EE101ME – Electric Circuits

Thevenin's Theorem

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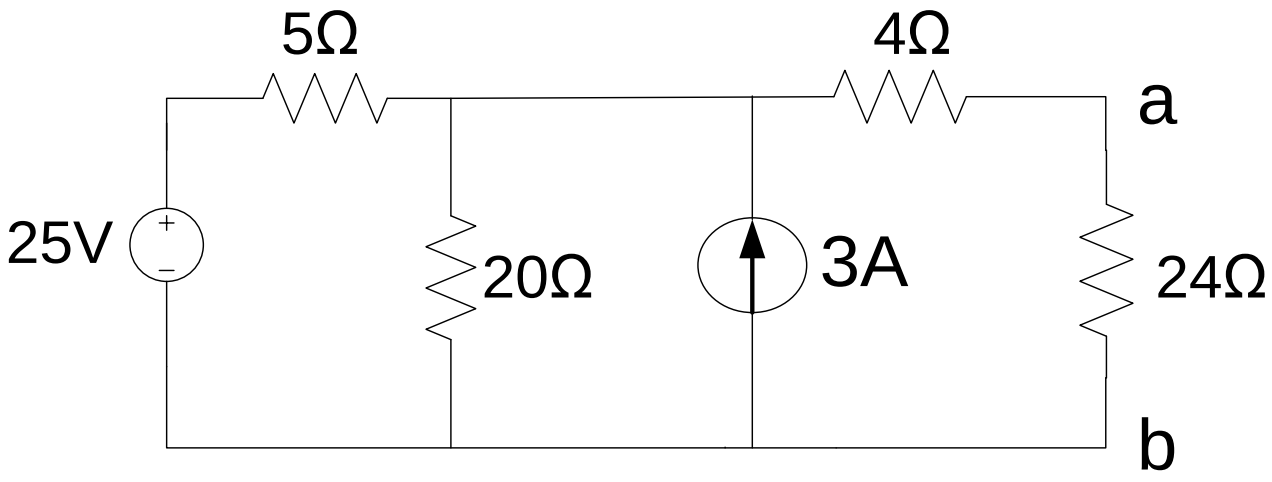
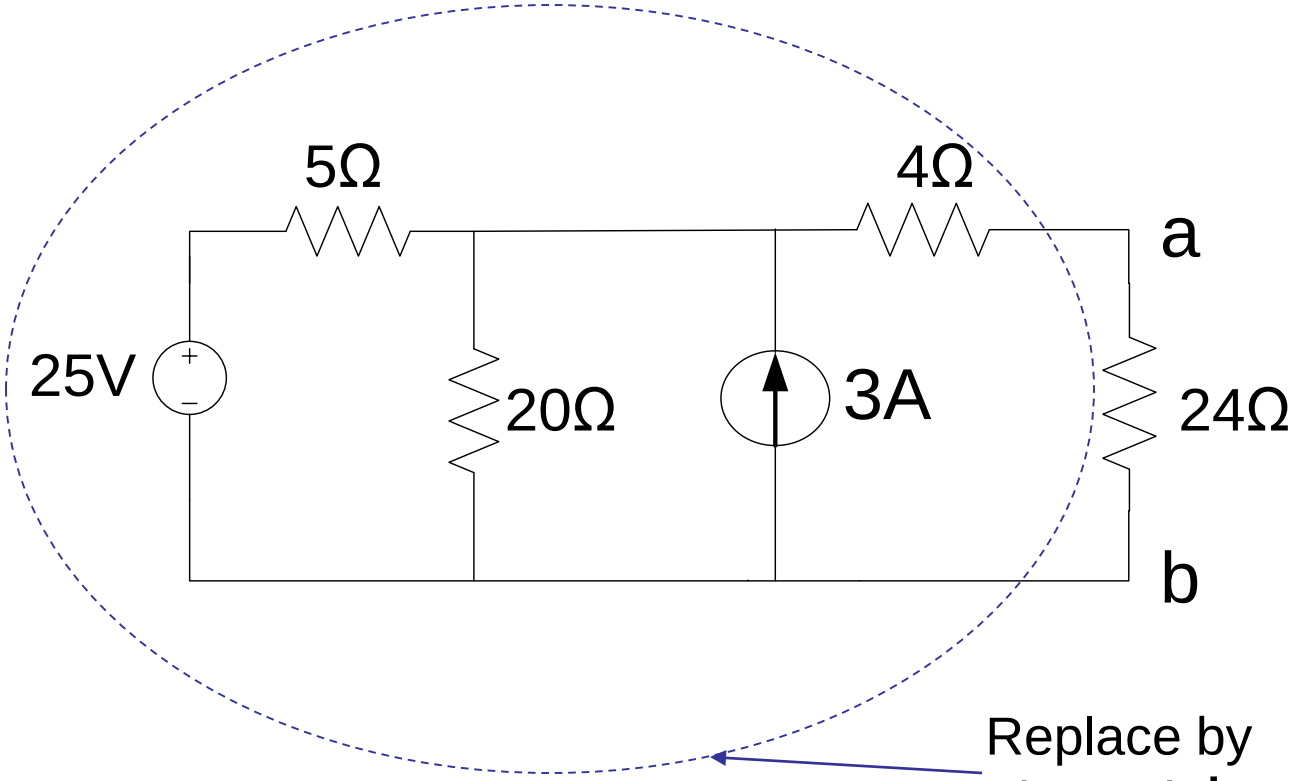
Theorem : Any two-node linear network (circuit) may be replaced by a voltage source equal to the open circuit voltage between the nodes in series with the resistance as seen by a load at this port

