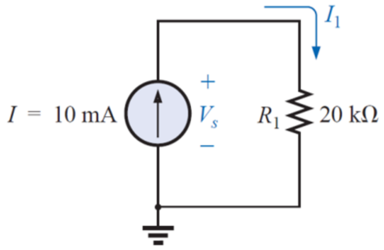
# Methods of Analysis and Selected Topics (dc)

## CURRENT SOURCES

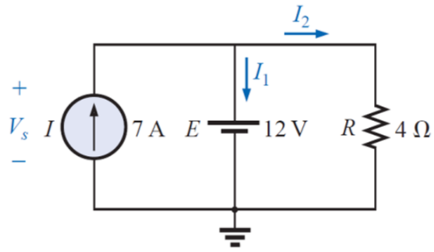
### EXAMPLE 1

Find the source voltage $V_s$ and the current $I_1$ for the circuit shown below

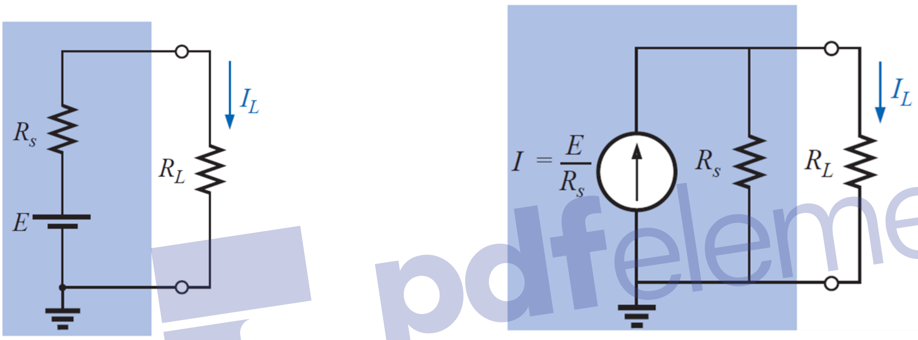



### EXAMPLE 2

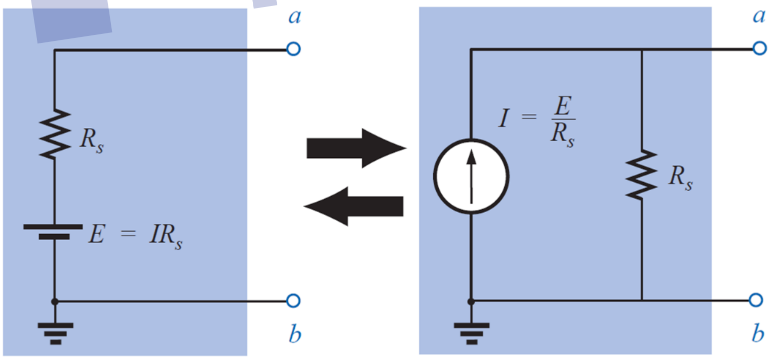
Find the source voltage $V_s$ and the current $I_1$ for the circuit shown below




