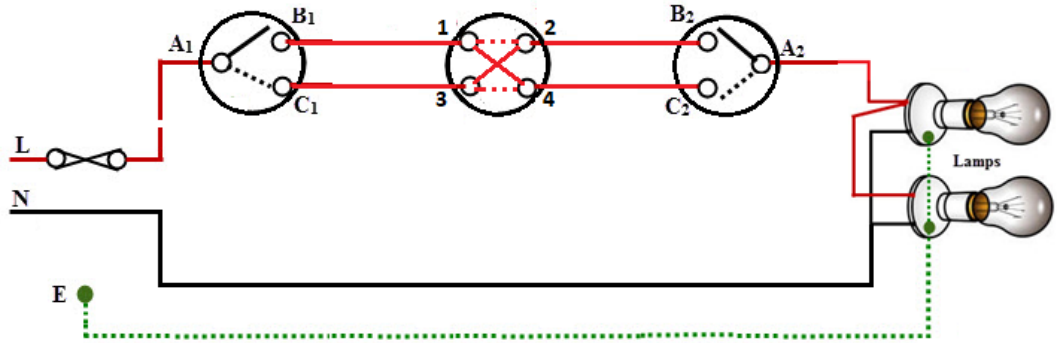



Fig 2.11: control two lamps in three place

❑ **Warehouse Wiring**

This type wiring is used in big godowns, long passages, warehouses and tunnel like structures having many rooms or portions. It follows the linear sequence for switching the lights from one end to the other. When a person leaves one room and enters the next, turning the light switch makes previous room's lamp to be switched OFF, while the present room lamps to be switched ON. It turns OFF one lamp while switching ON the another. The schematic wiring diagram for warehouse wiring is shown in below.

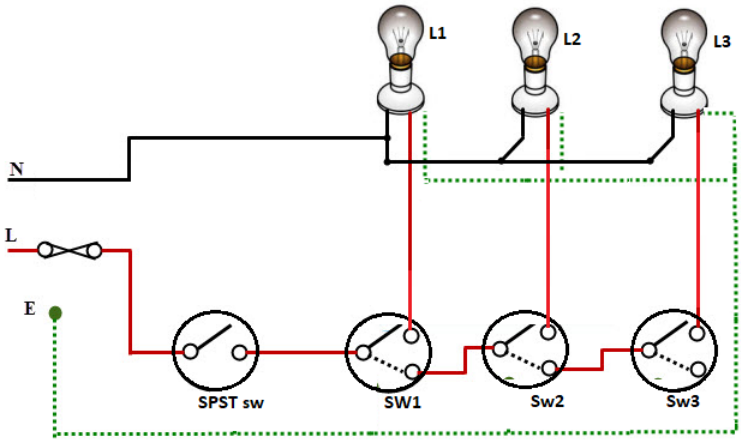



Fig 2.12: Lighting sequence

### ❑ Fluorescent Lamp Controlled by a One-Way Switch

The switching of fluorescent lamp with single one-way switch through ballast and capacitor is shown in below figure. In this, phase wire is connected to the one end of the switch and another end of the switch is connected to the choke (or ballast). One electrode of the lamp is connected to the choke and other to neutral terminal as shown in figure.