Find voltage V_{ab} across a-b (24Ω resistor or load) using Thevenin's theorem.

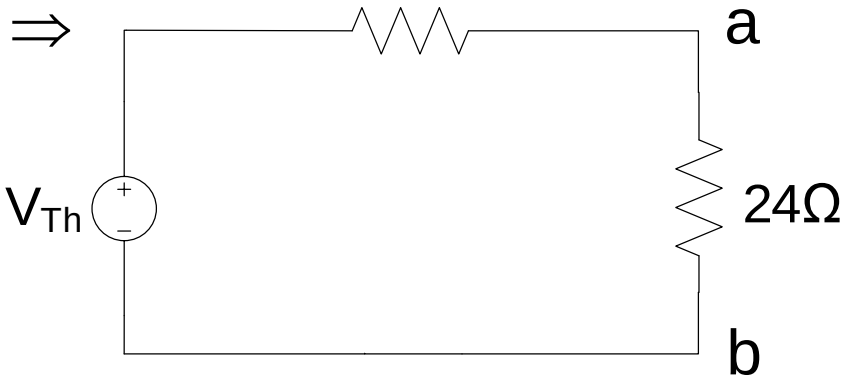




Replace by
Thevenin's Equivalent Circuit

$R_{th}=R_{eq}$

$\Rightarrow$

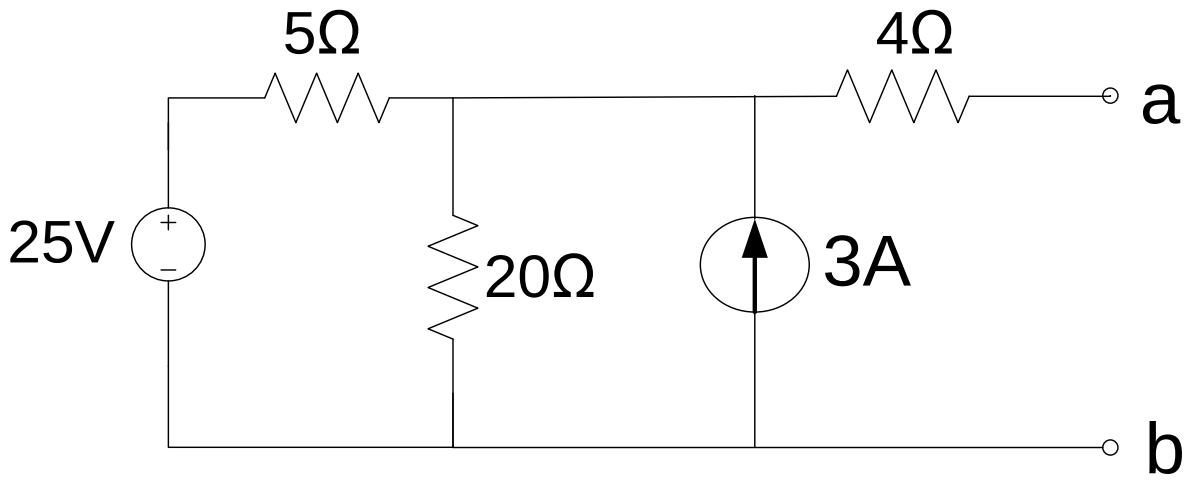


Thevenin's Equivalent Circuit

V_{Th} – Open circuit voltage across a-b

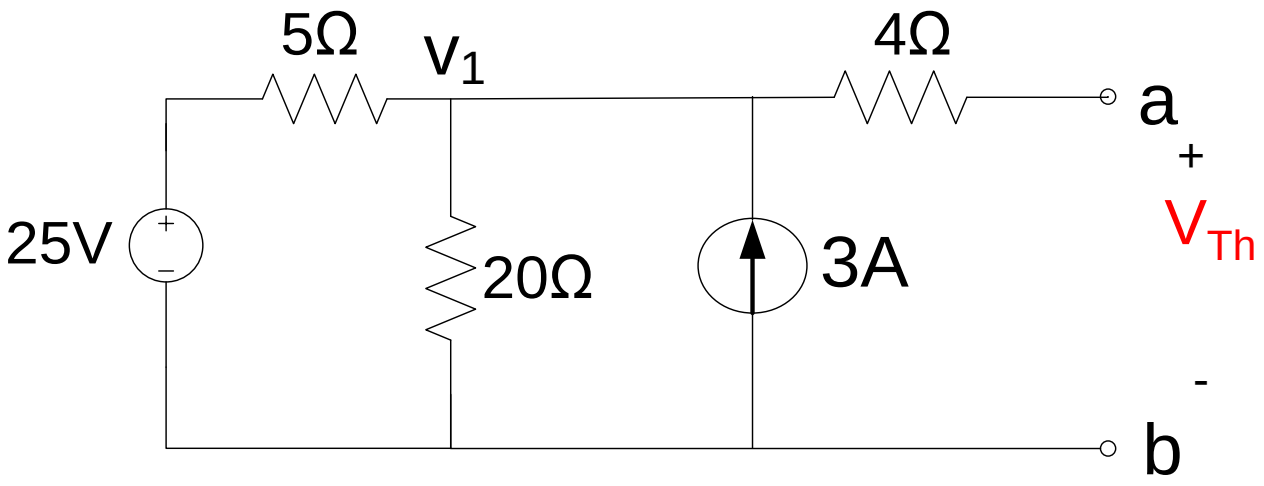
$R_{th} = R_{eq}$ - Equivalent Resistance as seen by the load after deactivating all independent sources (setting to 0)

1. Open Circuit at nodes (terminals) a-b



V_{Th}

$V_{Th} = v_1$



Applying nodal analysis,

$$\frac{v_1 - 25}{5} + \frac{v_1}{20} = 3$$

$$v_1 = 32V$$

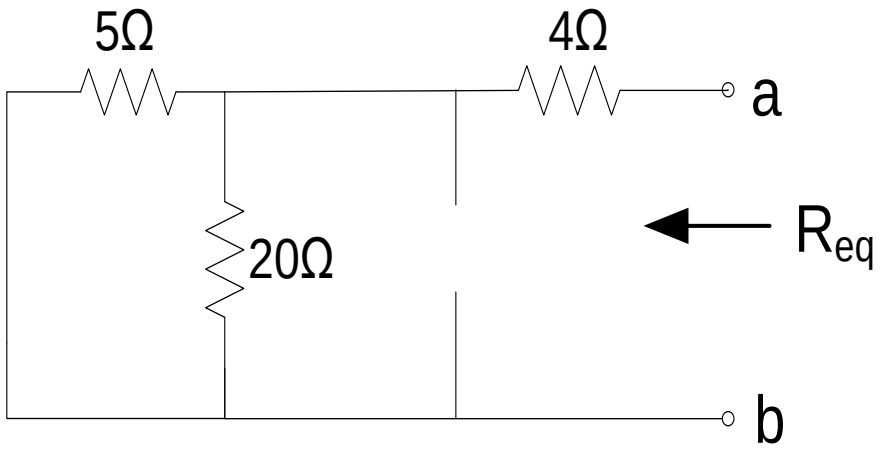
$$v_{Th} = 32V$$

$R_{eq} = R_{th}$

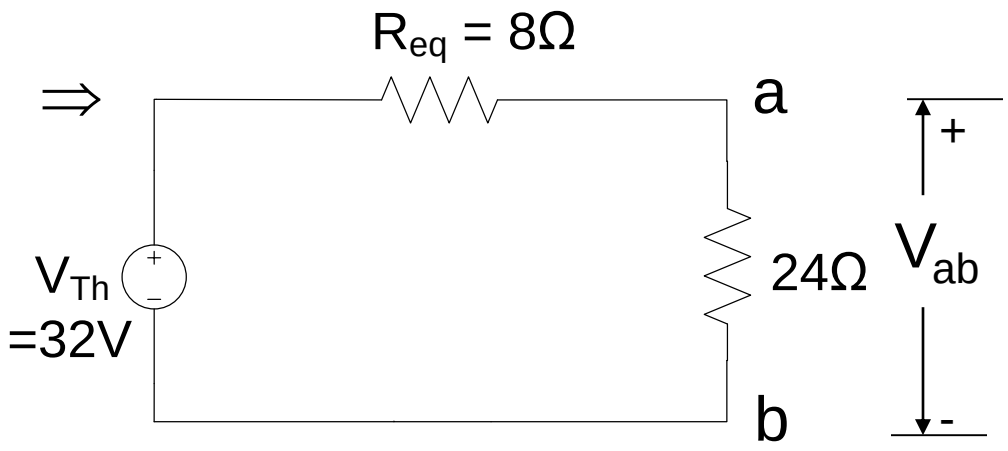
- Deactivate all independent sources (SET to 0)

