

# 1. Concept of Basic Electrical and Electronics Engineering

## 1.1 Basic concept:

### Ohm's law

Ohm's Law is a fundamental principle in electrical engineering that explains the relationship between voltage, current, and resistance in an electric circuit. According to this law, the current passing through a conductor is directly proportional to the voltage across its ends and inversely proportional to the resistance offered by the conductor. This relationship remains valid as long as the physical conditions, such as temperature, remain constant. This law is instrumental in understanding and designing electrical circuits, as it provides a basis for calculating any one of the three variables if the other two are known. The unit of resistance, the ohm, is named after Georg Simon Ohm, who formulated this principle. Understanding Ohm's Law is crucial for analyzing both simple circuits, like a single resistor connected to a voltage source, and complex systems involving networks of components.

### electric voltage and current

Voltage and current are two fundamental concepts in electrical circuits. Voltage, often referred to as potential difference, is the measure of the electric potential energy per unit charge between two points in a circuit. It is the driving force that causes electrons to move through a conductor, creating an electric current. Current, on the other hand, is the flow of electric charge through a conductor, measured in terms of the amount of charge passing through a point per unit time. Voltage is analogous to the pressure in a water pipe that pushes water, while current is similar to the flow of water. Together, these concepts form the backbone of circuit analysis, helping engineers understand and predict the behavior of electrical systems.

### power and energy

Electric power represents the rate at which electrical energy is converted into another form of energy, such as heat, light, or motion. It is a critical concept in understanding the efficiency and functionality of electrical devices. Power depends on both the voltage supplied and the current flowing through a device. Electrical energy, on the other hand, is the total amount of work done or energy transferred by an electrical circuit over a period. It is commonly measured in watt-hours (Wh) or joules (J). These concepts are fundamental in designing electrical systems and ensuring their optimal performance in various applications, from household appliances to industrial machines.

### conducting and insulating materials

Materials are classified as conductors or insulators based on their ability to allow the flow of electric current. Conductors, such as copper and silver, have a high density of free electrons that can move freely under the influence of an electric field, making them ideal for electrical wiring and connections. Insulators, such as rubber and glass, lack free electrons and resist the flow of electric current. They are essential for ensuring safety and preventing unwanted current flow in electrical systems. Understanding these materials is vital for selecting the appropriate components in electrical and electronic design.

### Series and parallel electric circuits

In a series circuit, components are connected end-to-end in a single path, so the same current flows through each component. However, the voltage across each component varies depending on its resistance. Series circuits are commonly used in applications where a consistent current is required. Parallel circuits, by contrast, involve components connected across the same voltage source. Each component receives the same voltage, but the total current is the sum of the

currents through individual components. Parallel circuits are widely used in household wiring to ensure each appliance operates independently. These two configurations form the basis for analyzing and designing complex electrical networks.

#### star-delta and delta-star conversion

Star and delta configurations are methods of connecting components in three-phase electrical systems. Star, or Y, configuration connects one end of each component to a common point, forming a Y shape, while delta connects the components in a triangular loop. These configurations can be interchanged using specific formulas to simplify circuit analysis. Conversions between star and delta are particularly important in electrical engineering to analyze power distribution systems and ensure proper load balancing in three-phase circuits.

#### Kirchhoff's law

Kirchhoff's Voltage Law (KVL) states that in any closed-loop circuit, the sum of the potential differences (voltages) is zero. This law is essential for analyzing energy conservation within circuits. Kirchhoff's Current Law (KCL), on the other hand, asserts that the total current entering a junction equals the total current leaving it. These laws are cornerstones of circuit theory, enabling engineers to analyze and design complex electrical networks systematically.

#### linear and non-linear circuit

Circuits can be classified based on the relationship between voltage and current. In linear circuits, this relationship is directly proportional, making them predictable and easy to analyze. Examples include circuits with resistors and capacitors. Non-linear circuits, such as those involving diodes or transistors, do not have a proportional relationship between voltage and current. Understanding these distinctions is crucial in modern electronics, where non-linear components play a central role in devices like amplifiers and signal processors.

#### bilateral and unilateral circuits

Bilateral circuits allow current to flow equally well in both directions, making their behavior symmetric regardless of the current's direction. Examples include circuits with resistors or capacitors. Unilateral circuits, however, permit current to flow in only one direction, as seen in components like diodes. These classifications are significant in designing circuits for specific functionalities, such as rectifiers or filters.

#### active and passive circuits

Active circuits contain components like voltage sources or transistors that can inject energy into the circuit, enabling signal amplification or oscillation. Passive circuits, by contrast, consist solely of elements like resistors, capacitors, and inductors that consume energy but do not generate it. These distinctions are foundational in understanding how circuits operate and are applied in everything from simple filters to complex electronic devices.