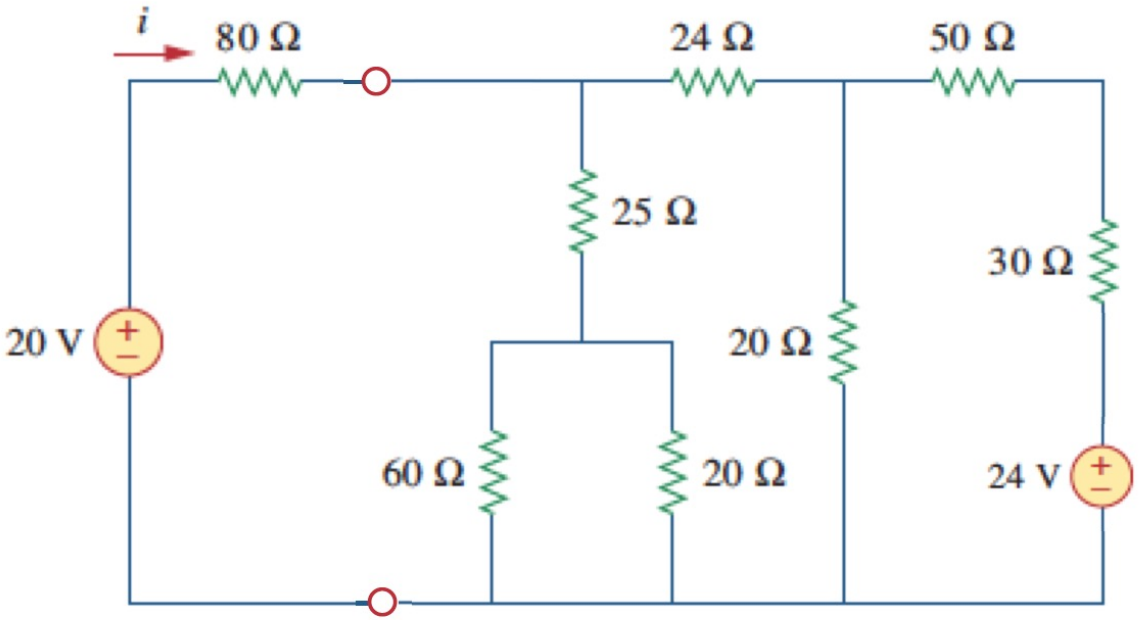
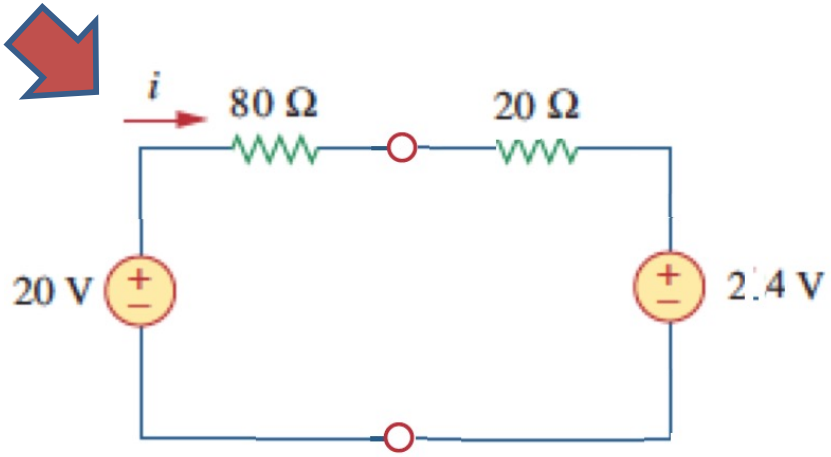
Lecture 25
Theorems – 2 of 6

Thévenin

Thévenin Models

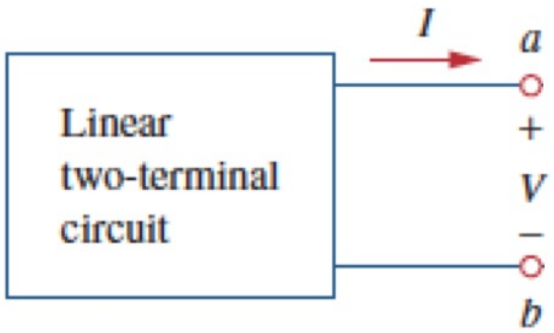
- Application – recall combining transformations and series/parallel methods from the last class:

