CSE 121 : Electrical Circuits

NORTON’S THEOREM

NETWORK THEOREMS

1. *SUPERPOSITION THEOREM*

2. *THEVENIN'S THEOREM*

3. *NORTON'S THEOREM*

4. *MAXIMUM POWER TRANSFER THEOREM*

NORTON’S THEOREM

STATEMEMNT OF 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. 9.59.

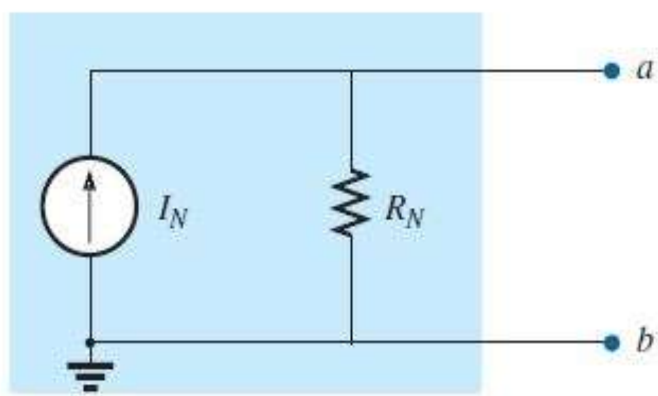


FIG. 9.59
Norton equivalent circuit.

NORTON’S THEOREM

STEPS OF NORTON’S THEOREM.

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.

DETERMINATION OF RN:

3. Calculate RN 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.

Since RN = RTh, the procedure and value obtained using the approach described for Thévenin’s theorem will determine the proper value of RN.

NORTON'S THEOREM

STEPS OF NORTON'S THEOREM.

DETERMINATION OF I_N:

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 equivalent circuit.

NORTON’S THEOREM

STEPS OF NORTON’S THEOREM.

Norton and Thévenin equivalent circuits can also be found from each other by using the **source transformation**

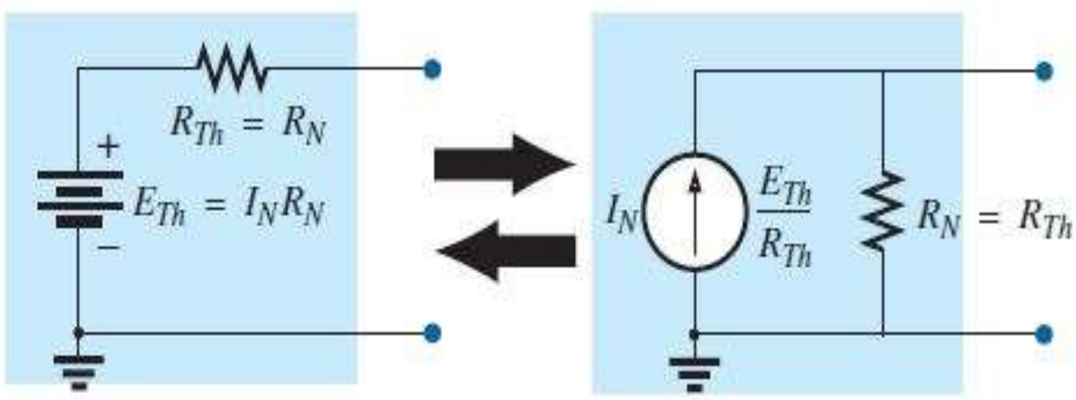


FIG. 9.60
Converting between Thévenin and Norton equivalent circuits.

NORTON'S THEOREM

EXAMPLE 9.11 Find the Norton equivalent circuit for the network in the shaded area i
Fig. 9.61.

