

Basic Electrical Engineering (TEE 101)

Lecture 2: Introduction to the Electrical Networks and their types

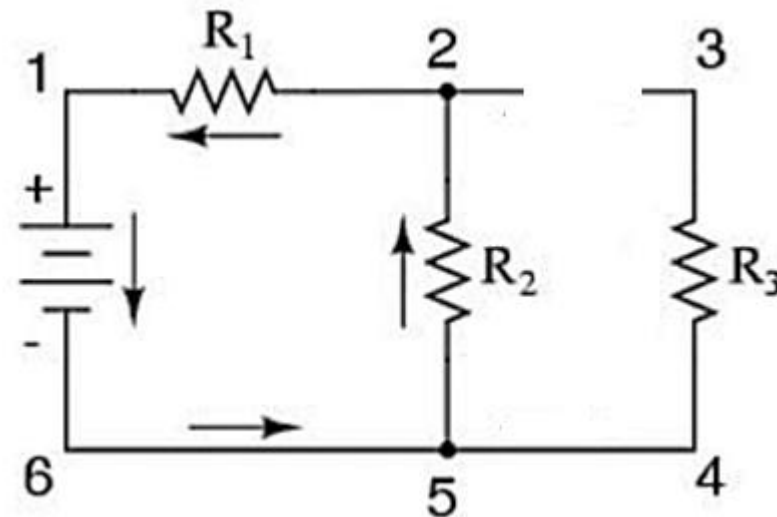
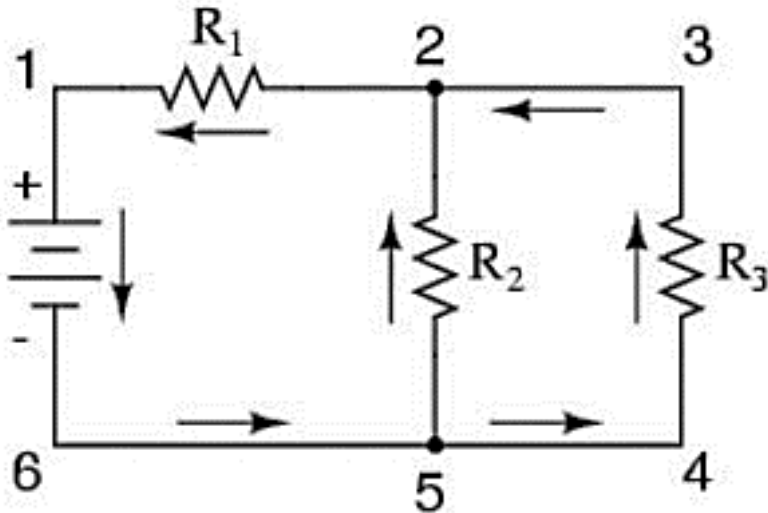
Objective:

- To discuss the basics about electrical networks
- To discuss various types of network elements
- To discuss the various types of electrical networks

Electrical Network

An **Electrical Network** is an interconnection of various circuit elements connected to one another in a particular topology (i.e either series, parallel or a combination of series and parallel)

Electrical Circuit: It is a closed path followed by an electric current. All electrical circuits are electrical networks.



An Electrical network comprises of following circuit elements (also known as network elements):

- **Active Elements**
- These elements deliver power to other elements, which are present in an electric circuit. Sometimes, they may absorb the power like passive elements. That means active elements have the capability of both delivering and absorbing power. **Examples:** Voltage sources and current sources.
- **Passive Elements**
 - **These elements** can't deliver power (energy) to other elements, however they can absorb power. That means these elements either dissipate power in the form of heat or store energy in the form of either magnetic field or electric field. **Examples:** Resistors, Inductors, and capacitors.

However, apart from being active and passive elements, network elements are also categorized as:

- **Linear and Non-linear Elements**
- **Bilateral and Unilateral Elements**
- **Lumped and Distributed Elements**

Linear and Non-Linear Elements

We can classify the network elements as **linear** or **non-linear** based on their characteristic to obey the property of linearity.

- **Linear Elements** are the elements that show a linear relationship between voltage and current.
 - **Examples:** Resistors, Inductors, and capacitors.
- **Non-Linear Elements** are those that do not show a linear relation between voltage and current.
 - **Examples:** Voltage sources and current sources.

A linear element or network is one which satisfies the principle of superposition, i.e. the principle of homogeneity and additivity.

An element which does not satisfy the above principle is called a nonlinear element.

Bilateral and Unilateral Elements

Network elements can also be classified as either **bilateral** or **unilateral** based on the direction of current flows through the network elements.

Bilateral Elements are the elements that allow the current in both directions and offer the same impedance in either direction of current flow.

