MECHANICS

LEVEL-III

Learning Guide-#66

Unit of Competence: **Install Electrical Measuring Instruments and Control Devices**

Module Title: **Install Electrical Measuring Instruments and Control Devices**

Module Code: XXXXX

LG Code: XXXXX

TTLM Code: XXXXX

***LO1*: Plan and Prepare Installation work**

Instruction Sheet	Learning Guide #66

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

- Introducing to electrical measuring system
- Electrical measuring instruments
- Basics of electricity
- Planning and preparing installation work
-

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

- Know electrical measuring system
- Identify electrical measuring instruments
- State basics of electricity
- Plan and prepare installation work

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 1 to 3.
3. Read the information written in the information “Sheet 1

Information Sheet 1	Introducing basics of electricity

1. Introduction

In **electrical**, the **instruments** used to **measure** the resistance or current, voltage, frequency, flux, etc. are called '**Electrical measuring instruments**'. These **instruments** are known as the ohmmeter, ammeter, voltmeter, frequency meter, flux meter, etc

In electrical, the instruments used to measure the resistance or current, voltage, frequency, flux, etc. are called **'Electrical measuring instruments'**.
These instruments are known as the ohmmeter, ammeter, voltmeter, frequency meter, flux meter, etc.

1.1. Electrical measuring instruments

Electrical measuring instruments are important to all aspects of plant maintenance and control. Some tasks require only simple yes or no checks, e.g., continuity, presence or absence of line power voltage, and current flow. Instruments for these tests may be rugged and inexpensive. Yet they must be safe, reliable, and accurate. Whether you are working on the production line, in the laboratory, or servicing equipment, measurements can yield cost savings proportional to instrument accuracy. Electrical measuring equipment is available in three basic configurations: handheld, bench-mounted, and panel-mounted.

Figure 1: handheld, bench-mounted, and panel-mounted electrical measuring instruments

1.2. Plan and Prepare Installation work

Work order and drawing are read and correctly interpreted in compliance with work requirements

Familiarize with the Standardized Electrical Symbols. Knowing what the symbols in your electrical drawing mean will help you find different appliances. Symbols usually resemble specific meaning. Familiarize yourself with descriptions for electrical appliances, understanding that different symbols appear for different objects. Refer to Basic Electrical **Symbols and Their Meanings** for specific resources and learn these symbols visually.

1.3. Basic electrical symbols

1. **An electric light-** is a device that produces **visible light** from electric current. It is the most common form of **artificial lighting** and is essential to modern society, providing interior lighting for buildings and exterior light for evening and nighttime activities

2. **Lights-** are shown as ovals with a squiggly line inside. They look like light bulbs. Different types of lights may be indicated with different symbols.

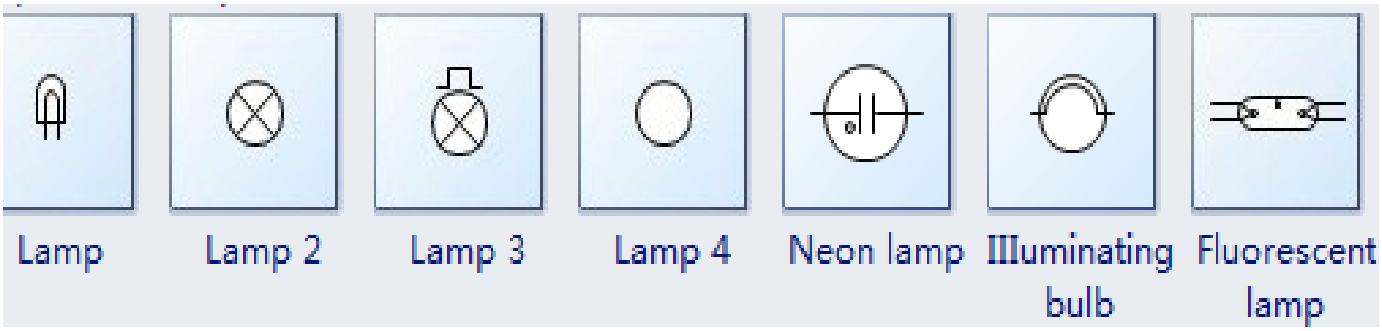

Figure 2: Different types of lights may be indicated with different symbols.

3. **Light switch-** is a switch most commonly used to operate electric lights, permanently connected equipment, or electrical. **Switches**: are symbolized by an opening or break in the line. It looks like the flip of a light switch.

