CET04202-BASIC ELECTRICAL AND ELECTRONICS ENGINEERING

Unit 1
Introduction

1.1. Definition or Meaning

Electrical and electronics are two fields which you cannot separate.

The function of these fields starts by Installation which refers to the act of setting up equipment, machinery, or software in a fixed position to make it ready for use.
In this module, the basic and fundamental concepts will be discussed.

- *Why computer specialists should study Electrical and Electronics basics?*

The answer may be simple, because the functionality of a computer systems, information technology and telecommunication both depend on electrical power availability.

Also, the wide range application of the fields in different ares make them core hub'

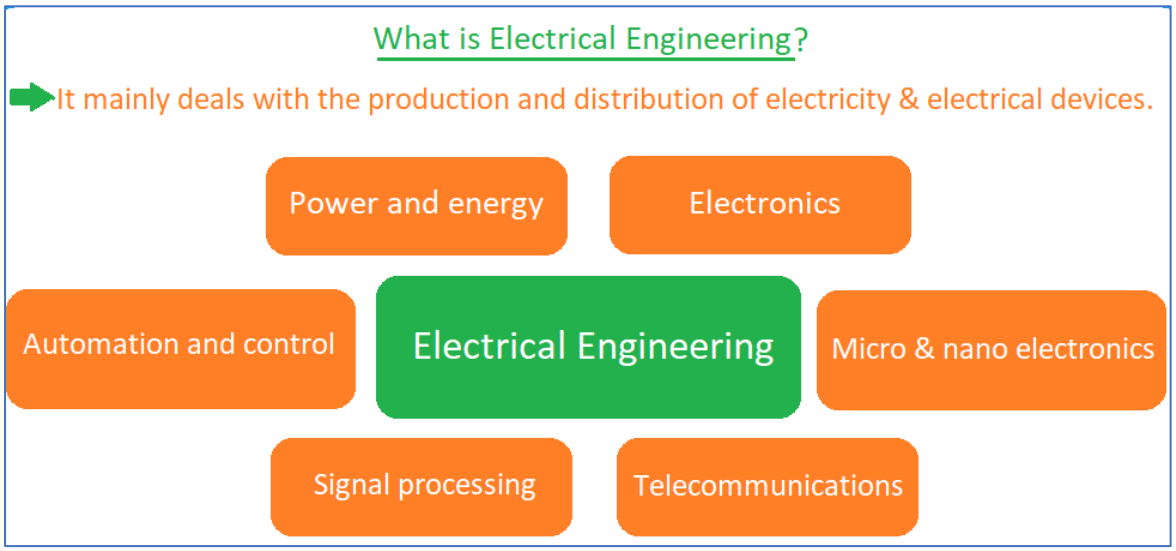
Key Usage Examples

- **Technology/Software:** "The installation of the new operating system took 30 minutes".
- **Construction/Equipment:** "The heating installation was completed yesterday".
- **Military/Industry:** "The airbase is a secure military installation".
- **Art:** "The modern art installation was made of light and sound".
- **Ceremony:** "The installation of the new chancellor is tomorrow".

Common Synonyms

- **Set up / Setup:** Setting up the apparatus.
- **Inauguration/Induction:** Formal introduction into a role.
- **Positioning/Placement:** Placing equipment in a specific spot.
- **Facility/Plant:** A place where equipment is installed.
- **Fitting:** Connecting plumbing or electrics

1.2. Branches of Electrical and Electronics



Electrical engineering is a broad field dedicated to the study, design, and application of electricity, electronics, and electromagnetism. It is divided into several specialized branches, ranging from massive power generation grids to microscopic semiconductor chips

The primary branches of electrical engineering include:

- **Power Engineering:** Focuses on the generation, transmission, and distribution of electricity. This includes working with power grids, substations, transformers, and renewable energy integration (like wind and solar power).
- **Electronics Engineering:** Deals with the design and testing of electronic circuits, semiconductors, microprocessors, and consumer devices (e.g., smartphones, computers).
- **Telecommunications Engineering:** Concentrates on the transmission and reception of information across channels, such as cable networks, fiber optics, satellites, and wireless communications.

- **Control Systems Engineering:** Involves the design of systems that monitor and regulate the behavior of other devices or systems. This branch is heavily utilized in robotics, automation, and manufacturing.
- **Computer Engineering:** Sits at the intersection of electrical engineering and computer science, focusing on the design and development of hardware architecture, microcontrollers, and embedded systems.
- **Instrumentation Engineering:** Specializes in creating and maintaining devices and sensors used to measure physical quantities like temperature, pressure, and flow.
- **Signal Processing:** Focuses on analyzing, modifying, and synthesizing signals (such as sound, images, and data) to improve communications, medical imaging, and data transfer.
- **Microelectronics & Photonics:** A highly specialized field dealing with the design of tiny integrated circuits (VLSI) and the study/application of light (lasers, fiber optics).

1.3. Electrical and Electronic Tools used for installation.

Electrical and Electronics tools are the devices or components or instruments, equipment and materials which used in the process of installation.

Types of Electrical and Electronics tools is derived from the following classifications.

The types of the tools depend on various categories.

1. Based on Operating mechanism

    (i) Manual/Hand tools- They are mostly mechanical tools e.g.
    (ii) Power tools-They are electrically powered or charged.

2. Based on functions

    (i) Cutting tools
    (ii) Non-Cutting tools
    (iii) Testing tools
    (iv) Drilling tools
    (v) Measuring tools

- Cutting tools- Those are tools used for cutting materials like wires.

Examples, *Wire cutter, Scissor, Side cutting plier, Technician knife, saws.*

- Non-Cutting Tools- The tools- They are used for other operational works like splicing, tightening, cleaning, etc.

Examples, screw drivers, spanners, harmer,

- Testing tools- They are used for testing the presence of power in a circuit. Example, Electrical tester,
- Drilling tools- They are used for drilling holes on wood, timber and walls during installation. Examples, *Manual drill tool, electric drill.*
- Measuring tools- They are devices used quantify physical properties such as length, weight for a specific purpose. Examples, Tape measures, micrometre screw gauge, ruler, vernier scale and vernier calliper.
- Power Tools- Are the electrically powered devices used for different purposes during installation.
  Examples, electrical hand drill for drilling, electrical grinder, bowers, and vacuum cleaners.

1.4. Electrical and electronic devices.

Those are components used along with the equipment to complete the installation and ensure the purpose of installation is obtained.

Examples, Switches, Sockets, measuring instruments like voltmeter, ammeter, wattmeter, ohmmeter, sensors, tester, diodes, etc.

1.5. Installation materials

Installation materials are the components used for connection of the equipment and devices. Some they are used to support and protect the wires.

Examples include, *Wires, cables, insulation tape, conduits, terminals,*

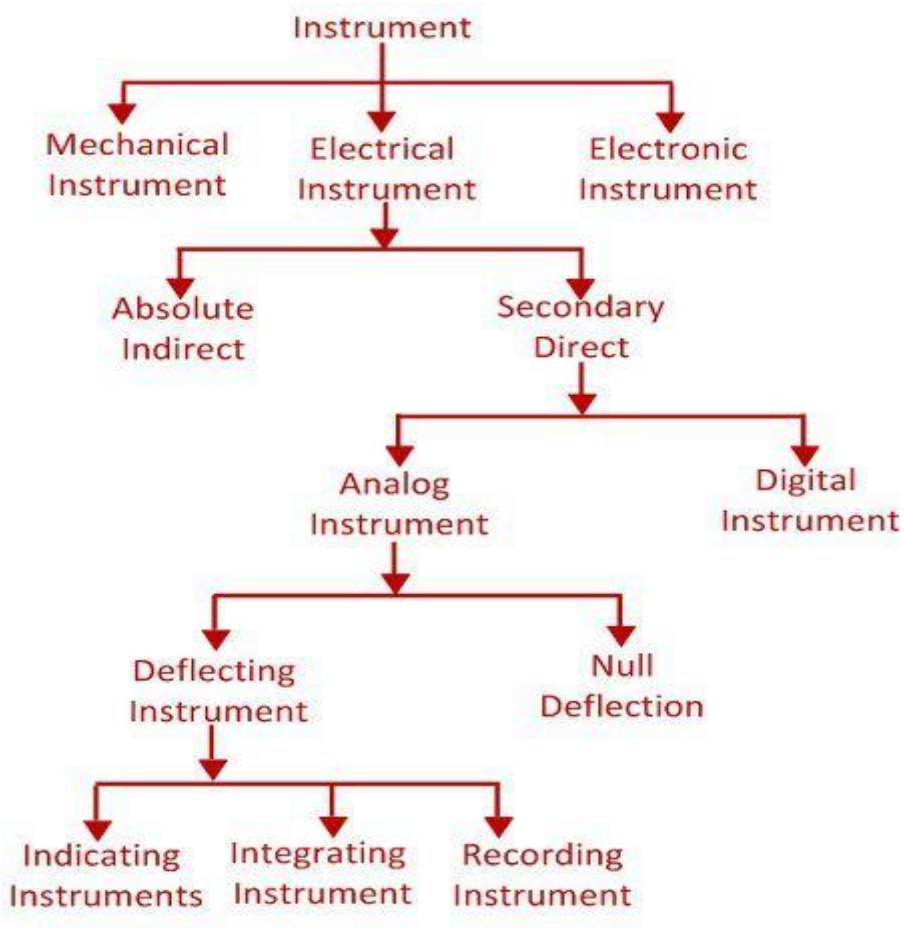
UNIT 2

Electrical and Electronic Instruments.

Instrument is the general term implying measuring devices/components. They can also be used to monitor

They are classified in different ways as follows.

(i) Based on the quantity of measurement AC and DC
(i) Based on accuracy or Standard
(ii) Based on nature of operation
(iii) Based on Measuring method- (indicating, reflecting, displaying
(iv) Based on Principle of operation (Moving iron and Moving coil)
(v) Based on the technology and nature of signal/data they are measuring (*Analog and digital)*



- Based on accuracy or Standard

These are instruments are reference and practical instruments that used in daily measuring practices or processes.

- Here we have Absolute or primary measuring instruments which provides the constant values.

The absolute instrument gives the value of measures quantities regarding the physical constant. The physical constant means the angle of deflection, degree and meter constant.