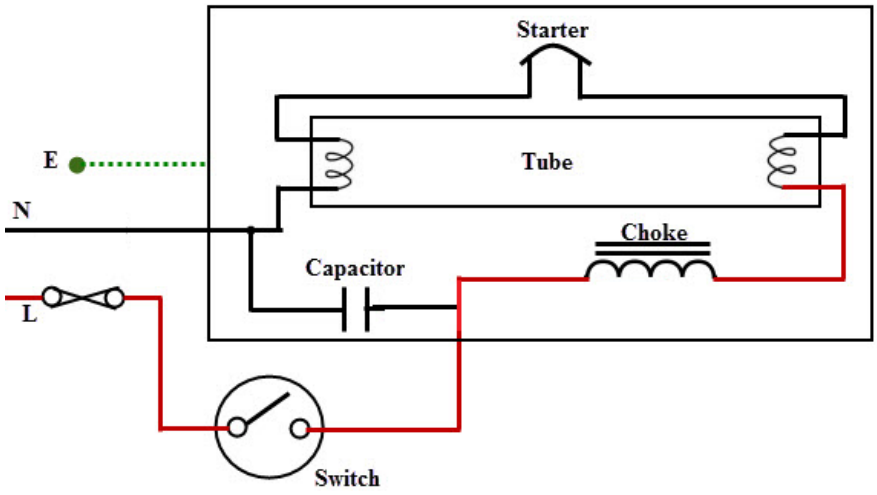



Fig 2.13: fluorescent lamp

### ❑ Socket Outlet Wiring

The outlet holds a plug and passes the current through it when the power is routed to the socket through a switch. The single socket connection and radial socket connection are shown in below figure.

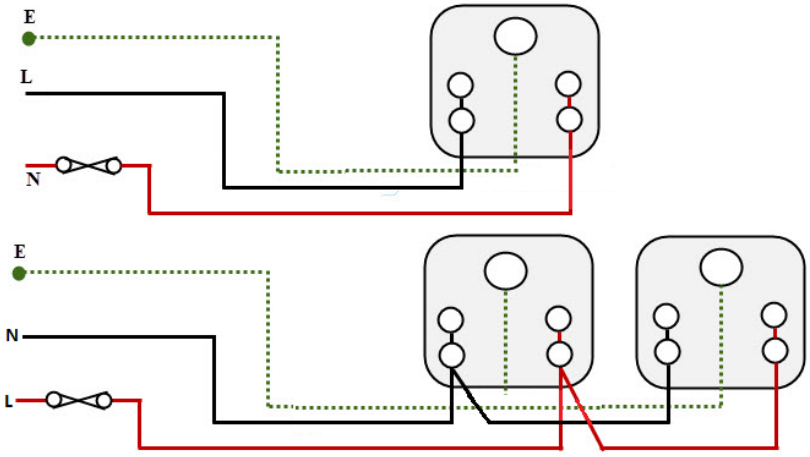



Fig 2.14: Socket outlet connection

### ❑ Control Switch Board Wiring

The schematic diagram for a control switch board is shown in the below figure. In this, a ceiling fan, a fluorescent lamp and a light bulb are controlled by appropriate switches

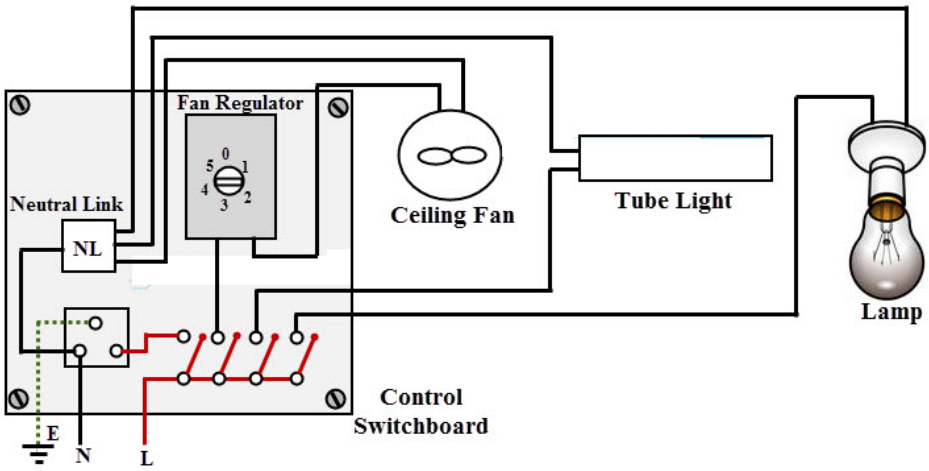



Fig 2.14: control switch board wiring connection

## 2.2. Recording test data

**Definition**: The skill of recording data involves the documenting of data and observations in a variety of forms in order to preserve it for later use. To record data is used to remember the information what we do, taking a correction action for the mistakes, report to the concerned personal & documented the stations & results for futures. The following format is used to record the testing result formats.