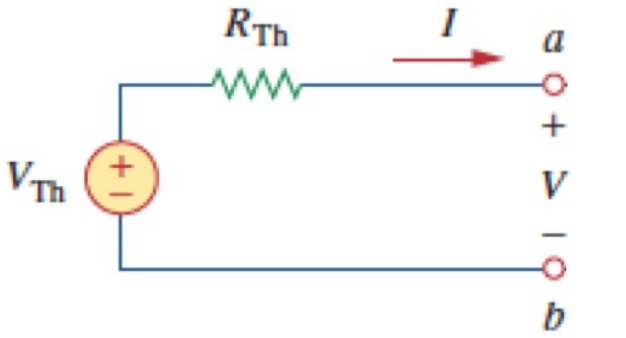




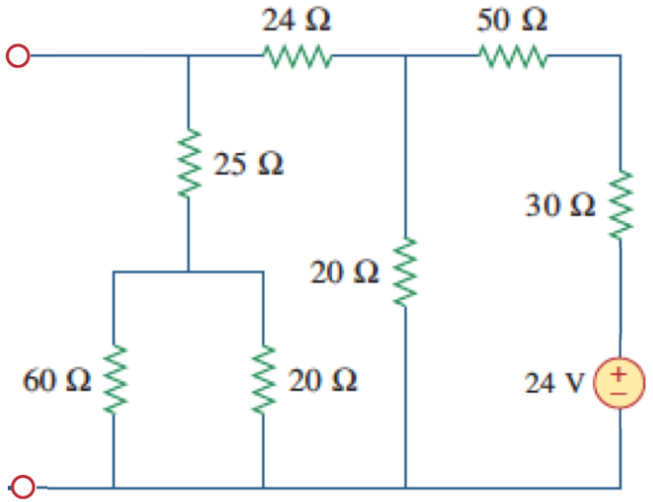
Thévenin equivalent circuit ≡ electrical equivalence at any pair of terminals

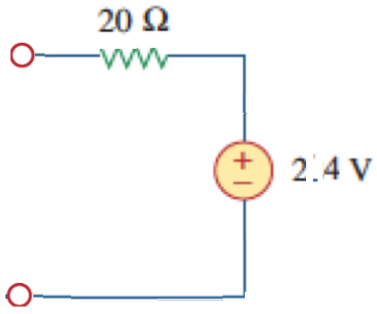
- 2 parameters:
  - V_{Th}
  - R_{Th}





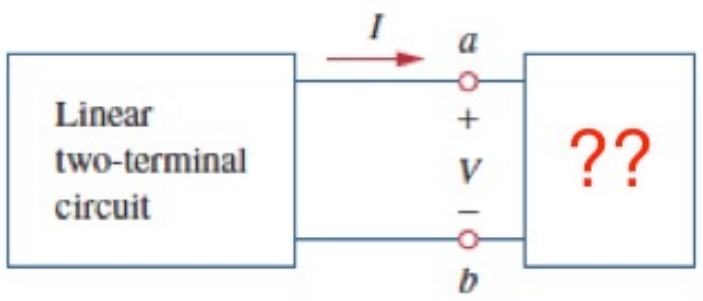
- Example:



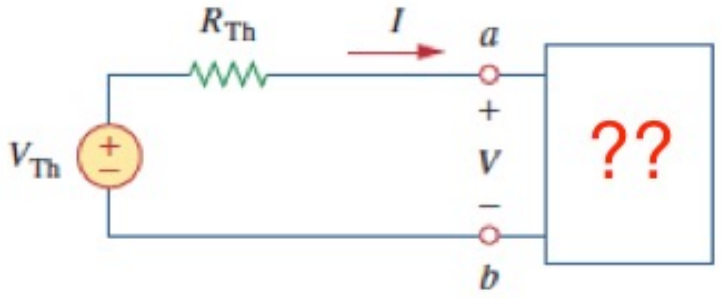


How to find V_{Th} and R_{Th} ?