## SOURCE CONVERSIONS

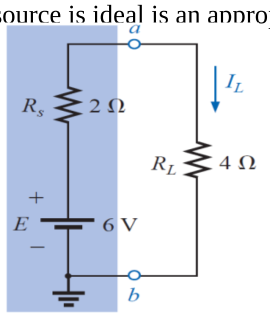


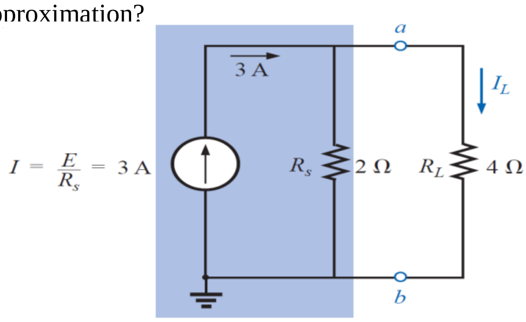



### EXAMPLE 3

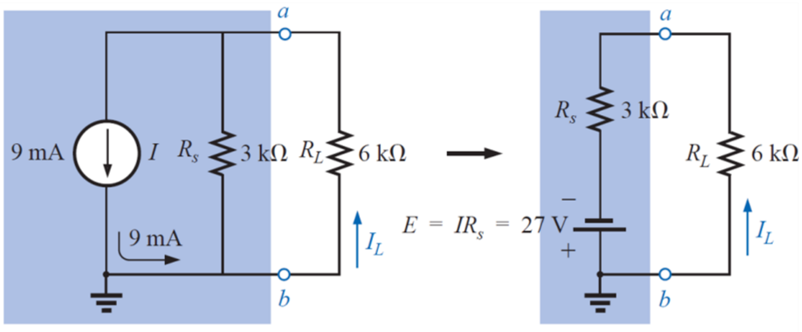
a. Convert the voltage source of Fig. 8.9(a) to a current source, and calculate the current through the 4Ω load for each source.
b. Replace the 4Ω load with a 1-kΩ load, and calculate the current $I_L$ for the voltage source.
c. Repeat the calculation of part (b) assuming that the voltage source is ideal ($R_s$ =0 Ω) because $R_L$ is so much larger than $R_s$. Is this one of those situations where assuming that the source is ideal is an appropriate approximation?



## EXAMPLE 4

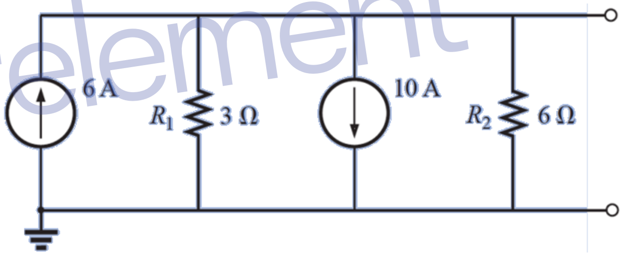
a. Convert the current source of Fig. shown below to a voltage source, and find the load current for each source.
b. Replace the 6-kΩ load with a 10Ω load, and calculate the current $I_L$ for the current source.
c. Repeat the calculation of part (b) assuming that the current source is ideal ($Rs = \infty$ Ω) because $R_L$ is so much smaller than $R_s$. Is this one of those situations where assuming that the source is ideal is an appropriate approximation?



(a) (b)

## CURRENT SOURCES IN PARALLEL

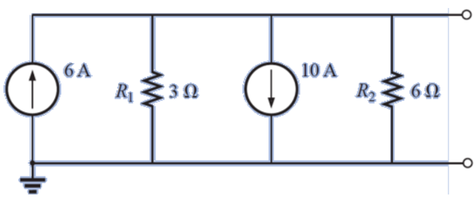
If two or more current sources are in parallel, they may all be replaced by one current source having the magnitude and direction of the resultant, which can be found by summing the currents in one direction and subtracting the sum of the currents in the opposite direction.





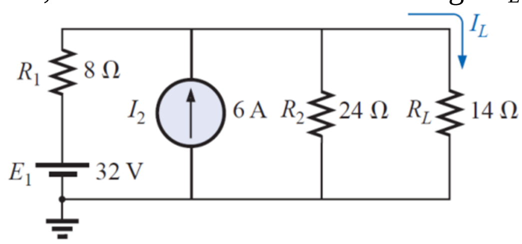
## EXAMPLE 5

Reduce the parallel current sources of Fig. shown below to a single current source.



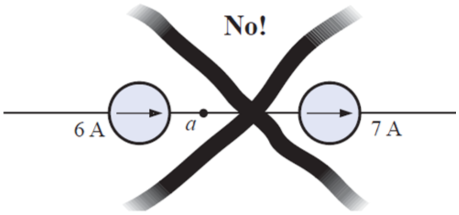

## EXAMPLE 6

Reduce the network of Fig. shown below to a single current source, and calculate the current through $R_L$.



