.

# EE1101: Circuits and Network Analysis

## Lecture 09: DC Circuit Analysis

August 18, 2025

**Topics :**

1. Mesh Analysis

2. Concept of Supermesh

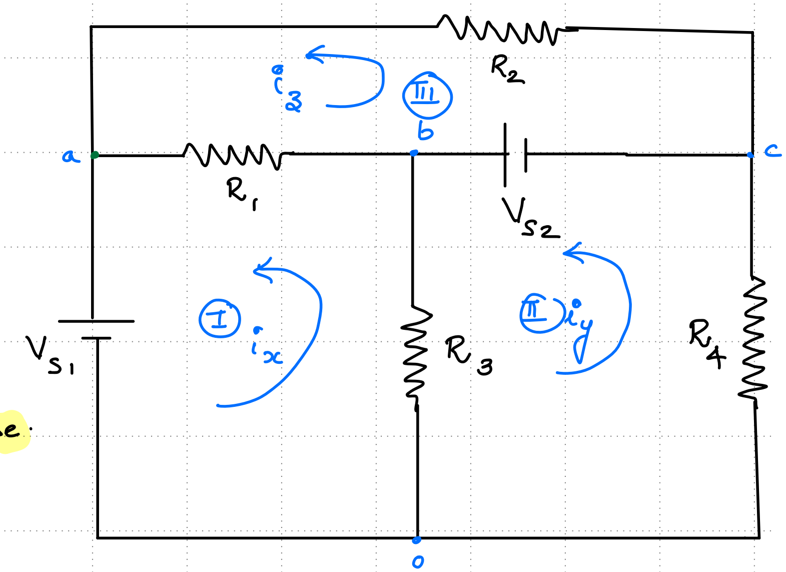
# Mesh Analysis - A Note on Convention

Variations in set of Equations

a) Choice of independent loops.

b) Convention → direction of mesh currents
↓
Prefer choosing current directions to be

uniformly $\begin{cases} \text{Counter clockwise.} \\ \text{or} \\ \text{Clockwise} \end{cases}$




$$\left.\begin{aligned}
&\text{for loop I}: && (R_1+R_3)\, i_x - R_3\, i_y - R_1\, i_3 = -V_{S_1} \\
&\text{for loop II}: && (R_3+R_4)\, i_y - R_3\, i_x = V_{S_2} \\
&\text{for loop III}: && (R_1+R_2)\, i_3 - R_1\, i_x = -V_{S_2}.
\end{aligned}\right\}$$

in matrix form: $[i] = [i_x, i_y, i_3]^t$

$$\underbrace{\begin{bmatrix} R_1+R_3 & -R_3 & -R_1 \\ -R_3 & R_3+R_4 & 0 \\ -R_1 & 0 & R_1+R_2 \end{bmatrix}}_{[Z]} \underbrace{\begin{bmatrix} i_x \\ i_y \\ i_3 \end{bmatrix}}_{[i]} = \underbrace{\begin{bmatrix} -V_{S_1} \\ V_{S_2} \\ -V_{S_2} \end{bmatrix}}_{[v]}$$

$[Z]\,[i] = [v].$

## Example - Use of Matrices in Mesh Analysis

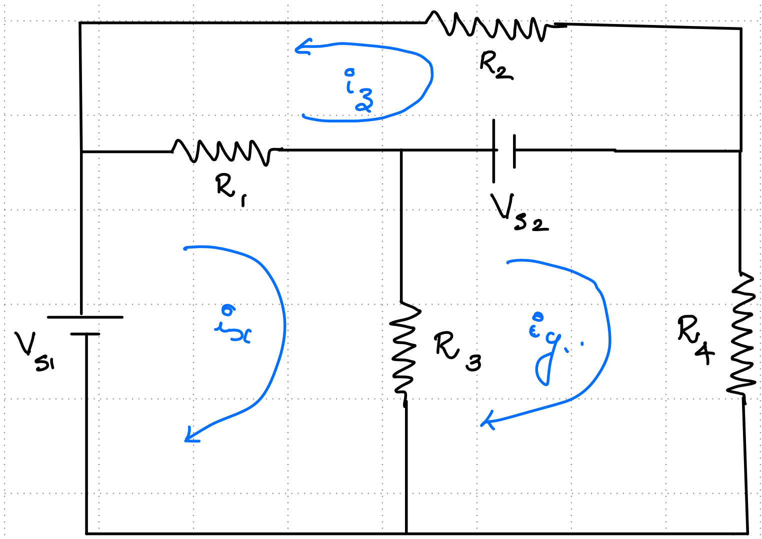
loop I : $-V_{s_1} + R_1(i_x + i_3) + R_3(i_x - i_y) = 0$

