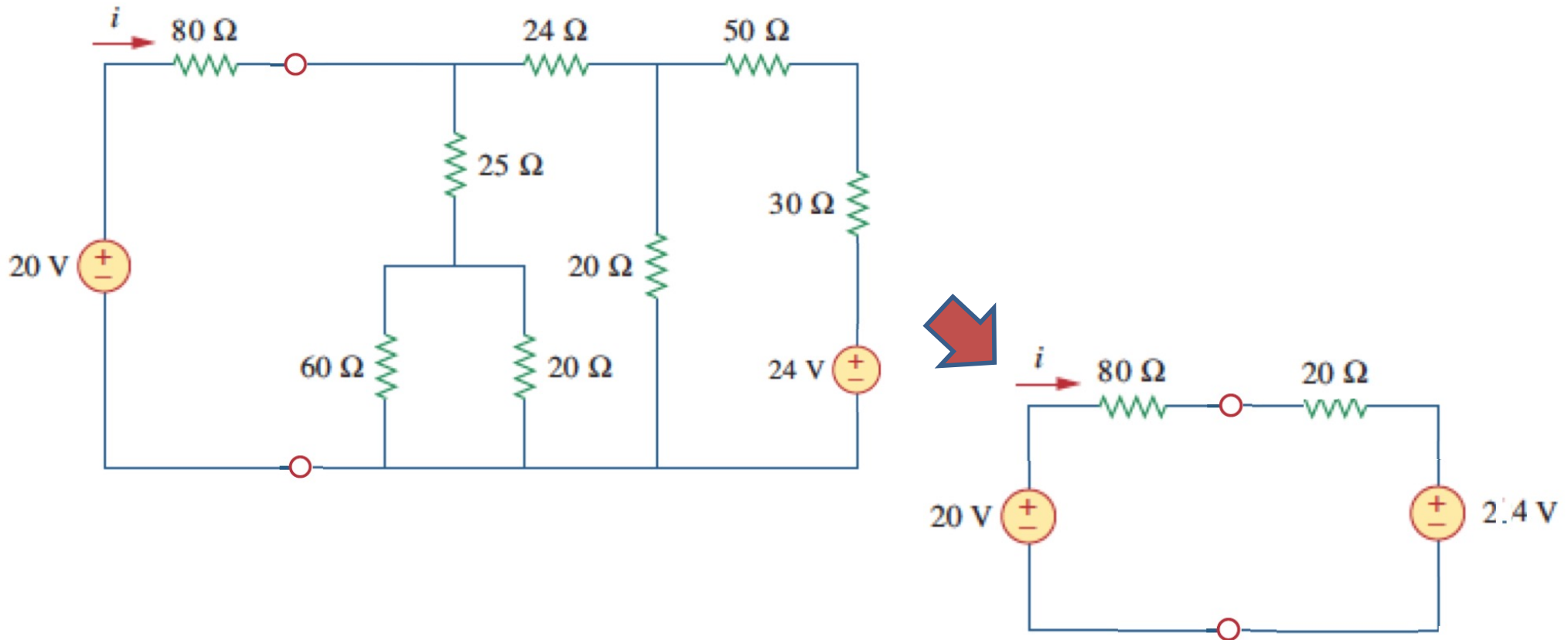


# Theorems – 2

Thévenin

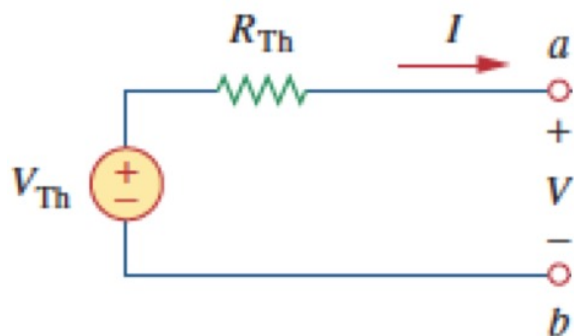
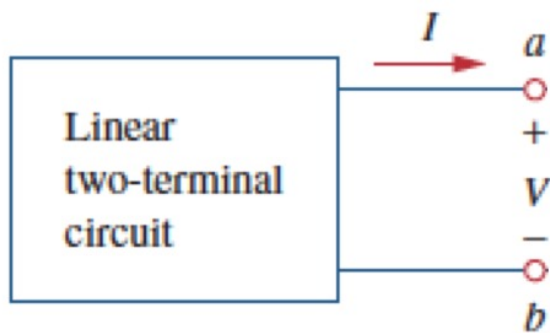
# Thévenin Models

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

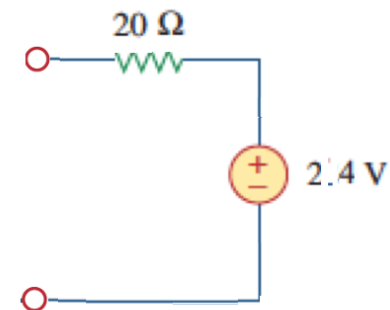
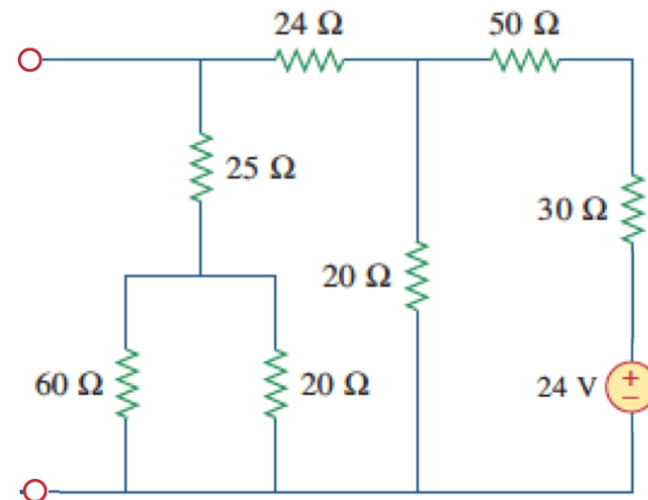


Thévenin equivalent circuit  $\equiv$  electrical equivalence at any pair of terminals

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

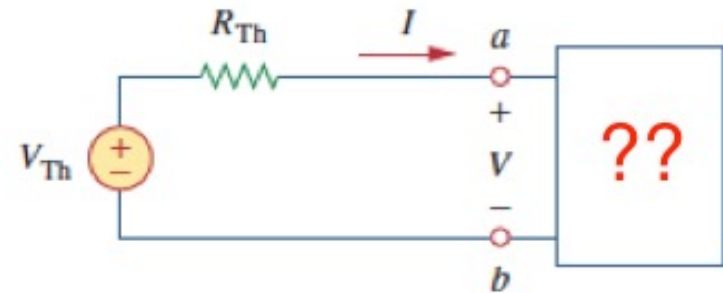
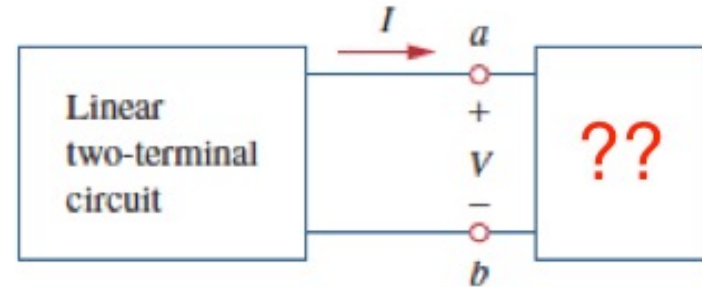


- Example:



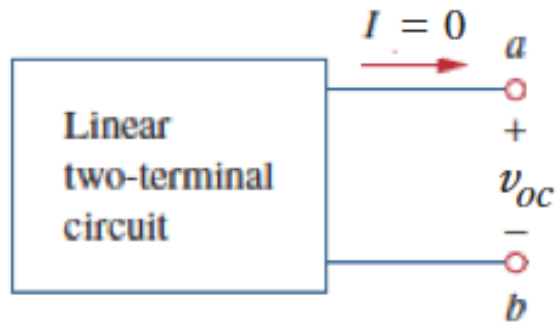
# How to find $V_{Th}$ and $R_{Th}$ ?

- 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



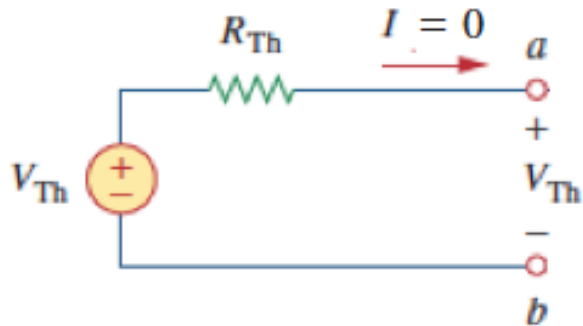
# Thevenin: Most Common Approach

- Connect nothing – “open circuit” test
  - Just need a voltmeter



Clearly

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



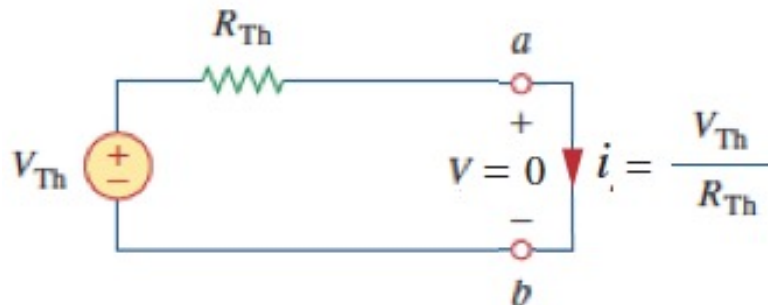
# Another popular approach

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



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

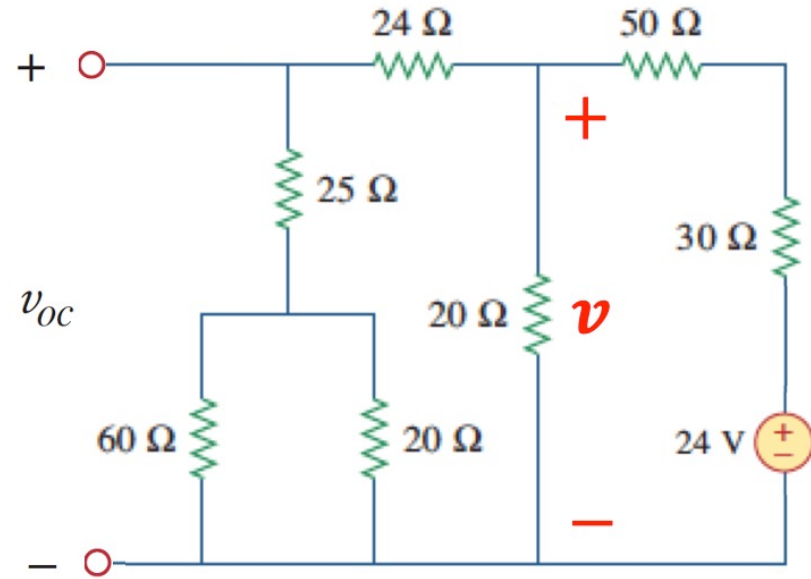
So



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

## Example:

- Use node analysis:

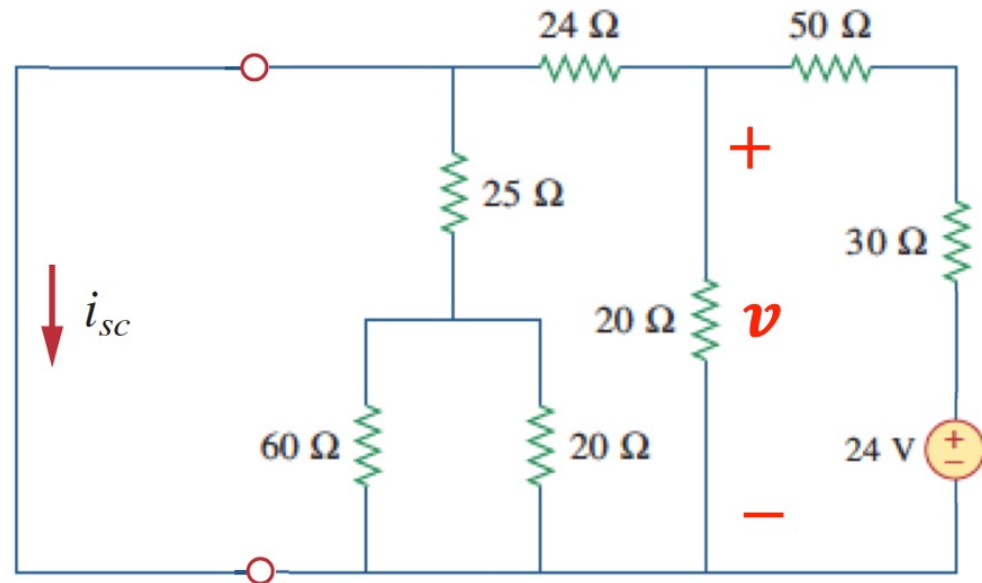


$$\frac{v}{20} + \frac{v - 24}{80} + \frac{v}{64} = 0 \Rightarrow v = \frac{96}{25}$$

- Then voltage division:

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

Note how the short changes the circuit



- Use node analysis:

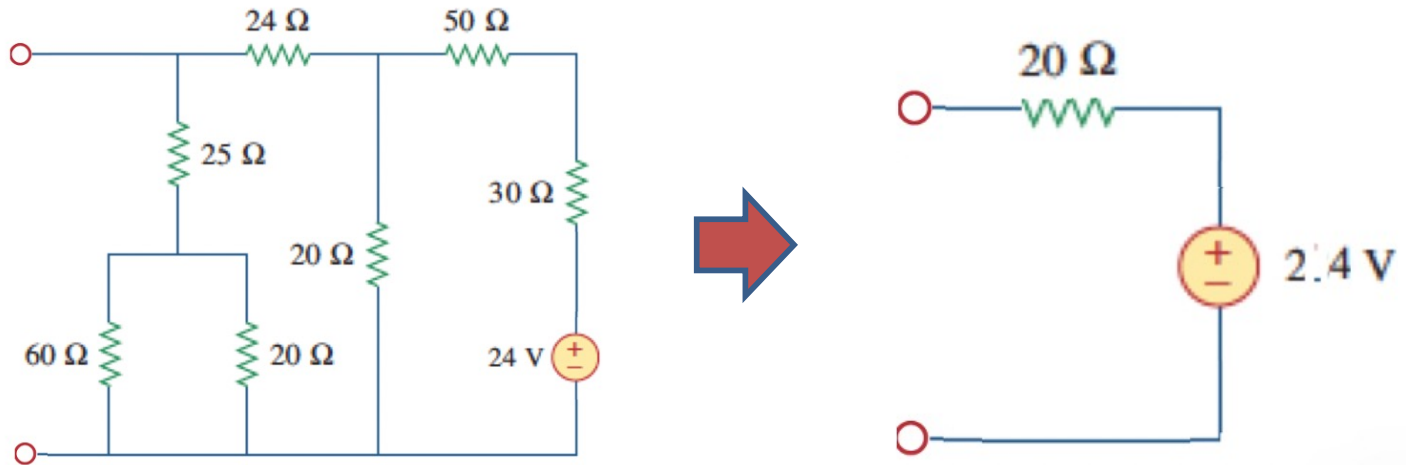
$$\frac{v}{20} + \frac{v - 24}{80} + \frac{v}{24} = 0 \Rightarrow v = \frac{72}{25}$$

- Then Ohm's Law:

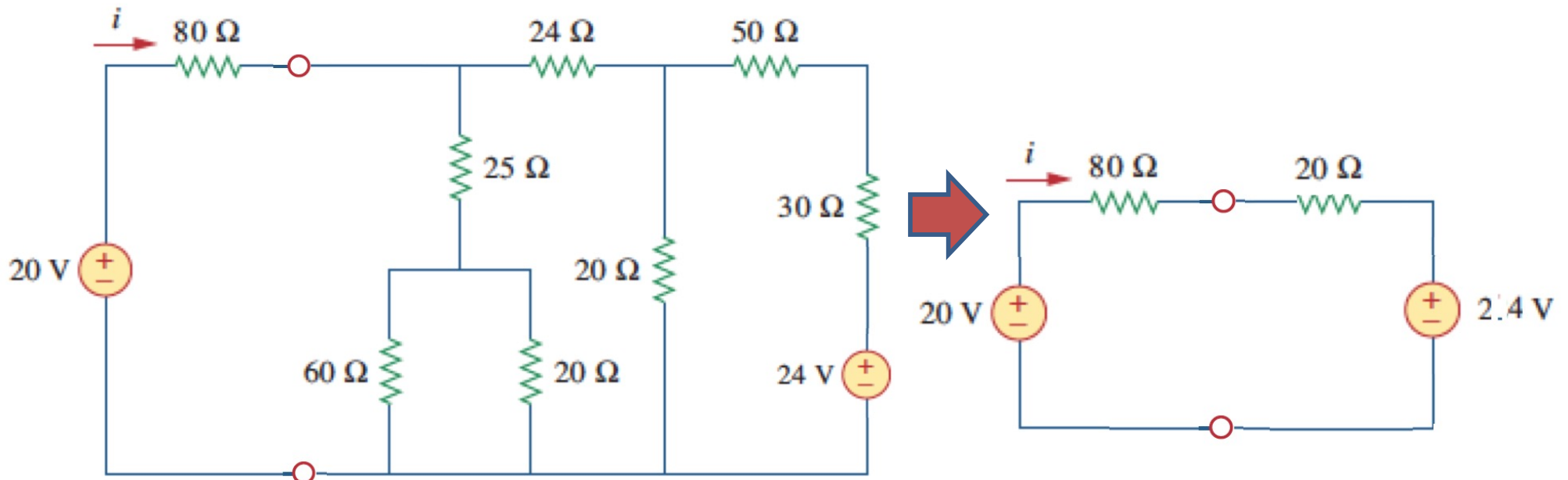
$$i_{sc} = \frac{v}{24} = 0.12 \Rightarrow R_{Th} = \frac{v_{oc}}{i_{sc}} = \frac{2.4}{0.12} = 20 \Omega$$



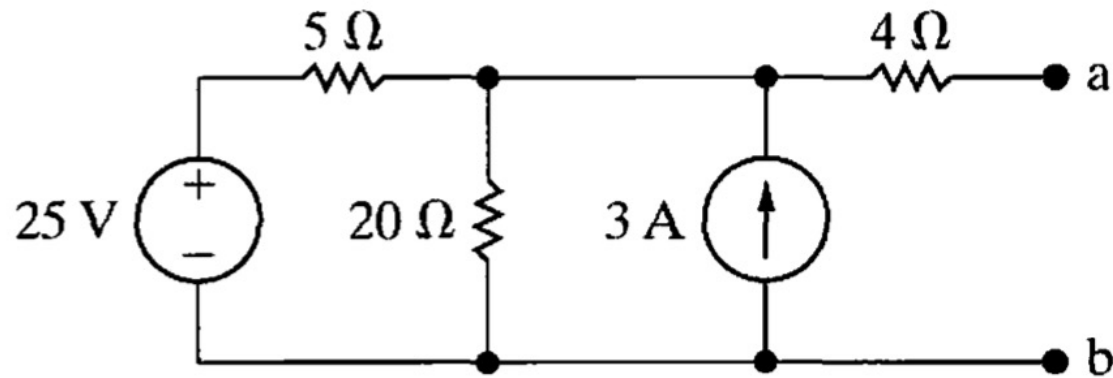
So  $V_{Th} = 2.4$  volts and  $R_{Th} = 20 \Omega$



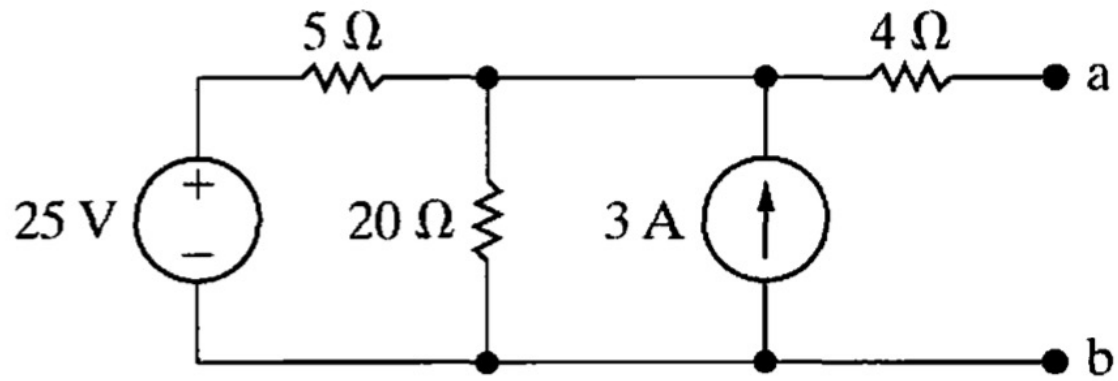
and



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



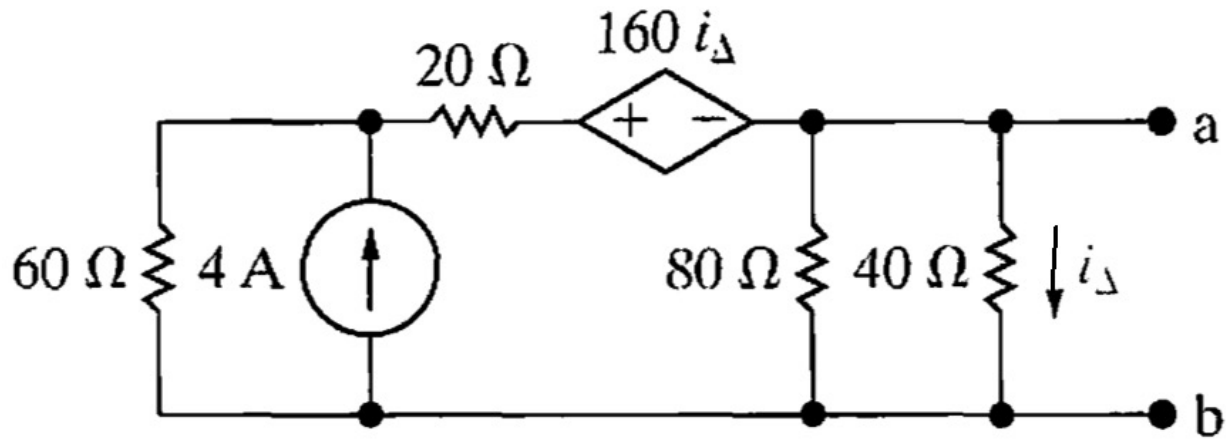
$$V_{Th} = v_{OC}$$
$$R_{Th} = \frac{v_{OC}}{i_{SC}}$$

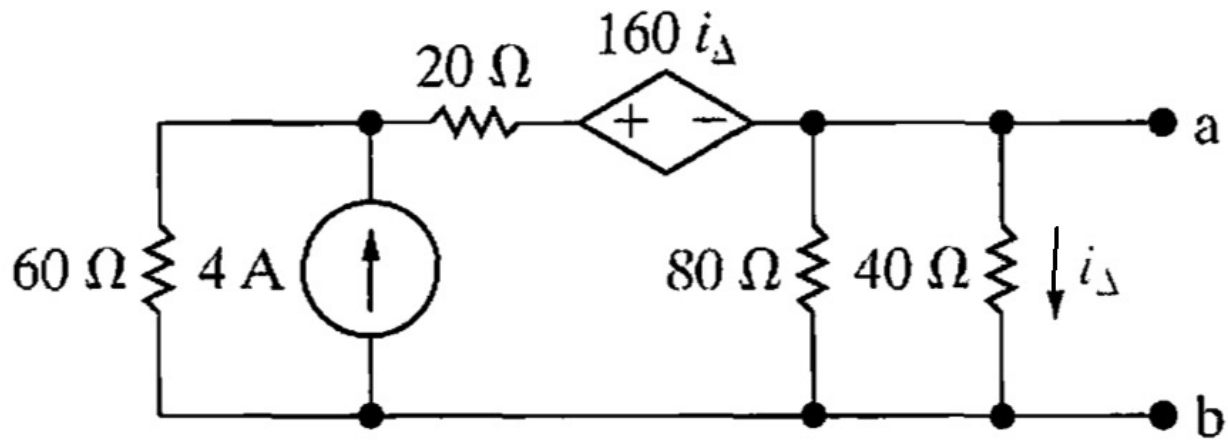


32 V, 8 Ω

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

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

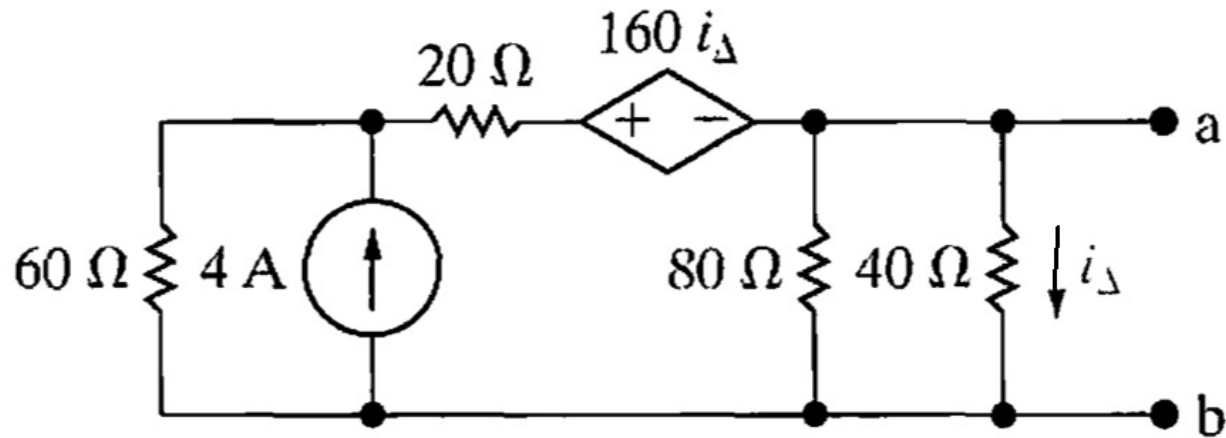




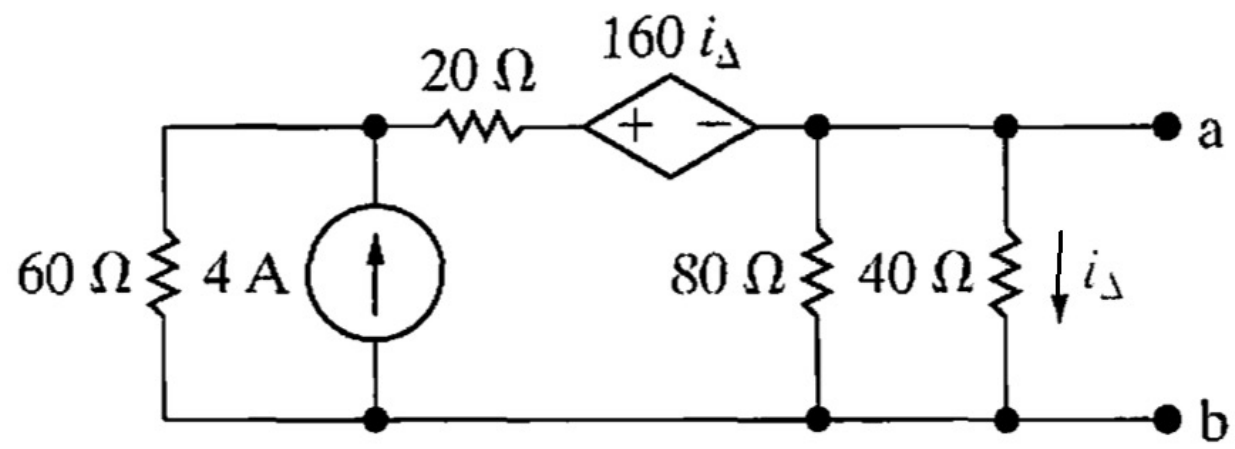
30 V, 10  $\Omega$

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

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