| **Project** | | | | | | | **Date of test** | | |
|---|---|---|---|---|---|---|---|---|---|
| **Sector** | | | | | | | **Tester** | | |
| **Area** | | | | | | | **Supervisor** | | |
| Test point | Conductor size types | MCB rating & types | Earth conductor | Insulation resistance | polarity | continuity | Connection Pass/fail | Voltage | current |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

**Electrical wiring and enclosures testing and Inspection**

- Tester or inspector Name: ---------- Date: ----------
- Types of tested and inspected circuit:_____ Location/Client:_____
- Installation type (New/addition/alteration of exist installation):_____

| No | Inspection and Testing activities | Test Result | | comment |
|---|---|---|---|---|
| | | Yes | No | |
| **A** | **Inspection** | | | |
| 1 | All mechanical connections are tight, as factory connections may loosen during shipment and storage. | | | |
| 2 | All accessible electrical connections are tightened to the torque specifications on the panel labeling. | | | |
| 3 | All screws connecting and tight switches, breakers, socket outlets, lamps, etc are properly installed and tightened | | | |
| 4 | Connections between branch circuits and breakers are properly secured. | | | |
| 5 | All ground connections are properly made (Note: ground wire must be installed after the panel box is mounted on the wall). | | | |
| 6 | All foreign materials have been removed from the panel and enclosure before installing the dead front and trim. | | | |
| 7 | Dead front is properly aligned and securely installed. | | | |
| 8 | Trim is properly mounted and securely installed. | | | |
| **B** | **Continuity Test** | | | |
| 1 | Conductors are connected in the correct and effective manner. | | | |
| 2 | all conductors around the ring circuit have continuity | | | |
| 3 | Live and Neutral Conductor Continuity Test | | | |
| **C** | **Polarity test** | | | |
| 1 | Each fuse or single pole control and protection device is connected only in the phase conductor. | | | |
| 2 | Intermediate contact of Edison screw lamp holder is connected to the phase conductor | | | |

| | | | | |
|---|---|---|---|---|
| 3 | phase, neutral and earth conductors at socket outlets are connected at the correct terminals | | | |
| D | **Over all functionality test** | | | |
| 1 | Light circuits are functional | | | |
| 2 | Control and protective devices are functional | | | |
| 3 | General purpose socket outlets are functional | | | |
| 4 | Metallic body of devices are grounded | | | |

# Self-check #3

## I. Choose the correct answer from the give alterative

1. The electricity supply to a domestic consumer is usually protected at the incoming service position by a:
   a) Meter b)Double pole switch c) MCB d) HBC fuse
2. The protective Type B MCB for a lighting circuit fed from a consumer unit in 1.0mm$^2$ or 1.5 mm$^2$ wire should be rated at:
   a) 6 A or 10 A b) 10 A or 16 A c) 32 A or 40 A d) 32 A only
3. The protective Type B MCB for general purpose socket outlet fed from a consumer unit in 2.5 mm$^2$ wire should be rated at:
   a) 6 A or 10 A b) 10 A or 16 A c) 16 A or 32 A c) 32 A or 40 A
4. A PVC insulated and sheathed cable is especially suited to:
   a) domestic installations c) burying underground
   b) fire alarm installations d) industrial installations
5. Construction sites receive special consideration in the IEE Regulations because of the hazard associated with:
   a) electricity and flammable liquids c) exposure to wind and rain
   b) electricity and water d) b) & c)
6. The permissible colors of 220 V single phase fixed wiring according to EBCS-10 are:
   a) brown, blue, green and yellow c) red, black, green and yellow
   b) brown, black, grey d) red, yellow, green and yellow
7. To work safely and care for the safety of others is the responsibility of:
   a) an employee b) an employer c) everyone d) the Government
8. A scale drawing showing the position of equipment by graphical symbol is a description of
   a) block diagram b) layout diagram or site plan c) wiring diagram d) circuit diagram
9. A diagram which shows the detailed connection between individual items of equipment is a description of a:
   a) block diagram b) layout diagram or site plan c) wiring diagram d) circuit diagram
10. A diagram which shows most clearly how a circuit works, with all items represented by graphical symbols is a description of:

a) block diagram b) layout diagram or site plan c) wiring diagram d)circuit diagram

11. In the SI system of units, the units of voltage current and resistance are:

a) volts, watts and Newton c) volts, amps and ohms

b) meter, kilogram and second d) Newton, joule and watt

12. An insulator is a material in which the electrons are:

a) very large compared with the nucleus c) tightly bound to the nucleus

b) positively charged to the nucleus d) loosely bound to the nucleus

13. A conductor is a material in which the electrons are:

a) very large compared with the nucleus c) tightly bound to the nucleus

b) positively charged to the nucleus d) loosely bound to the nucleus

14. A 'good conductor' material has:

a) a negative nucleus in the atoms of the material d) no free electrons

b) positive electrons available for current flow

c) free electrons available for current flow

15. A 'good insulator' material has:

a) a negative nucleus in the atoms of the material d) no free electrons

b) positive electrons available for current flow

c) free electrons available for current flow

16. The following materials are good conductors:

a) copper, Perspex and glass c) copper, brass and wood

b) copper, Silver and aluminum d) PVC, rubber and porcelain

17. The following materials are good insulators:

a) PVC, copper and aluminum c) PVC, rubber and porcelain

b) PVC, rubber and brass d) copper, gold and silver

18. An electric current in a circuit may also be described as a:

a) flow of atoms c) resistance in the circuit

b) difference of potential d) flow of free electrons

19. Most electrical cables are constructed in three parts, the:

a) conductor, copper and aluminum c) conductor, insulation and sheath

b) conductor, insulation and flexible cord d) conductor, outer sheath and protection

20. The protective conductor connecting exposed conductive parts of equipment to the main earthing terminal is called:
    a) the general mass of earth
    b) the circuit protective conductor
    c) exposed conductive parts
    d) extraneous conductive parts
21. A short circuit may be defined as:
    a) a current in excess of at least 15 A
    b) a current which exceeds the rated value in an otherwise healthy circuit
    c) an over current resulting from a fault between live and neutral conductors
    d) a current in excess of 60 A
22. It is the weakest link in the circuit. Under fault conditions it will melt, protecting the circuit conductors from damage. This is one description of:
    a) an electromagnetic relay
    b) an MCB (miniature circuit breaker)
    c) a fuse
    d) an isolating switch
23. To correctly measure the current and voltage in a circuit, the meters must be connected to the load in the following way:
    a) ammeter in series, voltmeter across the load
    b) ammeter across the load, voltmeter in series
    c) ammeter in series, voltmeter in parallel
    d) ammeter in parallel, voltmeter in series
    e) a) & c)
24. The act of connecting exposed conductive parts to the earthing terminal of an installation is called:
    a) earthing
    b) equipotential bonding
    c) exposed conductive parts
    d) extraneous conductive parts

Note: Satisfactory rating – above 60% Unsatisfactory - below 60%

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

## Operation sheet #3

**Operation Title:** control lamps in different locations

**Instruction:** control one lamp from one Location using SPST Switch (one way switch).

**Purpose:** to control different lamps using control switch in different places.

**Required tools and equipment:** tools from workshops like screw drivers, pliers, measuring tools,

**Precautions:**

**Precautions:**

- use safety precaution while confirm electric supply
- Properly handle the tools