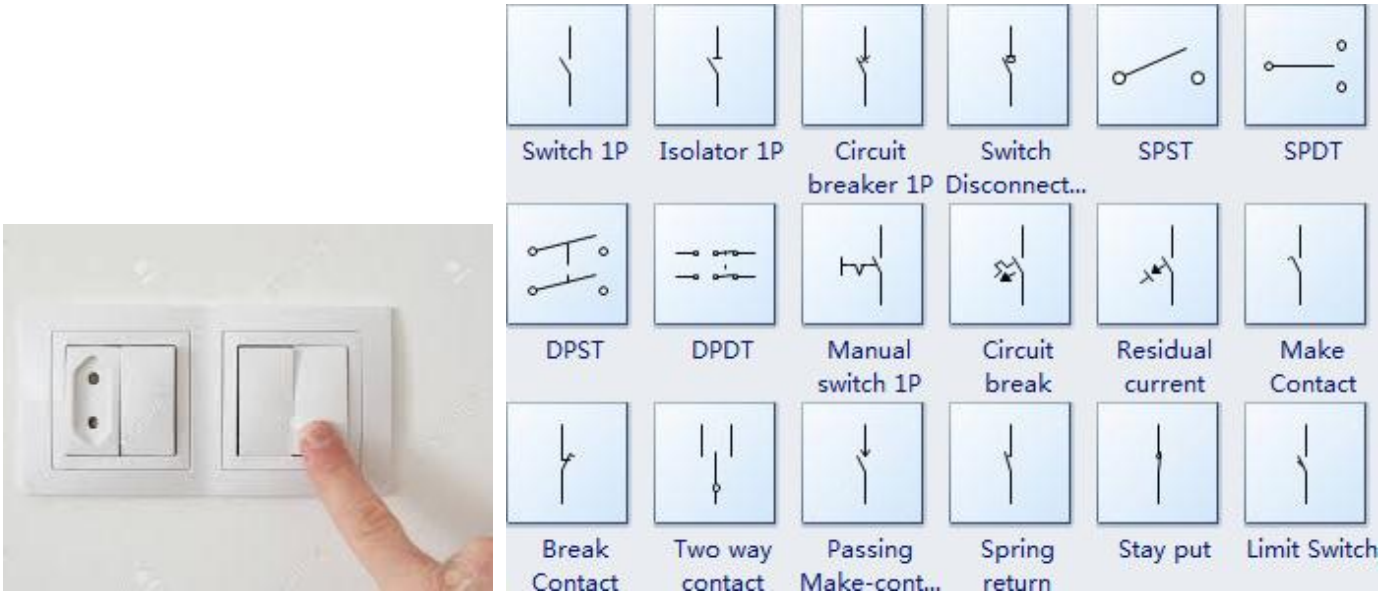

Figure 3: opening or break in the line of switches

4. **Fuse**- is an electrical **safety device** in electronics electrical engineering that operates to provide over current protection of an electrical circuit, it's essential component is a metal **wire or strip** that melts when too much current flows through it, thereby **interrupting the current**.

It is a **sacrificial device**; once a fuse has operated it is an open circuit, and it must **be replaced or rewired**, depending on type. A **fuse** is represented by a slight zigzag in the line.

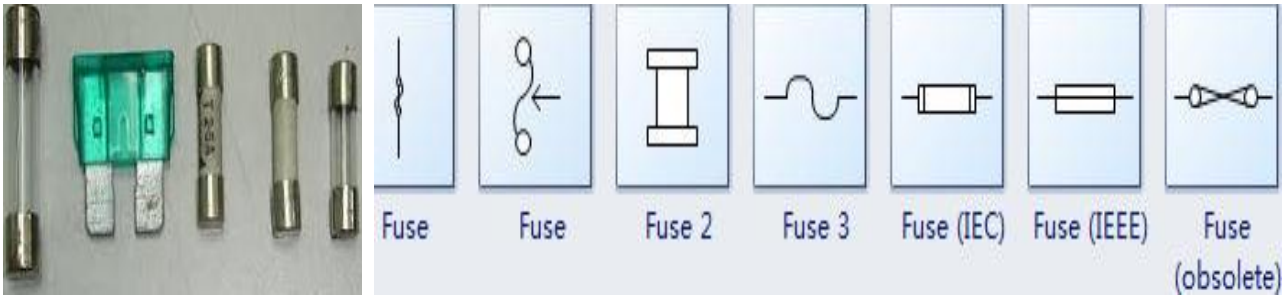

Figure 4: Electrical safety device (fuse)

5. **Electrical grounding** (or “Grounding”) - originally began as a **safety measure** used to help prevent people from accidentally coming in contact with **electrical hazards. Ground** is represented by either a triangle pointing down or a set of parallel lines that become shorter as they appear below each other, in effect representing the inner area of the triangle pointing down. **Ground** is a common reference point that schematics use to show the overall unity of the various functions of the circuit.

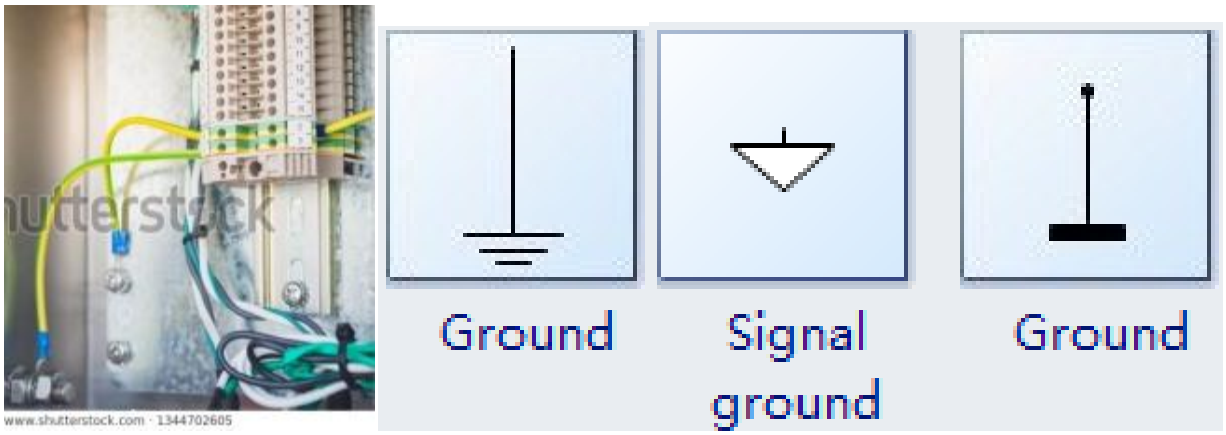

Figure 5: Electrical grounding

6. **Wires-** are used to link the devices together. A line represents a **wire**. All **points** along the wire are identical and connected. **Wires** may cross each other on an electrical drawing, but that does not necessarily mean that they connect. If they do not connect, one will be shown looping around the other in a semicircle. If they do connect, they will cross and a dot will be seen at the point where the lines cross.

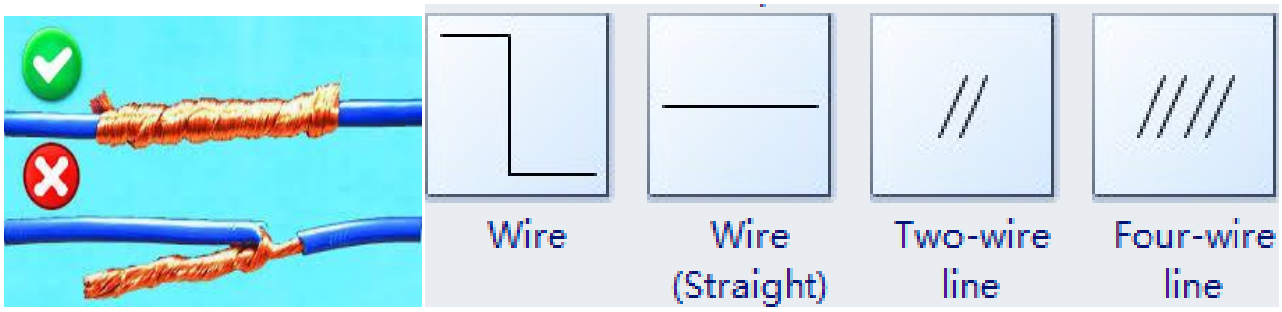

Figure 6: Electrical wire representation

7. **Resistor**- a resistor is an electrical component that limits or regulates the flow of electrical current in an electronic circuit. Resistors can also be used to provide a specific voltage for an active device such as a transistor**.** A zigzag shape stands for a resistor. **Resistors** act to slow down the flow of the circuit to an extent determined by the **resistance value** used.