✓Voltage sources – short circuit

✓Current sources – Open circuit

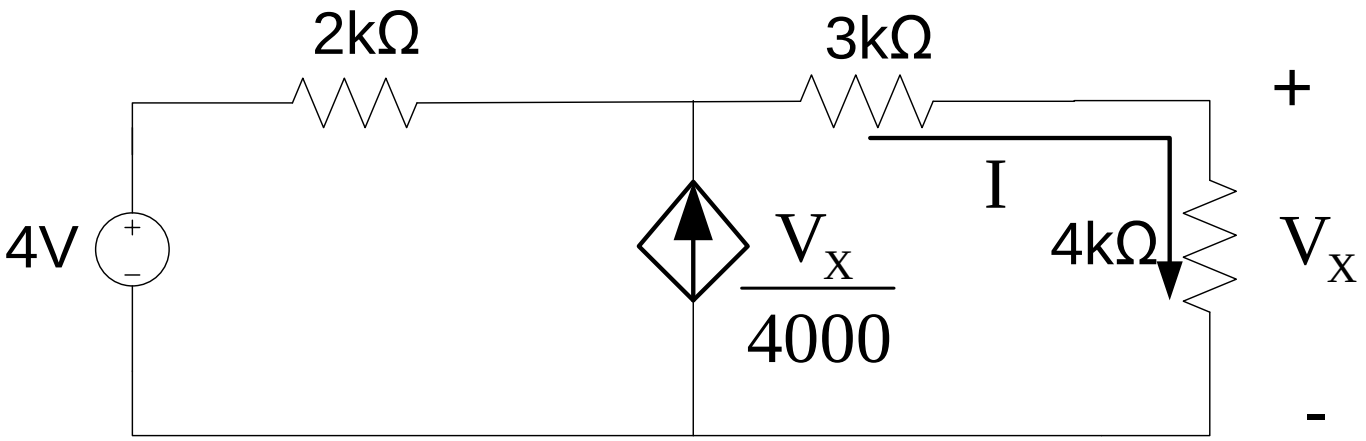


$$R_{eq} = 4 + 20 \| 5 = 4 + 4 = 8\Omega$$



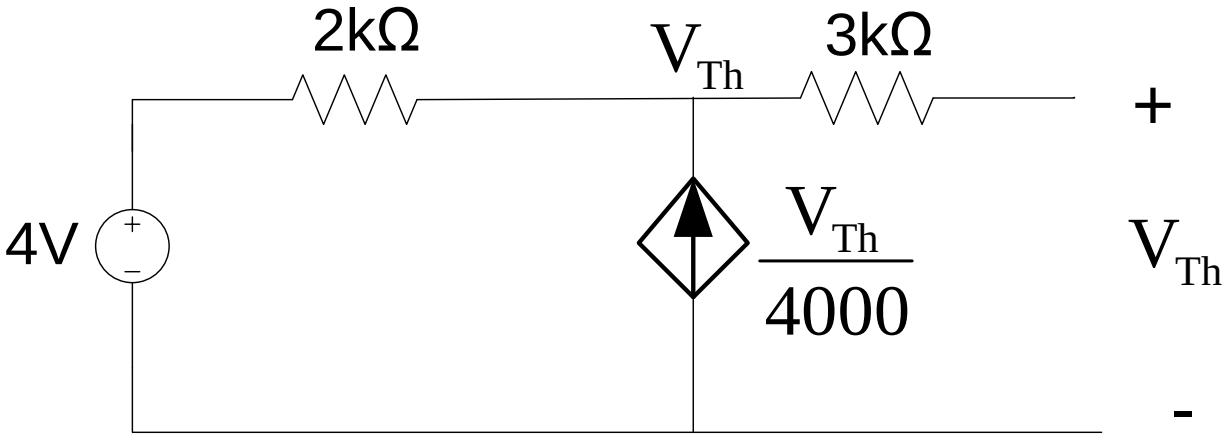
$$V_{ab} = 32 \times \frac{24}{24+8} = 24\text{V}$$

Find I (current through 4kΩ) applying Thevenin's Theorem



Solution V_{Th}

1. Open Circuit the 4kΩ resistance



Applying nodal analysis,

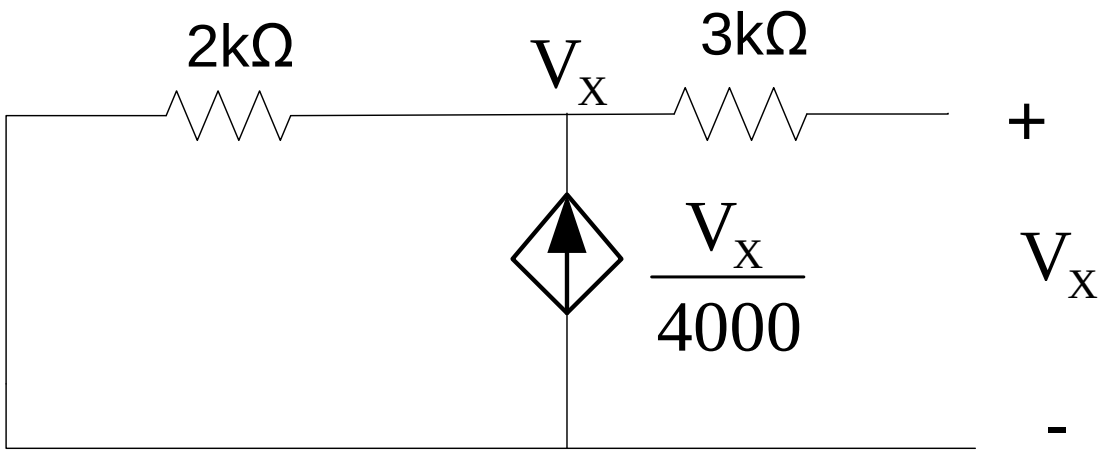
$$\frac{V_{Th} - 4}{2000} = \frac{V_{Th}}{4000}$$