The most common applications of this type of instrument are found in laboratories. Example, galvanometer.

- Secondary instruments- measures the calibrated values with reference to the absolute instruments. *Examples, common voltmeter, ammeter and wattmeter.*

Based on Principle of operation

1. Moving Iron Instruments

Definition: The **instrument** in which the **moving iron** is used for **measuring** the flow of **current or voltage** is known as the moving iron instrument. It works on the **principle** that the **iron place** near the **magnet attracts towards** it.

The **force of attraction** depends on the **strength** of the **magnet field**. The magnetic field induces by the electromagnet whose strength depends on the magnitude of the current passes through it.

Construction of Moving Iron Instrument

The plate or vane of soft iron is used as the moving element of the instrument.

The vane is so placed that it can freely move in the magnetic field of the stationary coil. The conductor makes the stationary coil, and it is excited by the voltage or current whose magnitude is used to be measured.

The moving iron instrument uses the stationary coil as an electromagnet. The electromagnet is the temporary magnet

whose magnetic field strength increases or decreases with the magnitude of the current passes through it.

Working of the Moving Iron Instrument

The moving iron instruments use the stationary coil of copper or aluminium wire which acts as an electromagnet when an electric current passes through it. The strength of the magnetic field induces by the electromagnet is directly proportional to the current passes through it.

The plates or vane of the iron pass through the coil increases the inductance of the stationary coil (the inductance is the property of the conductor which increases their electromotive force when the varying current passes through it).

The electromagnet attracts the iron vane. The vane passes through tries to occupy the minimum reluctance path (the reluctance is the property of the magnet which opposes the flow of electric current).

The vane passes through the coil experience a force of repulsion caused by the electromagnet. The repulsion force increases the strength of the coil inductance.

This happens because the inductance and reluctances are inversely proportional to each other.

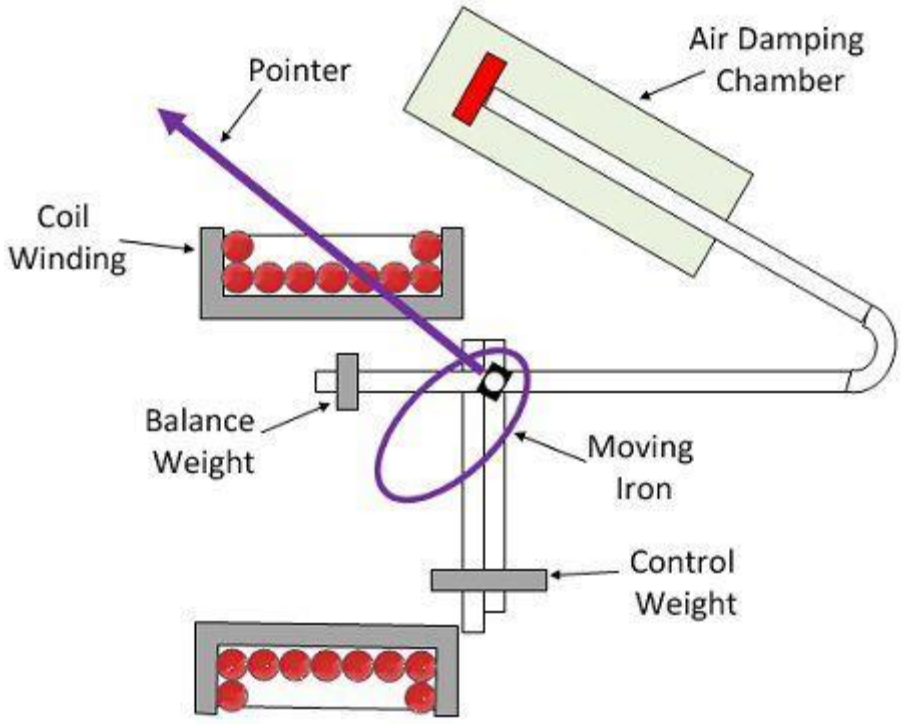
Classification of the Moving Iron Instruments

The attraction and the repulsion are the types of the moving iron instruments. Their detail explanation is shown below.

1. Attraction Type – The instrument in which the iron plate attracts from the weaker field towards the stronger field such type of instrument is known as the attraction type instrument.

Construction of Attraction Type Instrument – The stationary coil of the attraction type instrument is flat and has a narrow opening. The moving element is the flat disc of the iron core. The current flow

through the stationary coil produced the magnetic field which attracts the iron coil.

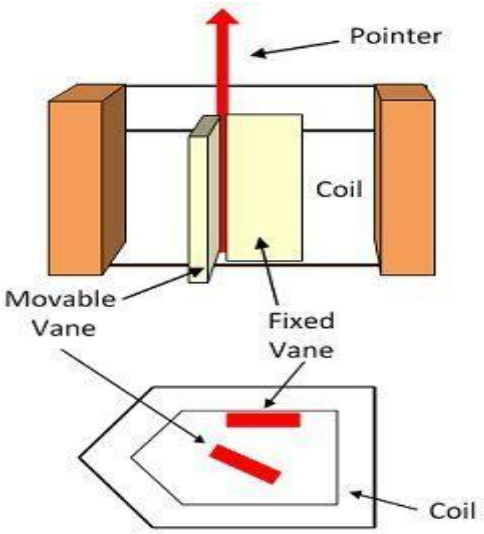


Attraction Type Moving Coil Instrument

The iron vane deflects from the low magnetic field to the high magnetic field, and the strength of the deflection is directly proportional to the magnitude of the current flow through it. In short, we can say that the iron coil attracts towards in.

The attraction type instruments use spring, which provided the controlling torque. The deflection of the coil is reduced by the aluminium piston which is attached to the moving coil.

2. Repulsion Type Instruments – The repulsion type instrument has two vanes or iron plates. One is fixed, and the other one is movable. The vanes become magnetised when the current passes through the stationary coil and the force of repulsion occur between them. Because of a repulsive force, the moving coil starts moving away from the fixed vane.



Radial Vane Type MI Instruments

The spring provides the controlling torque. The air friction induces the damping torque, which opposes the movement of the coil. The repulsion type instrument is a non-polarized instrument, i.e., free from the direction of current passes through it. Thus, it is used for both AC and DC.

Advantages of the MI Instruments

The following are the advantages of the moving iron instruments.

1. **Universal use** – The MI instrument is independent of the direction of current and hence used for both AC and DC.
2. **Less Friction Error** – The friction error is very less in the moving iron instrument because their torque weight ratio is high. The torque weight ratio is high because their current carrying part is stationary and the moving parts are lighter in weight.
3. **Cheapness** – The MI instruments require a smaller number of turns as compared to PMMC instrument. Thus, it is cheaper.
4. **Robustness** – The instrument is robust because of their simple construction. And also, because their current carrying part is stationary.

Disadvantages of Moving Iron Instruments.

The following are the disadvantages of Moving Iron Instrument.

1. **Accuracy –** The scale of the moving iron instruments is not uniform, and hence the accurate result is not possible.
2. **Errors –** Some serious error occurs in the instruments because of the hysteresis, frequency and stray magnetic field.
3. **Waveform Error –** In MI instrument the deflection torque is not directly proportional to the square of the current. Because of which the waveforms error occurs in the instrument.
4. **Difference between AC and DC calibration –** The calibration of the AC and DC are differed because of the effect of the inductance of meter and the eddy current which is used on AC. The AC is calibrated on the frequency at which they use.

Two type of error occurs in the MI instruments i.e., the error which occurs on both AC and DC and the error which only occur on AC.

Difference Between Moving Iron & Moving Coil Instrument

One of the significant differences between the moving iron and moving coil instrument is that *in moving iron instrument, the soft iron system is used for measuring mechanism*. Whereas *in moving coil instrument the conductor coil is used for DC measurement*.

The other differences between the moving iron and moving coil instrument are shown below in the comparison chart.

Basis for Comparison	**Moving Iron Instrument**	**Moving Coil Instrument**
Definition	In moving iron instrument, the soft iron is used for moving mechanism.	In moving coil instrument the conductor coil is used for measuring the current and voltage.
Working Principle	Magnetism	Similar to working principle of DC Motor
Symbolic Representation		
Uses	Both for AC and DC measurement	DC Measurement
Accuracy	Less	More

Scale	Non-uniform	Uniform
Damping	Air Friction Damping	Eddy Current Damping
Power Consumption	High	Low
Controlling Torque	Gravity or spring	Spring
Deflection	Proportional to Current	Square of current
Hysteresis Loss	Not occurs	Occurs
Can be used as	Ammeter, Voltmeter and Wattmeter	Voltmeter, ammeter, galvanometer, ohmmeter

Definition of Moving Iron Instrument

The instrument which uses the soft iron core for measuring the current or voltage is known as the moving iron instrument. It works on the principle that the iron attracts towards the magnet. The magnetic field induces because of the electromagnet and the iron piece is placed between this field. The force of attraction acting on the soft iron core and the magnitude of the force depends on the strength of the magnetic field.

Definition of Moving Coil Instrument

The instrument in which the coil rotates between the magnetic field of the permanent magnet for measuring the DC such type of instrument is known as the moving coil instrument. It works on the principle that the force acting on the coil places between the magnetic field of the permanent magnet. And because of this magnetic field, the coil rotates.

Key Differences Between Moving coil and Moving Iron Instrument

The following are the key differences between the moving coil and the moving iron instrument.

1. The moving iron instrument uses the soft iron piece as a rotating element. Whereas the moving coil instrument uses the coil as a rotating element.

2. The working principle of the moving iron instrument depends on magnetism. Whereas, the working principle of moving coil instrument is similar to the working principle of dc motor.

3. The MI iron instrument has the non-uniform scale. Whereas the moving coil instrument has the uniform sale.

4. The moving iron instrument is less accurate as compared to the moving coil instrument.

5. The moving iron instrument uses the air friction damping while the moving coil instrument uses the eddy current damping system. The damping is the phenomenon through which the amplitude of the oscillations decreases.

6. The moving iron instrument consumes more power as compared to the moving coil instrument.

7. The moving iron instrument is used for measuring both the direct and alternating current whereas the moving coil is used for the DC measurement.

