Al-Mustaqbal University
College Of Engineering Technology
Department Of Cyber Security Techniques Engineering
Class: 1st
Subject: fundamental of electrical engineering
Lecturer: Dr. Rami Qays Malik
1st term – Lecture: 7- Thevenin's & Norton's Theorem

الكلية التقنية الهندسية

قسم هندسة تقنيات الامن السيبراني

Lecture: 7- Thevenin's & Norton's Theorem

Email: rami.qays@uomus.edu.iq

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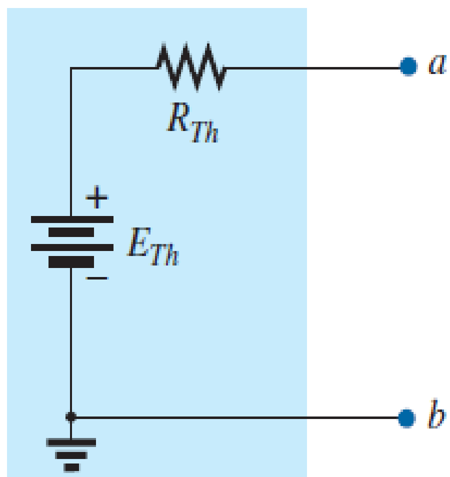
THÉVENIN'S THEOREM:

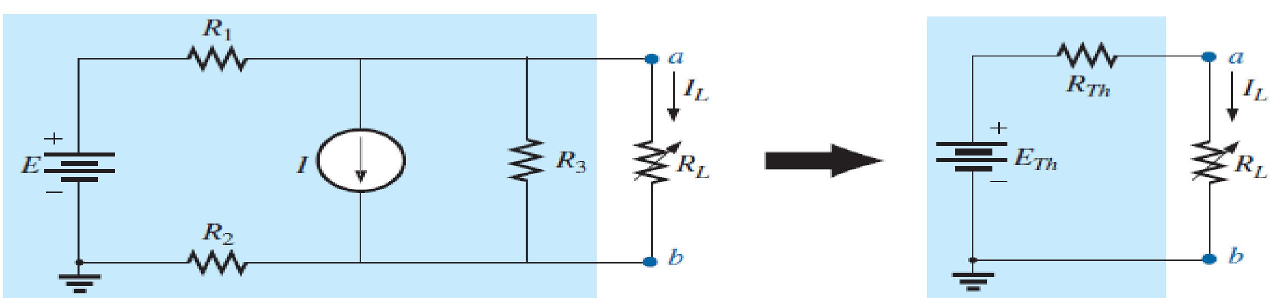
Any two-terminal dc network can be replaced by an equivalent circuit consisting solely of a voltage source and a series resistor as shown in Fig.



Thévenin's Theorem Procedure:

1. Remove that portion of the network where the Thévenin equivalent circuit is found. In Fig., this requires that the load resistor RL be temporarily removed from the network.

2. Mark the terminals of the remaining two-terminal network.



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R_{Th}:

1. Calculate R_{Th} by first setting all sources to zero (voltage sources are replaced by short circuits, and current sources by open circuits) and then finding the resultant resistance between the two marked terminals. (If the internal resistance of the voltage and/or current sources is included in the original network, it must remain when the sources are set to zero.)

E_{Th}:

2. Calculate E_{Th} by first returning all sources to their original position and finding the open- circuit voltage between the marked terminals. (This step is invariably the one that causes most confusion and errors. In all cases, keep in mind that it is the open circuit potential between the two terminals marked in step 2.)

