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EE1101: Circuits and Network Analysis

Lecture 08: DC Circuit Analysis

August 12, 2025

Topics :

1. Mesh Analysis

2. Concept of Supermesh

Mesh Analysis - Overview of the approach

Goal of any ckt Analysis tool :- To compute / solve the voltages & currents associated with various elem in the circuit.

In Mesh Analysis: → Compute the currents associated with the loops in the ckt.

↓

Not always the current through an element.

loop → Closed path.

Basic idea: Apply KVL in loops / mesh associated with the ckt.

→ Standard form: Typically in terms of voltage / potential difference.

↓

{ Try to express in terms of currents, wherever possible.

Claim:- if all loop currents are known

→ enough to compute (V, I, P) associated with every ckt element.

steps:- ① identify the no. of loops & indicate the unknown loop currents (m)

② set up 'm' LI Eqn's by using KVL.

Mesh Analysis - Overview of the approach

Can an element be a part of

a) Single loop : Yes

for choice 1 , 3 such elements.

for choice 2 No

b) two loops : Yes

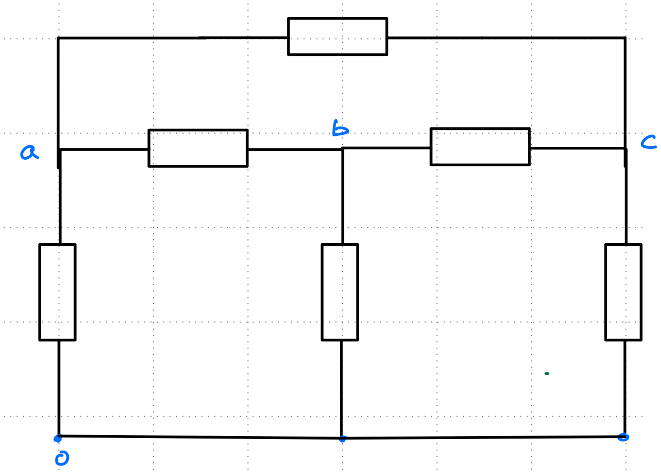
for choice 1 : 3 such elements.

for choice 2 : 4 such elements

c) more than two loops : Yes

for choice 3 : NO.

d) Not a part of any loop:

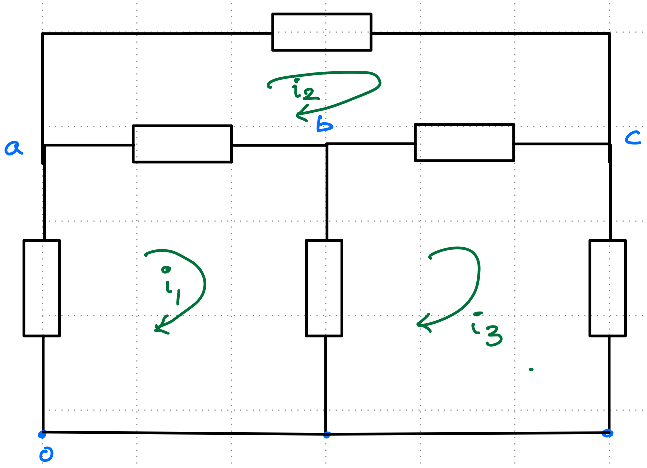


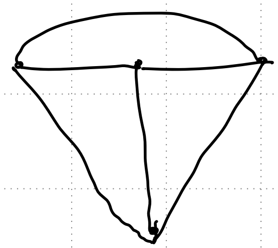
Choice 1.
- loop 1 : o - a - b - o : i_1
- loop 2 : a - c - b - a. : i_2
- loop 3 : o - b - c - o : i_3

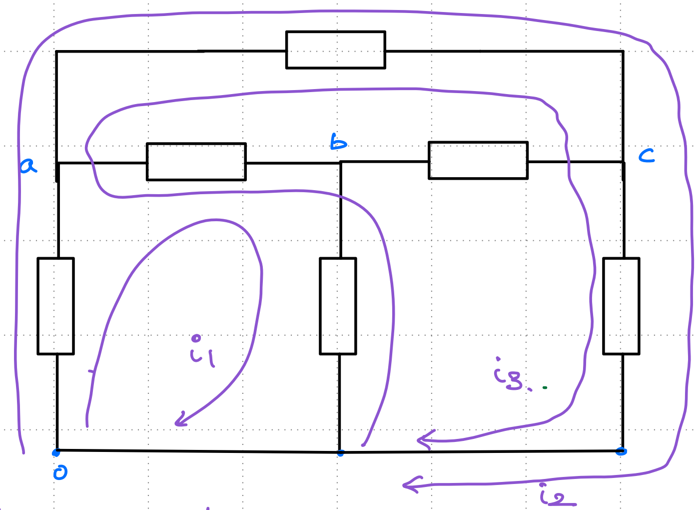
Choice 2 :
- loop 1 : o - a - b - o : i_1
- loop 2 : o - a - c - o : i_2
- loop 3 : o - b - a - c - o : i_3.

Choice 3 :
- loop 1 : o - a - b - o :
- loop 2 : o - a - b - c - o :
- loop 3 : o - a - c - o :

Mesh Analysis - Overview of the approach







Choice 1.

- loop 1 : 0 – a – b – 0 : i_1
- loop 2 : a – c – b – a : i_2
- loop 3 : 0 – b – c – 0 : i_3

Choice 2 :

- loop 1 : 0 – a – b – 0 : i_1
- loop 2 : 0 – a – c – 0 : i_2
- loop 3 : 0 – b – a – c – 0 : i_3

$i_{oa} = i_1$

$i_{ab} = i_1 - i_2$

$i_{bc} = i_3 - i_2$

$i_{ac} = i_2$

$i_{bo} = i_1 - i_3$

$i_{co} = i_3$

Currents through branches that are a part of atleast one loop.