8. In moving iron instruments, the gravity or spring provides the controlling torque to the instrument. Whereas in moving coil instrument the spring provides the controlling torque to the moving coil instrument.

9. The deflection of the moving iron instrument is proportional to the current. Whereas in moving coil instrument the deflection is proportional to the square of the current.

10. The moving iron instrument is free from the hysteresis loss. Whereas the hysteresis loss occurs in the moving coil instrument.

11. The instrument which uses the soft iron piece as a moving element such type of instrument is known as the MI instrument.

12. The moving iron instrument can be used as an ammeter, voltmeter and wattmeter. Whereas the moving coil instrument is used as a voltmeter, ammeter, galvanometer and ammeter.

Conclusion

The moving iron instrument consists the soft iron core and is used for both the AC and DC measurement. In moving iron instrument, the coil made of the conductor is placed between the magnetic field of the permanent magnet and the movement of coil gives the DC measurement.

Working of an Ammeter

To measure the current flowing through a circuit, an ammeter is connected in series with the load. This setup ensures that all the current flowing in the circuit also passes through the ammeter. Due to its very low internal resistance, it minimally affects the overall resistance of the circuit. By using these principles, ammeters provide a direct reading of current flow, which is essential for diagnostic and monitoring purposes in electrical and electronic systems.

When an ammeter is connected in series in a circuit, the current flowing through the ammeter is equal to the current flowing through the circuit. Due to this current, there are deflections in the magnetic coils of the ammeter, which moves the pointer across the graduated scale. This results in the measurement of the load current. The ammeter's working principle is the same as the working of the galvanometer. A galvanometer can also be modified into an ammeter by connecting a shunt resistance in parallel to the galvanometer, which would increase the range of measurement of current.

Classification of Ammeter

Ammeters can be classified in two main ways: based on the type of current they measure, and based on how they're built.

1. Based on the Type of Current

- **AC Ammeter:** Measures alternating current (AC).
- **DC Ammeter:** Measures direct current (DC).

2. Based on Design and Construction

- **Permanent Moving Coil (PMC) Ammeter:**
  Also called a D'Arsonval meter or galvanometer. It measures current by observing how much a coil turns in a steady magnetic field. These are used mainly for DC.
- **Moving Iron (MI) Ammeter:**
  This ammeter has a soft iron piece that moves freely inside a coil placed between magnetic poles. It works with both AC and DC.

- **Electro-dynamometer Ammeter**
  Works well with both AC and DC. Known for giving very accurate readings, often used in laboratories or precision work.

- **Rectifier Type Ammeter**
  This ammeter measures AC by converting it into DC using rectifiers. Commonly used in household AC circuits.

Parts of an Ammeter

An ammeter is constructed using different parts, as shown in the image above. The general construction of an ammeter includes

- **U-shaped magnet:** The magnet serves as a major component in an ammeter. It consists of concave poles.

- **Copper coil:** The copper coil is generally rectangular and is wound around a metallic core.

- **Iron Core:** The copper coil is wound around a soft iron core. Due to the presence of the soft iron cylindrical core, the magnetic field between the poles increases and the field lines remain parallel.

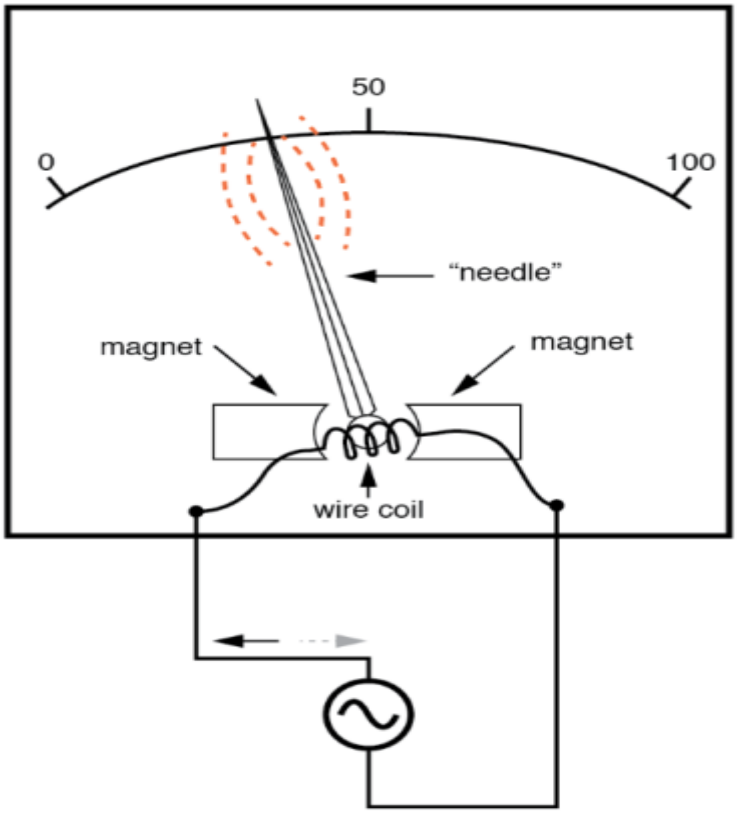
- **Shunt:** It is a low-value resistance connected in parallel to the galvanometer.

- **Pointer:** The pointer which is attached to the coil in a pivoting manner to read the deflection.

Formula of Ammeter

Since ammeters are connected in series in a circuit, the ammeter readings can be found in circuit diagrams by the formula of Ohm's Law which is.

For example



Construction and working of voltmeter

https://testbook.com/electrical-engineering/ammeter

https://www.viasion.com/blog/ammeter-definition-types-working-symbols/

Function generator and Signal generators

Signal Generator (function Generator) is a device which generates various types of wave forms like sin wave, the triangular wave, the square wave, the saw-tooth wave, the cosine wave etc. in a repeating or non-repeating signal in either the Analogue or the digital domain.

The signal generator is exactly what its name implies: a generator of signals used as a stimulus for electronic measurements. These electronic signals are either repeating or non-repeating as per the requirements and field of applications. Signal generators in all their forms are widely used within test and development systems, being used with other test instruments.

When looking at what a signal generator is, it will be seen that they come in many forms - there are many signal generator types, each one being used to provide a different form of signal. Some provide RF signals, others audio signals, some can provide different shapes of waveform and others may provide just pulses.

Signal generators have been used for many years. Early types were very basic by the standard of today's different types of signal generator. Performance levels as well as the variety of facilities that are available have increased and improved.

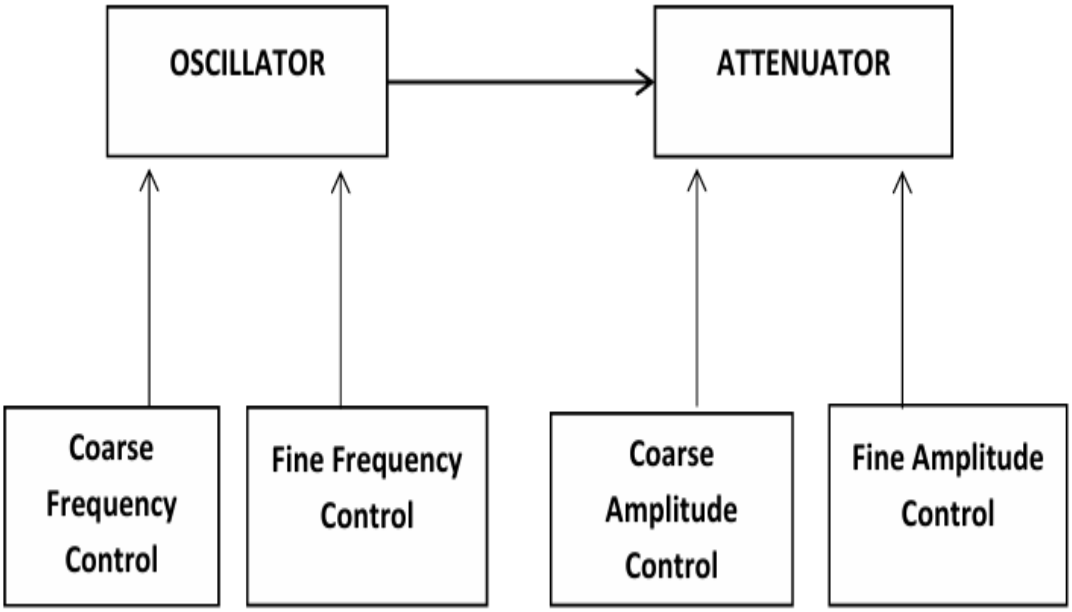
There are different types of signal generators with different levels of capability and functionality. All the signal generators have different designs, different dimensions, and parameters. So, the variety of generators serves different purposes and covers a range of applications. The signal generators are used in designing, repairing of electronic devices, and in troubleshooting. Every versatile signal generator can create unlimited number of signals to meet the debug challenges. You can vary the output of the signal generator by setting the amplitude and frequency of the output signal while a simulation is in the process.