The voltage-current relation is the same for current flowing in either direction.

- **Examples:** Resistors, Inductors and capacitors.

In contrast, a **unilateral element** has different relations between voltage and current for the two possible directions of current.

- **For example:** Vacuum diodes, silicon diodes, and metal rectifiers are examples of unilateral elements.

Lumped and Distributed Elements

Lumped elements are those elements which are very small in size.

Typical lumped elements are capacitors, resistors, inductors and transformers.

Generally the elements are considered as lumped when their size is very small compared to the wave length of the applied signal.

Distributed elements, on the other hand, are those which are not electrically separable for analytical purposes.

For example, a transmission line which has distributed resistance, inductance and capacitance along its length may extend for hundreds of miles.

Types of Electrical Networks/Circuits

The behavior of the entire network depends on the behavior and characteristics of its elements.

Based on such characteristics electrical network can be classified as below :

- **1.Linear Network**
- **2.Non linear Network**
- **3.Bilateral Network**
- **4.Unilateral Network**
- **5.Active Network**
- **6.Passive Network**
- **7.Lumped Network**
- **8.Distributed Network**

Linear and Non – Linear Networks

A circuit or network whose parameters i.e. elements like resistances, inductances and capacitances are always constant irrespective of the change in time, voltage, temperature etc. is known as **linear network**.

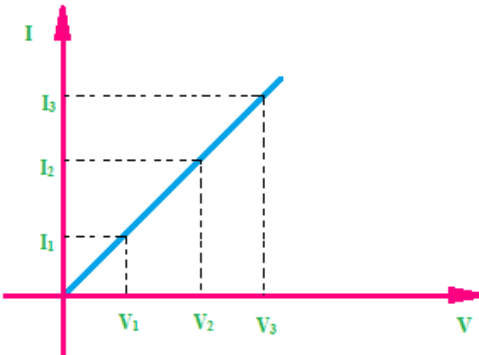
The Ohm's law can be applied to such network.

The mathematical equations of such network can be obtained by using the law of superposition.

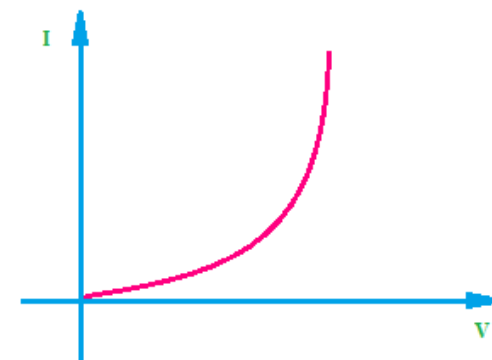
A circuit whose parameters change their values with change in time, temperature, voltage etc. is known as **non linear network**.

The Ohm's law may not be applied to such network.

Such network does not follow the law of superposition



Characteristics of linear network



Characteristics of non-linear network

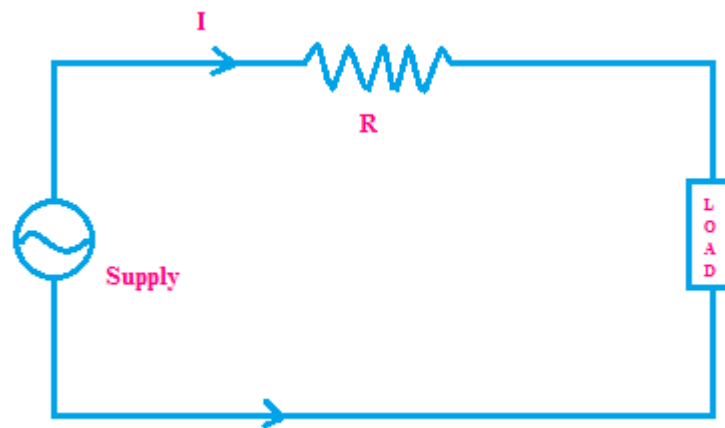
Bilateral and Unilateral networks

A circuit whose characteristics, behavior is same irrespective of the direction of current through various elements of it, is called **bilateral network**.

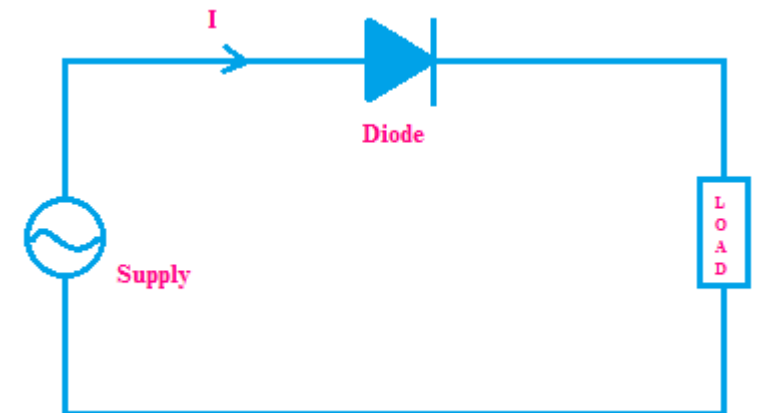
Network consisting only resistances is good example of **bilateral network**.

