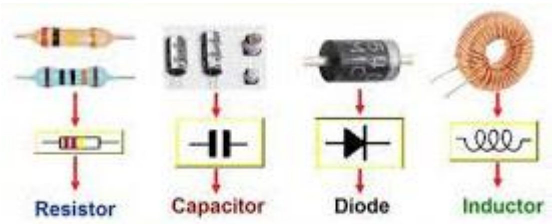
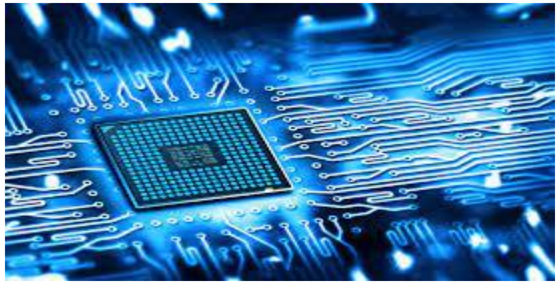
Electronics 1

BSC 113

Summer 2021-2022

Lecture 6





Thevenin's & Norton theorems

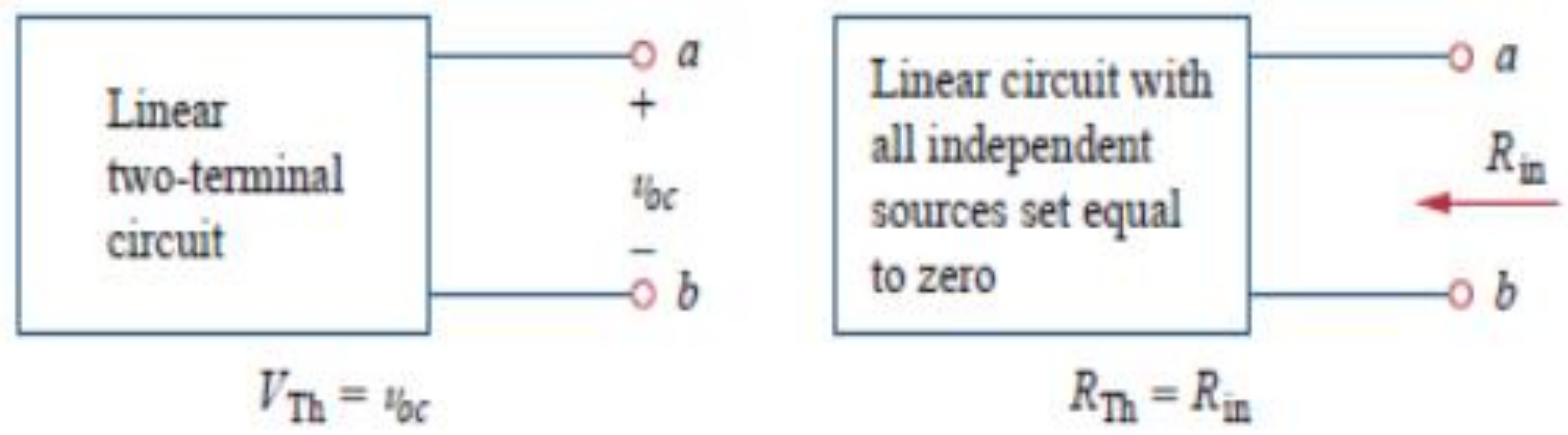
INSTRUCTOR

DR / AYMAN SOLIMAN

Contents

❑ Thevenin’s theorem

➢ Thevenin’s theorem states that a linear two-terminal circuit can be replaced by an equivalent circuit consisting of a voltage source V_{Th} in series with a resistor R_{Th}, where V_{Th} is the open-circuit voltage at the terminals and R_{Th} is the input or equivalent resistance at the terminals when the independent sources are turned off as shown in figure



THEVENIN & NORTON

THEVENIN'S THEOREM:

Consider the following:

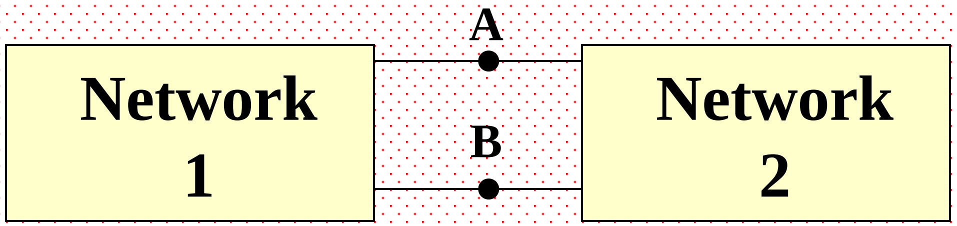


Figure: Coupled networks.

For purposes of discussion, at this point, we consider that both networks are composed of resistors and independent voltage and current sources

THEVENIN & NORTON

THEVENIN'S THEOREM:

Suppose Network 2 is detached from Network 1 and we focus temporarily only on Network 1.

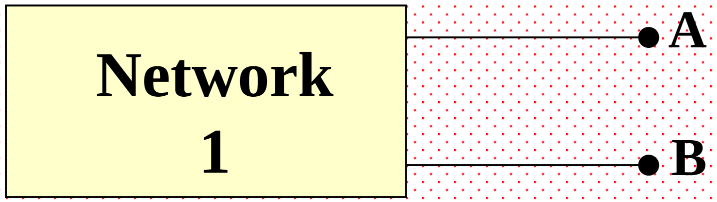
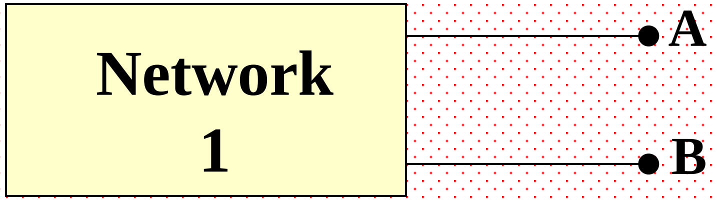


Figure: Network 1, open-circuited.

Network 1 can be as complicated in structure as one can imagine. Maybe 45 meshes, 387 resistors, 91 voltage sources and 39 current sources.

THEVENIN & NORTON

THEVENIN'S THEOREM:



Now place a voltmeter across terminals A-B and read the voltage. We call this the open-circuit voltage.

No matter how complicated Network 1 is, we read one voltage. It is either positive at A, (with respect to B) or negative at A.