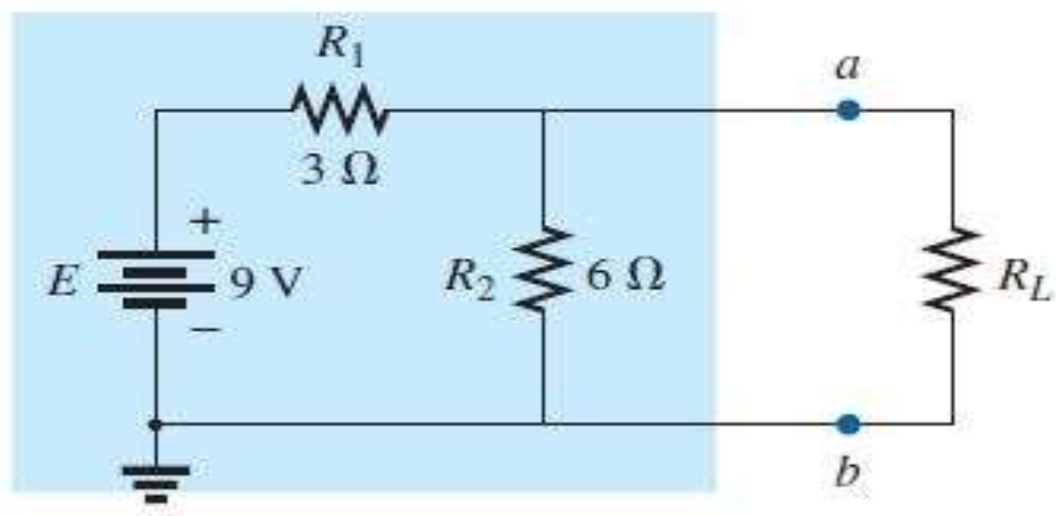


FIG. 9.61
Example 9.11.

NORTON'S THEOREM

Solution:

Steps 1 and 2: See Fig. 9.62.

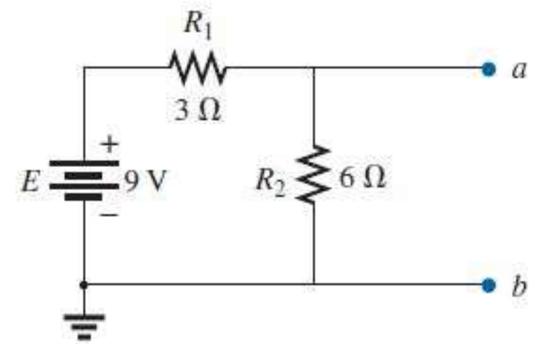


FIG. 9.62

Identifying the terminals of particular interest for the network in Fig. 9.61.

Step 3: See Fig. 9.63, and

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

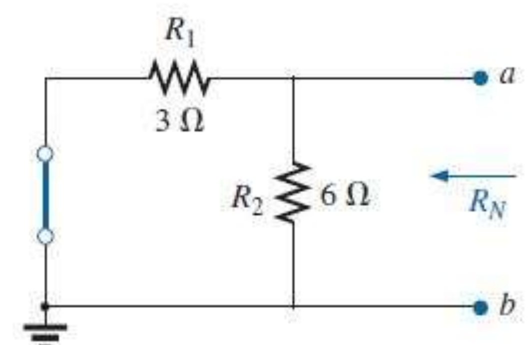


FIG. 9.63

Determining R_N for the network in Fig. 9.62.

NORTON’S THEOREM

Solution:

Step 4: See Fig. 9.64, which clearly indicates that the short-circuit connection between terminals *a* and *b* is in parallel with *R*2 and eliminates its effect. *IN* is therefore the same as through *R*1, and the full battery voltage appears across *R*1 since

$$V_2 = I_2R_2 = (0)6\ \Omega = 0\ \text{V}$$

Therefore,

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

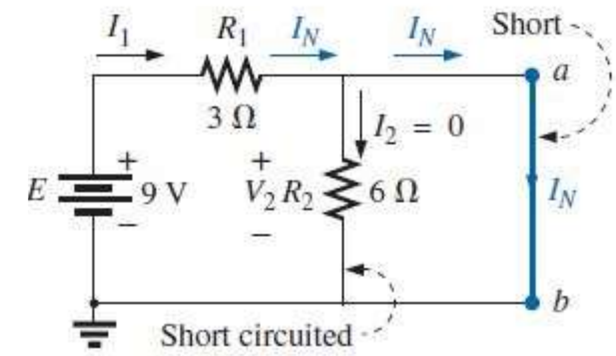


FIG. 9.64

Determining I_N for the network in Fig. 9.62.

NORTON'S THEOREM

Solution:

Step 5: See Fig. 9.65. This circuit is the same as the first one considered in the development of Thévenin's theorem.