Conclusion:

3. Draw the Thévenin equivalent circuit with the portion of the circuit previously removed replaced between the terminals of the equivalent circuit. This step is indicated by the placement of the resistor RL between the terminals of the Thévenin equivalent circuit

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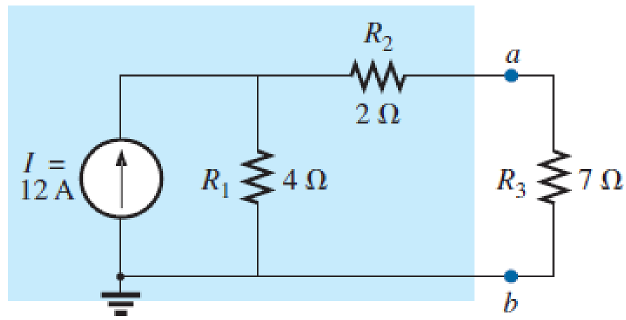
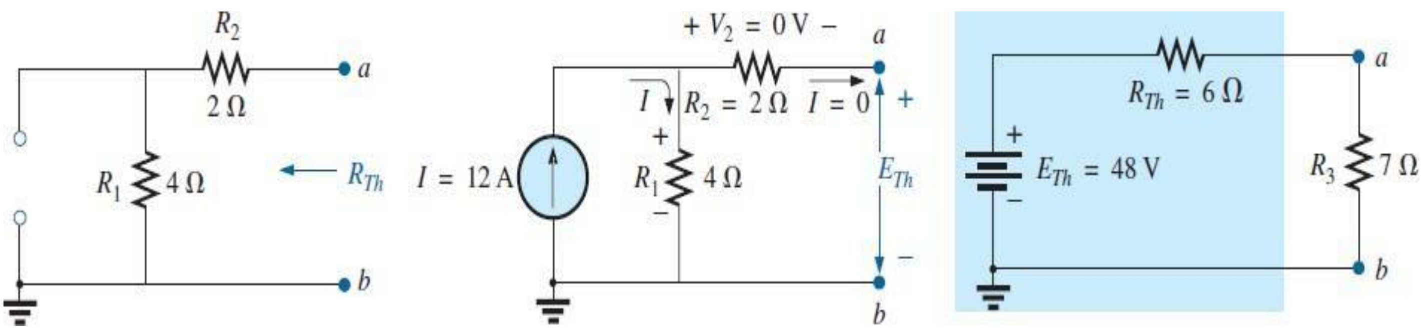
EXAMPLE 1

Find the Thévenin equivalent circuit for the network in the shaded area of the network in Fig

$$R_{Th} = R_1 + R_2 = 4\ \Omega + 2\ \Omega = 6\ \Omega$$





In this case, since an open circuit exists between the two marked terminals, the current is zero between these terminals and through the 2 Ω resistor. The voltage drop across R2 is, therefore,

$$V_2 = I_2R_2 = (0)R_2 = 0\ \text{V}$$

and $$E_{Th} = V_1 = I_1R_1 = IR_1 = (12\ \text{A})(4\ \Omega) = \mathbf{48\ V}$$

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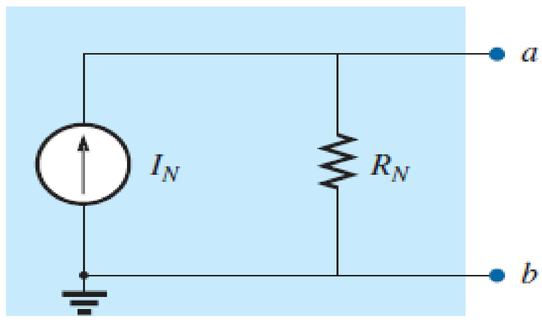
NORTON'S THEOREM

Any two-terminal linear bilateral dc network can be replaced by an equivalent circuit consisting of a current source and a parallel resistor, as shown in Fig



Norton's Theorem Procedure

1. Remove that portion of the network across which the Norton equivalent circuit is found.

2. Mark the terminals of the remaining two-terminal network. R_N:

3. Calculate R_N by first setting all sources to zero (voltage sources are replaced with short circuits, and current sources with open circuits) and then finding the resultant resistance between the two marked terminals. (If the internal resistance of the voltage and/or current sources is included in the original network, it must remain when the sources are set to zero.) Since $R_N = R_{Th}$, the procedure and value obtained using the approach described for Thévenin's theorem will determine the proper value of R_N.