- Concept: both the circuit and the model should behave the same way **no matter what** is connected at a-b



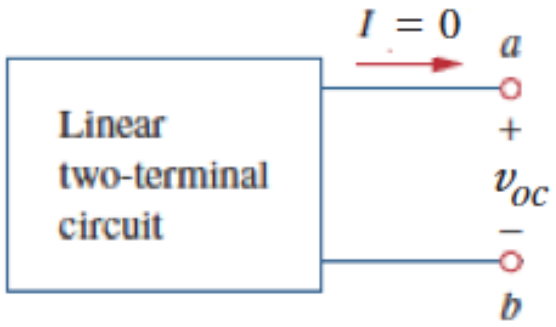
  - With only 2 variables in the model, we need only check **2** load situations



  - Need only match one of the V or I variables in each

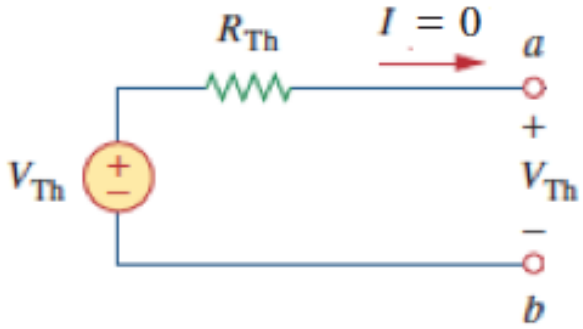
Thévenin: the most common approach

- Connect nothing – "open circuit" test
  - Just need a voltmeter



Clearly

$$V_{Th} = V_{OC}$$

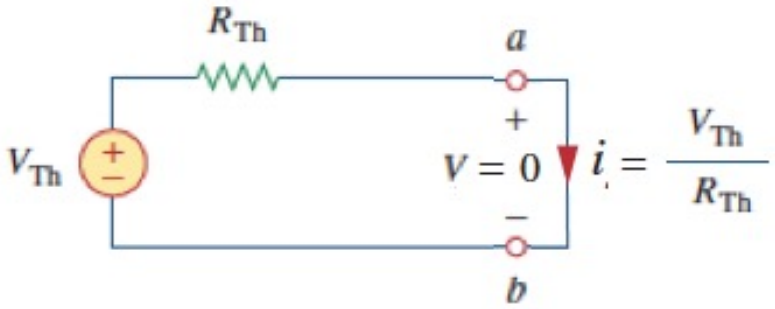


Another popular approach

- Connect a wire – "short circuit" test
  - Popular for paper analysis

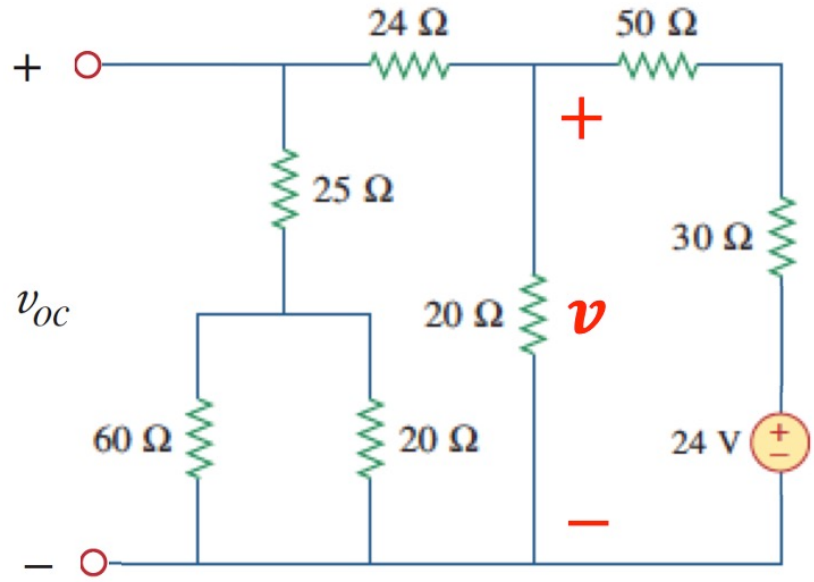
$$i_{SC} = \frac{V_{Th}}{R_{Th}}$$

So



$$R_{Th} = \frac{V_{Th}}{i_{SC}} = \frac{V_{OC}}{i_{SC}}$$

Example:



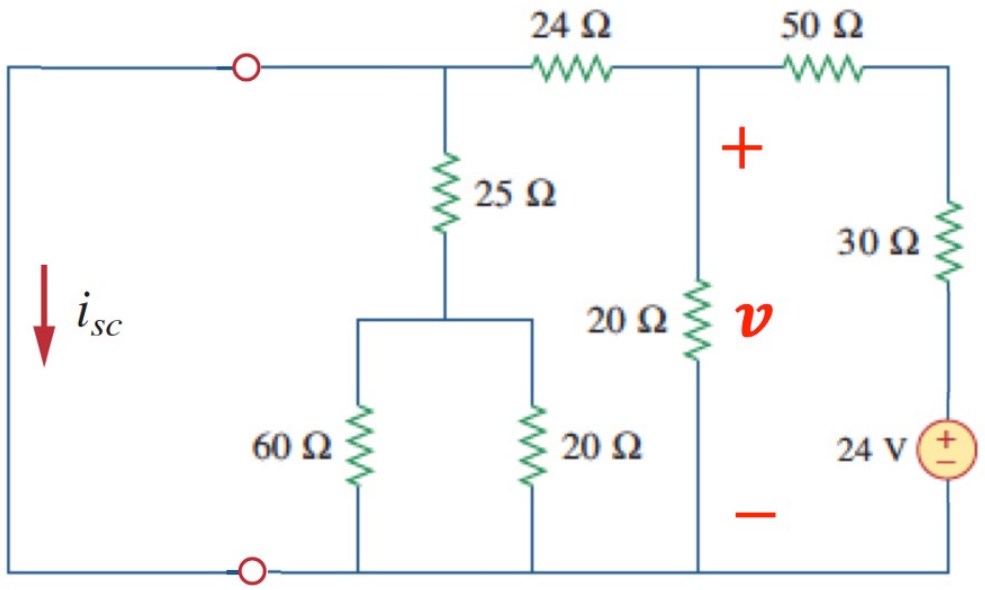
- Use node analysis:

$$\frac{v}{20}+\frac{v-24}{80}+\frac{v}{64}=0 \quad \Rightarrow \quad v=\frac{96}{25}$$

- Then voltage division:

$$v_{OC}=\frac{40}{64}v \quad \Rightarrow \quad V_{Th}=v_{OC}=2.4 \text{ volts}$$

Note how the short changes the circuit



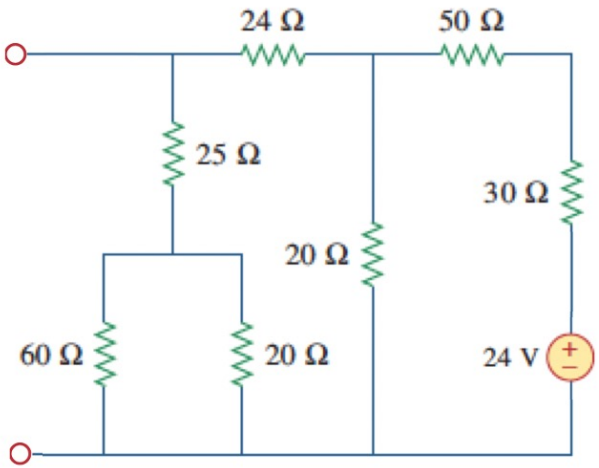
- Use node analysis:

