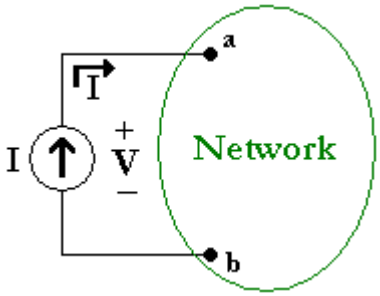
Currents

Topics:

A. Current Sources and Source Conversions

Current source provides a fixed current in the branch where it is located.

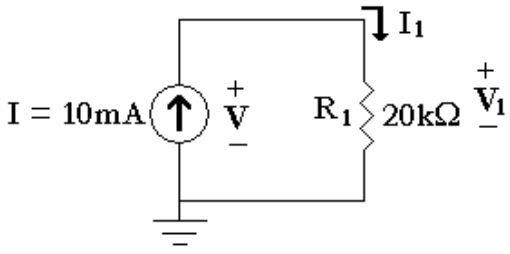


Vab = V

A current source determines _____

and _____ of the current in the branch where it is located.

If we have the following circuit:



$I_1 = I =$ _____mA

$V_1 = I_1R_1 =$

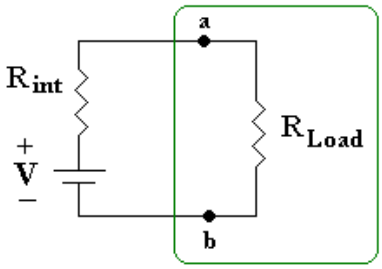
=

∴ V = =

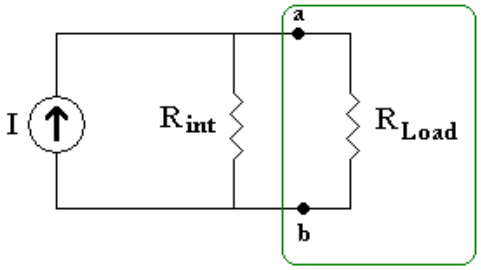
This current source is called an ideal source. Why?

In reality, all sources have some internal resistance.

For voltage source



For current source



What is the ideal R_{int} for voltage source?

R_{int} =

Why?

What is the ideal R_{int} for current source?

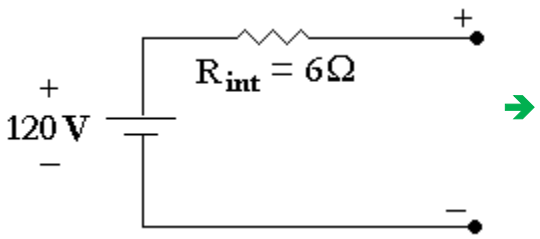
R_{int} =

Why?

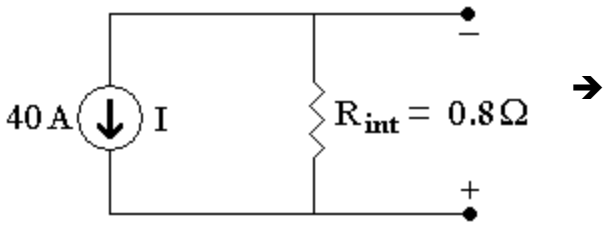
$$R_{int} = \frac{\text{Open - circuit terminal voltage}}{\text{Short - circuit terminal current}}$$

❋ Examples:

Find the equivalent current source for the following constant voltage source.

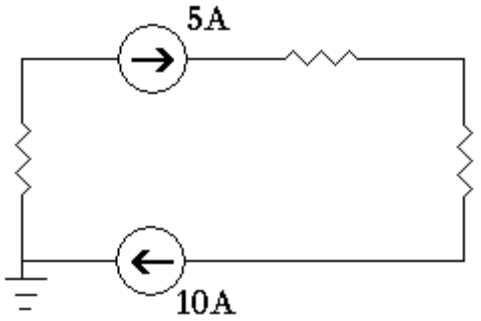


Find the equivalent voltage source for the following constant current source.