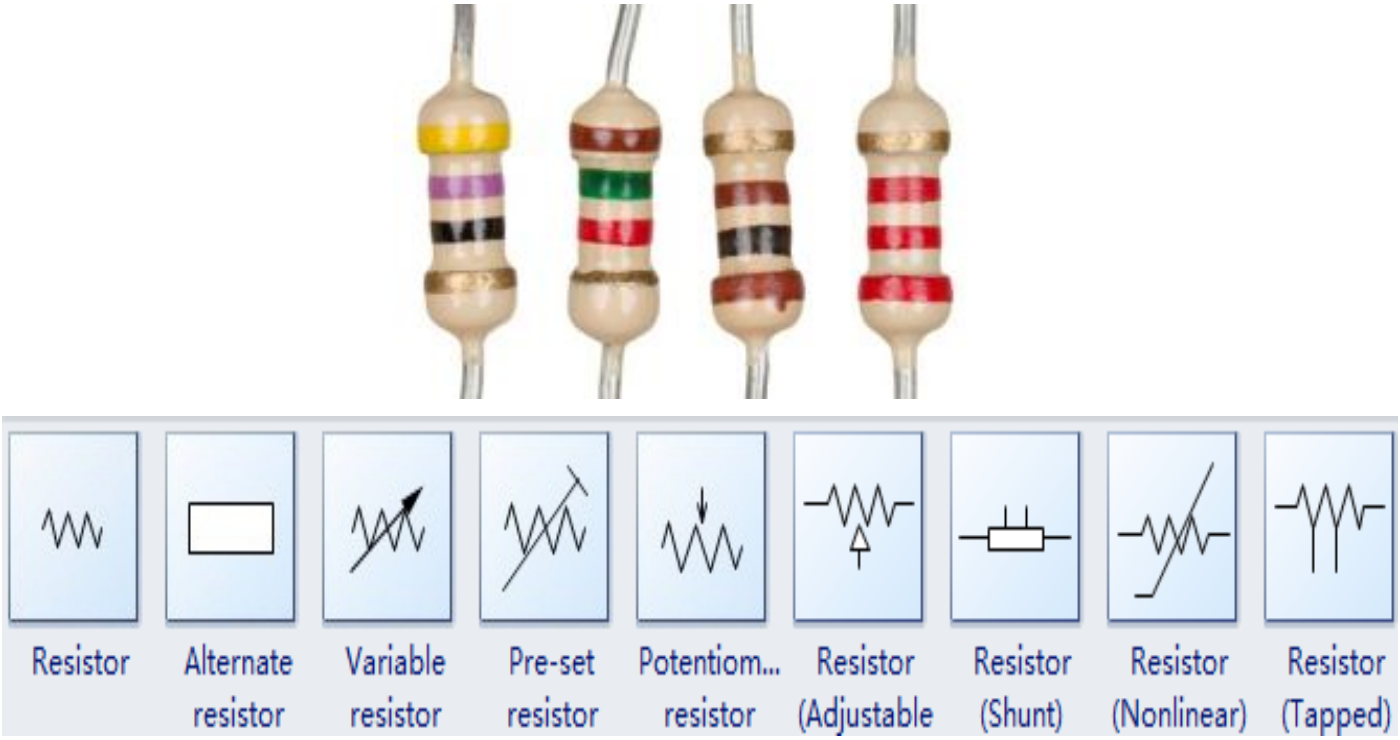

Figure 7: Electrical resistor

8. **Capacitor-** a capacitor is a device that stores electrical energy in an electric field. It is a passive electronic component with two terminals. The effect of a capacitor is known as capacitance. (The ability of a system to store an electric charge) While some capacitance exists b/n any two electrical conductors in proximity in a circuit, a capacitor is a component designed to add capacitance to a circuit.

   C**apacitors** are represented by two parallel lines. Capacitors are used to condition rapidly changing signals, as opposed to the static or slower changing signals that are conditioned by resistors. The traditional uses of capacitors in circuits is to draw noise, which is essentially a rapidly changing signal, away from the signal of interest and drain it away to ground.

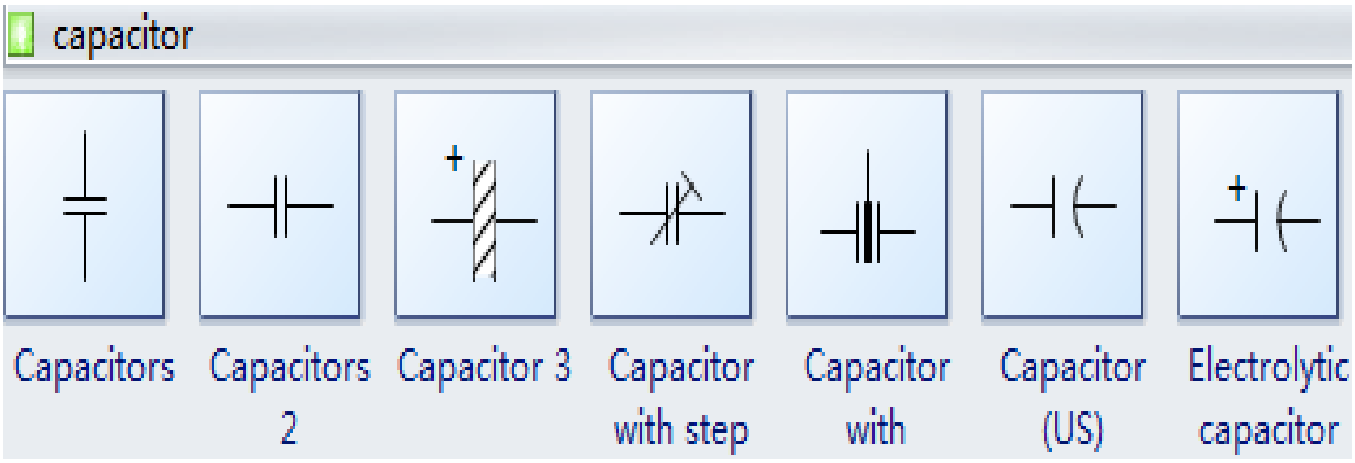

Figure 8: Electrical Capacitor

MECHANICS

LEVEL-III

Learning Guide-#67

Unit of Competence: Install Electrical Measuring Instruments and Control Devices

Module Title: Install Electrical Measuring Instruments and Control Devices

Module Code: XXXXX

LG Code: XXXXX

TTLM Code: XXXXX

LO2: Install instrumentation and control devices

Instruction Sheet	Learning Guide #67

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

- Installing instrumentation
- Controlling devices
- Personal Protective Equipment (PPE)