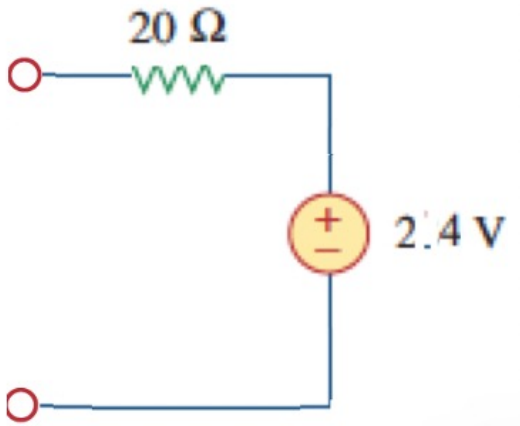
$$\frac{v}{20}+\frac{v-24}{80}+\frac{v}{\mathbf{24}}=0 \quad \Rightarrow \quad v=\frac{72}{25}$$

- Then Ohm's Law:

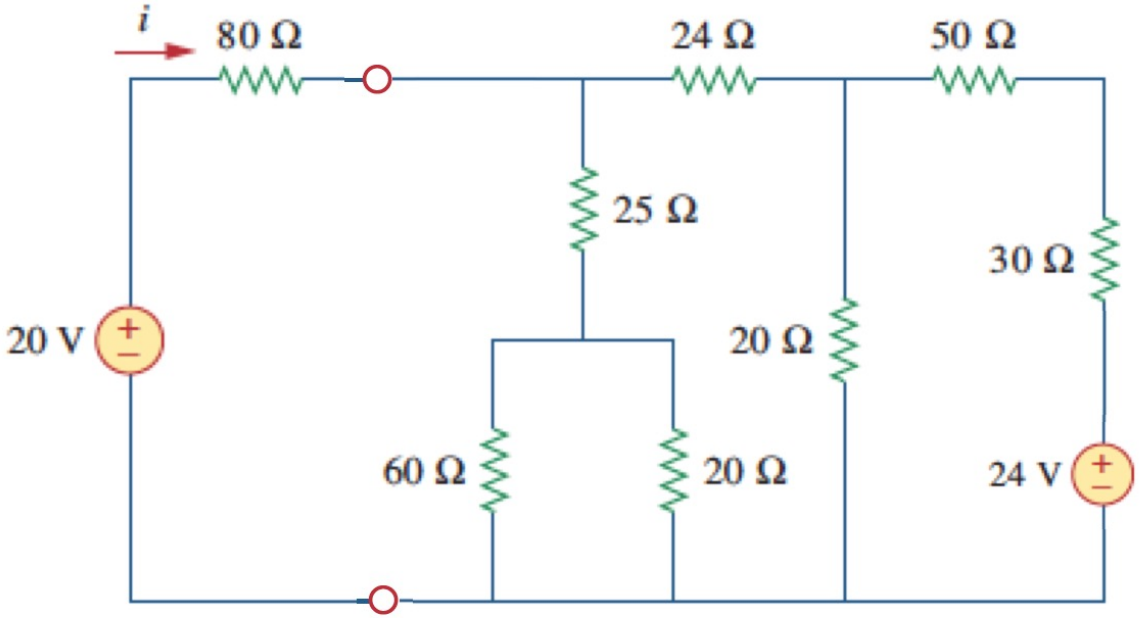
$$i_{SC}=\frac{v}{24}=0.12 \quad \Rightarrow \quad R_{Th}=\frac{v_{OC}}{i_{SC}}=\frac{2.4}{0.12}=20\ \Omega$$

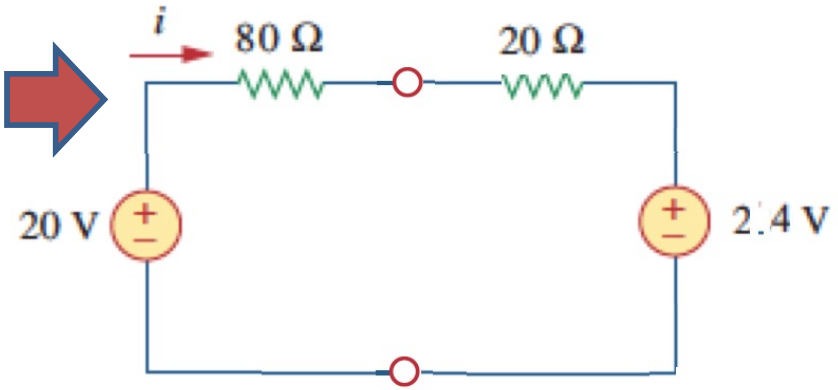
So $V_{Th} = 2.4$ volts and $R_{Th} = 20\ \Omega$