We call this voltage V_{os} and we also call it $V_{THEVENIN} = V_{TH}$

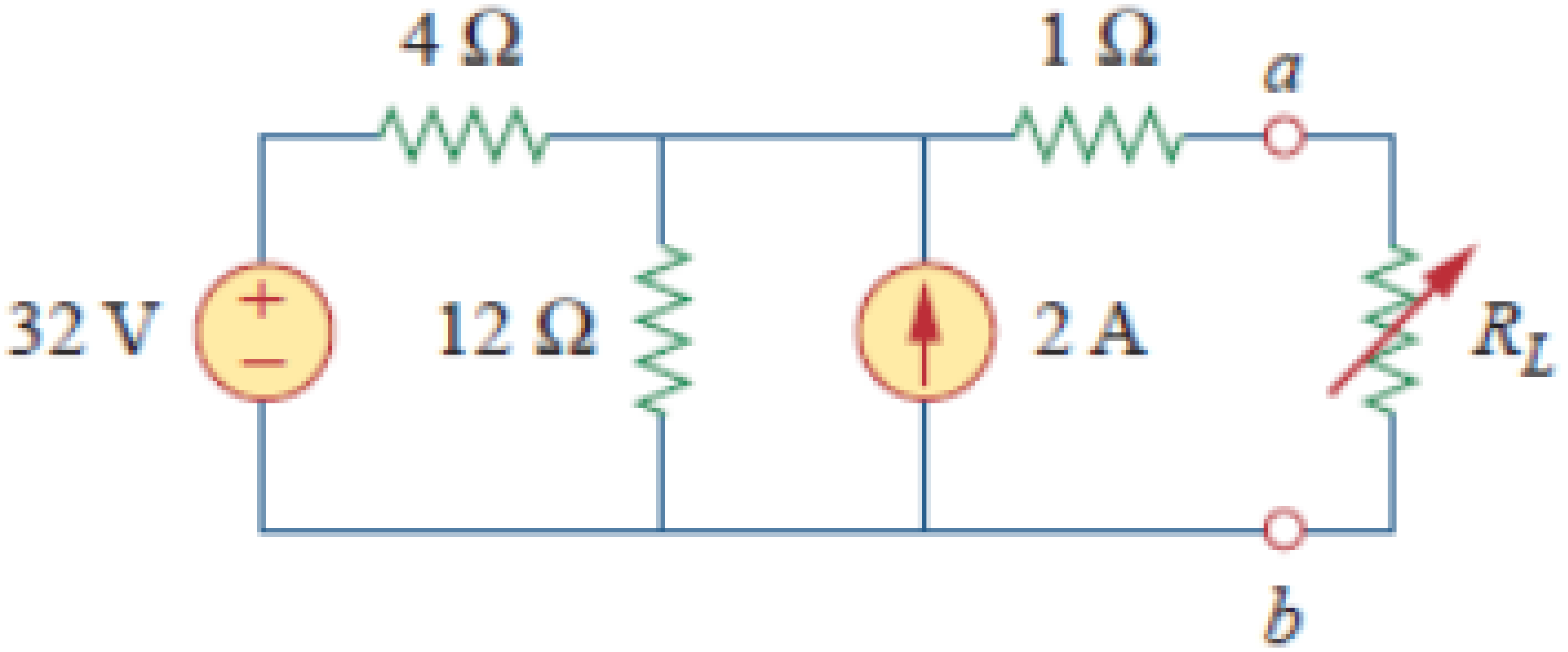
THEVENIN & NORTON

THEVENIN'S THEOREM:

- **We now deactivate all sources of Network 1.**
- **To deactivate a voltage source, we remove the source and replace it with a short circuit.**
- **To deactivate a current source, we remove the source.**

❑ Example1

➢ Find the Thevenin equivalent circuit of the circuit shown, to the left of the terminals a - b.

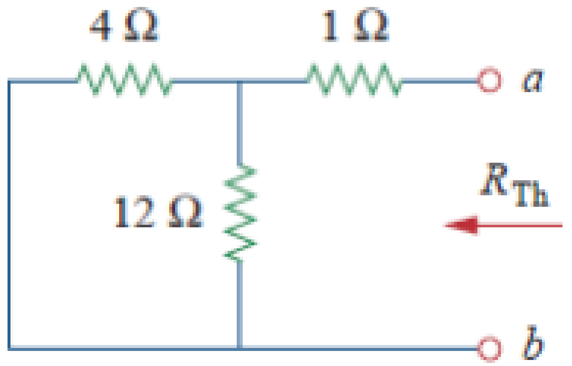


❑ Example1

- Find the Thevenin equivalent circuit of the circuit shown, to the left of the terminals a - b.

Answer:

R_{th}= (4//12) +1= 4Ω

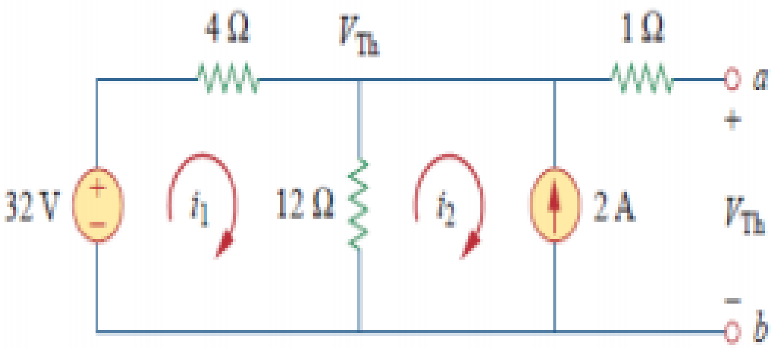


$$i_2 = -2A$$

$$-32 + 16i_1 - 12i_2 = 0$$

$$i_1 = 0.5A$$

$$V_{Th} = 12(i_1 - i_2) = 30V$$



THEVENIN & NORTON

THEVENIN'S THEOREM: Example 2.

