6.200 Circuits and Electronics

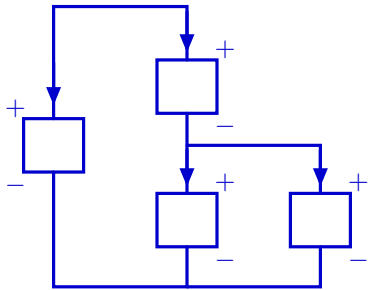
Week 2 Recitation:
Nodal Analysis

Course web site: `https://circuits.mit.edu`

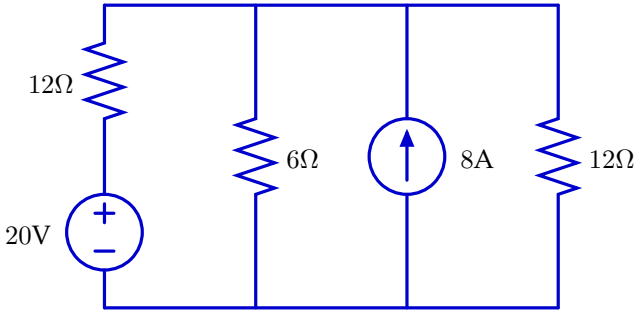
Grab participation sheet by the door.

The Lumped-element Abstraction

In 6.200, we will model systems as networks of interconnected idealized components connected by ideal conductors. Each component has a *current* flowing through it and a *voltage* that develops across it. Our idealized components are described by the constraints they impose on their current and voltage.



Solving Circuits: The Old Way



Each component has a voltage and a current: 10 unknowns.

Need 10 equations; where do they come from?

A Shift In Perspective

So far, we've talked about *branch voltages* that appear across the terminals of a single element. Today, we'll instead talk about *node voltages* (or *node potentials*), which refer to the difference in potential between a node and a chosen reference node (assumed to be at 0V potential).

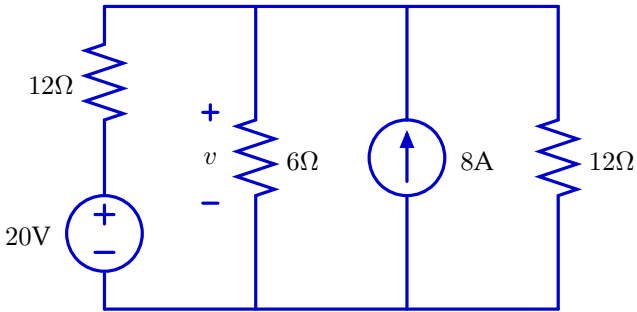
Node Method

1. Identify the nodes in the circuit and label one as the reference node (0V potential)
    - Good choice: the node with the most independent voltage sources connected to it
2. Replace trivially-solveable values with their solutions
3. Label the other nodes' potentials with names
4. Label currents with directions (arbitrary), names if you want
5. Write KCL equations for each node in terms of node potentials and constitutive equations
6. Solve those equations to find the node potentials
7. Use the node potentials to solve for anything else you want

Often, there are other simplifications/tricks/shortcuts we can take, but be careful!

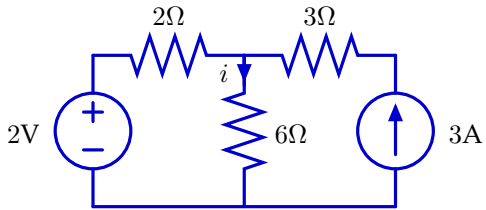
Example 1

Find the voltage v in the circuit below:



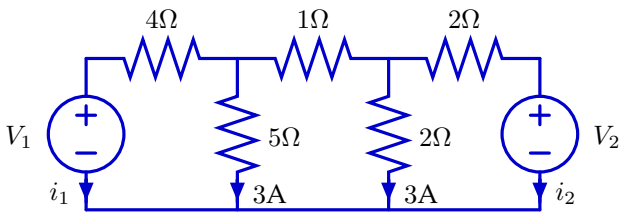
Example 2

Find the current i in the circuit below:

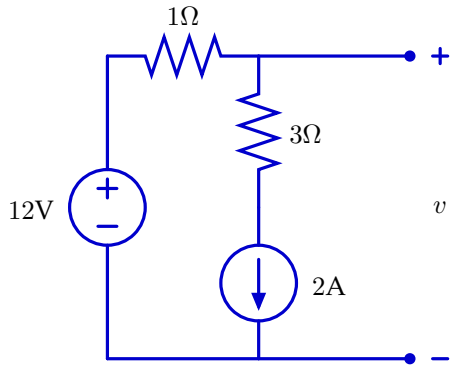


Example 3

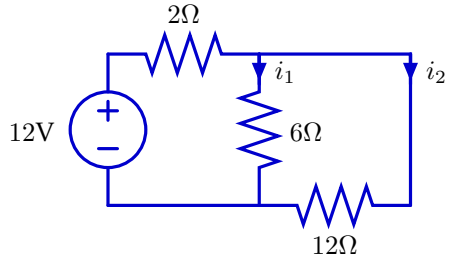
What values (V_1 and V_2) must the sources in the circuit below have to make the labeled currents consistent? What are the currents i_1 and i_2?



Example 4

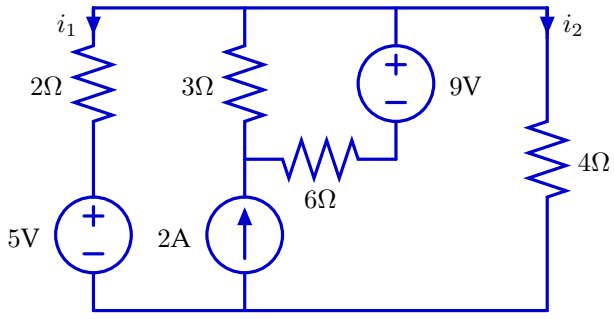


Example 5



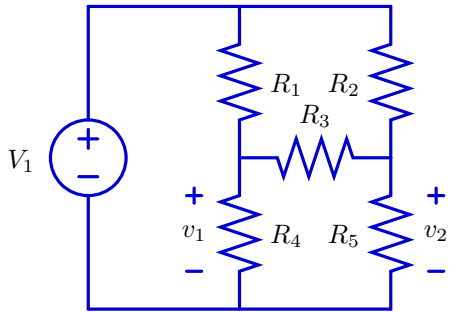
Example 6

Find the currents i_1 and i_2 in the circuit below:



Example 7

Find the voltages v_1 and v_2 in the circuit below:



Example 8

Find the voltages v_1 and v_2 in the circuit below: