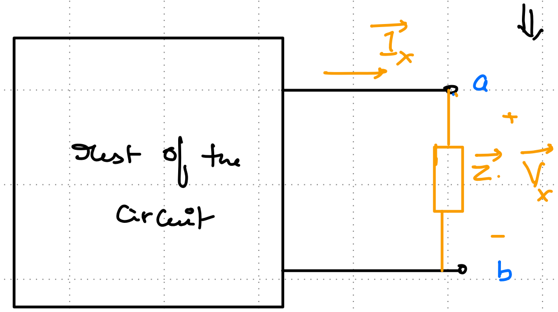
Lecture- 32
17/10/25

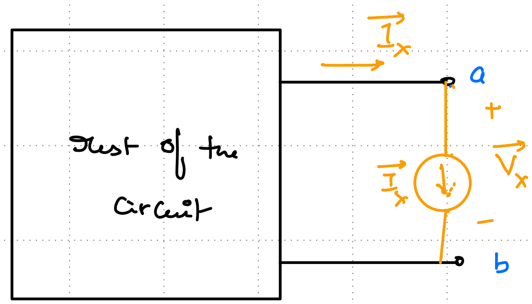
Thevenin's Theorem

given: A circuit where its sufficient to find the response associated with a particular elem (or) pair of terminals (single or a combination of elem can be connected across it)

⇓



Goal is to find response associated with a−b ($\vec{V}_x$, $\vec{I}_x$)



Step 1: Make use of substitution theorem

Replace $\vec{Z}$ with a Current Source $\vec{I}_x$

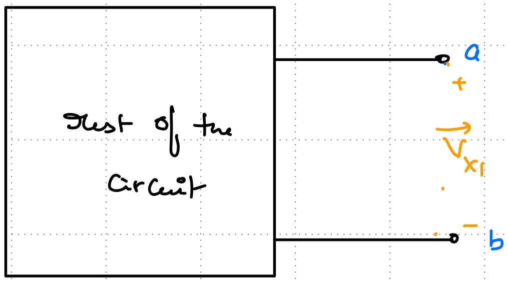
$\vec{I}_x$ is unknown

If $\vec{V}_x$ can be computed, $\vec{I}_x = \dfrac{\vec{V}_x}{\vec{Z}}$

Step 2: Use superposition theorem

$\vec{V}_x$ = Sum of voltages obtained from solving 2 ckts.

Thevenin's Theorem



Sub ckt ①

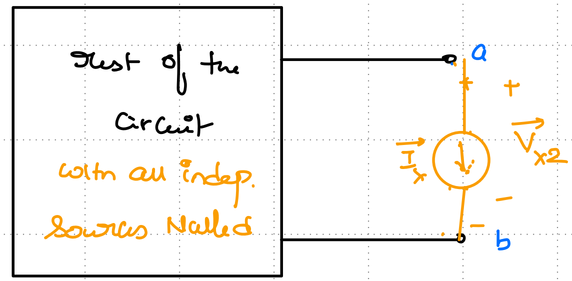
↓

all sources in the n/w except $\vec{I}_x$

($\vec{V}_{x_1}$ = open ckt voltage of port a-b)

⇓

$\vec{V}_{Th}$ ⟶ Thevenin Voltage



Sub ckt ②

↓

$\vec{V}_{x_2} = -\vec{Z}_{eq} \cdot \vec{I}_x$

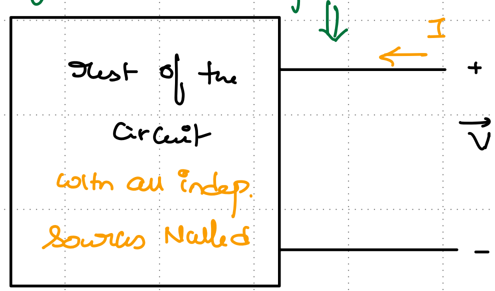
↓

Equivalent i/p imp of the port

$\vec{Z}_{th}$ ⟶ Thevenin impedance.

Ref for computing Z_{th} :-

⇓



$Z_{eq} = \dfrac{\vec{V}}{\vec{I}}$

Step 2: Use superposition theorem

$$\vec{V}_x = \vec{V}_{x_1} + \vec{V}_{x_2}$$

$$\vec{V}_x = \vec{V}_{Th} - \vec{Z}_{th}\vec{I}_x \longrightarrow ②$$

Step 3: Simplification

$$\vec{V}_x = \vec{I}_x \vec{Z} \longrightarrow ③$$

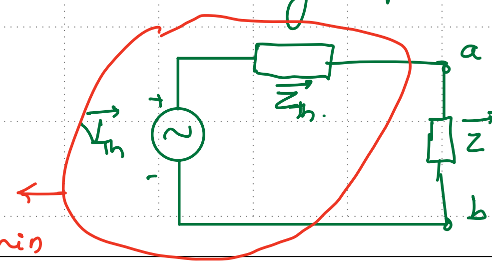
Sub ③ in ②

$$\vec{I}_x \vec{Z} = \vec{V}_{Th} + \vec{Z}_{th}\vec{I}_x$$

or $$\vec{I}_x = \frac{\vec{V}_{Th}}{\vec{Z} + \vec{Z}_{th}} \longrightarrow \text{I}$$

and $$\vec{V}_x = \frac{\vec{V}_{Th}}{\vec{Z} + \vec{Z}_{th}} \times \vec{Z} \longrightarrow \text{II}$$

Eq (I) & (II) can be combined into following Eq. ckt

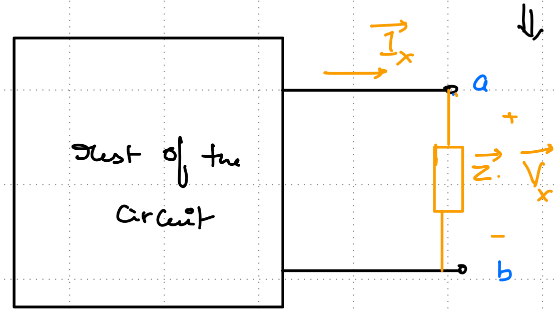


Thevenin Eqt of the RoC.

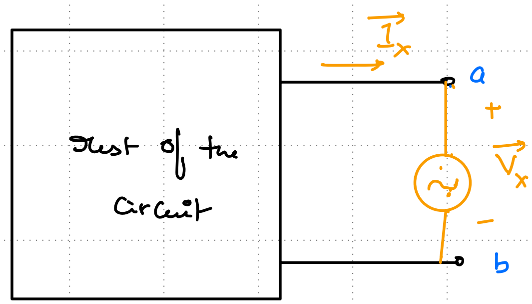
Norton's
~~Thevenin~~'s Theorem

given: A circuit where its sufficient to find the response associated with a particular elem (or) pair of terminals (single or a combination of elem can be connected across it)

$\Downarrow$



goal is to find response associated with a−b ($\vec{V_x}$, $\vec{I_x}$)



Step 1: Make use of substitution theorem

Replace $\vec{Z}$ with a voltage source $\vec{V_x}$

$\downarrow$

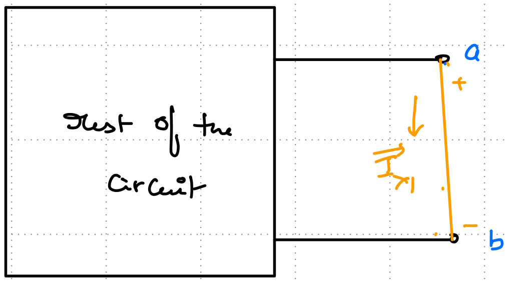
unknown

If $\vec{I_x}$ can be comp, $\vec{V_x} = Z\vec{I_x}$

Step 2: use superposition theorem

$\vec{I_x}$ = Sum of currents obtained from solving 2 ckts.

Thevenin's Theorem



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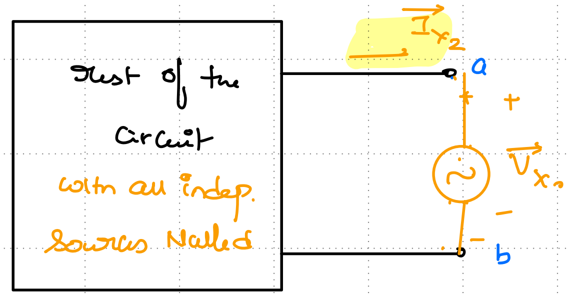

Sub ckt ①
↓
all Sources in the N/w except $\vec{V}_x$

($\vec{I}_{x_1}$ = Short Circuit Current of Port a-b)
⇓
$\vec{I}_N \rightarrow$ Norton Current

Sub ckt ②
↓
$\vec{I}_{x_2} = -\dfrac{\vec{V}_x}{\vec{Z}_{eq}}$
↓ ($\vec{Z}_{eq}$)
Equivalent input impedance the port

$\vec{Z}_{eq} \rightarrow \vec{Z}_N \rightarrow$ Norton imp
||
Thevenin imp

Step 2 : use Superposition theorem

$\vec{I}_x = \vec{I}_{x_1} + \vec{I}_{x_2}$

$\vec{I}_x = \vec{I}_N - \dfrac{\vec{V}_x}{\vec{Z}_N} \rightarrow ①$

Step 3 : Simplification

$\vec{I}_x = \dfrac{\vec{V}_x}{\vec{Z}} \rightarrow ②$

using ① & ②

$\dfrac{\vec{V}_x}{\vec{Z}} = \vec{I}_N - \dfrac{\vec{V}_x}{\vec{Z}_N}$

$\vec{I}_N = \dfrac{\vec{V}_x}{\vec{Z}} + \dfrac{\vec{V}_x}{\vec{Z}_N}$

Norton Eq. ckt. →