Find V_X by first finding V_{TH} and R_{TH} to the left of A-B.

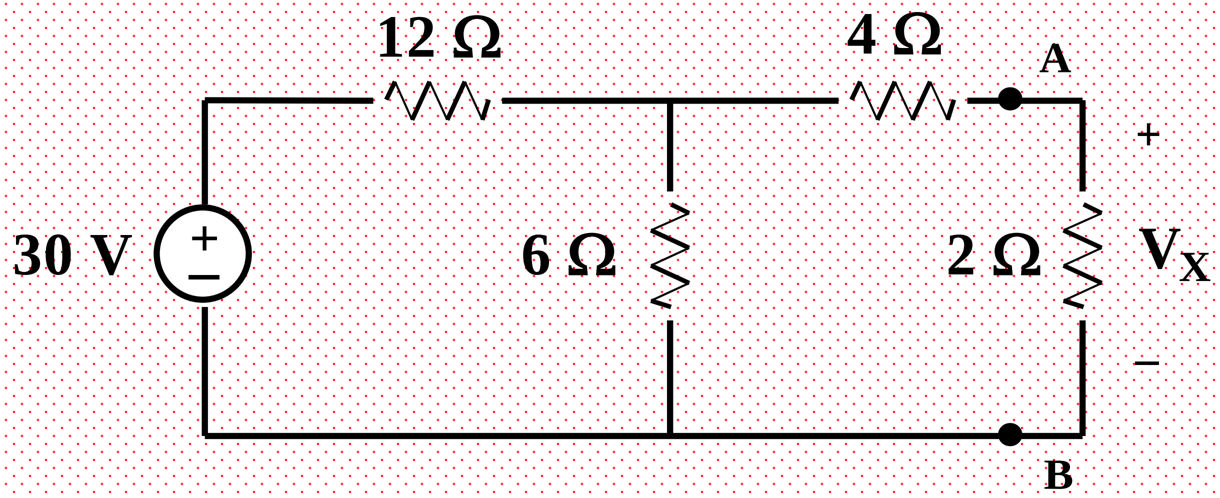


Figure: Circuit for Example 2.

First remove everything to the right of A-B.

THEVENIN & NORTON

THEVENIN'S THEOREM: Example 2. continued

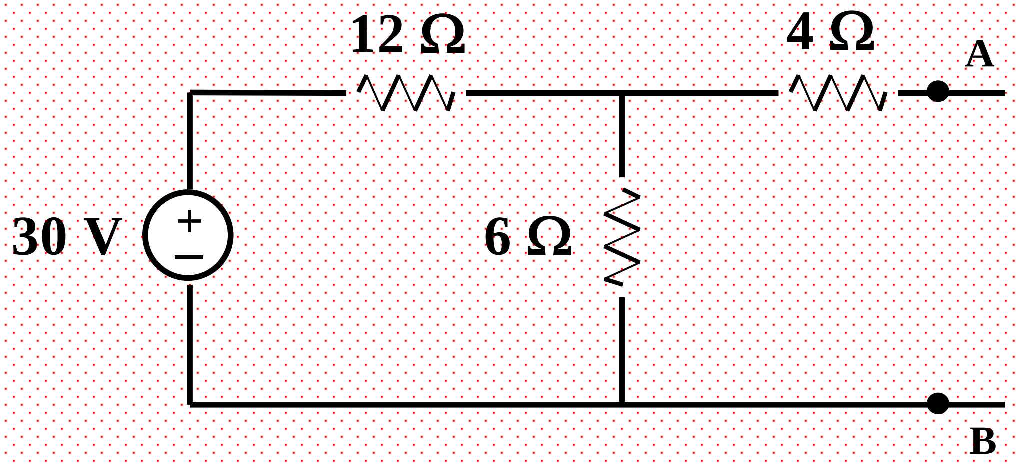


Figure: Circuit for finding V_{TH} for Example 2.

$$V_{AB} = \frac{(30)(6)}{6+12} = 10V$$

Notice that there is no current flowing in the 4 Ω resistor (A-B) is open. Thus there can be no voltage across the resistor.