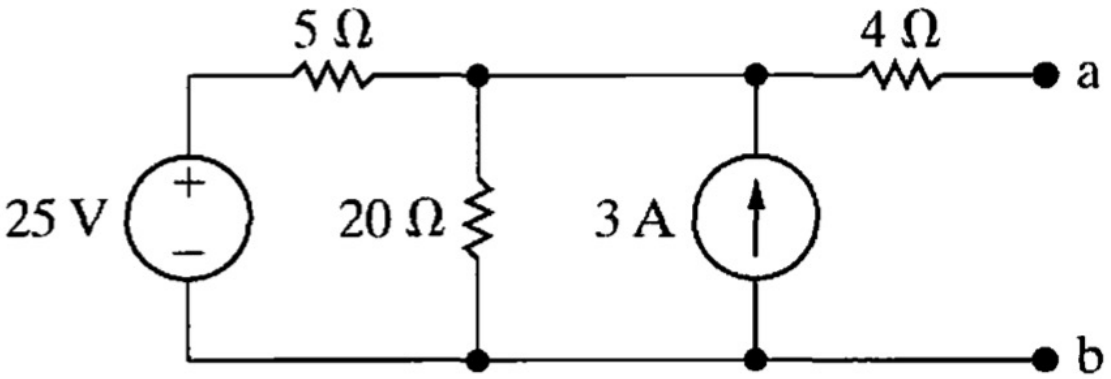
and

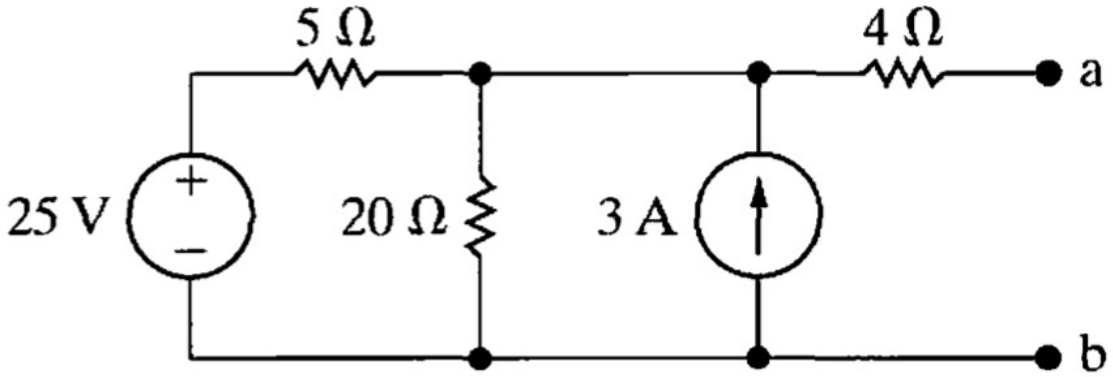




$$V_{Th} = v_{OC}$$
$$R_{Th} = \frac{v_{OC}}{i_{SC}}$$

Example: find V_{th} and R_{Th}

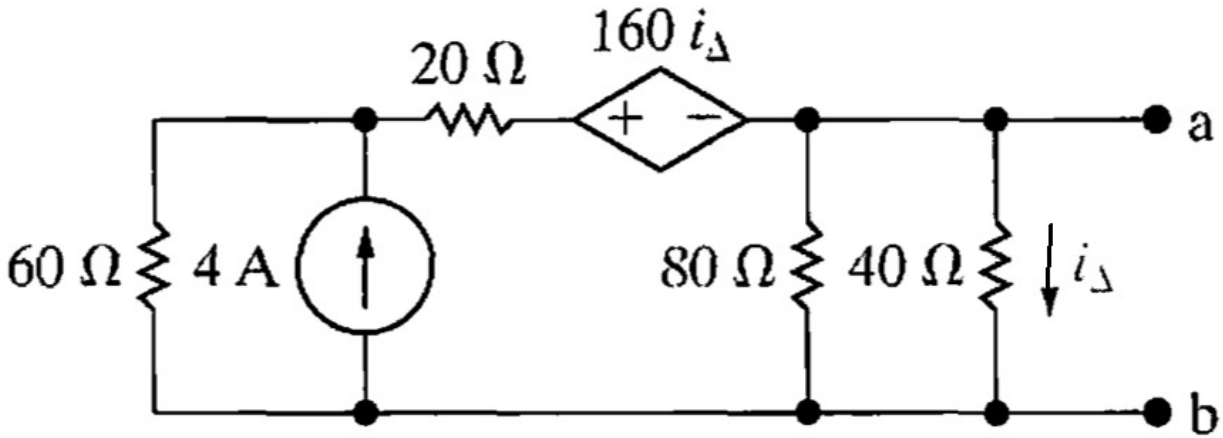


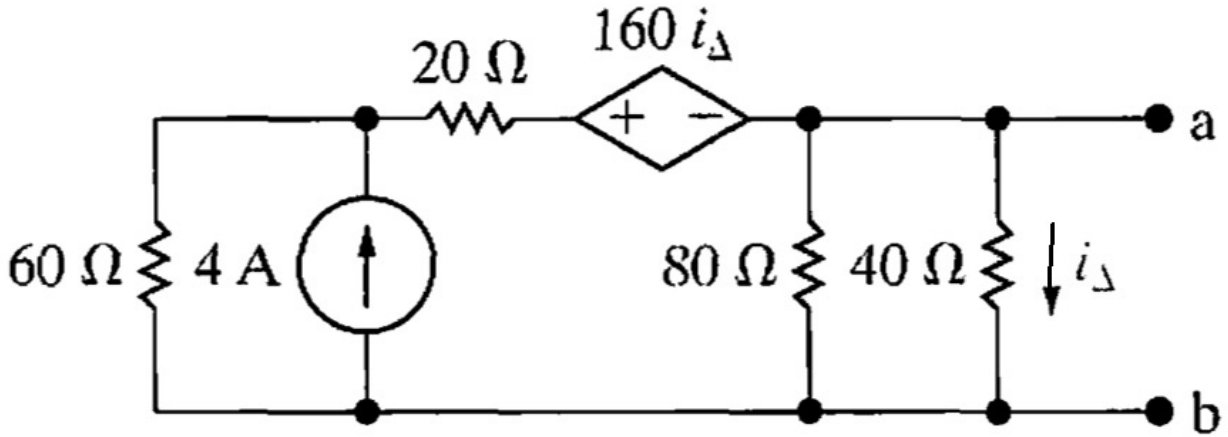