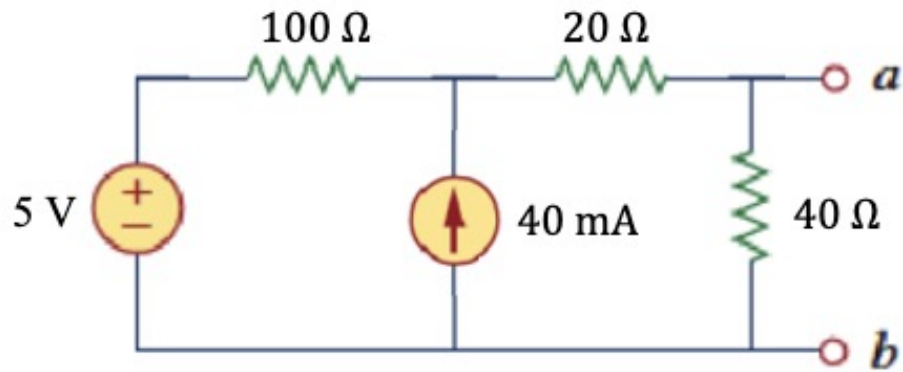


30 V, 10  $\Omega$



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

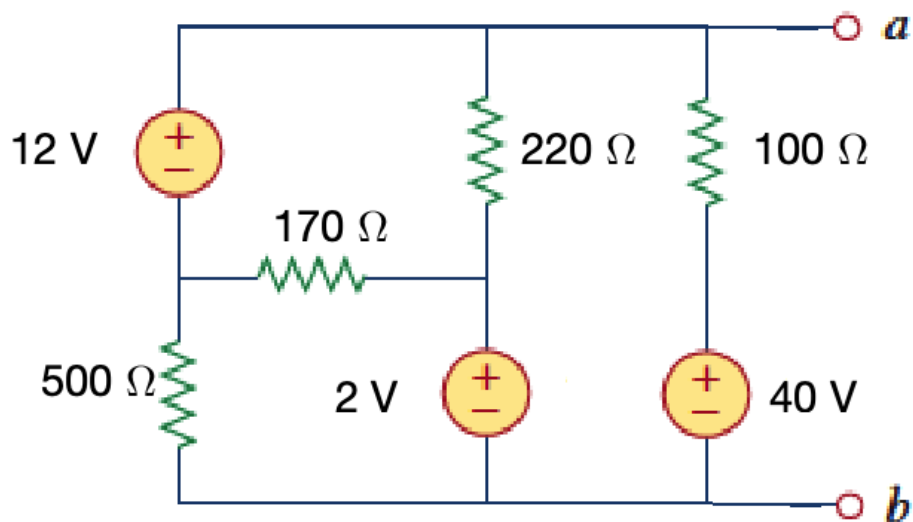
$\frac{9}{4} V, 30 \Omega$





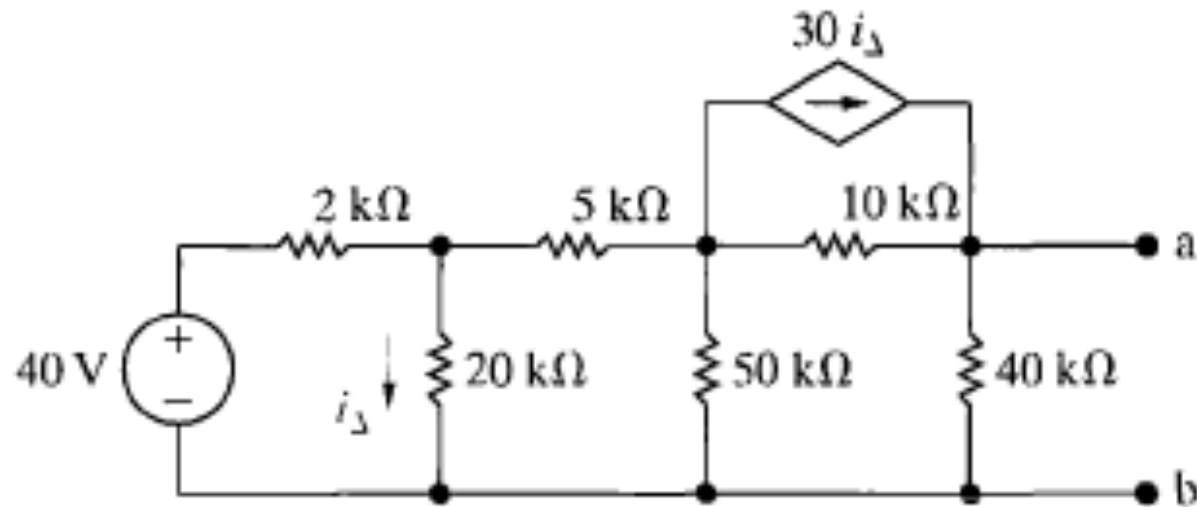
**Practice problem:** find  $V_{th}$  and  $R_{Th}$

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  $R_{Th}$

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