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

- Install instrumentation
- Identify control devices
- Use Personal Protective Equipment (PPE)

Learning Instructions:

2. Read the specific objectives of this Learning Guide.
3. Follow the instructions described below 1 to 3.
4. Read the information written in the information “Sheet 1

Information Sheet 1	Install instrumentation and control devices

1. Introduction

Occupational health and safety legislation (enforced by Work Safe), **OHS**, policies and procedures inclusive protective clothing for installation are applied in line with the regulations

In brief, the *Occupational Safety and Health Act 1984* specifies the following fundamental, generic requirements:

A) **An employer** shall provide and maintain a working environment in which the employees are not exposed to hazards and in particular, an employer shall-

- Provide such information, instruction, and training to, and supervision of, the employees as is necessary to enable them to perform their work in such a manner that they are not exposed to hazards.
- Where it is not practicable to avoid the presence of hazards at the workplace**, provide** the employees with adequate personal protective equipment to protect them against those hazards.

B) **An employee** shall take reasonable care-

- to ensure his or her own health and safety at work; and
- to avoid harmfully affecting the safety or health of any other person through any act or omission at work

An employee commits a breach of these requirements if the employee —

- fails to comply, so far as the employee is reasonably able, with instructions given by the employee's employer for the safety or health of the employee or for the safety or health of other persons; or
- fails to use such protective clothing and equipment as is provided, or provided for, by his or her employer in a manner in which he or she has been properly instructed to use it; or
- misuses or damages any equipment provided in the interests of safety or health; or
- fails to report forthwith to the employee's employer —
    I. any situation at the workplace that the employee has reason to believe could constitute a hazard to any person that the employee cannot correct; or

II. any injury or harm to health of which he or she is aware that arises in the course of, or

III. in connection with, his or her work.

C) An employee shall cooperate with the employee's employer in the carrying out by the employer of the obligation imposed on the employer under this Act.

1.1. Electricity in the Workplace

Places of work generally have power nominally supplied at 220 volt (single phase) and 380 volt (3 phase) although some larger workplaces will receive electricity at a higher supply voltage. The information below relates to workplaces using 220 and 380 volt supplies.

The main hazards with electricity are:

- contact with live parts causing shock and burns
- faults which could cause fires;
- fire or explosion where electricity could be the source of ignition in a potentially flammable or explosive atmosphere, e.g. in a spray paint booth.

The risk of injury from electricity is strongly linked to where and how it is used and there is greater risk in wet and/or damp conditions.

1.2. Basics of Contact with Electricity

It is the level of voltage the body is exposed to and the resistance to flow of electrical current offered by the body that determines the impact of exposure to electricity. The following factors determine the severity of the effect electric shock has on your body:

- The level of voltage
- The amount of body resistance you have to the current flow
- The path the current takes through your body
- The length of time the current flows through your body

As an Employer it is YOUR responsibility to ensure:

Extension cables and other flexible leads which are particularly prone to damage to plugs and sockets and to their connections are visually checked, maintained and where necessary replaced

before using portable equipment. The ends of flexible cables should always have the outer cover of the cable firmly clamped to stop the wires (particularly the earth) pulling out of the terminals

- Use the correct cable connectors or couplers to join lengths of cables together and do not allow taped joints.
- Electrical installations are installed and maintained by a competent person and checked regularly
- Socket Outlets are not overloaded by the use of adaptors
- Electrically powered equipment provided is suitable for use
- Fixed electrical equipment should have a clearly identified switch to cut off power in an emergency
- that portable equipment labeled as being double insulated has had the live and neutral connected properly to the plug by a competent person unless the plug is of a molded type

1.3. Personal Protective Equipment (PPE) in eclectic work place

Appropriate PPE is worn in line with standard operating procedures. The **Importance** of **PPE** is equipment that will **protect workers against health or safety risks on the job**. The purpose is to reduce employee exposure to hazards when engineering and administrative controls are not feasible or effective to reduce these risks to acceptable levels.

The best way to keep people safe from electrical hazards in the workplace is by implementing policies and procedures that reduce or eliminate various risks. Unfortunately, it is impossible to take steps that can be 100% effective, and if there is even one incident it can be deadly.

With this in mind, it is important that anyone working with or around dangerous electrical equipment use personal protection equipment to keep them safe in the event of an accident. The following are among the most frequently used types of PPE, and how they can keep your workplace safer.

Depending on the job task to be performed, PPE for the electric power industry generally includes:-

- safety glasses,
- face shields,
- hard hats,
- safety shoes,

- insulating (rubber) gloves with leather protectors,
- insulating sleeves, and
- Flame-resistant (FR) clothing.

Figure 9: Proper use of PPE

MECHANICS

LEVEL-III

Learning Guide-#68

Unit of Competence: Install Electrical Measuring Instruments and Control Devices

Module Title: Install Electrical Measuring Instruments and Control Devices

Module Code: XXXXX

LG Code: XXXXX

TTLM Code: XXXXX

LO3: Assure quality instrumentation and control devices

Instruction Sheet	Learning Guide #68

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

- Assuring quality instrumentation
- Assuring electrical control devices
- Identifying electric measuring tools
- Identifying electrical control system

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

- Assure quality instrumentation
- Assure control devices
- Identify electrical tools

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 1 to 3.
3. Read the information written in the information “Sheet 1

Information Sheet 1	Assure quality instrumentation and control devices

3.1. Assure quality instrumentation and control devices

Devices are tested functionally in accordance with standard procedures

Use proper hand tool, power tools and equipment

Electrical tools that every beginner and pro electrician needs

Figure 10: Common electrical Tools

Electrical work can't be done without the right tools. As basic tools have been improved over the years and new specialized tools are developed, the list of tool choices for electricians becomes even longer.

