

UNIT 1

DC CIRCUIT ANALYSIS

1. INTRODUCTION:

The interconnection of various electric elements in a prescribed manner comprises as an electric circuit in order to perform a desired function. The electric elements include controlled and uncontrolled source of energy, resistors, capacitors, inductors, etc. Analysis of electric circuits refers to computations required to determine the unknown quantities such as voltage, current and power associated with one or more elements in the circuit. To contribute to the solution of engineering problems one must acquire the basic knowledge of electric circuit analysis and laws. Many other systems, like mechanical, hydraulic, thermal, magnetic and power system are easy to analyze and model by a circuit. To learn how to analyze the models of these systems, first one needs to learn the techniques of circuit analysis. We shall discuss briefly some of the basic circuit elements and the laws that will help us to develop the background of subject.

2. BASIC ELEMENTS & INTRODUCTORY CONCEPTS:

Electrical Network:

A combination of various electric elements (Resistor, Inductor, Capacitor, Voltage source, Current source) connected in any manner what so ever is called an electrical network. We may classify circuit elements in two categories, passive and active elements.

Passive Element:

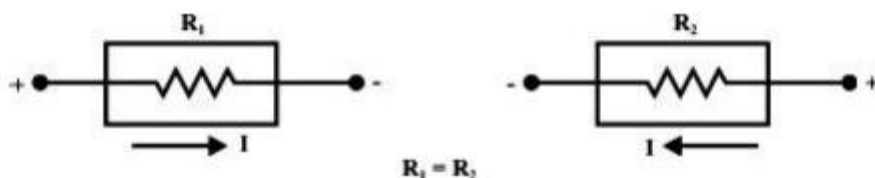
The element which receives energy (or absorbs energy) and then either converts it into heat (R) or stored it in an electric (C) or magnetic (L) field is called passive element.

Active Element:

The elements that supply energy to the circuit is called active element. Examples of active elements include voltage and current sources, generators, and electronic devices that require power supplies. A transistor is an active circuit element, meaning that it can amplify power of a signal. On the other hand, transformer is not an active element because it does not amplify the power level and power remains same both in primary and secondary sides. Transformer is an example of passive element.

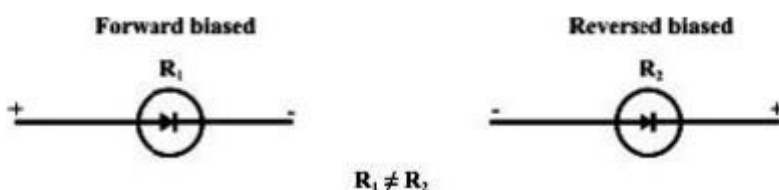
Bilateral Element:

Conduction of current in both directions in an element (example: Resistance; Inductance; Capacitance) with same magnitude is termed as bilateral element.



Unilateral Element:

Conduction of current in one direction is termed as unilateral (example: Diode, Transistor) element.



Meaning of Response:

An application of input signal to the system will produce an output signal, the behavior of output signal with time is known as the response of the system.

Potential Energy Difference:

The voltage or potential energy difference between two points in an electric circuit is the amount of energy required to move a unit charge between the two points.

An electric circuit consists various circuit elements such as energy sources, resistors, inductors, capacitors, etc. An electric circuit must have at least one source of energy.

Based on the manner in which the circuit elements are connected, the electric circuit is classified into following two types –

- Series Circuit
- Parallel Circuit

An electric circuit in which the circuit elements are connected one after the other (or in cascaded manner) is known as a series circuit. In a series circuit, the second terminal of first element is connected to the first terminal of the second element as shown in the figure below.

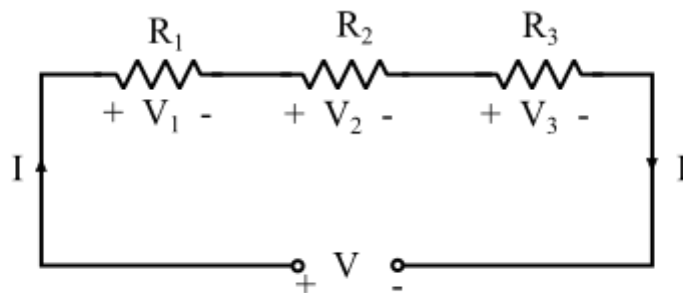


Figure - Series Circuit

As from the connection diagram of the series circuit, it is clear that all the circuit elements are cascaded in a single line, thus same current passes through all the elements while the voltage across each element is different.

An electric circuit in which starting terminals of all the elements are connected together at a common point, while the ending terminals are connected together at another common point is known as a **parallel circuit**. The connection diagram of the parallel circuit is shown in the following figure.

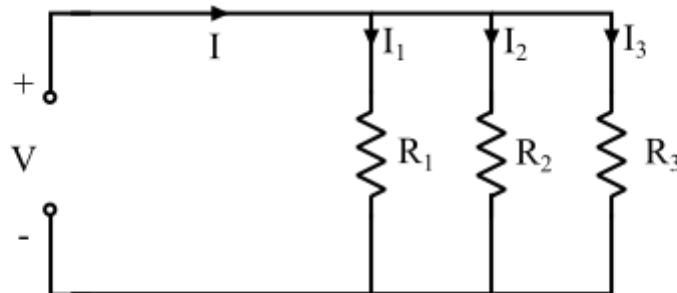


Figure - Parallel Circuit

From the diagram of the parallel circuit it can be seen that the number of paths for current to flow is equal to the number of parallel branches in the circuit and different current is flowing through each branch based on the value of element. Also, all the parallel branches are connected between the common points, thus the same voltage exists across all the elements.

Parameter	Series Circuit	Parallel Circuit
Definition	When the circuit elements are connected one after the other (or back to back), then circuit is called a series circuit.	When all the elements are connected such that the starting terminals are joined together and ending terminals are joined together, then the circuit is called a parallel circuit.
Circuit current	In a series circuit, all the circuit elements share the same current.	In case of parallel circuit, the current flowing through each element is different.
Voltage across elements	The voltage across each circuit element is different in a series circuit.	The voltage across all the elements remain the same in the parallel circuit.
Number of paths for current flow	In a series circuit, there is only one path for current to flow.	In a parallel circuit, the number of paths for current to flow depend upon the number of elements connected in parallel.
Effect of fault	In a series circuit, the fault in a single circuit element interrupt the operation of the complete circuit.	In a parallel circuit, the fault in a single circuit element does not affect the operation of rest of the circuit
Equivalent resistance	For a resistive series circuit the equivalent resistance is given by, $R_s = R_1 + R_2 + R_3 + \dots$	For parallel resistive circuit, the equivalent resistance is given by, $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots$
Equivalent inductance	The equivalent inductance of a series inductive circuit is given by, $L_s = L_1 + L_2 + L_3 + \dots$	The equivalent inductance of a parallel inductive circuit is, $\frac{1}{L_p} = \frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3} + \dots$