## CURRENT SOURCES IN SERIES

***current sources of different current ratings are not connected in series,***

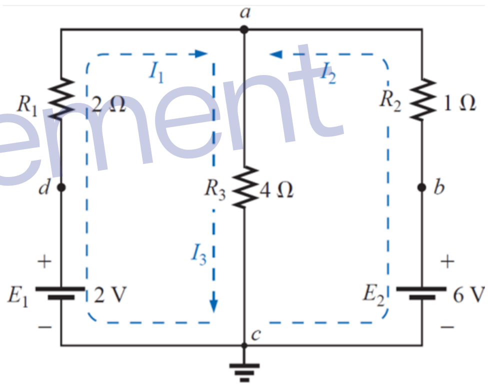



## BRANCH-CURRENT ANALYSIS

1. ***Assign a distinct current of arbitrary direction to each branch of the network (N).***
2. ***Label each of the N branch currents.***
3. ***Indicate the polarities for each resistor as determined by the assumed current direction.***
4. ***Count the number of current sources***
5. ***Number of variables equal to N- number of current sources***
6. ***Apply Kirchhoff's voltage law around each closed, independent loop of the network.***
7. ***Express any additional organize the equations.***
8. ***Solve the resulting simultaneous linear equations for assumed branch currents.***

Example 7

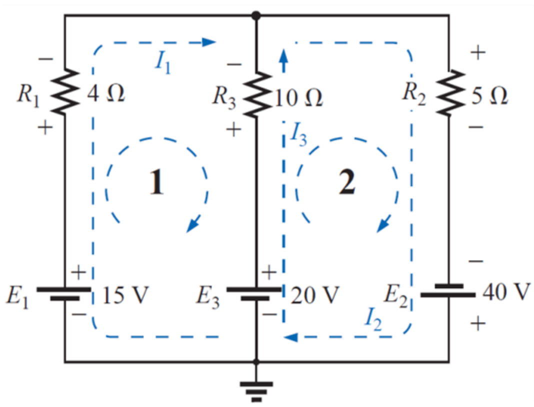
Apply the branch-current method to the network of the following network






Example 8

Apply the branch-current method to the network of the following network

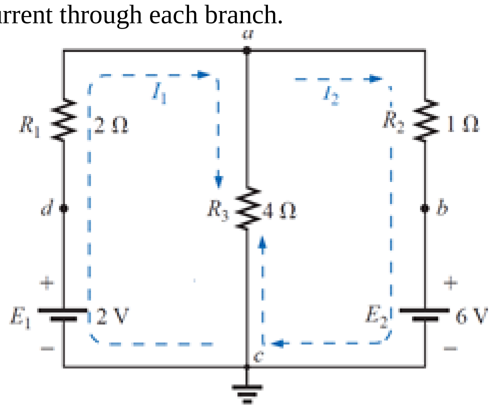


## MESH ANALYSIS

1. ***Assign a distinct current in the clockwise or anticlockwise direction to each independent, closed loop of the network (N).***
2. ***Label each of the N mesh currents.***
3. ***Indicate the polarities for each resistor as determined by the assumed current direction.***
4. ***Count the number of current sources***
5. ***Number of variables equal to N- number of current sources***
6. ***Apply Kirchhoff's voltage law around each closed, independent loop of the network.***
7. ***Express any additional organize the equations.***
8. ***Solve the resulting simultaneous linear equations for assumed branch currents.***

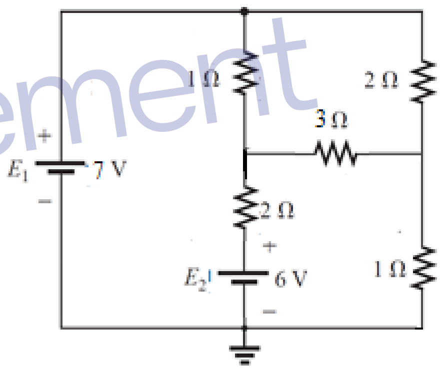
Example 9

Apply the Mesh method to the network of the following network to find the current through each branch.