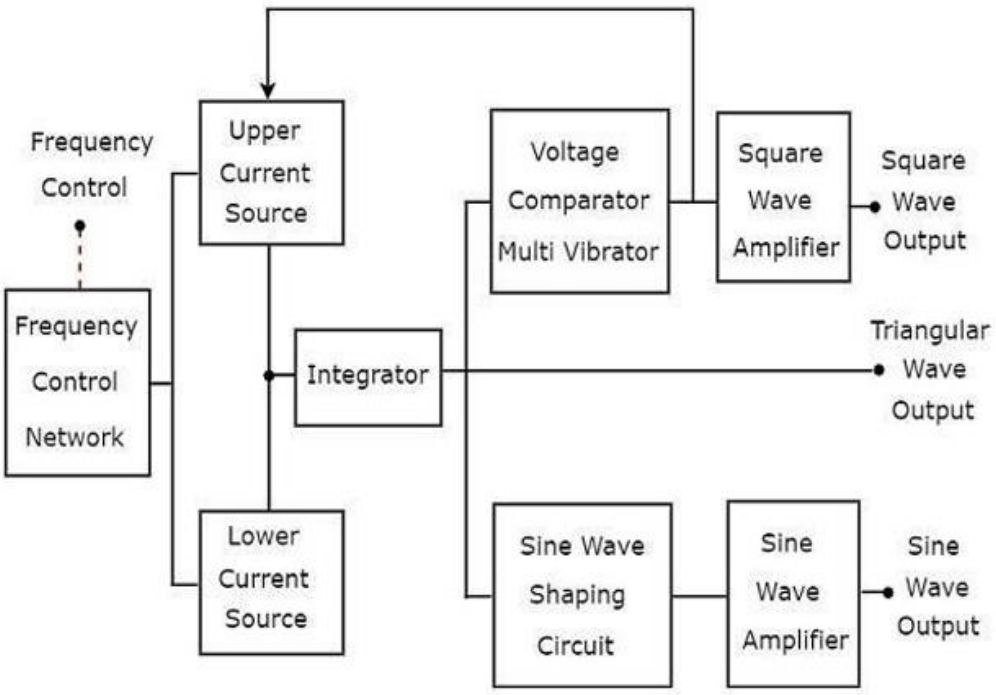
Today's electronic system requires many signal waveforms shapes. Common waveforms are the square wave, triangular wave since wave and single pulse wave with fixed duration. Fixed duration pulses are used in communication and control systems. Square waves are used as a clock per digital systems. Triangular waves are used per scanning an electron beam on a cathode ray tube (CRT) screen in precise measurement and in time modulation.

With the development of modern technology, the function Generator with independent control Amplitude and frequency play an important role in applied electronics, communications, instrumentation, and signal processing application. And it is measurement with a long history, it has been produced in 1920 with the development of communication technique and radar technique. In 1940, the signal generator was used to test standard signal of various receiver appeared, this improvement changes the signal generator form a qualitative investigation test instrument to a quantitative analysis measuring instrument.

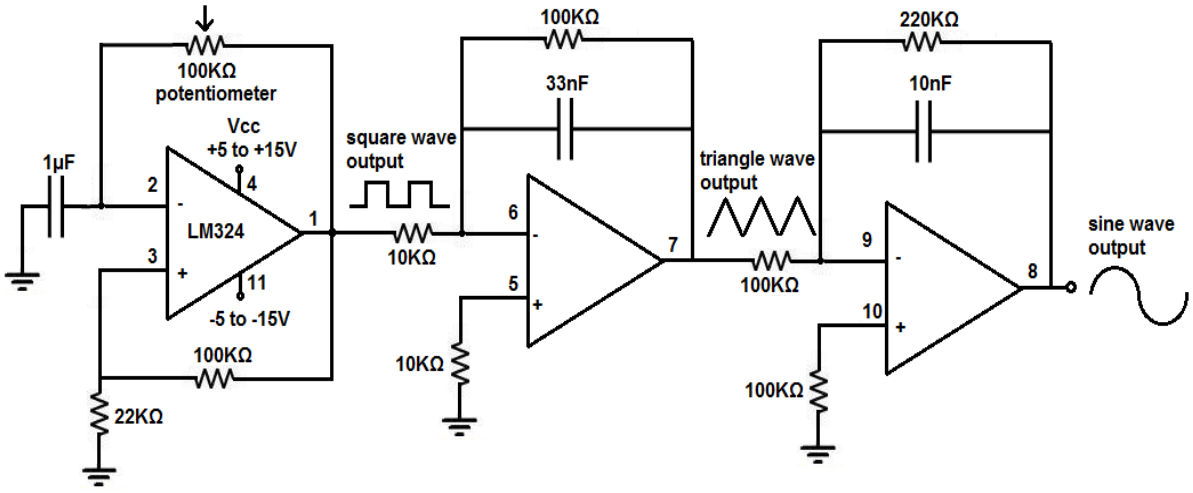
In education, communication, industrial and control fields, an electronic system known as signal generator is normally required to provide periodic signals with different waveforms, and frequencies, the measurement of wave forms and how to display this measurement is not fast and simple and need some other devices such as oscilloscope, when this device is not available then it can cause some of damage for sensitive components in the circuits if the input signal is applied without measurement.(Thiessen, Arthur 1965). There are many specialized function generators available, some costing hundreds to thousands of dollars to provide input signals with different waveforms and frequencies.

Signal generators have been used for many years. Early types were very basic by the standard of today's different types of signal generator. Performance levels as well as the variety of facilities that are available have increased and improved. The frequency control of a signal

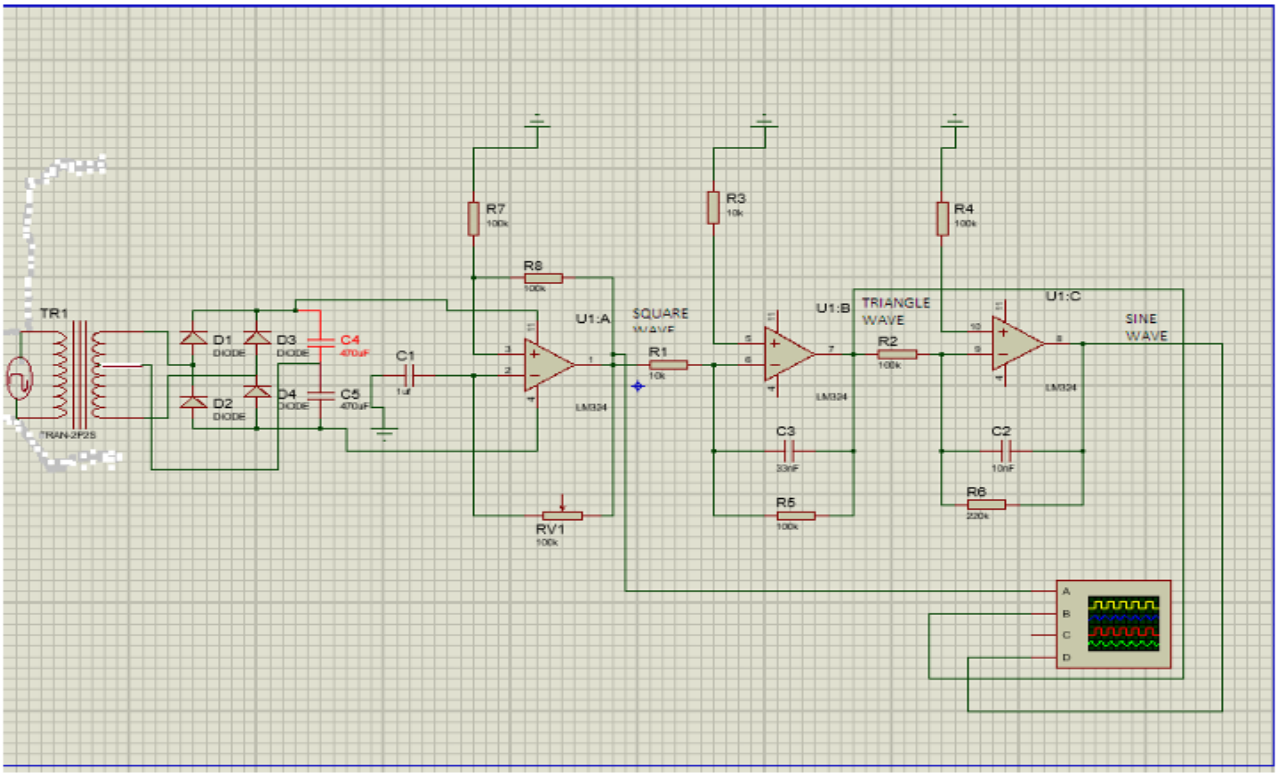


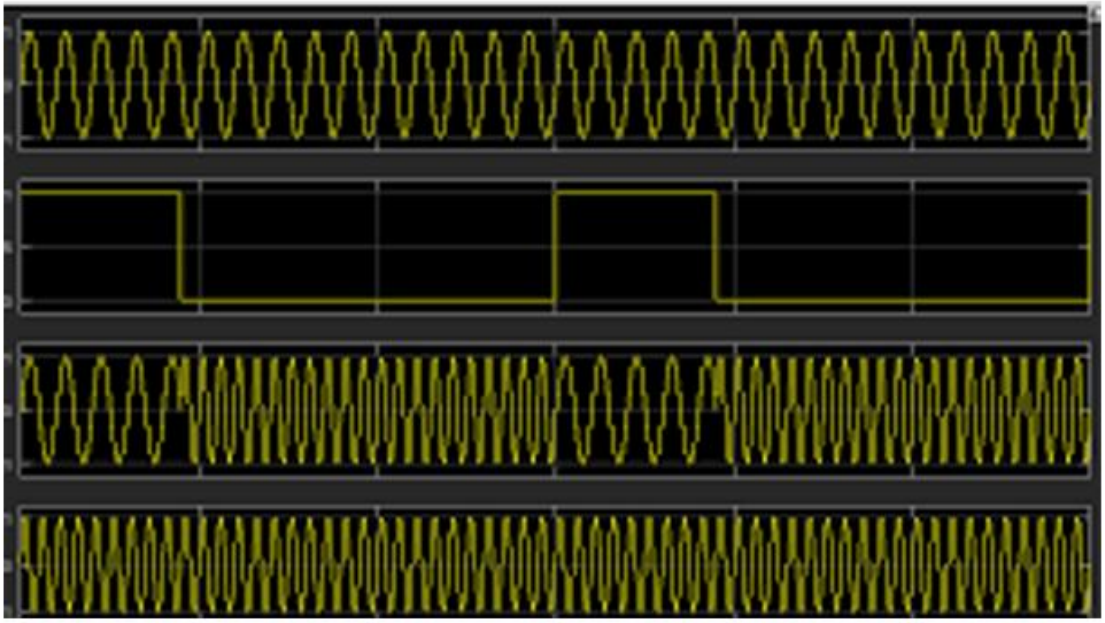


Block diagram of signal generator



Circuit Diagram of Signal generator





Sample wave forms

Unit 3

Electric Circuits

3.1. Definition

Electric circuits are pathways for electricity. It is an interconnection of various elements in which there is at least one closed path in which current can flow.

Some may say, electric circuit is a closed path in which electric current flows.

An Electric circuit is used as a component for any engineering system.

3.2. Classification

- Component arrangement
    1. Series,
    2. Parallel,
    3. combination)
- Current type
    1. AC
    2. DC.