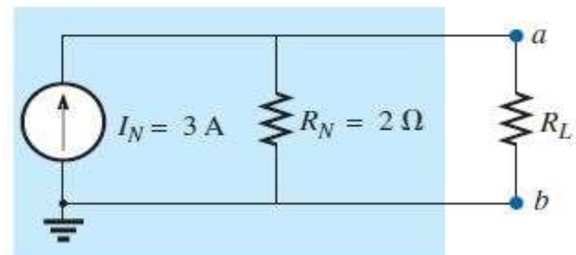


FIG. 9.65
Substituting the Norton equivalent circuit for the network external to the resistor R_L in Fig. 9.61.

simple conversion indicates that the Thévenin circuits are, in fact, the same (Fig. 9.66).

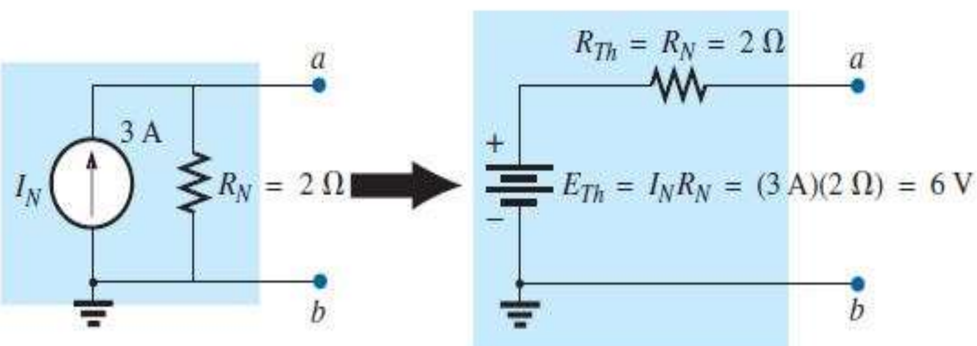


FIG. 9.66
Converting the Norton equivalent circuit in Fig. 9.65 to a Thévenin equivalent circuit.

NORTON’S THEOREM

EXAMPLE 9.12 Find the Norton equivalent circuit for the network external to the 9 Ω resistor in Fig. 9.67.

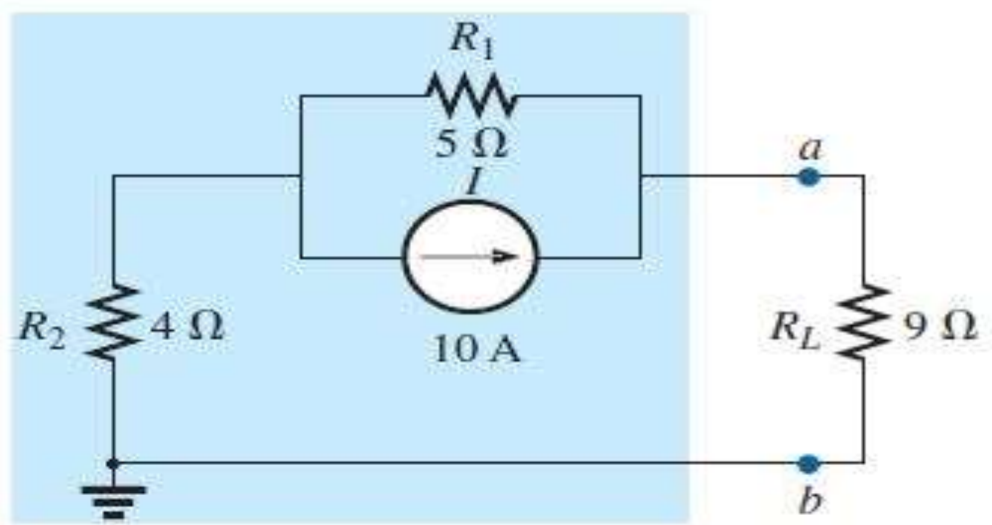


FIG. 9.67
Example 9.12.