Example 10

Find the branch currents of the network shown below

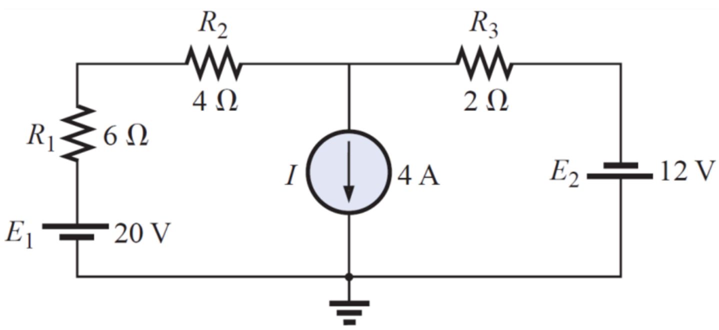





## Supermesh Currents

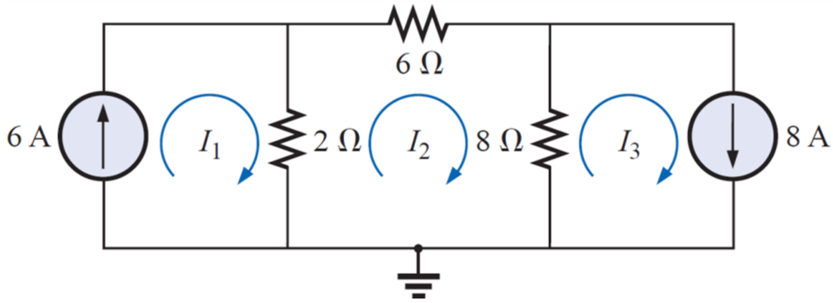
Example 11

Using mesh analysis, determine the currents of the network shown below



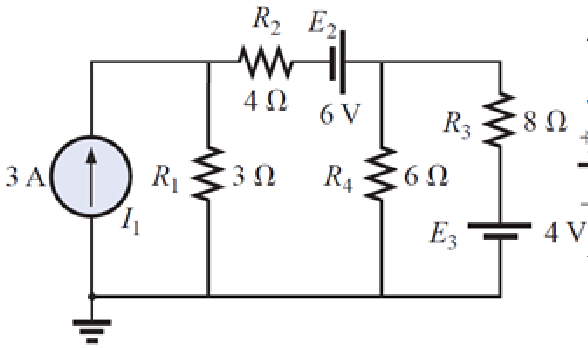
Example 12

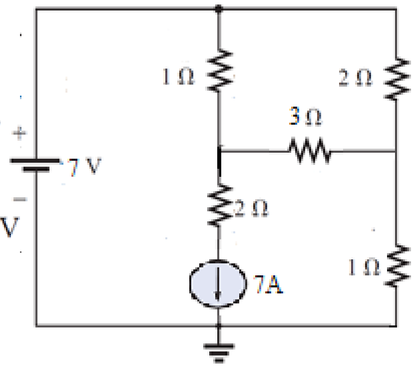
Using mesh analysis, determine the currents of the network shown below




H.W

Find the mesh currents of the network shown below



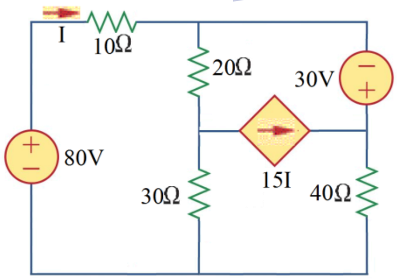

## Dependent source

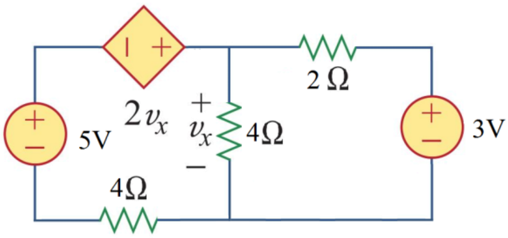
An independent voltage/current source is an idealized circuit component that fixes the voltage or current in a branch, respectively, to a specified value.

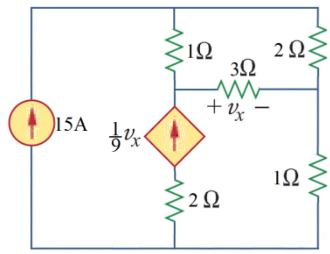
Example 13

Determine the currents of the network shown below





# NODAL ANALYSIS

A **node** is defined as a junction of two or more branches. If we now define one node of any network as a reference (that is, a point of zero potential or ground), the remaining nodes of the network will all have a fixed potential relative to this reference. For a network of *N* nodes, therefore, there will exist (*N* -1) nodes with a fixed potential relative to the assigned reference node. Equations relating these nodal voltages can be written by applying Kirchhoff's current law at each of the (*N* -1) nodes. To obtain the complete solution of a network, these nodal voltages are then evaluated in the same manner in which loop currents were found in loop analysis.