Series circuits have one path, while **parallel circuits** offer multiple paths.

- Operational State
    1. **Closed circuits** have current flowing, while
    2. **open circuits** are broken, and
    3. **short circuits** provide an unintended, high-current path

- Characteristics
    1. Linear Circuit
    2. Non-Linear Circuit

Primary Types of Electric Circuits:

- **Series Circuit:** Components are arranged in a single loop, end-to-end. The current is the same through each component, and if one component fails, the entire circuit stops working.
- **Parallel Circuit:** Components are connected side-by-side, providing multiple, independent paths for current. If one branch fails, others continue to function.

- **Series-Parallel (Combination) Circuit:** A complex circuit that combines both series and parallel arrangements.

Operational State Circuits:

- **Closed Circuit:** A complete path that allows current to flow uninterrupted.
- **Open Circuit:** A broken or incomplete path, causing current flow to stop (e.g., a switch in the 'off' position).
- **Short Circuit:** A dangerous, unintended path with low resistance that allows high current flow, often leading to damage or overheating

Current Type Circuits:

- **Direct Current (DC) Circuit:** Current flows in one direction only, commonly used in battery-powered devices and electronics.
- **Alternating Current (AC) Circuit:** Current reverses direction periodically, used for electrical power distribution in homes and businesses.

Characteristics of Circuits:

- **Linear Circuit:** Circuit parameters (like resistance) do not change with voltage or current.
- **Non-linear Circuit:** Circuit parameters vary with respect to the voltage or current.

3.3. Types of Electrical Circuits

Electrical circuits are categorized based on how their components are connected and how current flows through them.

The key types of electrical circuits include:

3.3.1 Open Circuit

An open circuit is a type of electrical circuit where the path for current flow is incomplete. This interruption means that electricity cannot flow through the circuit.

Common causes include a switch being in the 'off' position or a break in the conductor. Open circuits are essentially non-functional until the gap is closed, completing the path for current flow.

3.3.2 Closed Circuit

A closed circuit has a complete path, allowing current to flow uninterrupted from the power source, through the components, and back to the source.

This type of circuit is operational, with all connections intact and switches closed. Everyday examples include a light bulb turning on when its switch is flipped to the 'on' position.

3.3.3 Short Circuit

A short circuit happens when a low-resistance connection forms between two points in an electrical circuit, bypassing the intended path of current flow.

This can cause excessive current to flow through the circuit, potentially leading to overheating, component damage, or even fires. Short circuits are often the result of faulty wiring, component failures, or accidental connections.

3.3.4 Series Circuit

In a series circuit, components are connected end-to-end in a single path for the current to flow. This means that the same current flows through all components sequentially.

However, if one component fails or is disconnected, the entire circuit stops working. Series circuits are commonly used in applications where components need to operate in a specific sequence, such as certain types of Christmas lights.

3.3.5 Parallel Circuit

Parallel circuits have multiple paths for the current to flow, with each component connected across common points. This configuration allows each component to operate independently; if one component fails, the others can still function.

Parallel circuits are widely used in household electrical wiring, where each outlet and light operate independently of the others.

3.3.6 Series-Parallel Circuit

A series-parallel circuit combines elements of both series and parallel circuits. Some components are connected in series, while others are connected in parallel within the same circuit.

This hybrid configuration can optimize performance and provide greater flexibility for various applications, balancing the benefits of both circuit types.

3.3.7 AC Circuit

An AC (alternating current) circuit is one where the current periodically reverses direction. AC circuits are the standard for power distribution systems because they can efficiently transmit electricity over long distances.

The use of transformers in AC circuits allows for the easy conversion of voltage levels, which is crucial for the grid system supplying power to homes and industries.

3.3.8 DC Circuit

A DC (direct current) circuit has current flowing in one direction only, typically from a battery or a DC power supply.

DC circuits are commonly found in electronic devices, such as smartphones, laptops, and other portable gadgets. The stable voltage of DC circuits makes them ideal for applications requiring precise and consistent power delivery.

3.3.9 Digital /logical circuits.

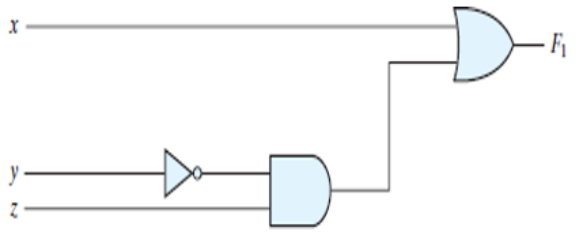
These are built by logical gates; eg, AND, OR, NOR NAND gates.

They are implemented or justified by using truth tables and the operation is done by mathematical operations.

Example of logical circuit.

Truth Table for F1

x	y	z	F_1
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1



Gate Implementation of F1 = x + y'z

Each circuit type has unique characteristics and applications, essential for powering devices and ensuring efficient electrical flow

3.4. Key Components of Electrical Circuits

Electrical circuits are made up of various components, each serving a specific function that contributes to the overall operation of the system.

The most common components found in electrical circuits include:

Resistors

Resistors are fundamental components that oppose the flow of electric current, thereby controlling the amount of current that flows through a circuit. They are used to limit current, divide voltages, and protect other components from excessive current.

Resistors are characterized by their resistance value, measured in ohms (Ω). They come in various forms, including fixed resistors, variable resistors (potentiometers), and special types like thermistors and varistors.

Capacitors

Capacitors store and release electrical energy in a circuit. They are used to smooth out fluctuations in voltage, filter signals, and in

timing applications. A capacitor consists of two conductive plates separated by an insulating material called a dielectric.

When connected to a power source, capacitors store energy in the electric field between their plates. The capacitance value, measured in farads (F), determines how much charge a capacitor can store.

Inductors

Inductors, also known as coils or reactors, are components that store energy in a magnetic field when electric current flows through them.

They are used in filtering, tuning circuits, and in applications requiring energy storage. Inductors oppose changes in current flow, which makes them useful for smoothing out AC signals in power supplies and for creating inductive kickback in various circuits.

The inductance value, measured in henrys (H), indicates the inductor's ability to store magnetic energy.

Diodes

Diodes are semiconductor devices that allow current to flow in one direction only, acting as a one-way valve for electric current.

They are used in rectification (converting AC to DC), signal demodulation, and voltage regulation. The most common type is the silicon diode, but there are also special-purpose diodes like light-emitting diodes (LEDs) and Zener diodes, which are used for voltage regulation and protection.
Transistors

Transistors are semiconductor devices that can act as amplifiers or switches.

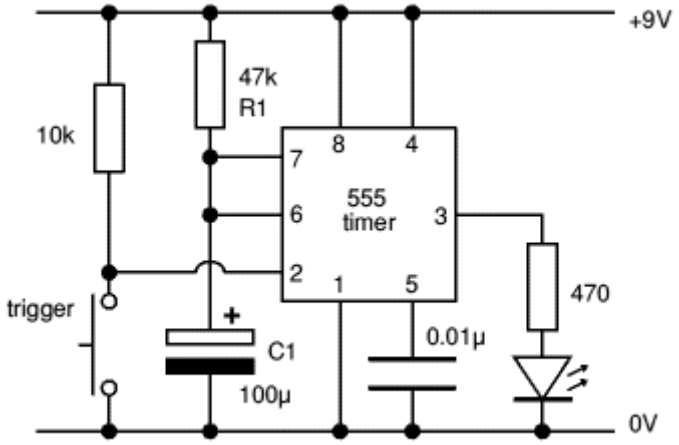
They are fundamental building blocks in modern electronics, used in virtually every electronic device. Transistors come in two main types: bipolar junction transistors (BJTs) and field-effect transistors (FETs).

They control the flow of current between two of their terminals (collector and emitter for BJTs, source and drain for FETs) based on the voltage applied to the third terminal (base for BJTs, gate for FETs).

3.5 Circuit symbols in diagrams

Circuit symbols are used in circuit diagrams showing how a circuit is connected together. The actual layout of the components is usually quite different from the circuit diagram.

To build a circuit you need a different diagram showing the layout of the parts on breadboard (for temporary circuits), stripboard or printed circuit board.

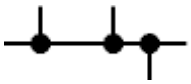


Example of Electronic circuits A circuit diagrams

3.5.1 Wire and connection symbols

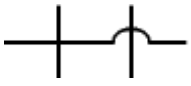
Wire

Connects components and passes current easily from one part of a circuit to another.



Wires joined

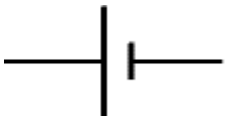
A 'blob' should be drawn where wires are connected (joined), but it is sometimes omitted. Wires connected at 'crossroads' should be staggered slightly to form two T-junctions, as shown on the right.



Wires not joined

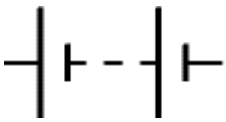
In complex diagrams it is often necessary to draw wires crossing even though they are not connected. The simple crossing on the left is correct but may be misread as a join where the 'blob' has been forgotten. The bridge symbol on the right leaves no doubt!

3.5.2 Power supply symbols



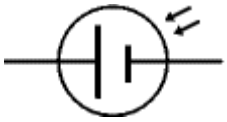
Cell

Supplies electrical energy. The larger line is positive (+). A single cell is often called a battery, but strictly speaking a battery is two or more cells joined together.



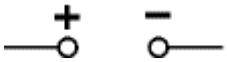
Battery

Supplies electrical energy. A battery is more than one cell. The larger line is positive (+).



Solar Cell

Converts light to electrical energy. The larger line is positive (+).



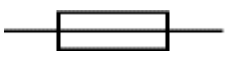
DC supply

Supplies electrical energy. DC = Direct Current, always flowing in one direction.

AC supply

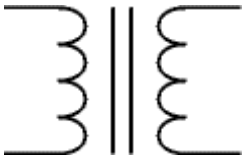


Supplies electrical energy. AC = Alternating Current, continually changing direction.



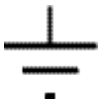
Fuse

A safety device which will 'blow' (melt) if the current flowing through it exceeds a specified value.



Transformer

Two coils of wire linked by an iron core. Transformers are used to step up (increase) and step down (decrease) AC voltages. Energy is transferred between the coils by the magnetic field in the core, there is no electrical connection between the coils.