THEVENIN & NORTON

THEVENIN'S THEOREM: Example 2. continued

We now deactivate the sources to the left of A-B and find the resistance seen looking in these terminals.

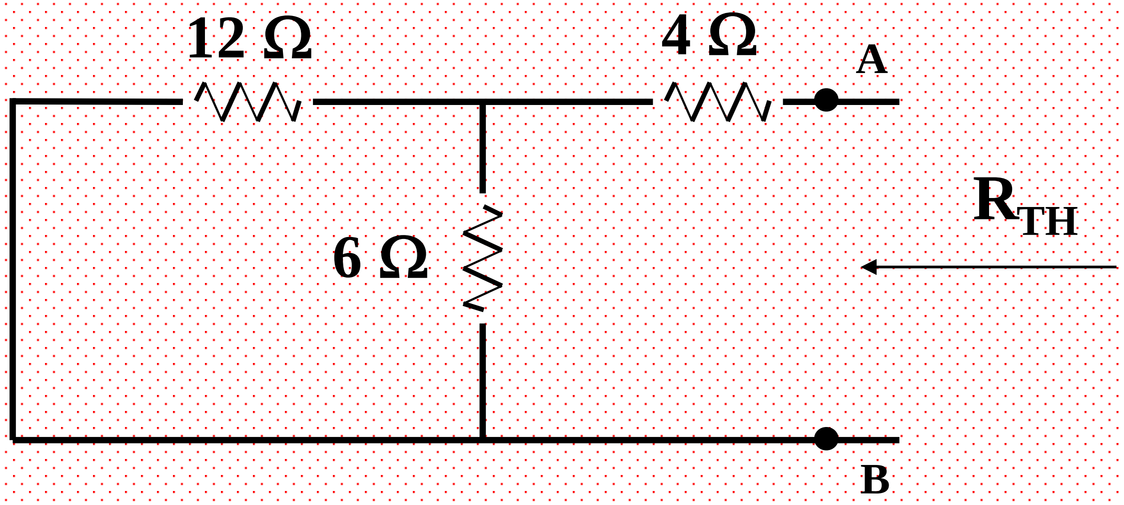


Figure: Circuit for find R_{TH} for Example 2.

We see,

$$R_{TH} = 12||6 + 4 = 8\ \Omega$$

THEVENIN & NORTON

THEVENIN'S THEOREM: Example 2. continued

After having found the Thevenin circuit, we connect this to the load in order to find V_X.