If you're a professional electrician you're probably on the lookout for the **latest and greatest tools that can provide great results fast for all your electrical** jobs. Most tools are easily available, but if you're in the **electrical trade**, you know that there are some **top quality branded tools** that can last for decades and other **cheaper tools commonly known as 'throw away**

tools' that need to be replaced over and over again. More often than not quality always prevails over price & choosing the right tools wisely, even if you're just starting out or want to build an electrical kit for home use will **save you much time and headache** in the long run.

You select the top tools that every home user, beginner or pro electrician needs in their tool-bag:

4. **Tape measure**: A must-have for beginners and pro electricians alike, a tape measure is essential for measuring heights for switch and outlet placement, centering lighting fixtures, and of course for **measuring** where **electrical** equipment (such as plasma televisions) will be mounted on walls, and so much more clear-coated blade protection for more durable markings and designed to fit comfortably in hand.

Figure 11: Tape measure

5. **Multimeter:** a multimeter **(or** multitester**),** also known as a **VOM (**volt-ohm-milliammeter**),** is an electronic measuring instrument that combines several measurement functions in one unit. A typical multimeter can measure **voltage, current, and resistance. Analog multimeters use a microammeter** with a moving pointer to display readings**. Digital multimeters (**DMM, DVOM**)** have a numeric display, and may also show a graphical bar representing the measured value.

Figure 12: Multimeter

6. **Wire stripper**: Is a handy tool used to strip or cut off the insulation on wires. A good quality wire stripper will do a clean job every time and is designed with a cutoff portion and various sized cutting teeth for different sized wires or cable. Top models include ergonomically designed handles requiring less hand force and curved cutting blades to ensure cleaner, precise cuts.

Fig13: Wire stripper

7. **Fish tape: a fish tape** (also known as a **draw wire** or **draw tape** or an "electricians snake") is a tool used by electricians to route new wiring through walls and electrical conduit. Made of a narrow band of spring steel, by careful manipulation, the tape can be guided through confined spaces such as wall cavities or conduits in many countries. The goal is to push toward an area where guide string has been dropped inside the confined space and to pull it through, so the guide string can then be used to pull through various types of wiring, such as phone wire, network cables or speaker wire. Fish tape is designed to pull through guide string only. Using it to directly pull the target wire can damage or warp the fish tape.

Figure 14: fish tape

8. **Non-contact- t**here will be many times you will need to do a quick safety check to see if there is a current present or a circuit is indeed live. A **non-contact** voltage tester is a tool used for determining the presence of **AC voltage** (electricity) without touching the wires or items in questions. The sensing tip may be sized to fit into an electrical outlet to check for power at that outlet. The tester indicates the presence of nearby voltage with a visual indicator (such as a light) and/or sound.

Figure 15: Non-contact voltage detector

9. **Pliers: Pliers** come in many types depending on what needs to done. For example, side-cutting or diagonal pliers are specially designed for wire cutting. Their cutting edge goes to the tip of the pliers and comes in handy to trim wires in tight spaces. You'll also need a quality set of do-it-all pliers. These can cut wire, twist wires together using their squared off tip and grip and pull wire. We carry a wide range of pliers for any job at hand.

Figure 16: pliers

10. **Level**: a spirit level, bubble level or simply a level is an instrument designed to indicate whether a surface is horizontal (level) or vertical. A great installation starts with getting the basics right. A level is used to make sure all your work is level including straight outlet covers, and switches. Light weight and compact, it provides accurate readings, including horizontal, vertical and at 45-degree angles.

Figure 17: level

11. **Flashlight for electrical job**: any pro electrician will tell you that proper lighting is key to any electrical job, and that you should never try and reach into a panel without proper lighting. When lighting conditions on the job site are not the best, a good flashlight or work light can save the day.

Figure 18: Flashlight

12. **Crimping tool-** is a device used to conjoin two pieces of metal by deforming one or both of them in a way that causes them to hold each other. The result of the tool's work is called a **crimp**. A good example of crimping is the process of affixing a connector to the end of a cable. For instance, network cables and phone cables are created using a crimping tool. An **electrical crimp** is a type of solderless electrical connection

Figure 19: wire crimping tool

13. **A screwdriver:** You'll need different types like the Phillips screwdriver for Phillips head screws, and a set of straight blade screwdrivers. There are a ton of options available including electronic screwdrivers, magnetic screwdrivers for better grip, mutli-tip screwdrivers with interchangeable tips, precision screwdriver sets, pocket clip-style screwdrivers and more.

A screwdriver is a tool, manual or powered, for screwing (installing) and unscrewing (removing) screws. A typical simple screwdriver has a handle and a shaft, ending in a tip the user puts into the screw head before turning the handle. The shaft is usually made of tough steel to resist bending or twisting. A **cordless screwdriver** is a power tool designed to insert and remove screws. Some cordless screwdrivers can also be used to drill holes.

Common Screwdrivers

There are several types of screwdriver heads that are commonly needed for items around the house. There's a good chance you already own some or all of these.

Slotted *Also known as:* ***flat blade, flat head, straight***

One of the most popular of all screwdriver types, these screwdrivers has a chisel-shaped blade which spans the width of a screw's head. They often double as a chisel in emergencies, and can also be sometimes used on a Phillips head screw.

Phillips *Also known as:* ***cross head***

Known for being less likely to round a slot than Phillips screwdrivers, the tip of these is sometimes prone to slipping sideways out of a slot when a lot of pressure is applied. For this reason, they're not as popular among professionals as they once were, but are still a staple in most fields.

Figure 20: different types of drives

Because of their usefulness, you'll find Phillips screwdrivers in almost every field. While they will never fully replace slotted screwdrivers, they now tend to be the most preferred type of screwdriver and head combination and the best screwdriver sets will always include multiple Phillips screwdrivers.

Torx plus version, Torx security version, star: Torx drives were originally used for security functions, but they've since become popular in commercial fields. The blades of these drives resemble a rounded off star or flower and provide incredibly high torque tolerances.

Currently, Torx drives are popular in appliance manufacturing and security fields due to their efficiency and the fact that consumers have a more difficult time taking apart an appliance that has Torx screws.