Earth (Ground)

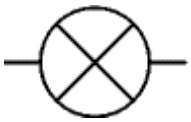
A connection to earth. For some electronic circuits this symbol is used for the 0V (zero volts) of the power supply, but for mains electricity and some radio circuits it really means the earth. It is also known as ground.

3.5.3 Output device symbols



Lamp (lighting)

A transducer which converts electrical energy to light. This symbol is used for a lamp providing illumination, for example a car headlamp or torch bulb.



Lamp (indicator)

A transducer which converts electrical energy to light. This symbol is used for a lamp which is an indicator, for example a warning light on a car dashboard.



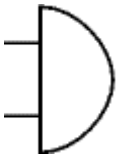
Heater

A transducer which converts electrical energy to heat.



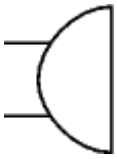
Motor

A transducer which converts electrical energy to kinetic energy (motion).



Bell

A transducer which converts electrical energy to sound.



Buzzer

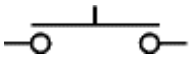
A transducer which converts electrical energy to sound.



Inductor, Coil, Solenoid

A coil of wire which creates a magnetic field when current passes through it. There may be an iron core inside the coil. It can be used as a transducer converting electrical energy to mechanical energy by pulling on something magnetically.

3.5.4 Switch symbols



Push-to-make switch

A push switch allows current to flow only when the button is pressed. This is the switch used to operate a doorbell.



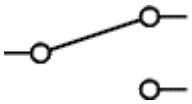
Push-to-break switch

This type of push switch is normally closed = on, it is open = off only when the button is pressed.



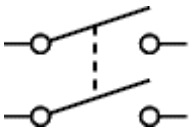
SPST, on-off switch

SPST = Single Pole, Single Throw. Current flows only when the switch is in the closed =on position.



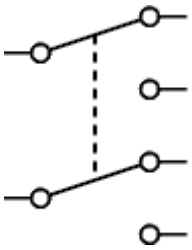
SPDT, 2-way switch

SPDT = Single Pole, Double Throw. A 2-way changeover switch directs the flow of current to one of two routes according to its position. Some SPDT switches have a central off position and are described as 'on-off-on'.



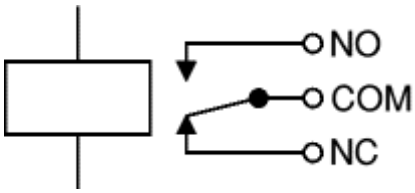
DPST switch

DPST = Double Pole, Single Throw. A dual on-off switch which is often used to switch mains electricity because it can isolate both the live and neutral connections.



DPDT switch

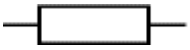
DPDT = Double Pole, Double Throw. This switch can be wired up as a reversing switch for a motor. Some DPDT switches have a central off position.



Relay

An electrically operated switch, for example a 9V battery circuit connected to the coil can switch an AC mains circuit. The rectangle represents the coil.
NO = Normally Open, COM = Common, NC = Normally Closed.

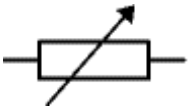
Resistor symbols



Resistor

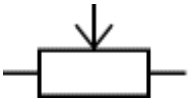
A resistor restricts the flow of charge. Uses include limiting the current passing through an LED, and slowly charging a capacitor in a timing circuit.

Some publications use the old resistor symbol: 



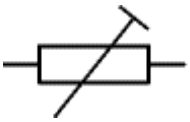
Rheostat variable resistor

A rheostat has 2 contacts and is usually used to control current. Uses include controlling lamp brightness or motor speed and changing the rate of flow of charge into a capacitor in a timing circuit.



Potentiometer variable resistor

A potentiometer has 3 contacts and is usually used to control voltage. It can be used like this as a transducer converting position (angle of the control spindle) to an electrical signal.

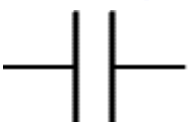


Preset variable resistor

A preset is operated with a small screwdriver or similar tool. It is designed to be set when the circuit is made and then left without further adjustment. Presets are cheaper than standard variable resistors so they are sometimes used in projects to reduce the cost.

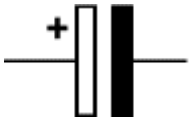
3.5.5 Capacitor symbols

Capacitor, unpolarised



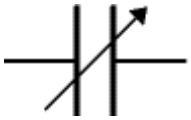
A capacitor stores electric charge. It can be used with a resistor in a timing circuit, for smoothing a supply (it provides a reservoir

of charge) and can be used as a filter (blocking DC signals but passing AC signals). Unpolarised capacitors usually have small values, less than 1µF.



Capacitor, polarised

A capacitor stores electric charge. Polarised capacitors must be connected the correct way round. They usually have larger values, 1µF and greater. See above for uses.



Variable capacitor

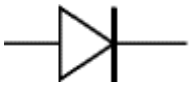
A variable capacitor is used in a radio tuner.



Trimmer variable capacitor

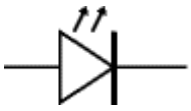
This type of variable capacitor is designed to be set when a circuit is made and then left without further adjustment.

3.5.6 Diode symbols



Diode

A device which allows current to flow in only one direction.



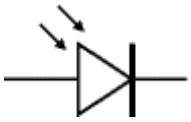
Light Emitting Diode

A transducer which converts electrical energy to light. Usually abbreviated to LED.



Zener diode

A Zener diode can be used to maintain a fixed voltage.



Photodiode

A light-sensitive diode.

Transistor symbols



Transistor NPN

A transistor amplifies current and can be used with other components to make an amplifier or switching circuit. This symbol is for a bipolar junction transistor (BJT), the type you are most likely to use at first.



Transistor PNP

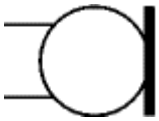
A transistor amplifies current and can be used with other components to make an amplifier or switching circuit. This symbol is for a bipolar junction transistor (BJT), the type you are most likely to use at first.



Phototransistor

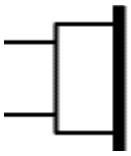
A light-sensitive transistor.

3.5.7 Audio and Radio symbols



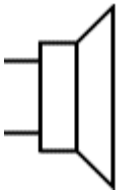
Microphone

A transducer which converts sound to electrical energy.



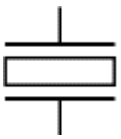
Earphone

A transducer which converts electrical energy to sound.



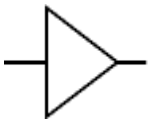
Loudspeaker

A transducer which converts electrical energy to sound.



Piezo Transducer

A transducer which converts electrical energy to sound.



3.5.8 Amplifier (general symbol)

An amplifier circuit with one input. Really this is a block diagram symbol because it represents a circuit rather than just one component.



Aerial (Antenna)

A device to receive or transmit radio signals. It is also known as an antenna.

3.5.9 Meters and Oscilloscope



Voltmeter

Measures voltage. The proper name for voltage is 'potential difference' but voltage is more widely used.



Ammeter

Measures current.



Galvanometer

A very sensitive meter used to measure tiny currents, usually 1mA or less.



Ohmmeter

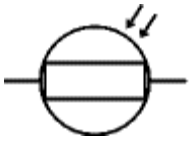
Measures resistance. Most multimeters have an ohmmeter setting.



Oscilloscope

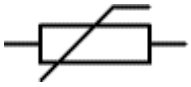
An oscilloscope is used to display the 'shape' of electrical signals - showing how they vary with time. It can be used to measure voltage and time periods.

3.5.10 Sensors (input devices)



LDR

A transducer which converts brightness (light) to resistance (an electrical property). LDR = Light Dependent Resistor

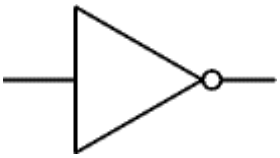


Thermistor

A transducer which converts temperature (heat) to resistance (an electrical property).

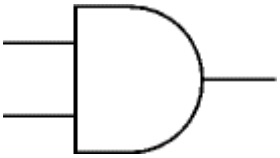
3.5.11 Logic gate symbols

Logic gates process signals which represent **true** (1, high, +Vs, on) or **false** (0, low, 0V, off). For more information please see the page on logic gates. The symbols shown here are the traditional ones for logic gates as these are the most widely used symbols.



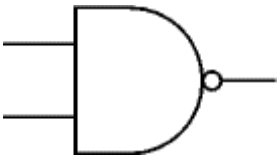
NOT

A NOT gate can only have one input. The 'o' on the output means 'not'. The output of a NOT gate is the inverse (opposite) of its input, so the output is true when the input is false. A NOT gate is also called an inverter.



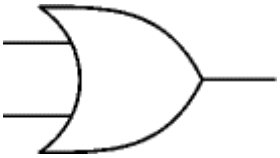
AND

An AND gate can have two or more inputs. The output of an AND gate is true when all its inputs are true.



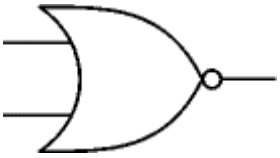
NAND

A NAND gate can have two or more inputs. The 'o' on the output means 'not' showing that it is a **N**ot **AND** gate. The output of a NAND gate is true unless all its inputs are true.



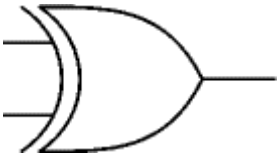
OR

An OR gate can have two or more inputs. The output of an OR gate is true when at least one of its inputs is true.



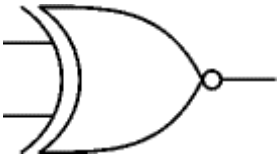
NOR

A NOR gate can have two or more inputs. The 'o' on the output means 'not' showing that it is a **N**ot **OR** gate. The output of a NOR gate is true when none of its inputs are true.



EX-OR

An EX-OR gate can only have two inputs. The output of an EX-OR gate is true when its inputs are different (one true, one false).



EX-NOR

An EX-NOR gate can only have two inputs. The 'o' on the output means 'not' showing that it is a **N**ot **EX-OR** gate. The output of an EX-NOR gate is true when its inputs are the same (both true or both false).