$32\ V, 8\ \Omega$

$$V_{Th} = v_{OC}$$
$$R_{Th} = \frac{v_{OC}}{i_{SC}}$$

Example: find V_{th} and R_{Th}

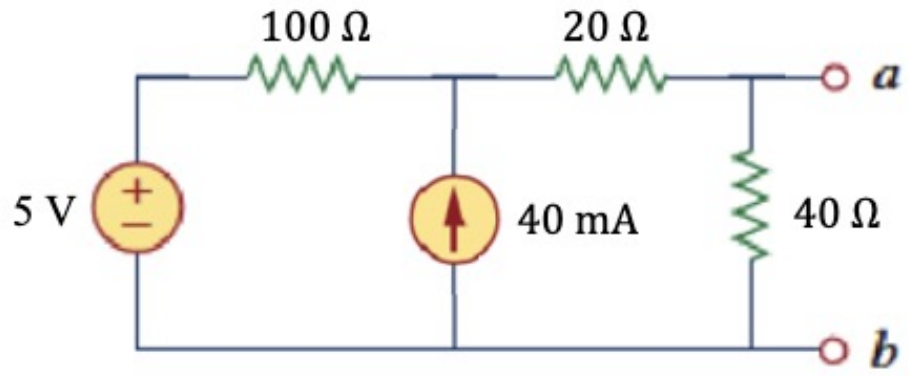




$30\ V, 10\ \Omega$

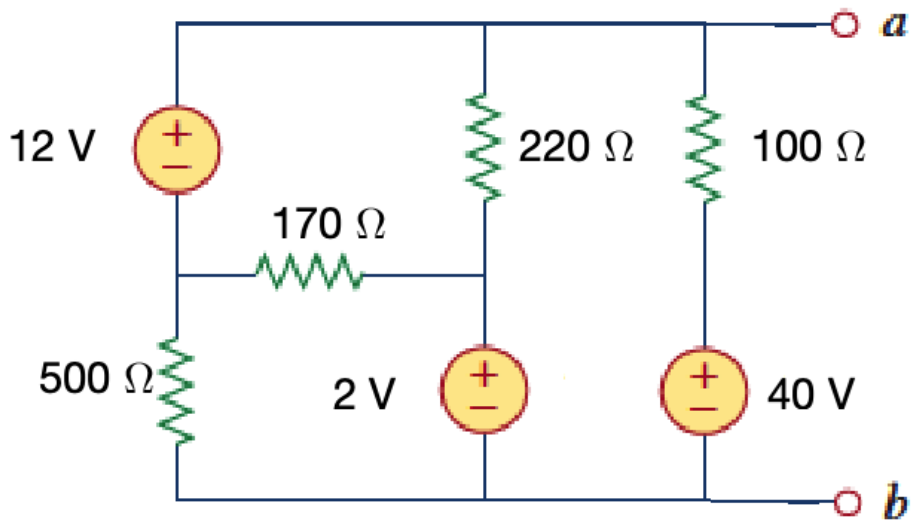
Practice problem: find V_{th} and R_{Th}

$\frac{9}{4}\ V, 30\ \Omega$