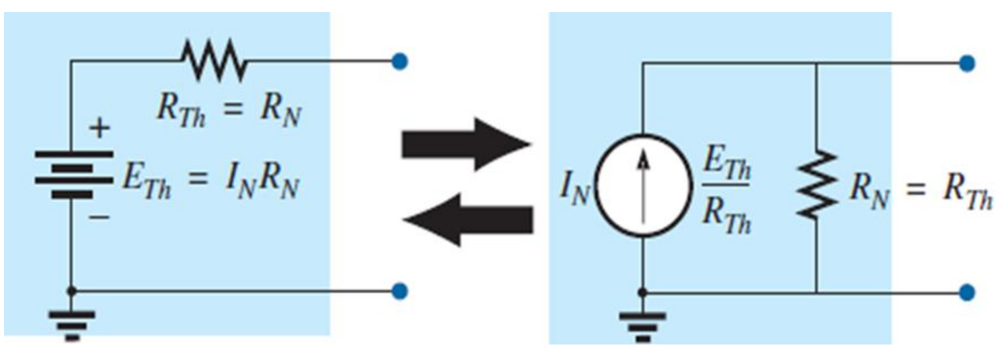
IN:

4. Calculate IN by first returning all sources to their original position and then finding the short- circuit current between the marked terminals. It is the same current that would be measured by an ammeter placed between the marked terminals.

Conclusion:

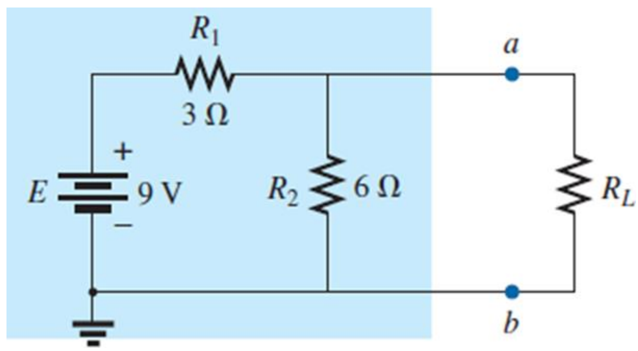
5. Draw the Norton equivalent circuit with the portion of the circuit previously removed replaced between the terminals of the equavilant circuit

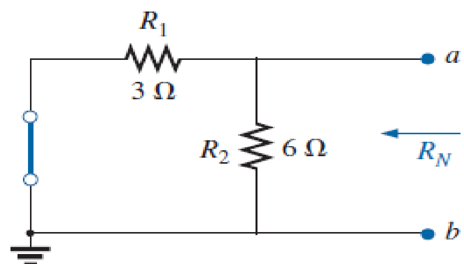
The Norton and Thévenin equivalent circuits can also be found from each other by using the source transformation and reproduced in Fig.