**Procedures**

1. Collect hand tools, testing instruments, measuring tools, marking, drawing tools and adjust the electrical accessories based on the layout diagram.
2. Based on the mark their positions and dimension by a pencil on the wiring board.
3. Mark the point on them by the poker.
4. Fix all Connection Boxes, outlet boxes and Distribution boards
5. Install the conduits based on the layout diagram
6. Based on the wiring Diagram, Insert the wires in the installed conduits,
7. after removing the insulation; Splice, Terminate and connect wires and accessories
8. Then fix all accessories on the board by wooden screws after making holes on them by the poker.
9. Then fix all covers on the accessories.
10. Test the wiring systems for continuity and polarity Test using appropriate testing Device.
11. After testing completed and getting approval from your trainer make the power ON and Observe the Result
12. finalized your observation , Dismantle the wiring and accessories safely
13. Return all Accessories, material, Tools and Equipments to their stored place properly and clean the working area.

**Quality criteria:**

**Operation sheet #4**

**Operation Title:** control lamps in different locations

**Instruction:** connect three lamps in series & control from one Location using SPST Switch (one way switch).

**Purpose:** to control different lamps using control switch in different places.

**Required tools and equipment:** tools from workshops like screw drivers, pliers, measuring tools,

**Precautions:**

**Precautions:**

- use safety precaution while confirm electric supply
- Properly handle the tools

**Procedures**

1. Collect hand tools, testing instruments, measuring tools, marking, drawing tools and adjust the electrical accessories based on the layout diagram.
2. Based on the mark their positions and dimension by a pencil on the wiring board.
3. Mark the point on them by the poker.
4. Fix all Connection Boxes, outlet boxes and Distribution boards
5. Install the conduits based on the layout diagram
6. Based on the wiring Diagram, Insert the wires in the installed conduits,
7. after removing the insulation; Splice, Terminate and connect wires and accessories
8. Then fix all accessories on the board by wooden screws after making holes on them by the poker.
9. Then fix all covers on the accessories.
10. Test the wiring systems for continuity and polarity Test using appropriate testing Device.
11. After testing completed and getting approval from your trainer make the power ON and Observe the Result
12. finalized your observation , Dismantle the wiring and accessories safely
13. Return all Accessories, material, Tools and Equipments to their stored place properly and clean the working area.

**Quality criteria:**

## Operation sheet #5

**Operation Title:** control lamps in different locations

**Instruction:** connect three lamps in parallel & control from one Location using SPST Switch (one way switch).

**Purpose:** to control different lamps using control switch in different places.

**Required tools and equipment:** tools from workshops like screw drivers, pliers, measuring tools,

**Precautions:**

**Precautions:**

- use safety precaution while confirm electric supply
- Properly handle the tools

**Procedures**

1. Collect hand tools, testing instruments, measuring tools, marking, drawing tools and adjust the electrical accessories based on the layout diagram.
2. Based on the mark their positions and dimension by a pencil on the wiring board.
3. Mark the point on them by the poker.
4. Fix all Connection Boxes, outlet boxes and Distribution boards
5. Install the conduits based on the layout diagram
6. Based on the wiring Diagram, Insert the wires in the installed conduits,
7. after removing the insulation; Splice, Terminate and connect wires and accessories
8. Then fix all accessories on the board by wooden screws after making holes on them by the poker.
9. Then fix all covers on the accessories.
10. Test the wiring systems for continuity and polarity Test using appropriate testing Device.
11. After testing completed and getting approval from your trainer make the power ON and Observe the Result
12. finalized your observation , Dismantle the wiring and accessories safely
13. Return all Accessories, material, Tools and Equipments to their stored place properly and clean the working area.

**Quality criteria:**

## Operation sheet #6

**Operation Title:** control lamps in different locations

**Instruction:** connect two lamps & one socket in parallel & control from two Location using double way switches Switch (one way switch).