3.6 Applications of Electrical Circuits in Different Areas

Electrical circuits are the backbone of modern technology, playing a crucial role in a wide range of industries. Understanding how these circuits are applied can help you appreciate their importance and potential.

Here, we explore some key industries where electrical circuits are indispensable.

1. Automotive Industry

In the automotive industry, electrical circuits are integral to the operation and efficiency of vehicles. Modern cars are equipped with numerous electronic systems that enhance performance, safety, and comfort.

From the engine control unit (ECU) that manages engine functions to advanced infotainment systems, electrical circuits are everywhere. They control lighting, power windows, airbags, and navigation systems, ensuring that vehicles are not only functional but also safe and enjoyable to drive.

2. Telecommunications

Telecommunications relies heavily on electrical circuits to transmit voice, data, and video over long distances. Circuits in this industry are designed to handle high-frequency signals and large amounts of data.

They are used in devices such as smartphones, routers, and satellites. Communication networks, including the internet, depend on complex circuit designs to maintain fast and reliable connections. These circuits manage signal processing, data encoding, and error correction, enabling seamless global communication.

3. Consumer Electronics

Electrical circuits are at the heart of consumer electronics, powering devices like smartphones, laptops, televisions, and home appliances. These circuits allow for the miniaturization of components, making devices more compact and efficient.

In consumer electronics, circuits are responsible for processing data, managing power, and interfacing with users. For instance, the circuits in a smartphone enable it to perform many functions, from making calls and browsing the internet to running applications and taking high-quality photos.

4. Industrial Automation.

In industrial settings, electrical circuits are used to control machinery and processes, enhancing efficiency and precision. Programmable logic controllers (PLCs) and automated systems rely on these circuits to perform tasks such as monitoring sensors, controlling motors, and managing production lines.

By using electrical circuits to automate repetitive and complex tasks, industries can achieve higher productivity and consistency in their operations.

5. Healthcare

The healthcare industry benefits significantly from the application of electrical circuits in medical devices and equipment. These circuits are crucial in diagnostic tools like MRI and CT scanners, which provide detailed images of the human body.

They are also used in life-saving devices such as pacemakers, defibrillators, and monitoring systems. Electrical circuits in healthcare equipment must be highly reliable and precise, as they directly impact patient care and treatment outcomes.

UNIT 4

ELECTRONIC COMPONENTS

Active and Passive Components

Active Components

These are components that can inject energy into a circuit and are capable of amplifying signals or controlling current flow. They require an external power source to function.

• Characteristics:

1. Energy Control: Can control the flow of current or voltage.

2. Amplification: Capable of amplifying signals (e.g., transistors).

3. Dependency on Power Source: Operate only when powered by an external source.

Examples: Diodes (in some configurations like LEDs or Zener diodes). Transistors (BJTs, MOSFETs). Integrated Circuits (ICs)

Passive Components

These components cannot introduce energy into a circuit but can store, dissipate, or control energy in various ways. They do not require an external power source to function.

Characteristics:

1. Energy Consumption/Storage: Consume or store energy but do not amplify.

2. Independent Operation: Do not require an external power source to function.

3. Bidirectional Operation: Typically allow current to flow in both directions.

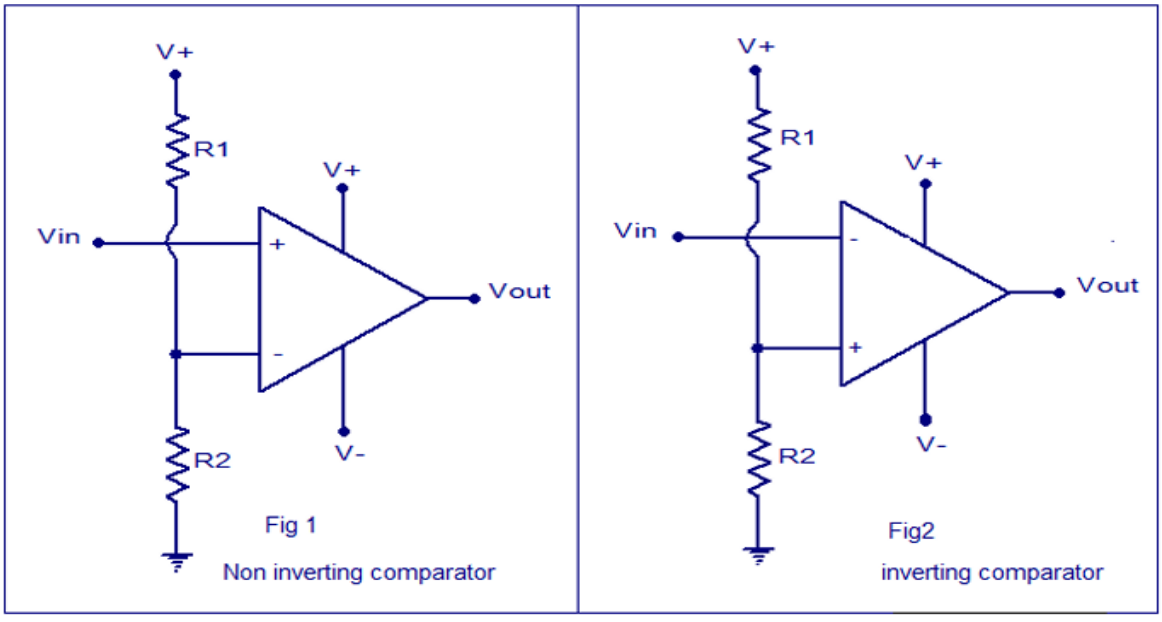
Examples:

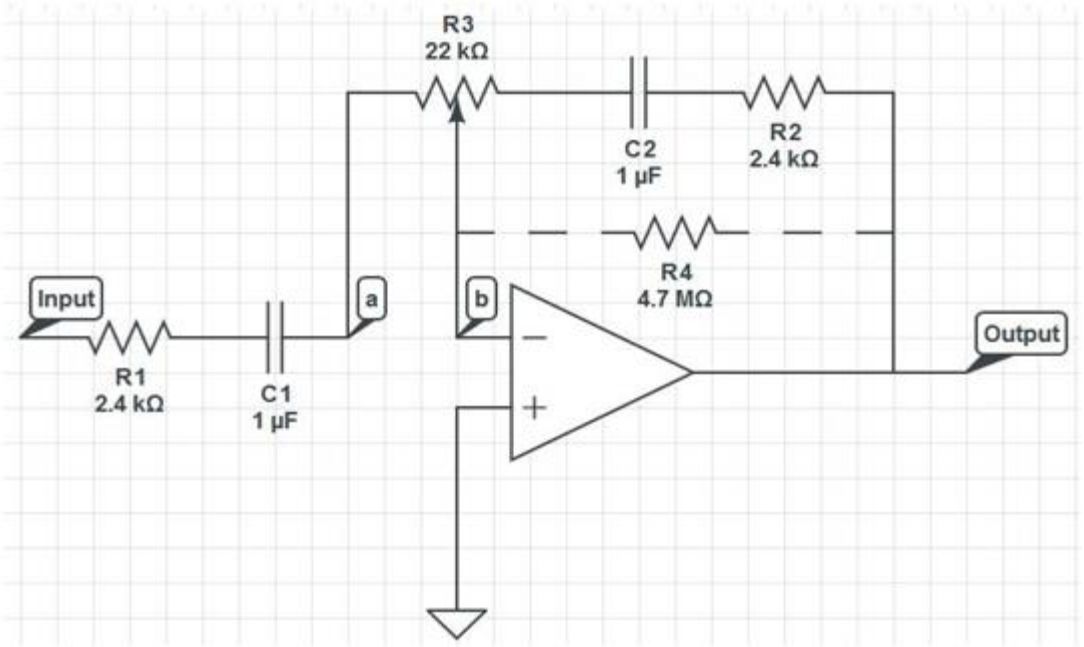
1. Resistors (dissipate energy).
2. Capacitors (store energy in the form of an electric field).
3. Inductors (store energy in the form of a magnetic field).

Difference between Active and Passive Electronic components

No	Feature	Active Components	Passive Components
1	Power Source	Requires an external power supply (like a battery) to function.	Does *not* require an external power supply.
2	Functionality	Can amplify signals, switch, or generate/control current.	Stores, resists, or dissipates energy.
3	Power Gain	Capable of providing power gain.	Incapable of providing power gain.
4	Energy Role	Energy donors (injects energy into a circuit).	Energy acceptors (utilizes/absorbs energy).
5	**Examples**	Transistors, Integrated Circuits (ICs), diodes, and batteries.	Resistors, capacitors, inductors, and transformers.

Examples of Electronic circuit.





Frequency network control system

CET04202-BASIC ELECTRICAL AND ELECTRONICS ENGINEERING

Assignment 2.

Groups.

Each group 1 question.
Written work 5 Marks, individual Viva 5marks
Given 21 May,2026, Presentation group 1&2, 28 May, group 3-5, 29 May,2026. Duration of Presentation 20minutes.

1. With diagrams and mathematics, discuss and present on the following circuit laws and theorems.

i/ Ohms law
ii/ Kirchhoff laws
iii/ Superposition theorem
iv/ Thevenin's theorem
v/ Norton's theorem.

2. With diagrams and formulae, explain the working principles of ammeter and voltmeter and explain the safety precautions while using these devices.

3. With diagram(s) and examples, Discuss the working of

i/ Signal generator
ii/ Function generator
iii/ Explain safety precautions while using these devices.

4. With diagrams describe the functions of active and passive electrical and electronic components (characteristics and functions).

5. Discuss the construction of Electronics circuits and the components used. Give 3 sample circuits.

NB: Indicate the reference source of your material, e.g books name, google Link name, you tube link.

Book references will have added advantages (both softcopy and hardcopy from library). Go to library get the books

BM. Dele, Module Teacher.

Unit 5
Maintenance of Electronics Components used in Computer

Maintenance of electronics components involves soldering of loosen terminals, replacement and connections.

