Electric Circuits

Chapter 1

$$1\,C = \frac{1}{1.602 \times 10^{-19}}$$

$$e = 1.602 \times 10^{-19}$$

$$I = \frac{dq}{dt} \quad \text{(Ampere)}$$

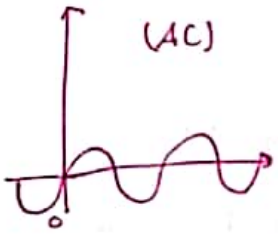
$$Q = \int_{to}^{t} I\, dT$$

Two Types of Current:-

Direct current

remains constant with time.

Alternating current



varies sinusoidally with time.

Voltage: Is the energy required to move a unit charge through an element

1 volt = 1 joule / columbl

$$V_{ab} = \frac{dw}{dq} \qquad w = \int V\, dq$$

$$P = \frac{dw}{dt} = \frac{dw}{dq} \cdot \frac{dq}{dt} = V \cdot i = i_2 \cdot R \,/\, \frac{V^2}{R}$$

$\frac{dw}{dq}$ → V, $\frac{dq}{dt}$ → i

$i \cdot V$ → instantaneous power

* passive sign convention

↳ The current enters through the positive Terminal

→ + −

$P = V \cdot i > 0$ power absorbed

$P = V \cdot i < 0$ power supplied / delivered.

* قانون حفظ الطاقة

Power absorbed = power Supplied

$$\sum_{i=1}^{N} P_i = 0$$

$$W = \int_{t_0}^{t} p\,dt = \int_{t_0}^{t} v.i\,dt$$

Types of elements:-

1. active elements → Generators and Batteries. / voltage or current Sources
2. passive elements → Resistors, Capacitors and Inductors.

Sources
- Dependent
- Independent

Chapter 2

Basic Laws

Oh'ms Law

$$R = \frac{\rho L}{A} \quad ; \quad R = \frac{V}{I} \quad \text{Volt / Ampere}$$

Conductance ; $G = \frac{1}{R} = R^{-1} \Rightarrow \Omega^{-1}$ / S.

$V = I.R$

$V = \frac{I}{G}$ $\quad V = \frac{I}{G}. \Rightarrow V.I$

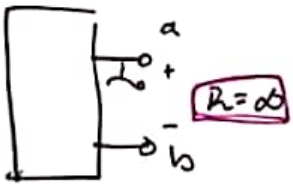
Short Circuits: -

$V_{ab} = I \cdot R = 0$

$V_{ab} = 0$

$\boxed{V_a = V_b}$

Open Circuits: -



open circuit

يعني لا يوجد تيار.

$i = \frac{V}{R}$

$\lim_{R \to \infty} \frac{V}{R} = 0$

$\boxed{i = 0}$

$\frac{P}{\infty} = 0$

Branches :- no of Branches = no. of elements

Nodes :- point of connection between 2 or more Branches

Loops : any closed path.

$$\underset{\text{branch}}{b} = \underset{\text{ind. loop}}{l} + n - 1$$

n nodes

KVL and KCL

- Algebric sum of Currents entering a node is zero.

$$\sum_{n=1}^{N} i_n = 0$$

$\sum$ entering = $\sum$ leaving

N: # of Branches connected to the node.

- KCL

Algebric sum of all voltages around a closed path = 0

$$\sum_{m=1}^{M} V_m = 0$$

M: # of Branches in the loop

Voltage Divider rule / voltage division

Circuit في سلسلة on series

$$V_1 = R_1 \cdot i = \frac{R_1 V}{R_1 + R_2}$$

$$V_2 = R_2 i = \frac{R_2 V}{R_1 + R_2}$$

$$V_i = \frac{R_i \cdot V}{R_{eq}} \qquad i \in \{1, 2, 3, 4, \ldots\}$$

Current Division / Current divider rule

في سلسلة Circuits on parallel

$$i_1 = \frac{R_2}{R_1 + R_2} \cdot i \Rightarrow i_1 = \frac{G_1 \cdot i}{G_1 + G_2}$$

$$i_2 = \frac{R_1}{R_1 + R_2} \cdot i \Rightarrow i_2 = \frac{G_2 \cdot i}{G_1 + G_2}$$