**Purpose:** to control different lamps using control switch in different places.

**Required tools and equipment:** tools from workshops like screw drivers, pliers, measuring tools,

**Precautions:**

**Precautions:**

- use safety precaution while confirm electric supply
- Properly handle the tools

**Procedures**

1. Collect hand tools, testing instruments, measuring tools, marking, drawing tools and adjust the electrical accessories based on the layout diagram.
2. Based on the mark their positions and dimension by a pencil on the wiring board.
3. Mark the point on them by the poker.
4. Fix all Connection Boxes, outlet boxes and Distribution boards
5. Install the conduits based on the layout diagram
6. Based on the wiring Diagram, Insert the wires in the installed conduits,
7. after removing the insulation; Splice, Terminate and connect wires and accessories
8. Then fix all accessories on the board by wooden screws after making holes on them by the poker.
9. Then fix all covers on the accessories.
10. Test the wiring systems for continuity and polarity Test using appropriate testing Device.
11. After testing completed and getting approval from your trainer make the power ON and Observe the Result
12. finalized your observation , Dismantle the wiring and accessories safely
13. Return all Accessories, material, Tools and Equipments to their stored place properly and clean the working area.

**Quality criteria:**

**LAP Test #2**

Name: _____ Date: _____

Time started: _____ Time finished: _____

**Instruction I:** Given necessary templates, tools and materials you are required to perform the following tasks within 10 hours.

**Task 1:** Install lighting Circuit control using (single pole single through) one way switch. ***(3 hours).***

**Task 2:** Install lighting Circuit in series & control using (single pole single through gang switch) one way gang switch. ***(4hours)***

**Task 3:** Install lighting Circuit in parallel & control using two way switches. ***(4hours)***

**Task 4:** Install lighting Circuit control using two way and Intermediate switch ***(5hours)***

**Task 5:** Measuring, Inspection and Testing (***30 minutes*** for each task1, Task 2, Task 3 and task 4

# UNIT TWO: INSPECT AND NOTIFY COMPLETION OF WORK

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

- Work done report
- Seek appropriate action

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

- Done the report to relevant people those necessary variations to the planned program of work
- Sought the appropriate action from the relevant people.

### 1.1. Work Done Report

It is a kind of verbal / nonverbal documents or informations which the worker or employers are reported his boss about how many hours of work you are done, how much material you used on that job, what is the work you perform.

- **How do you write a work done report?**
  - Identify your purpose. When you are requested to write a report, your topic will already be addressed.
  - Choose an appropriate report writing formats.
  - Outline your points.
  - Gather any supporting materials.
  - Proofread your work.
  - Personal work report.
  - Project progress report

When during or completing the job & prepare your report, follow the instructions given and make sure that your writing is understandable – print if it makes your writing clearer. Finally, read through the form to make sure that you have completed all the relevant sections. Now, let us look at five standard forms used by most installation works.

- **Time Sheets:** it is a standard form completed by each employee to inform the employer of the actual time spent working on a particular contract or site. This helps the employer to bill the hours of work to an individual job. Office personnel require time sheets such as that shown in Table 1.1 so that wages can be made up.

Table 3.1: Time Sheets

| Time sheet | | | | | | |
|---|---|---|---|---|---|---|
| Employees Name | | | | | | |
| Week ending | | | | | | |
| data | Job Number | Start time | Finished time | Total hour | Travel time | Expenses |
| **Mo.** | | | | | | |
| | | | | | | |
| **Tu.** | | | | | | |
| | | | | | | |
| **Wend.** | | | | | | |
| | | | | | | |
| **Thru.** | | | | | | |
| | | | | | | |
| **Fri.** | | | | | | |
| | | | | | | |
| **Sat.** | | | | | | |
| | | | | | | |
| **Sun** | | | | | | |
| | | | | | | |
| **Employee's signature** _____ **Date**___ _____ | | | | | | |

- **Job Sheets:** carries information about a job which needs to be done, usually a small job. It gives the name and address of the customer, contact telephone numbers, often a job reference number and a brief description of the work to be carried out. A typical job sheet work description might be:
  - Job 1 – Upstairs lights not working
  - Job 2 – Funny fishy smell from kettle socket in kitchen

The time spent on each job and the materials used are sometimes recorded on the job sheets, but alternatively, a day work sheet can be used.