B. Current Sources in Parallel and Series

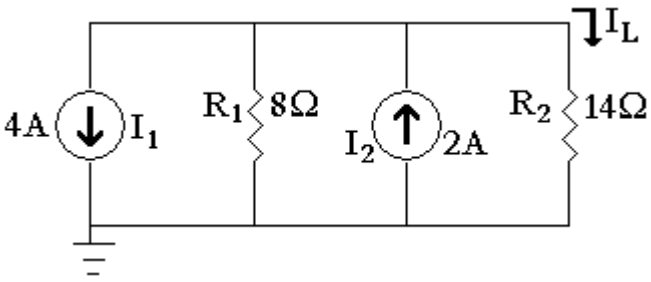
Let's evaluate the following circuit:



What is wrong with this circuit?

Why?

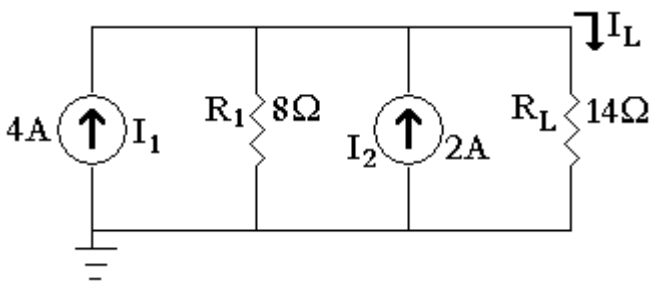
Now, let's evaluate the following circuit:



Will the circuit work?

Why?

❋ Example:



- simplify the circuit
- Find I_L

- Simplified Circuit

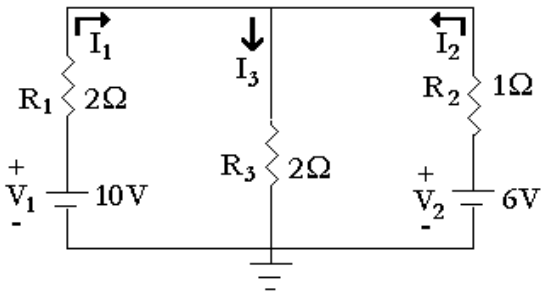
- I_L

- Conclusions:

C. Branch-Current Analysis

Can we simplify the circuit?

How do we find I_1 and I_2?



We need to use branch-current analysis.

Step 1: Assign an arbitrary direction of current to each branch of the circuit.

Step 2: Indicate the polarities for each resistor.

Step 3: Apply Kirchhoff's Voltage Law (KVL) around each closed loop.

Loop 1:

Loop 2:

Step 4: Apply KCL at the minimum number of nodes that will include all the branch currents.

Step 5: Solve the equations

D. Mesh Analysis

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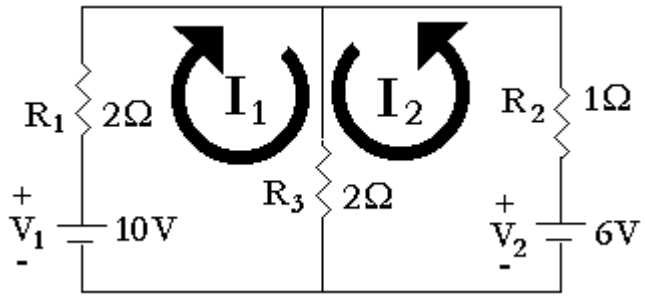
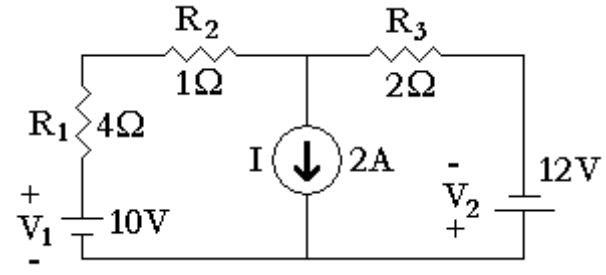
How? Skip step 4 but we need to explicitly indicate that magnitude and direction of the net current flowing on each branch.

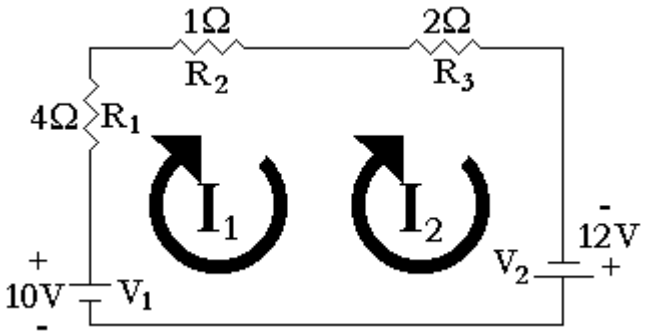


Now, what should we do if we are asked to evaluate the following circuit?



We have a current source I=2A without a parallel resistance.

Use supermesh!



E. Nodal Analysis

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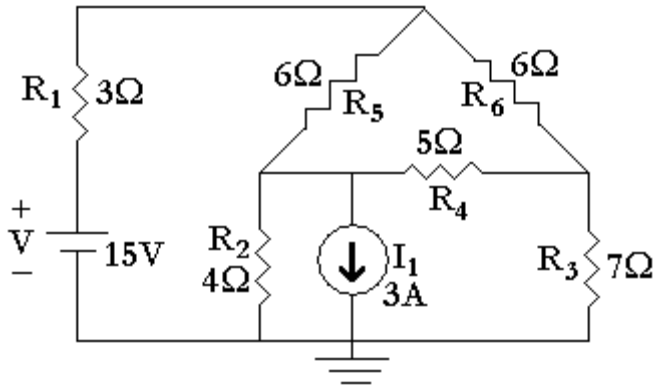
We use KCL

Nodal Analysis Procedure

1. Determine the number of nodes within the network
2. Pick and label each node with a subscripted value of voltage (V_1, V_2,…)
3. Apply KCL at each node except the reference
4. Solve the resulting equations for the nodal voltages.

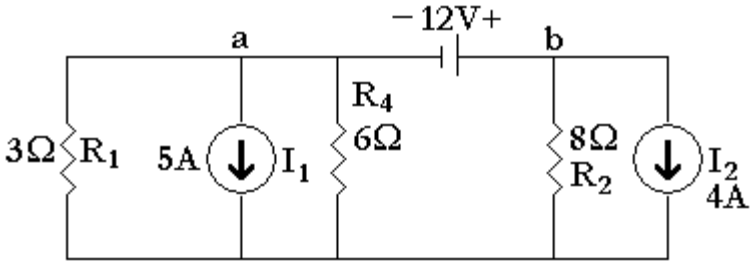
❋ Example:

For the circuit below, write the nodal equations and solve for the nodal voltages.



How many nodes?

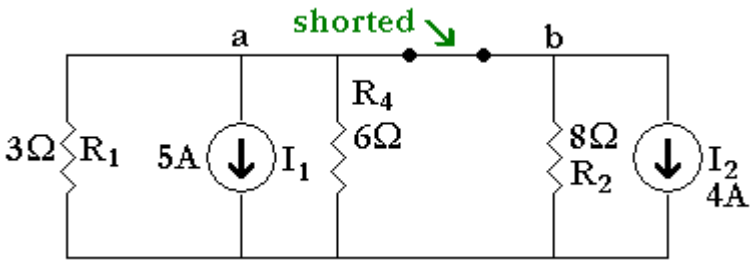
Supernode



Find V_a and V_b

How do we solve this problem?

We use supernode. Why?



What are the steps?

How many nodes do we have now?

$$\square\ I_{in} = \square\ I_{out}$$