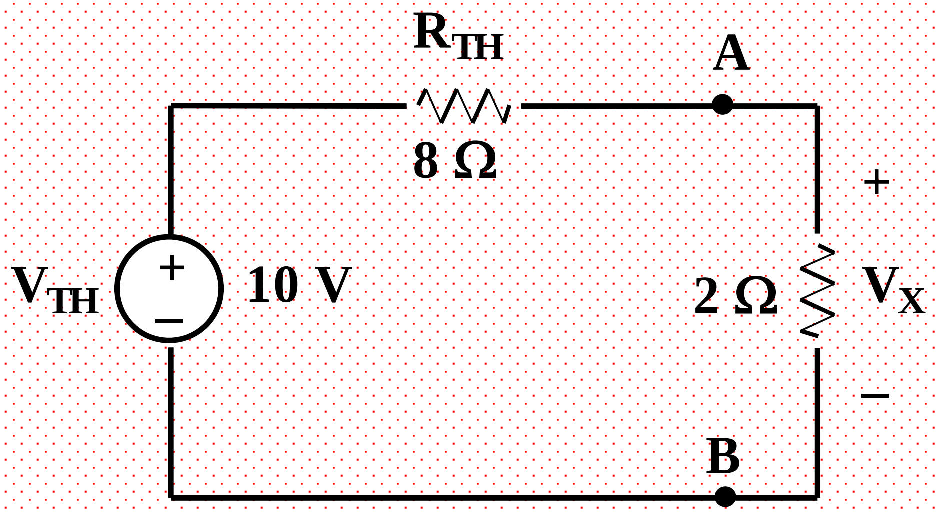


Figure: Circuit of Ex 2 after connecting Thevenin circuit.