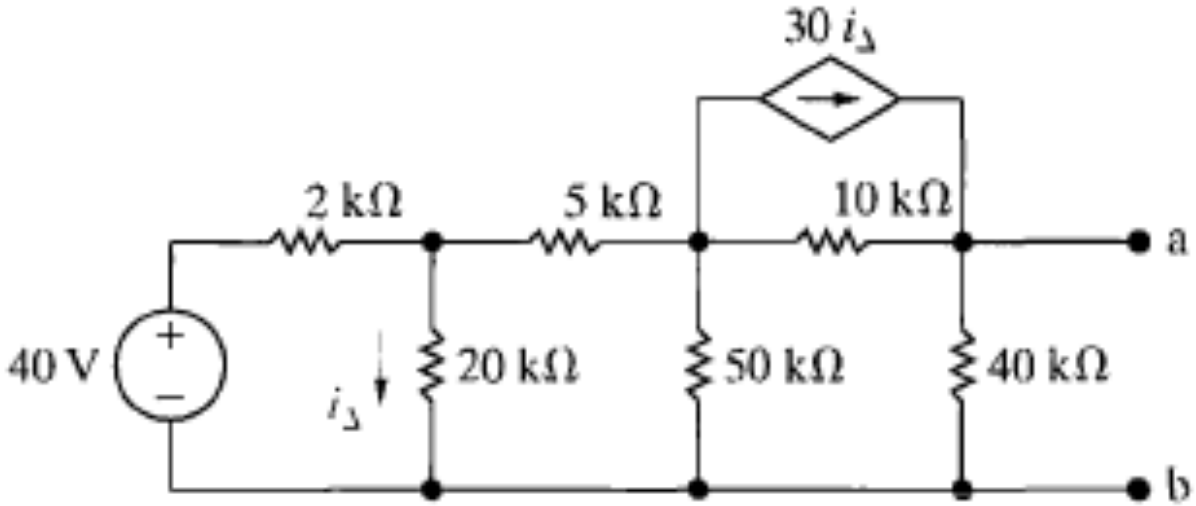
Practice problem: find V_{th} and R_{Th}

$23.0\ V, 44.6\ \Omega$



Practice problem: find V_{th} and R_{Th}

$200\ V, 14{,}3\ k\ \Omega$



Practice problem: find V_{th} and R_{Th}

$\frac{500}{3}\ V, 10\ \Omega$