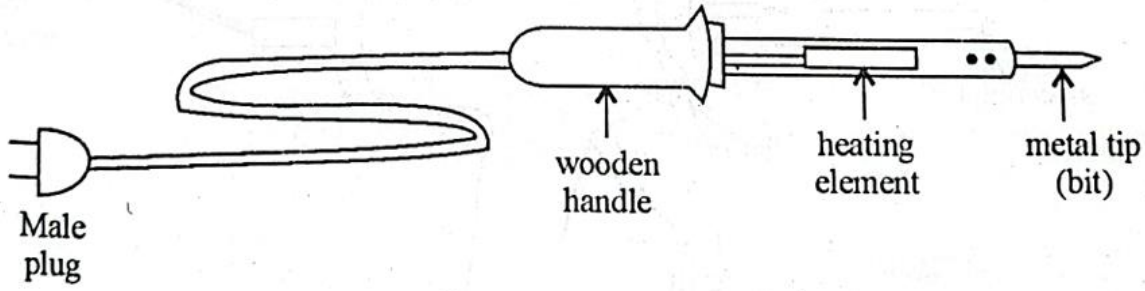
Soldering Process

Soldering is defined as the joining of metal conductors by a fusion of alloys. The alloys have relatively low melting point. The filler alloy metal, known as solder, flows into the joint. Soldering does not involve melting of the work piceces. Hence soldering differs from welding.

Solder: Solder is a metallic alloy used, when melted, to join metallic surfaces together. Common type of solder is a alloy of tin and lead. The common alloys (tin/lead) used for electronics work is 60/40. The melting point of the alloy is 190^{0}C.

Solder is not used to make electrical contact. It is used to encapsulate a joint and prevent oxidation of the joint. It provides minor mechanical support for a connection.

Soldering iron: A soldering iron is a hand tool used in soldering. It supplies heat to melt the solder so that it can flow into the joint between

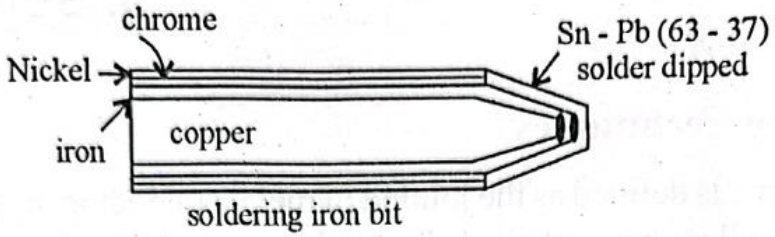


Soldering Iron

two work pieces. A soldering iron is composed of a metal tip (bit) a resistive heating element and an insulated handle. Heating the tip is achieved electrically (by indirect heating) by passing an electric current through the heating element.

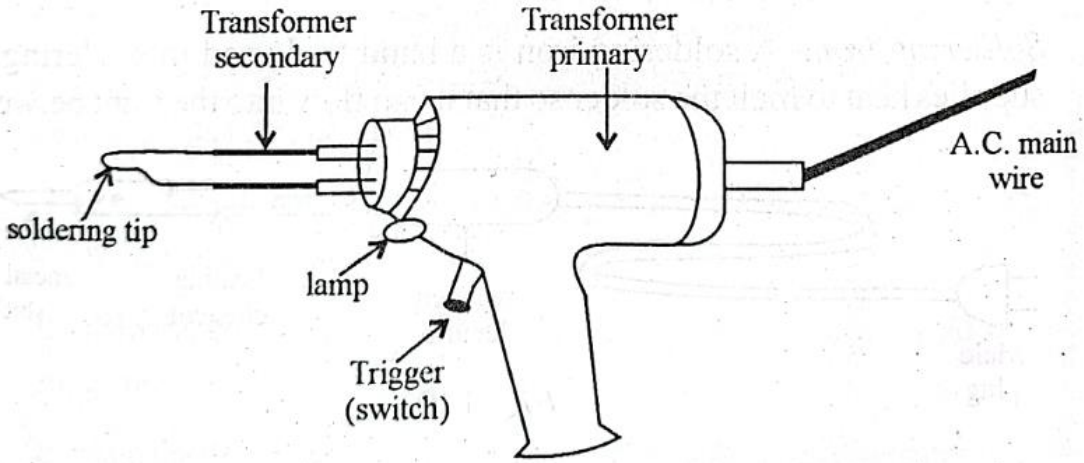
Low-power iron of 15 to 35 watts, is used for electrical and electronics work. The soldering iron is kept on a stand, to keep the hot iron away from flammable materials.

Metal tip (bit) Soldering iron metal tip (bit) transfers thermal energy from soldering iron to the solder connection.



The base metal is copper. A tip's thermal conductivity determines how fast thermal energy can be sent from the heater to the connection. Fine tapered chisel tips are used for electronics works. Figure illustraters the plating techniques used for soldering iron tips. Nickel-chrome plating on the rear of the tip prevents solder from adhering to the back portion of the tip and provides a controlled wetted area on the iron tip.

Soldering gun



Soldering gun is a pistol-shaped tool used for soldering. The tool has a trigger style switch, so that it can be easily operaed with one hand. The body of the tool contains a transformer with primary windings connected

Flux

A flux is a chemical cleaning agent. It has the ability to dissolve existing oxides on the metal surface and promote wetting with solder. It also acts as an oxygen-barrier by coating the hot surface, preventing its oxidation. Rosin flux is used for the light soldering work in making wire connection. Generally, the rosin flux is kept in the hollow core of the solder, so that a separate flux is unnecessary for soldering work.

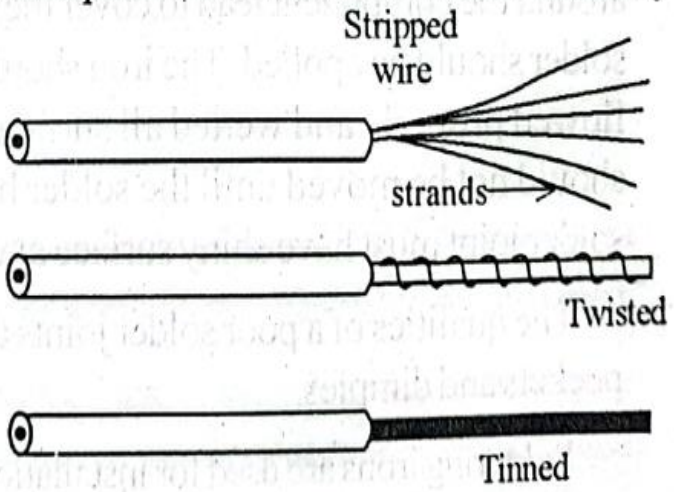
Tools for soldering The following tools are needed for soldering : (a) miniature needle nose plier (b) miniature side cutter (c) wire stripper (d) sponge and (e) heat sink clips.

Preparation for soldering

Allow the soldering iron to reach adequate temperature. The tip is cleaned by wiping on sponge. The tip is wetted with solder. A clean, shiny tip surface is obtained. This is known as tinning the tip.

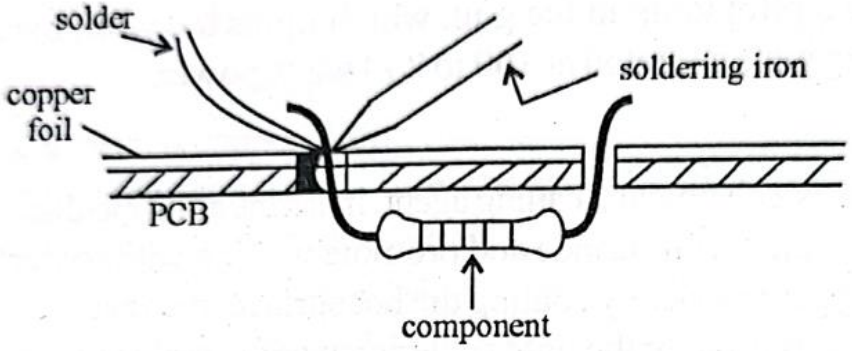
Preperation of the surface to be soldered:

If soldering to a PCB, the copper foil should be cleaned using fine steel wool or fine sand paper. The copper surface should have a bright,shiny appearance.



Stranded wire should be used for connection from PCB. Strip,twist and lightly, 'tin' the wire before soldering it in place. This prevents fraying of the conductors. This wire is hooked around a terminal or soldered into place on a PCB.

Construction and soldering Techniques



Component mounting in PCB

The components are pushed through holes of PCB. The component leads are bent slightly to hold the component.. The soldering iron tip should be placed in contact with both the copper foil and the component lead. The two should be the heated only enough to melt solder. The solder is then touched to the area and the molten solder is allowed to flow freely around the component lead to cover the solder pad. A minimal amount of solder should be applied. The iron should be removed after the solder has flowed properly and wetted all surfaces. The component and the PCB should not be moved until the solder has cooled and hardened. A good solder joint must have shiny surface and good smooth filler.

The qualities of a poor solder joints are dull surface, excess solder, air pockets and dimples.

Soldering irons are used for installation, repairs and limitted production work in electronics assembly.

Desoldering Techniques

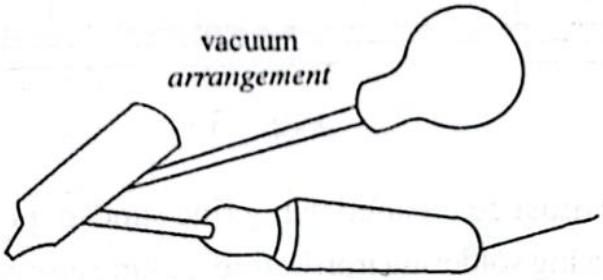
Desoldering is the removal of solder and components from a circuit board for trouble shooting, repair, replacement and salvage.

A defective component is removed from printed-wiring board by desoldering . From the wiring side of the PC board, desolder at the holes where the component leads go through the board to join the printed wiring. There are three methods used for desoldering.

(i) Soldering gun with vacuum attachement

(ii) Soldavac tool with a separate iron. The vacuum plunger pulls the molten solder out of the connection.

(iii) Soldawick or similar metal braid (de-soldering wick) with a separate iron. Heat the braid and the connection, and the molten solder runs up into braid.



Desoldering iron with a vacuum pump

Remove the solder, so that one can see the hole where the component leads come through. Then the component will practically fall off the board.

Desoldering requires application of heat to the solder that joint may be separated. If the joint is over heated the components a may be damaged or the PCB may be destroyed.

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