Network analysis,

Network analysis

- **Network:** An electrical network is an interconnection of electrical elements such as resistors, inductors, capacitors, voltage sources, current sources and switches.
- **Network Analysis:** The analysis of any network means to obtain response (like voltage across any branch or current passes through any branch) of a network for a known excitation (i.e. input signal).

Classification of Network Elements:

Active and Passive elements:

- The elements which are capable to generate electrical energy or have the capability of enhancing the energy level of a signal passing through it are called active elements.
  - *e.g. voltage and current sources, op. amps, transistors etc.*
- *On the other hand passive* are those elements which consume energy. They having tendency to change the form of applied energy into other form of energy.

Classification of Network Elements:

Unilateral and Bilateral:

- Unilateral are those elements in which the direction of current passes through them is changed, then the characteristics or properties of the circuit may also change.
  - e.g. diode, transistors etc.
- While the elements which don’t show any change in their response the direction of excitation is changed, are called bilateral elements,
  - e.g. resistors, inductor, capacitor etc.

Classification of Network Elements:

Lumped and distributed:

- A network in which all the network elements are physically separable is known as lumped network.
  - Eg. Resistor, inductor, capacitor etc
- A network in which the circuit elements like resistance, inductance etc. cannot be physically separable for analysis purposes.
  - Eg. Transmission lines

- **Transient behaviour of a network:** When any changes occurs in any circuit, the circuit behaviour changes in terms of their responses with respect to their excitation. These conditions changes may be classifies into two categories:
- **Transient Condition**: When changes occurs in any network, for a very short duration of time the circuit response changes rapidly. It may contain peaks of very high amplitudes; this period of time is known as transient period.

- **Steady State Condition:** After transient period, the circuit responses reach its stable value and such condition is called Steady state condition.
- **Solution of Circuits Using Differential Equations**: In a network generally excitation and response both are the functions of time. We can solve any circuit with the help of differential equations.

  eg. First order differential equation, Second order differential equation.

Initial Conditions in Circuits:

- The behaviour of any electrical circuit can be examined using differential equations.
- These equations are given as values of voltage, current, charge or derivatives of these quantities at the instant when network condition changed.
- When any signal applied to the network their conditions changed,

Initial Conditions in Circuits:

- *e.g. a switch act as a step signal and we always assumes that a switch operate in zero time but in such situation circuit conditions doesn't changes instantly.*
- *The network conditions at this instant are called the initial conditions.* t = 0 is the reference value of time.

- The time instant at which the condition of network is not yet changed but it is about to be changed is denoted as t(0-), while t(0+) is the instant at which the conditions of network is just changed.

Initial Conditions in Elements:

- **Resistor:**
  - The relation between applied voltage, resulting current and resistance of a conductor is given as:

    V = IR,
  - This equation is a linear time independent equation.
  - It shows that the current through resistor changes instantaneously if applied voltage changes instantaneously.

Initial Conditions in Elements:

- **(b) Capacitor:**
  - Capacitor does not allow sudden change in voltage.
  - A fully charged capacitor is like an open circuit, so a sudden change in voltage doesn't affect the capacitor.
  - The relation between voltage across any capacitor and current passes through it is given as:

$$\mathbf{i = Cdv/dt}$$

Initial Conditions in Elements:

Inductor:

- Inductor does not allow sudden change in current.
- A fully charged inductor is like a short circuit, so a sudden change in current doesn't affect the inductor.
- The relation between voltage across any inductor and current passes through it is given as:

$$v = L\frac{di}{dt}$$


Thank You!