A circuit whose operation, behaviour is dependent on the direction of the current through various elements is called **unilateral network**.

Circuit consisting diodes, which allows flow of current only in one direction is good example of unilateral circuit.



bilateral network



unilateral network

Active and Passive Networks

An **active network** contains at least one voltage source or current source that can supply energy to the network indefinitely.

A **passive network** does not contain an active source.

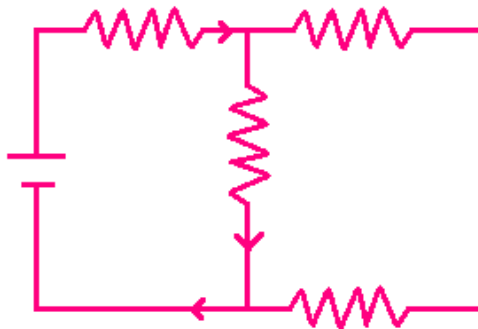
An **active network** contains one or more sources of electromotive force.

Practical examples of such sources include a battery or a generator.

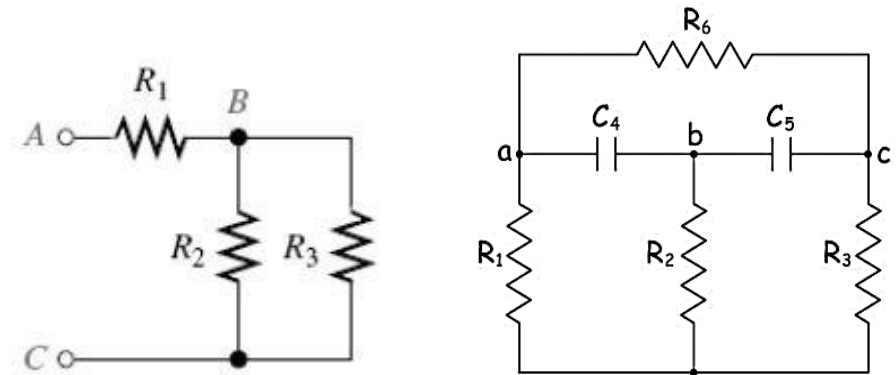
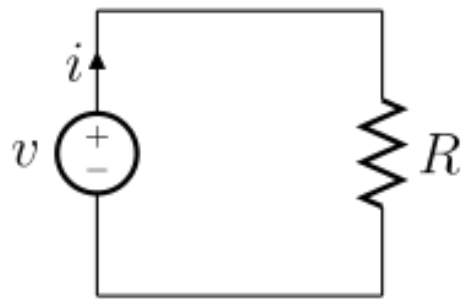
Active elements can inject power to the circuit, provide power gain, and control the current flow within the circuit.

Passive networks do not contain any sources of electromotive force.

They consist of **passive elements** like resistors and capacitors.



Active Networks example



Passive Networks example

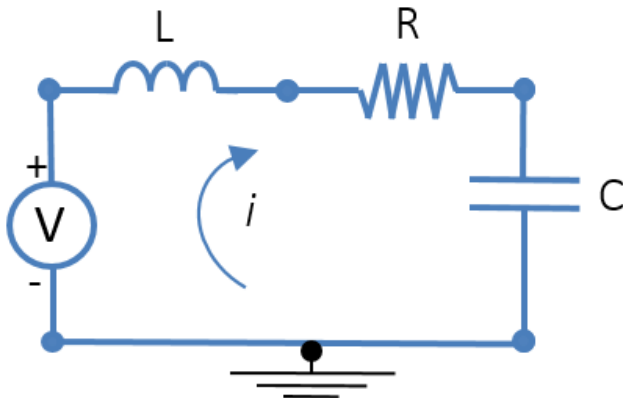
Lumped and Distributed Networks

Lumped Network :

- A network in which all the network elements are physically separable is known as **lumped network**.
- Most of the electric networks are lumped in nature.

Distributed Network :

- A network in which the circuit elements like resistance, inductance etc. cannot be physically separable for analysis purposes, is called **distributed network**
- The best example of such a network is a **transmission line** where resistance, inductance and capacitance of a transmission line are distributed all along its length and cannot be shown as a separate elements, any where in the circuit.



lumped network



distributed network