Hex *Also known as:* ***Allen wrench, hex key, hexagon***

Another, more unusual type of screwdriver that has become increasingly popular, the hex key most commonly lacks a handle or tip. In most cases, they resemble a small, six-sided metal shank bent into an L-shape and lacking a head.

Figure 21: Wrench

Figure 22: different types of Screwdrivers

Figure 23: electric screwdriver

3.2. Control System

A control system is a system of devices or set of devices, that manages commands, directs or regulates the behavior of other devices or systems to achieve desired results. In other words, the definition of a control system can be simplified as a system, which controls other systems.

An **electrical control system** is a physical interconnection of devices that influences the behavior of other devices or systems. A simple electronic system is made up of an input, a process, and an output. Both input and output variables to the system are signals. Examples of such systems include circulation pumps, compressors, and manufacturing systems.

Input devices such as sensors gather and respond to information and **control a physical process** by using **electrical energy** in the form of an output action. **Electronic systems** can be classed as 'causal' in nature. The input signal is the '**cause' of the change** in the process or **system operation**, while the output signal is the '**effect', the consequence of the cause**. An example is a microphone (input device) **causing sound waves** to be converted into **electrical signals** and being amplified by a speaker (output device) **producing sound waves.**

3.2.1. Types of Control Systems

There are various types of control systems, but all of them are created to control outputs. The system used for controlling the position, velocity, acceleration, temperature, pressure, voltage and current etc. are examples of control systems.

Let us take an example of the simple temperature controller of the room, to clear the concept. Suppose there is a simple heating element, which is heated up as long as the electric power supply is switched on. As long as the power supply switch of the heater is on the temperature of the room rises and after achieving the desired temperature of the room, the power supply is switched off. Again due to ambient temperature, the room temperature falls and then manually the heater element is switched on to achieve the desired room temperature again. In this way, one can manually control the room temperature at the desired level. This is an example of **manual control system**.

Hence, there are two main **types of control system**. They are as follow

1. Open loop control system
2. Closed loop control system

1. Open Loop Control System

A control system in which the **control action** is totally independent of output of the system then it is called **open loop control system**. A manual control system is also an open loop control system. Figure below shows a control system block diagram of an open loop control system in which process output is totally independent of the controller action

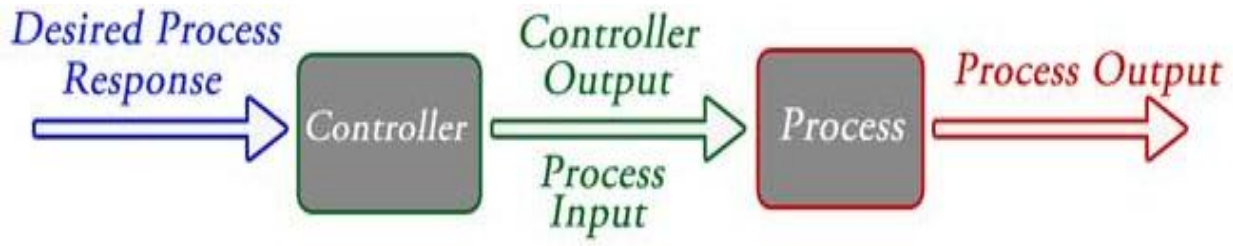

Figure 24: Open loop control

Practical Examples of Open Loop Control System

1. Automatic Washing Machine – This machine runs according to the pre-set time irrespective of washing is completed or not.
2. Bread Toaster – This machine runs as per adjusted time irrespective of toasting is completed or not.
3. Automatic Tea/Coffee Maker – These machines also function for pre adjusted time only.
4. Light Switch – Lamps glow whenever light switch is on irrespective of light is required or not.
5. Volume on Stereo System – Volume is adjusted manually irrespective of output volume level.

Advantages of Open Loop Control System

1. Simple in construction and design.
2. Economical.
3. Easy to maintain.
4. Generally stable.
5. Convenient to use as output is difficult to measure.

Disadvantages of Open Loop Control System

1. They are inaccurate.
2. They are unreliable.
3. Any change in output cannot be corrected automatically.

2. Closed Loop Control System

Control system in which the output has an effect on the input quantity in such a manner that the input quantity will adjust itself based on the output generated is called **closed loop control system**. **Open loop control system** can be converted in to closed loop control system by **providing a feedback**. This feedback automatically makes the suitable changes in the output due to external disturbance. In this way closed loop control system is called **automatic control system**. Figure below shows the block diagram of closed loop control system in which feedback is taken from output and fed in to input.

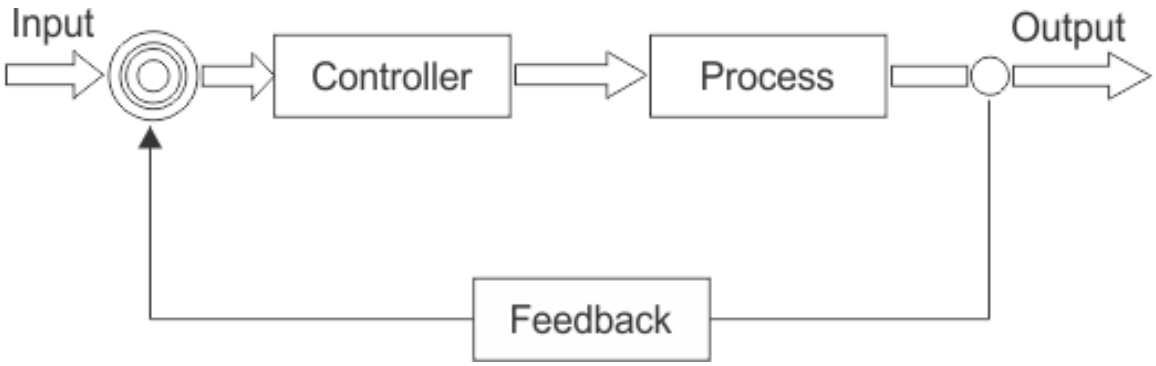

Figure 25: Closed loop control

Practical Examples of Closed Loop Control System

1. Automatic Electric Iron – Heating elements are controlled by output temperature of the iron.
2. Water Level Controller – Input water is controlled by water level of the reservoir.
3. An Air Conditioner – An air conditioner functions depending upon the temperature of the room.