$$(R_1 + R_3)\, i_x + R_1 i_3 - R_3 i_y = V_{s_1}$$

loop II : $(R_3 + R_4)\, i_y - R_3 i_x = -V_{s_2}$

Loop III : $(R_1 + R_2)\, i_3 + R_1 i_x = -V_{s_2}$.

$$\begin{bmatrix} R_1+R_3 & -R_3 & +R_1 \\ -R_3 & R_3+R_4 & 0 \\ R_1 & 0 & R_1+R_2 \end{bmatrix} \begin{bmatrix} i_x \\ i_y \\ i_3 \end{bmatrix} = \begin{bmatrix} V_{s_1} \\ -V_{s_2} \\ -V_{s_2} \end{bmatrix}$$



## Mesh Analysis with Current Sources - Supermesh Concept

in the presence of a Current Source in a loop } Introduce a new Variable i.e., Voltage across the Current Source.

⇓

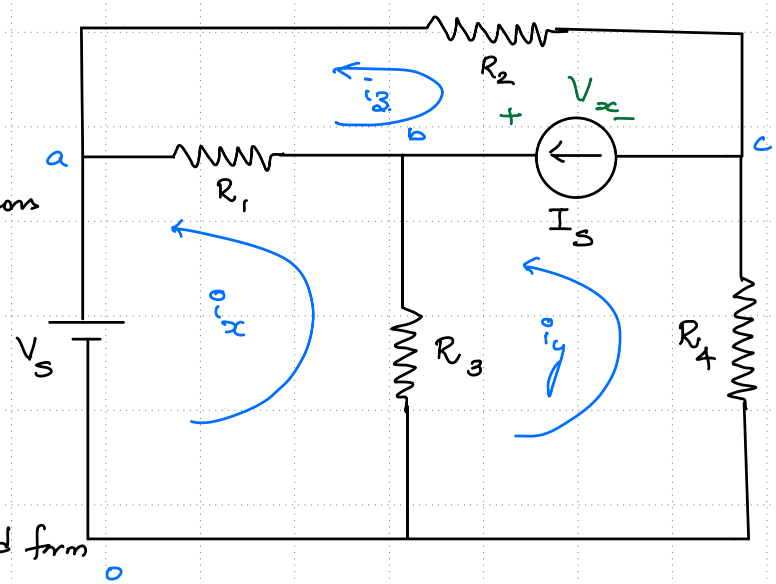
apply loop analysis in standard form

⇓

Combine the Eqn's to remove the V across the I Source.

⇓

Super mesh.




(1) ← for loop (I): $(R_1+R_3)i_x - R_1 i_3 - R_3 i_y = -V_s$

(2) ← for loop (II): $(R_3+R_4)i_y - R_3 i_x - V_x = 0$ ($V_x$ → unknown.)

(3) ← for loop (III): $(R_1+R_2)i_3 - R_1 i_x + V_x = 0$

4 unknowns, 3 Eqn's

(4) ← $4^{th}$ Eqn: $i_y - i_3 = I_s$. ← Current Eqn of super mesh.

from (2) & (3), eliminate $V_x$ ⇒ (2)+(3) ⇒ $\underbrace{-(R_1+R_3)i_x + (R_3+R_4)i_y + (R_1+R_2)i_3 = 0}$

Voltage Eqn of a super mesh.

Combining loop voltages in loops (II) & (III) but ignoring the drop across I Source.

Super mesh: o − c − a − b − o.