DC CIRCUITS:

→ Charge (q):

→ Electric current is the rate of change of charge per unit ~~current~~ time.

$\boxed{I = \frac{V}{R}}$ $\boxed{i = \frac{dq}{dt}}$

DC → remains constant with respect to time

AC → changes w.r.to time periodically.

→ Voltage or potential difference is the energy required to move a charge from one point to another. (Voltage (V))

→ Power is the rate of change of energy per unit time. (Power (W))

$\boxed{P = VI}$

$\boxed{P = \frac{dw}{dt}}$

$I = \frac{dq}{dt}$

$V = \frac{dw}{dq}$

→ Energy is the capacity to do work.

→ Independent source: provides current or voltage completely independent of other circuit elements.

→ Dependent source: provides voltage or current which is controlled by another voltage or current.

Types of Independent Sources:

- Voltage Source
- Current Source.

Types of Dependent Sources:

- Voltage dependent voltage source.
- Voltage dependent current source.
- Current dependent current source.
- Current dependent voltage source.

→ Ability to resist the flow of current is called resistance.

→ Ability to the flow of current is called conductance.

$\boxed{R = \frac{\rho l}{A}}$

R → resistance
ρ → resistivity
l → length of conductor
A → area of conductor.

→ According to Ohm's law; voltage (V) across a resistor is directly proportional to current flowing through it.

$V \propto i$

$\boxed{V = iR}$

* Short circuit : $R \to 0$; $V = 0$

Open circuit : $R \to \infty$; $I = 0$

→ $\boxed{b = l + n - 1}$

$b \to$ branches

$n \to$ nodes

$l \to$ independent loops

→ Elements in series → same current, diff. voltage.

Elements in parallel → same voltage, diff. current.

* KIRCHOFF'S LAW :

KCL: Algebraic sum of incoming (or) outgoing currents at a given node is zero.

KVL: Algebraic sum of voltages around a closed path is zero.

* Voltage Division :

If resistances are in series I is same

$V_1 = \frac{R_1 V}{R_1 + R_2}$; $V_2 = \frac{R_2 V}{R_1 + R_2}$

* Current Division :

If resistances are in parallel ; V is same

$I_1 = \frac{R_2 I}{R_1 + R_2}$; $I_2 = \frac{R_1 I}{R_1 + R_2}$

* Method of Analysis :

→ Nodal Analysis (KCL) :

Selecting nodes and applying KCL to get current in each branch.

I = high potential to low potential

$$\boxed{I = \frac{V_{high} - V_{low}}{R}}$$

* Super Node: A super node is formed by enclosing a voltage source b/w 2 non-reference nodes and an element in parallel with it.

→ Mesh Analysis (KVL) :

Applicable only for planar circuits

Mesh is a loop which do not contain any other loop within it.

Apply mesh currents to each mesh and apply KVL to each mesh and we get currents.

* Super Mesh: A super mesh results when 2 meshes have a current source in common.

* Bilateral: Behaves same in any direction

* Unilateral: Behaves different in different directions.

* Linearity : O/P ∝ I/P.

*Active: Finite amount of power in infinite time.

***→ Super Position Theorem:**

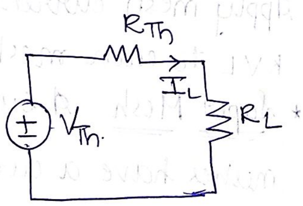
In any linear bilateral active network containing more than one source; the response in any element is equal to the individual responses due to each source.

Voltage Sources: Short circuited | Current Sources: Open circuited.

***→ Source Transformation:**

Replacing a voltage source in series with resistor by a current source in parallel with resistor (or) vice versa

***→ Thevenin's Theorem**



This states that any linear bilateral active network can be replaced by an equivalent circuit consisting of voltage V_{Th} with resistor R_{Th} in series

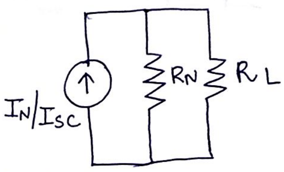
V_{Th} = open circuiting load terminals & measuring voltage across it.

R_{Th} = Equivalent resistance b/w terminals A & B by replacing sources with their internal resistances.

$\boxed{I_L = \frac{V_{Th}}{R_{Th}+R_L}}$

$$\boxed{\begin{array}{l} V_L = I_L R_L \\ V_L = \frac{R_L V_{Th}}{R_{Th}+R_L} \end{array}}$$

***→ Norton's Theorem:**



This states that any linear bilateral active network can be replaced by an equivalent circuit consisting of current I_N with resistor R_N in parallel.

I_N = short circuiting load terminals & measuring current across it.

R_N = Equivalent resistance b/w terminals A & B replacing sources with IRs.

$\therefore \boxed{R_N = R_{Th}}$

$\boxed{R_{Th} = \frac{V_{oc}}{I_{sc}} = R_N}$

$I_N = \frac{V_{Th}}{R_{Th}}$

***→ Maximum Power Transfer theorem:**

Maximum power will be transferred from source to load when $R_L = R_s / R_{Th}$.

$$P = I_L^2 R_L$$

$$P_{in} = \frac{V_{Th}^2}{2R_{Th}} \qquad P_{max} = \frac{V_{Th}^2}{4R_{Th}}$$

* → Tellegen's Theorem :

$$\Sigma P = 0 \qquad P = \text{power}$$