Advantages of Closed Loop Control System

1. Closed loop control systems are more accurate even in the presence of non-linearity.
2. Highly accurate as any error arising is corrected due to presence of feedback signal.
3. This system is less affected by noise.

Disadvantages of Closed Loop Control System

1. They are costlier.
2. They are complicated to design.
3. Required more maintenance.
4. Feedback leads to oscillatory response.
5. Overall gain is reduced due to presence of feedback.

Table 1: Comparison of Closed Loop And Open Loop Control System

S/No.	Open loop control system	Closed loop control system
1	The feedback element is absent.	The feedback element is always present.
2	An error detector is not present.	An error detector is always present.
3	It is stable one.	It may become unstable.
4	Easy to construct.	Complicated construction.
5	It is an economical.	It is costly.
6	Having small bandwidth.	Having large bandwidth.
7	It is inaccurate.	It is accurate.
8	Less maintenance.	More maintenance.
9	It is unreliable.	It is reliable.
10	Examples: Hand drier, tea maker	Examples: Servo voltage stabilizer, spiration

3.2.2. Feedback Loop of Control System

A feedback is a common and powerful tool when designing a **control system**. Feedback loop is the tool which takes the system output into consideration and enables the system to adjust its performance to meet a desired result of system.

In any control system, the output is affected due to change in environmental condition or any kind of disturbance. So one signal is taken from the output and is fed back to the input. This signal is compared with a reference input and the error signal is generated. This error signal is applied to controller and output is corrected. Such a system is called feedback system. The figure below shows the block diagram of a feedback system.

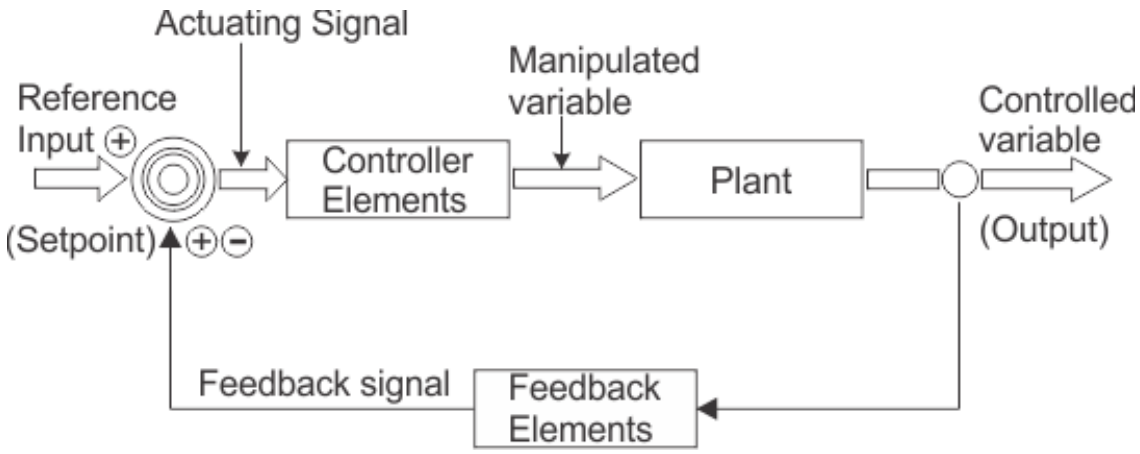

Figure 26: ***Feedback Loop of Control System***

3.3. Sensors

A sensor is a device that detects and responds to some type of input from the physical environment. The specific input could be light, heat, motion, moisture, pressure, or any one of a great number of other environmental phenomena. The output is generally a signal that is converted to human-readable display at the sensor location or transmitted electronically over a network for reading or further processing.

Motion sensors in various systems including home security lights, automatic doors and bathroom fixtures typically send out some type of energy, such as microwaves, ultrasonic waves or light beams and detect when the flow of energy is interrupted by something entering its path.

A photo sensor detects the presence of visible light, infrared transmission (IR), and/or ultraviolet (UV) energy.

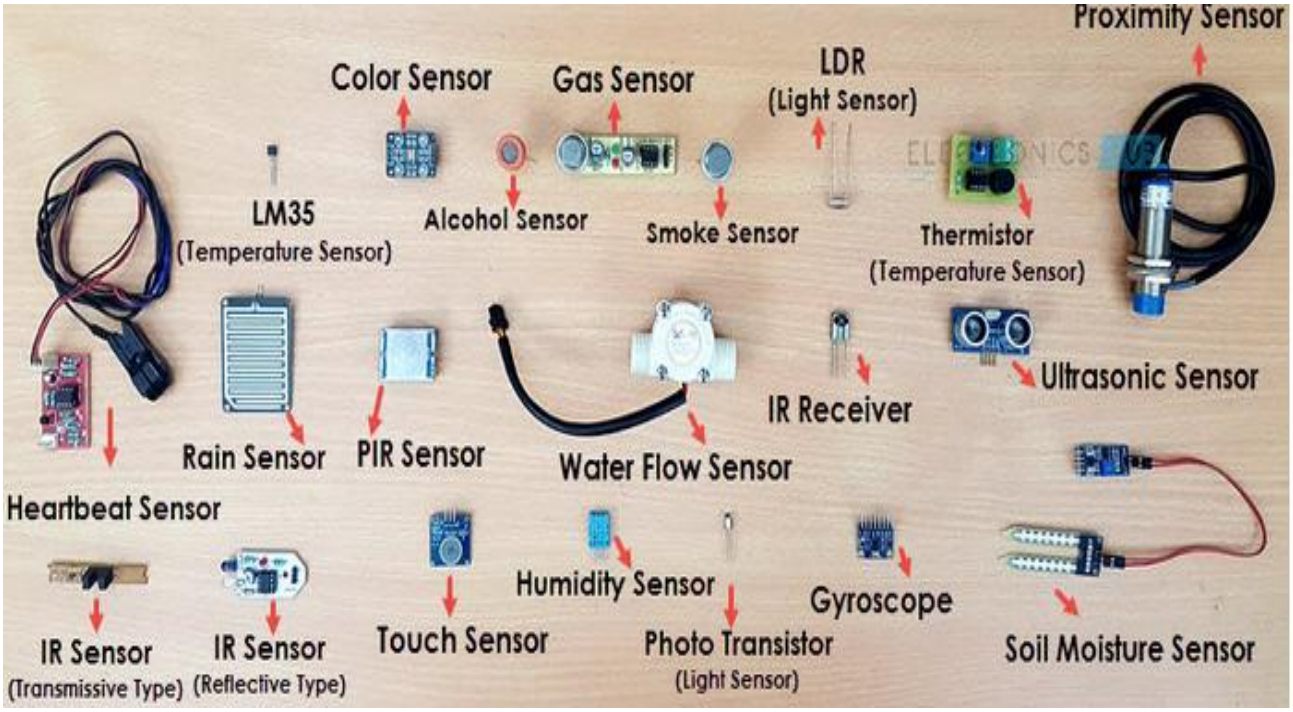

Figure 27: types of sensors

3.3.1. Different Types of Sensors

The following is a list of different types of sensors that are commonly used in various applications. All these sensors are used for measuring one of the physical properties like Temperature, Resistance, Capacitance, Conduction, Heat Transfer etc.