QUIZ

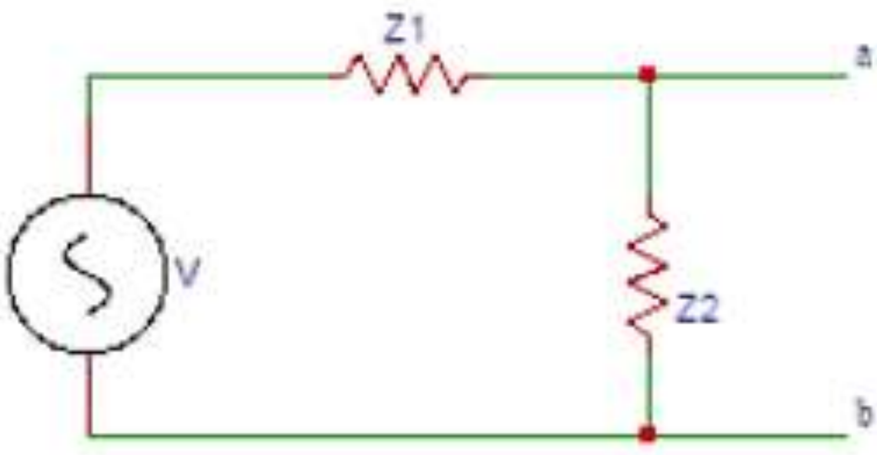
1. Norton’s current is equal to the current passing through the ____________ circuited ____________ terminals.

A. short, input
B. short, output
C. open, output
D. open, input

ANS: B. short, output

QUIZ

2. The expression of Norton's current (I_N) in the circuit shown below is?



A. V/Z_1
B. V/Z_2
C. $V(Z_2/(Z_1+Z_2))$
D. $VZ_1/(Z_1+Z_2)$

ANS: A. V/Z_1

QUIZ

3. In Norton's theorem Isc is___________

A . Sum of two current sources
B. A single current source
C. Infinite current sources
D. 0

ANS: B. A single current source

QUIZ

4. In Norton's equivalent circuit, Norton Resistance and Current source are connected in ___________

A . Series
B. Parallel
C. Star connection
D. Delta connection

ANS: B. Parallel

QUIZ

5. Norton resistance is found by?

A. Shorting all voltage sources
B. Opening all current sources
C. Shorting all voltage sources and opening all current sources
D. Opening all voltage sources and shorting all current sources

ANS: C.

HOME WORK

PRACTICE PROBLEM: (Two sources) Find the Norton equivalent circuit for the portion of the network to the left of *a-b in Fig. 9.72.*

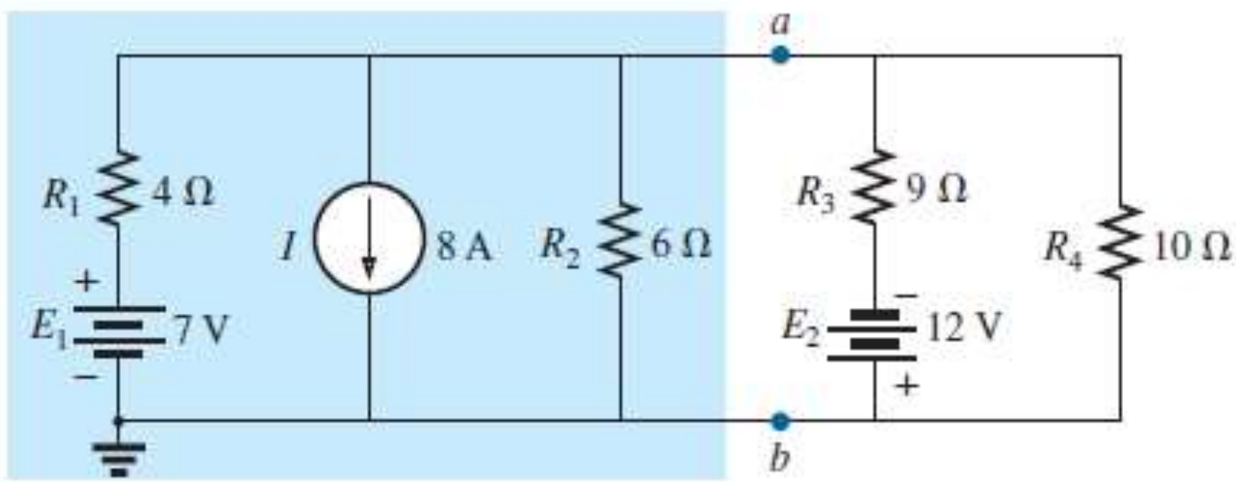


FIG. 9.72
Example 9.13.

Write down a program using C language to solve the above circuit.