Table 3.2 Job Sheets

| |
|---|
| Job sheet<br><br>Job number_____ |
| Customer Name_____<br>Address of job _____<br>_____<br>_____<br>Contact telephone no _____ |
| Work to be carried out_____<br>_____<br>_____<br>_____<br>_____ |
| Any special insulations/ conditions/ materials used |

- **Day work Sheets:** it is one way of recording variations to a contract, that is, work done which is outside the scope of the original contract. If day work is to be carried out, the site supervisor must first obtain a signature from the client's representative, for example, the Architect, to authorize the extra work. A careful record must then be kept on the day work sheets of all extra time and materials used so that the client can be billed for the extra work and materials. A typical day work sheet is shown in table 1.3

Table 3.3 Day work Sheets

| **Day work sheet** | | | | | |
|---|---|---|---|---|---|
| **Client name:**_____ | | | | | |
| **Job Number:**_____ | | | | | |
| date | labour | Start tine | Finish time | Total time | Office use |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| Material quantity | | Description | | Office | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| Site supervisor of electrical representative responsible for carrying out work _____ | | | | | |
| Signature of person approving work & status<br>Client ☐ Architect ☐ Q.S. ☐ Main contractor ☐ clerk of works ☐<br>Signature: _____ | | | | | |

- **Delivery Notes:** When materials are delivered to site, the person receiving the goods is required to sign the driver's 'Delivery Note'. This record is used to confirm that goods have been delivered by the supplier, who will then sent out an invoice requesting payment, usually at the end of the month. The person receiving the goods must carefully check that all items stated on the Delivery Note have been delivered in good condition. Any missing or damaged items must be clearly indicated on the Delivery Note before signing because, by signing the Delivery Note the person signing is saying 'yes, these items were delivered to me as my company's representative on that date and in good condition and I am now responsible for those goods'. Copies of Delivery Notes should be sent to Head Office so that payment can be made for the goods received.

- **Reports: T**he foreman or supervisor is often required to keep a report of the relevant events which happen on the site; for example, how many people from the company you work for are working on site each day; what goods were delivered; whether there were any breakages or accidents and records of site meetings attended. Some firms have two separate documents, a site diary to record all daily events and a weekly report which is a summary of the week's events extracted from the site diary. The site diary remains on site and the weekly report is sent to Head Office to keep managers informed of the work's progress.
- **Installation Completion and supervision Report**

**Form G**

**(Regulation 14)**

**Electricity supply act 1990**

**Supervision & completion certificate**

**To** _____

| **Part 1: Details of the installation** |
|---|
| Client: _____<br>Address: _____<br>This installation is a/an anew installation/addation/alternation of existing installation: |
| **Part 2: Supervision & completion** |
| _____<br>_____<br>_____<br>_____<br>Name:_____<br>For & on behalf of<br>Address:<br>Signature:<br>Certificate of competency:<br>Certificate of competency No,:<br>Date: |
| **Part 3: Schedule of drawings** |
| Each drawing listed below shall bear the following undertaking |

| |
|---|
| _____<br>_____<br>Name:<br>Wireman with single/ three phase restriction:<br>Certificate of competency:<br>Certificate of competency No,:<br>For & on behalf of:<br>Address:<br>Signature Date: |
| a)<br>b)<br>c)<br>d)<br>e) |
| Notes |

### 1.2. Seek Appropriate Action

Before the electrical wiring is energized, it must be systematically inspected & tested. Any abnormality must be corrected prior to energizing. Periodic inspection & testing of internal wiring installations is necessary. Internal wiring should be checked and corrected every work for safe operations. While carrying out inspection and testing of internal wiring installations, following point's correction action must be carried out.