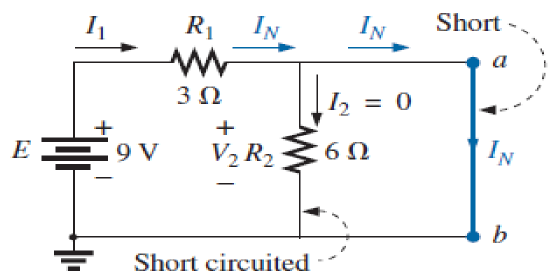
EXAMPLE

Find the Norton equivalent circuit for the network in the shaded area in Fig



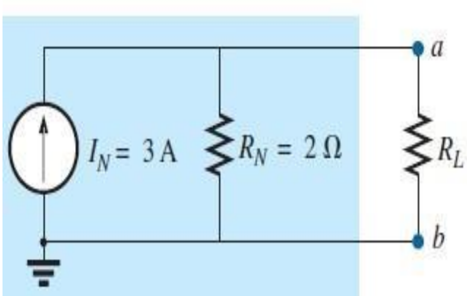


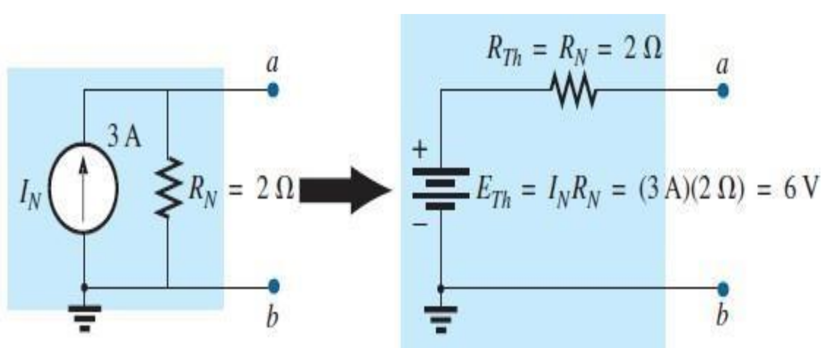
$$R_N = R_1 \parallel R_2 = 3\,\Omega \parallel 6\,\Omega = \frac{(3\,\Omega)(6\,\Omega)}{3\,\Omega + 6\,\Omega} = \frac{18\,\Omega}{9} = \mathbf{2\,\Omega}$$



$$V_2 = I_2 R_2 = (0)6\,\Omega = 0\text{ V}$$

$$I_N = \frac{E}{R_1} = \frac{9\text{ V}}{3\,\Omega} = \mathbf{3\text{ A}}$$





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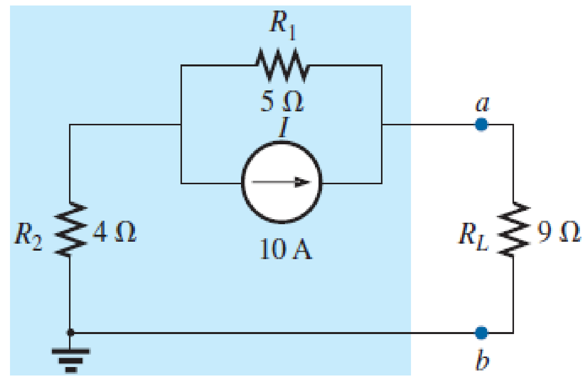
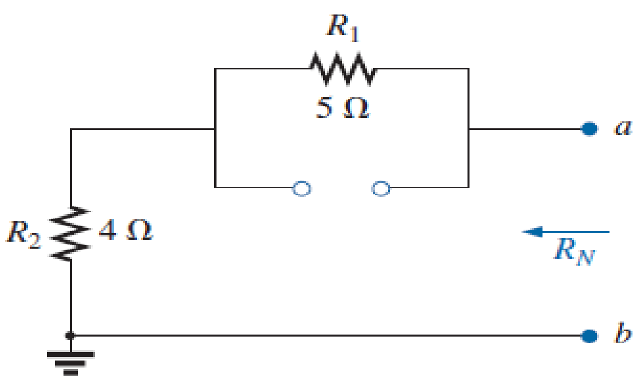
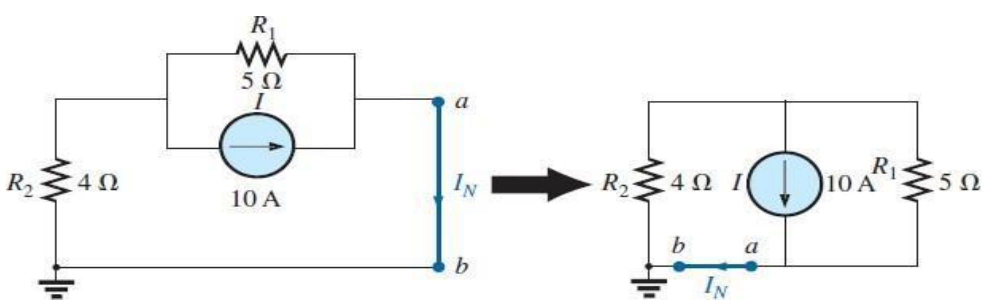
EXAMPLE

Find the Norton equivalent circuit for the network external to the 9 Ω resistor in Fig.



$$R_N = R_1 + R_2 = 5\ \Omega + 4\ \Omega = 9\ \Omega$$





$$I_N = \frac{R_1 I}{R_1 + R_2} = \frac{(5\ \Omega)(10\ \text{A})}{5\ \Omega + 4\ \Omega} = \frac{50\ \text{A}}{9} = \mathbf{5.56\ A}$$