$i_{oa} = i_1 + i_2$

$i_{ab} = i_1 - i_3$

$i_{bc} =$ → Not a part of any loop.

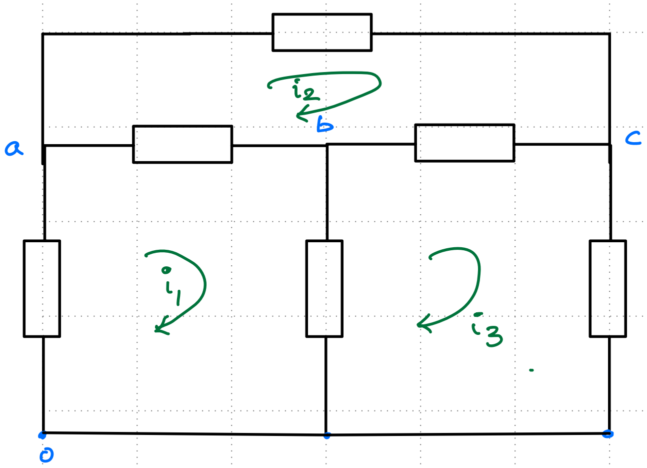
can be computed by applying KCL at node c

$i_{ac} = i_2 + i_3$

$i_{bo} = i_1 - i_3$

$i_{co} = i_2 + i_3$

Mesh Analysis - Overview of the approach



Choice 1.

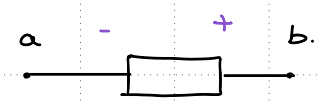
$$\begin{cases} \text{loop 1: } o-a-b-o : i_1 \\ \text{loop 2: } a-c-b-a : i_2 \\ \text{loop 3: } o-b-c-o : i_3 \end{cases}$$

$$\left.\begin{aligned} i_{oa} &= i_1 \\ i_{ab} &= i_1 - i_2 \\ i_{bc} &= i_3 - i_2 \\ i_{ac} &= i_2 \\ i_{bo} &= i_1 - i_3 \\ i_{co} &= i_3 \end{aligned}\right\} \text{Currents through branches that are a part of atleast one loop.}$$

Step 1: Mark loops

Step 2: write KVL.

2a)



→ Part of a loop

$$\underbrace{\quad}_{\sum V} \; -\underbrace{a-b}_{?}- \; \underbrace{\quad}_{\sum V = 0}$$

a) if its a Resistor $V_{ab} = R(i_{ab})$ → $\sum i_i$

b) if its a Voltage Source $V_{ab} = \pm V_s$.

c) if its a Current Source: $V_{ab} = ?$

$I_{ab} = \sum i_i$ } Super mesh.

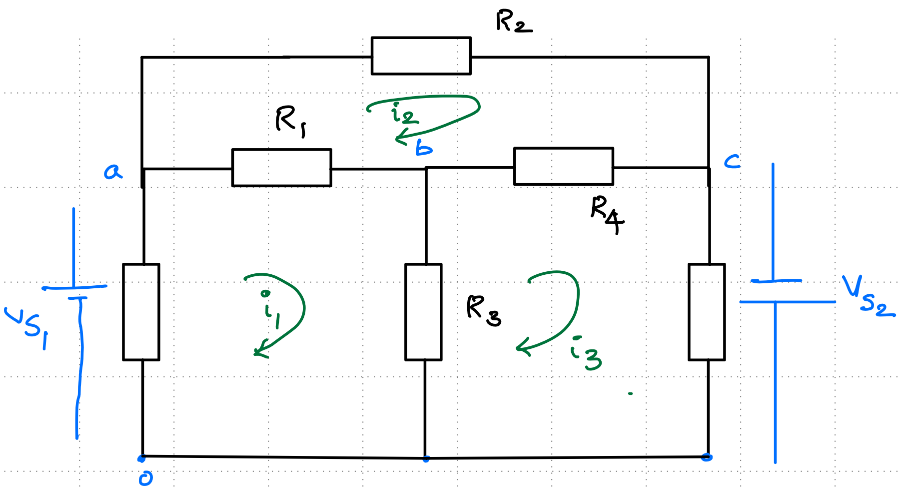
2b) formal application of KVL:

loop 1: $V_{oa} + V_{ab} + V_{bo} = 0$

loop 2: $V_{ac} + V_{cb} + V_{ba} = 0$

loop 3: $V_{ob} + V_{bc} + V_{co} = 0$

Mesh analysis with ~~current~~ Voltage sources and resistors



loop 1 :- $-V_{S_1} + R_1(i_1 - i_2) + R_3(i_1 - i_3) = 0$

$$(R_1+R_3)\,i_1 - R_1 i_2 - R_3 i_3 = V_{S_1}$$

loop 2 :- $R_2 i_2 + R_4(i_2 - i_3) + R_1(i_2 - i_1) = 0$

$$(R_2 + R_1 + R_4)\,i_2 - R_4 i_3 - R_1 i_1 = 0$$

loop 3 :- $R_3(i_3 - i_1) + R_4(i_3 - i_2) - V_{S_2} = 0$

$$(R_3+R_4)\,i_3 - R_3 i_1 - R_4 i_2 = V_{S_2}$$

$$\underbrace{\begin{bmatrix} R_1+R_3 & -R_1 & -R_3 \\ -R_1 & R_2+R_1+R_4 & -R_4 \\ -R_3 & -R_4 & R_3+R_4 \end{bmatrix}}\begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} V_{S_1} \\ 0 \\ V_{S_2} \end{bmatrix}$$

$$[Z][I] = [V]$$