**Correction action for Electrical wiring, enclosures tested & inspected**

- ❑ Tester or inspector Name:_____ Date:_____
- ❑ Types of tested and inspected circuit:_____ Location/Client:_____
- ❑ Installation type (New/addition/alteration of exist installation):_____

| No | Inspecting and Testing activities | Correction Action for Inspected and Tested activities |
|---|---|---|
| **A** | **Inspecting** | **After Inspection** |
| 1 | All mechanical connections are tight, as factory connections may loosen during shipment and storage. | Check and retighten all mechanical connections |
| 2 | All accessible electrical connections are tightened to the torque specifications on the panel labeling. | Check and retighten all All accessible electrical connections |
| 3 | All screws connecting and tight switches, breakers, socket outlets, lamps, etc are properly installed and tightened | Check, reinstall and retighten<br>All screws connecting and tight switches, breakers, socket outlets, lamps, etc |
| 4 | Connections between branch circuits and breakers are properly secured. | Check and reconnect the connections between branch circuits and breakers |
| 5 | All ground connections are properly made (Note: ground wire must be installed after the panel box is mounted on the wall). | Check and reconnect the all ground connections |
| 6 | All foreign materials have been removed from the panel and enclosure before installing the dead front and trim. | Check and remove foreign materials<br>from the panel and enclosure |
| 7 | Dead front is properly aligned and securely installed. | Check, re-align and re-secure dead fonts |
| 8 | Trim is properly mounted and securely installed. | Check, re-mount and re-secure installation |

| B | Continuity Test | After Continuity Test |
|---|---|---|
| 1 | Conductors are connected in the correct and effective manner. | Check and reconnect the conductors |
| 2 | all conductors around the ring circuit have continuity | check and reconnect the ring circuits |
| 3 | Live and Neutral Conductor Continuity Test | check and reconnect the Live and Neutral Conductor |
| **C** | **Polarity test** | **After Polarity test** |
| 1 | Each fuse or single pole control and protection device is connected only in the phase conductor. | check and reconnect fuse or single pole control and protection device in the phase wire |
| 2 | Intermediate contact of Edison screw lamp holder is connected to the phase conductor | check and reconnect Edison screw lamp holder Intermediate contact to phase conductor |
| 3 | phase, neutral and earth conductors at socket outlets are connected at the correct terminals | check and reconnect phase, neutral and earth conductors at socket outlets correct terminals |
| D | **Over all functionality test** | **After Over all functionality test** |
| 1 | Light circuits are functional | Check and rewire the light circuit |
| 2 | Control and protective devices are functional | Check, reconnect, rewire or replace Control and protective devices |
| 3 | General purpose socket outlets are functional | Check, reconnect, rewire or replace General purpose socket outlets |
| 4 | Metallic body of electrical devices are grounded | Check, reconnect, rewire and ground the metallic body of electrical devices |

## Self-check #3

**Directions:** Choose the Best Answer from the given Alternatives. (1 points for each question)

1) A Time Sheet shows:
   a) a record of goods delivered by a supplier
   b) a record of work done which is outside the original contract
   c) information about work to be done, usually a small job
   d) the actual time spent working on a particular job or site
2) A Job Sheet or Job Card shows:
   a) a record of goods delivered by a supplier
   b) a record of work done which is outside the original contract
   c) information about work to be done, usually a small job
   d) the actual time spent working on a particular job or site
3) A Day Work Sheet shows:
   a) a record of goods delivered by a supplier
   b) a record of work done which is outside the original contract
   c) information about work to be done, usually a small job
   d) the actual time spent working on a particular job or site
4) A 'competent' worker is one who:
   a) cannot do the job or task d) has been trained to do a job or task successfully
   b) can do the job or task more quickly than anyone else
   c) is quarrelsome and likely to cause an argument at work
5) A positive attitude to safety at work:
   a) is the duty of every employer c) increases accidents at work
   b) is the duty of every employee d) All

Note: Satisfactory rating – above 60% Unsatisfactory - below 60%

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

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MINISTRY OF LABOR AND SKILLS

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