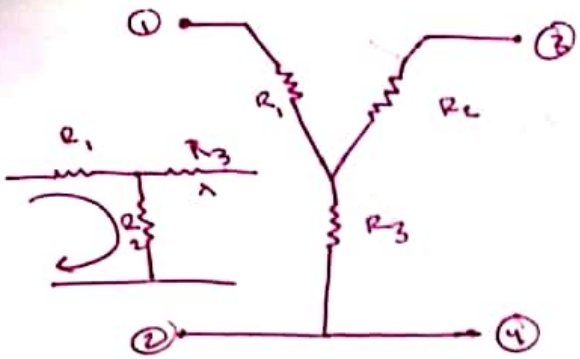
$i_k =$

$i_1 = \frac{V}{R_1}$

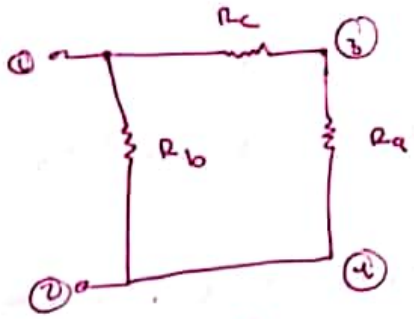
$V = i R_{eq}$

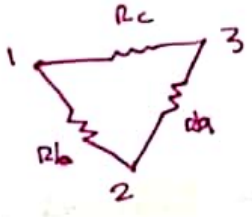
$i = \frac{R_1 R_2}{R_1 + R_2}$

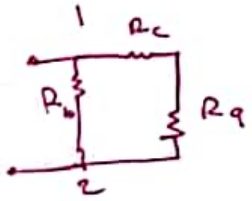
Delta - Wye Connection:-



Y Connection







Delta Connection

Delta to wye connection

$$R_{12}(Y) = R_1 + R_3$$

$$R_{12}(\nabla) = R_b \parallel (R_a + R_c)$$

$$R_1 + R_3 = R_b \parallel (R_a + R_c) = \text{---- 1} \rightarrow \frac{R_b (R_a + R_c)}{R_a + R_b + R_c}$$

$$R_1 + R_2 = R_c \parallel (R_a + R_b) = \frac{R_c (R_a + R_b)}{R_a + R_b + R_c} \quad \text{... 2}$$

$$R_2 + R_3 = R_a \parallel (R_b + R_c) = \frac{R_a (R_b + R_c)}{R_a + R_b + R_c} \quad \text{... 3}$$

$$R_1 = \frac{R_b \cdot R_c}{R_a + R_b + R_c}$$

$$R_2 = \frac{R_a \cdot R_c}{R_a + R_b + R_c}$$

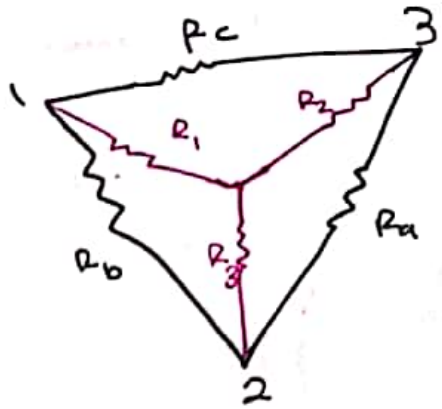
$$R_3 = \frac{R_a + R_b}{R_a + R_b + R_c}$$

$$R = R_a = R_b = R_2$$

$$R_a = \frac{R_1R_2 + R_1R_3 + R_2R_3}{R_1}$$

$$R_b = \frac{R_1R_2 + R_1R_3 + R_2R_3}{R_2}$$

$$R_c = \frac{R_1R_2 + R_1R_3 + R_2R_3}{R_3}$$



Nodal Analysis (Interested in applying KCL) Chapter Methods of Analysis.