The nodal analysis method is applied as follows:

***1. Determine the number of nodes within the network.***

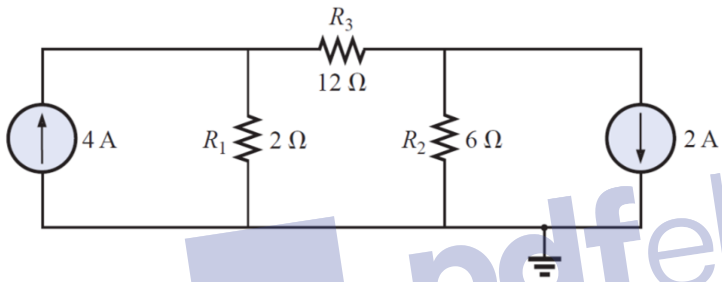
***2. Pick a reference node, and label each remaining node with a subscripted value of voltage: V1, V2, and so on.***

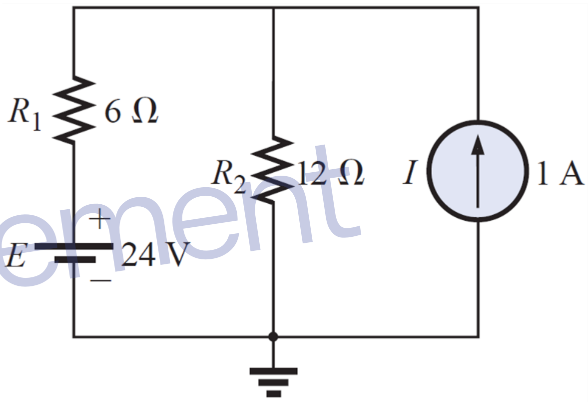
***3. Apply Kirchhoff's current law at each node except the reference. Assume that all unknown currents leave the node for each application of Kirchhoff's current law.***

***4. Solve the resulting equations for the nodal voltages.***

Example 14

Determine the nodal voltages



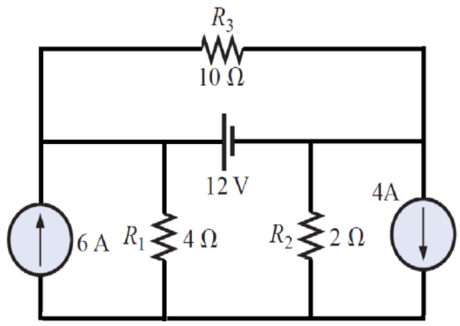






## Supernode

Example 15

Determine the nodal voltages



Delta – star and star – delta convertors

$R_1 = \frac{R_a R_b}{R_a R_b R_c}$

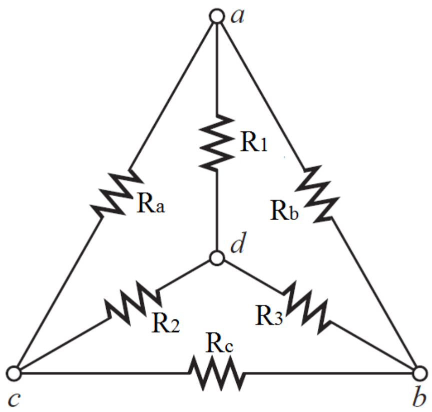
$R_2 = \frac{R_a R_c}{R_a R_b R_c}$

$R_3 = \frac{R_c R_b}{R_a R_b R_c}$

$R_a = \frac{R_1 R_2 + R_1 R_3 + R_2 R_3}{R_3}$

$R_b = \frac{R_1 R_2 + R_1 R_3 + R_2 R_3}{R_2}$

$R_c = \frac{R_1 R_2 + R_1 R_3 + R_2 R_3}{R_1}$




Example

Calculate the total resistance of the circuit shown below