$$V_X = \frac{(10)(2)}{2+8} = 2V$$

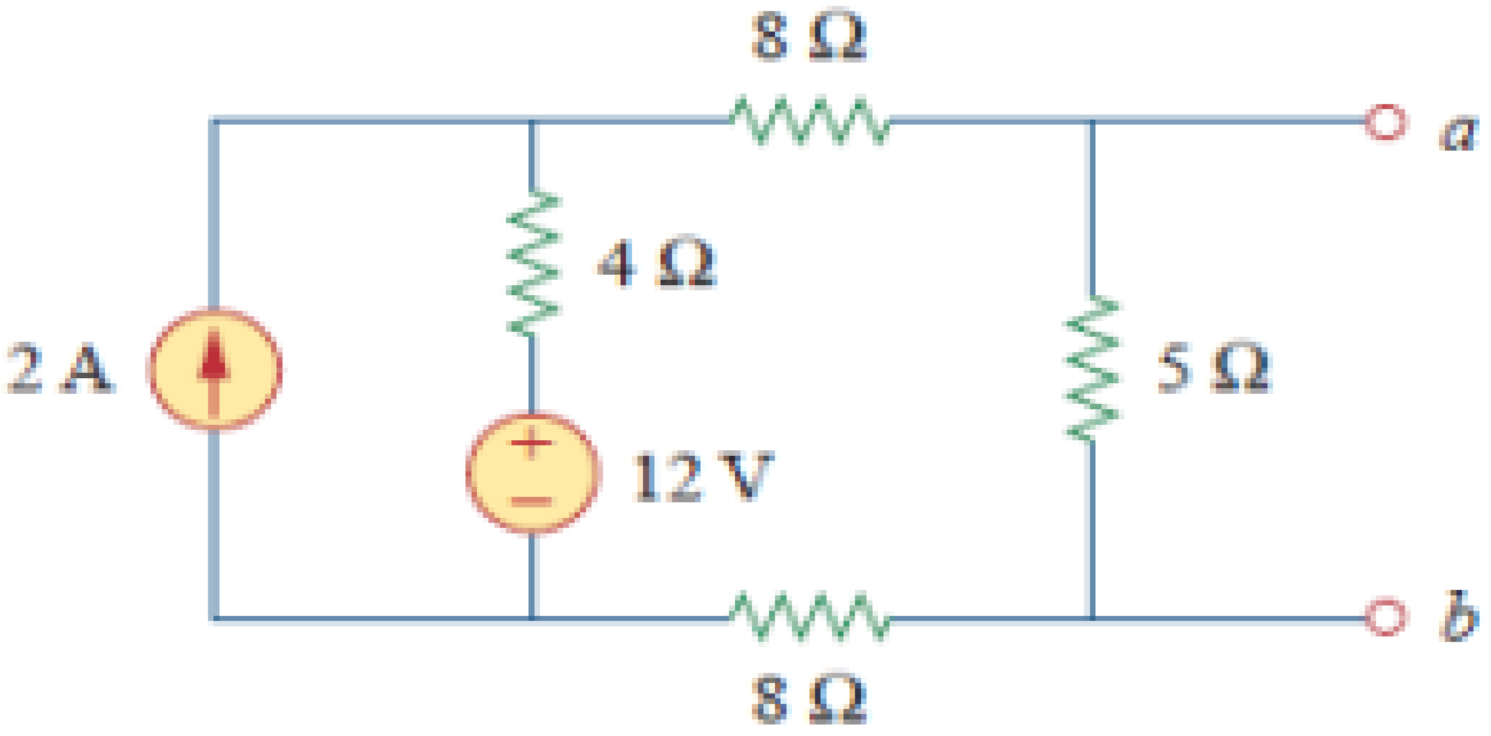
Norton theorem

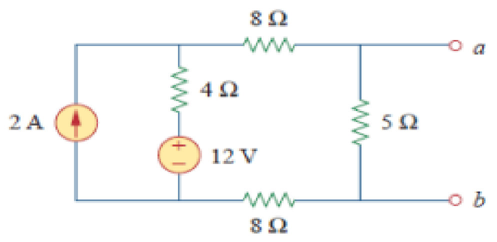
❑ Norton theorem

- Norton's theorem states that a linear two-terminal circuit can be replaced by an equivalent circuit consisting of a current source $I_N = V_{Th}/R_{Th}$ in parallel with a resistor $R_N = R_{Th}$, where I_N is the short-circuit current through the terminals and R_N is the input or equivalent resistance at the terminals when the independent sources are turned off.

❑ Example

➢ Find the Norton equivalent circuit of the circuit shown, to the left of the terminals a - b.



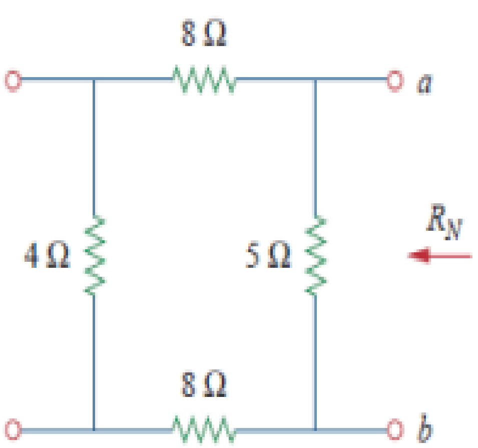


❑ Example

➢ Find the Norton equivalent circuit of the circuit shown, to the left of the terminals a - b.

Answer:

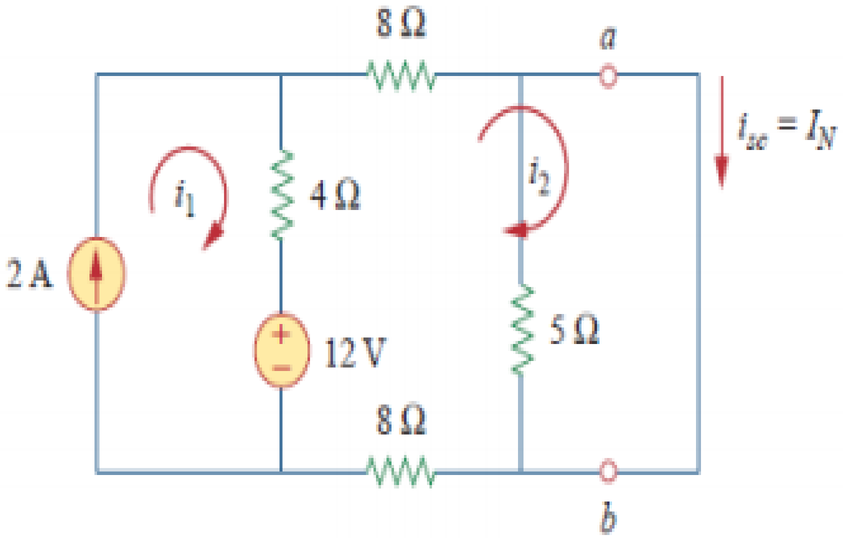
R_N =5//(8+4+8)= 4Ω



$i_1 = 2A$

$20i_2 - 4i_1 - 12 = 0$

$i_2 = 1A = i_{sc} = I_N$




Thank
you