To find Node voltages:-

1] select reference node

2] Apply KCL to nonreference node

3] Solve equations.

$$i = \frac{V_x - V_y}{R}$$

- If a voltage source connected betwe reference node and nonreference node

  voltage at nonreference node = voltage source

Voltage source (dependent/ Independent) is connected between 2 nonreference node

⇒ SuperNode

* Supernode can be neglected and anything is parallel to it.

Mesh Analysis :- (Interested in applying KVL)

is a loop that does not contain any other loop within it.

* The current through a mesh is known as mesh current.

To find mesh current:-

1] Assign mesh current.

2] Apply KVL.

3] Solve equations.

(supermesh) Mesh analysis with current Sources:-

1] Case 1: when a current exist only in one mesh.

* بس بنحط اشارة ال Current بال mesh التانية وبعمل معادلة، لا بنكتب

2] Case 2:- when a current exists between two meshes.

⇒ we creating a supermesh by excluding the Current Source and any elements connected in series with it.

Superposition

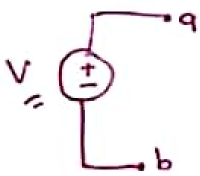
Steps to apply superposition:-

1] Turnoff all independent sources

2] Repeat step 1 for each of the other independent sources

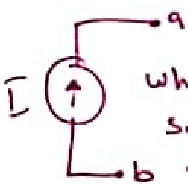
3] find the total contribution

[A]

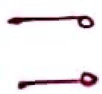


when we kill voltage source, we make it short circuit.

[B]

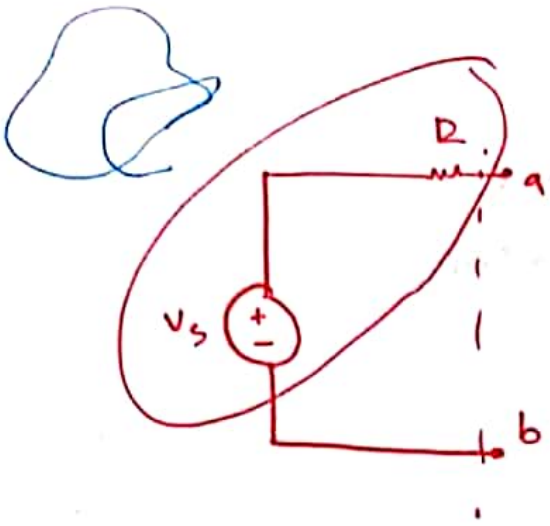


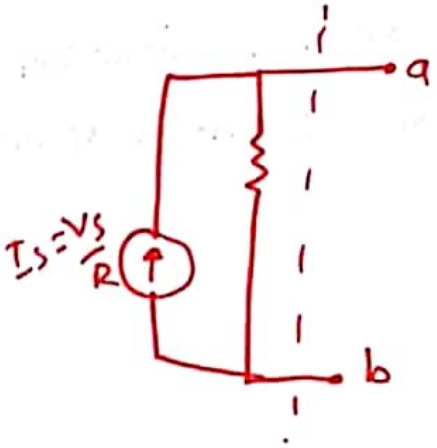
when we kill current source, we make it open circuit

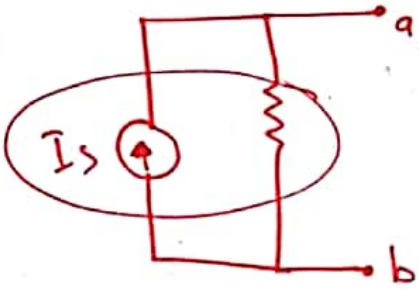


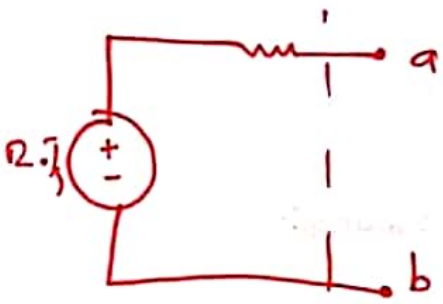
Scanned with CamScanner

Source Transformation









Linear property.