- Temperature Sensor
- Proximity Sensor
- Accelerometer
- IR Sensor (Infrared Sensor)
- Pressure Sensor
- Light Sensor
- Ultrasonic Sensor
- Smoke, Gas and Alcohol Sensor
- Touch Sensor
- Color Sensor
- Humidity Sensor
- Tilt Sensor
- Flow and Level Sensor

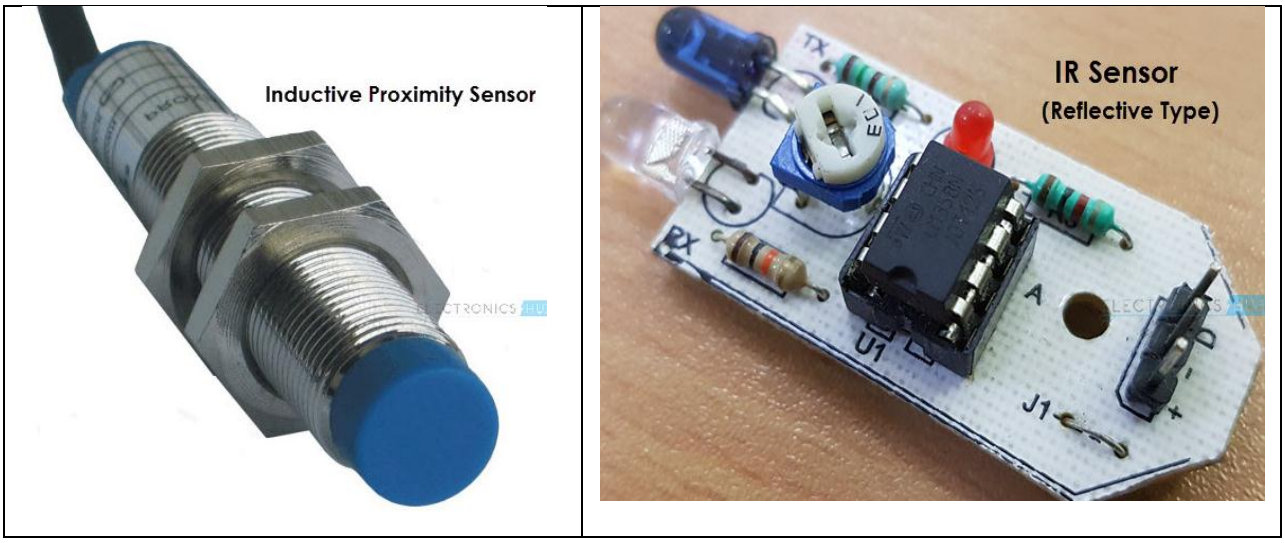

Figure 28: inductive proximity and IR sensors respectively

3.4. Transducer

A **transducer** is a device that **converts** energy from one form to another. Usually a transducer converts a **signal** in one form of energy to a signal in another.

Transducers are often employed at the boundaries of **automation, measurement**, and **control systems,** where electrical signals are converted to and from other physical quantities (energy, force, torque, light, motion, position, etc.). The process of converting one **form of energy** to another is known as **transduction**

A transducer is an electronic device that converts energy from one form to another. Common examples include **microphones, loudspeakers, thermometers, position and pressure sensors, and antenna.**

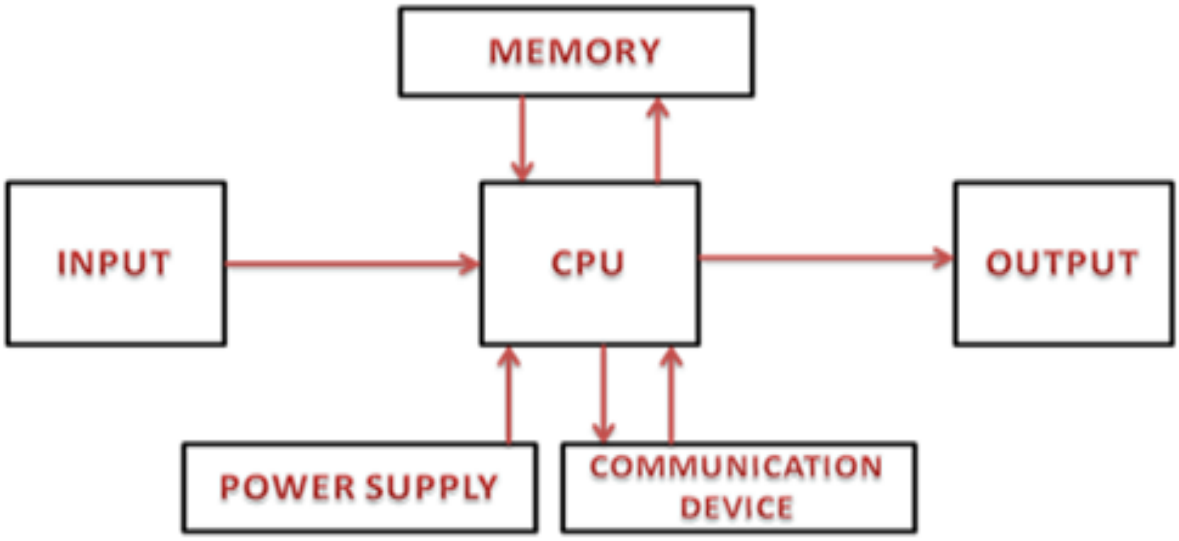

Figure 29: input/ Output communication using transducers

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