$$\text{or, } 2V_{Th} - 8 = V_{Th}$$

$$V_{Th} = 8V$$

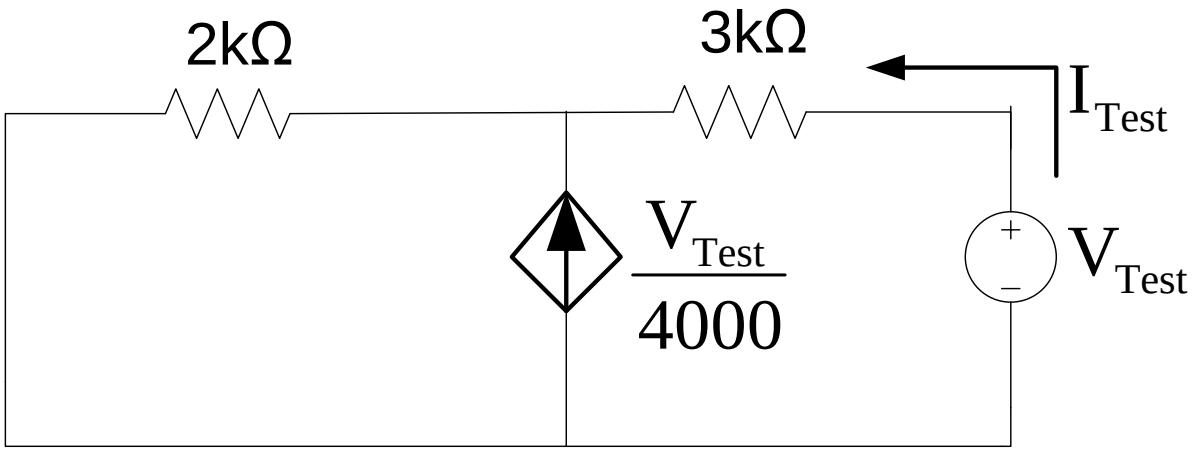
R_{eq}

1. Deactivate the independent sources



You must NOT deactivate DEPENDENT source(s)

1. Apply a test voltage V_{Test}



Applying nodal analysis,

$$I_{Test} + \frac{V_{Test}}{4000} = \frac{\left(V_{Test} - I_{Test} \times 3000\right)}{2000}$$

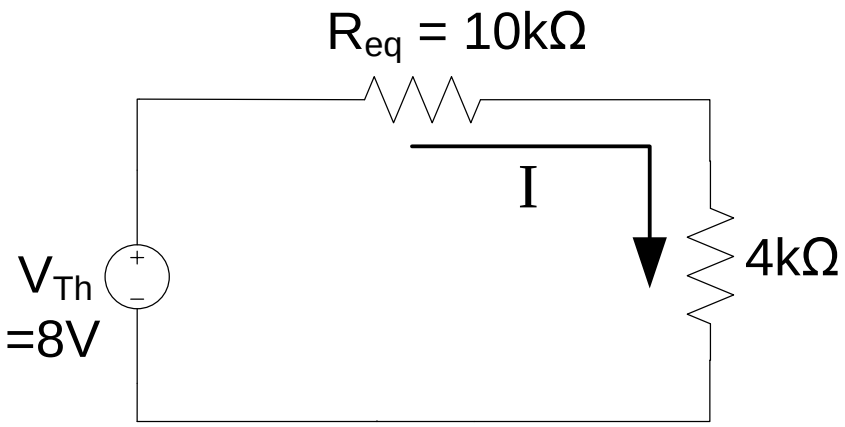
$$4000I_{Test} + V_{Test} = 2V_{Test} - 6000I_{Test}$$

$$V_{Test} = 10000I_{Test}$$

$$\frac{V_{Test}}{I_{Test}} = 10000 = 10k\Omega$$

$$R_{eq} = 10k\Omega$$

Thevenin's Equivalent Circuit



Current through the 4 kΩ resistor becomes

$$I = \frac{8}{10+4} = 0.571\text{mA}$$

END