6.200 Circuits and Electronics

Week 1 Recitation:

The Lumped-element Abstraction

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

Please sign up for recitation/lab sections **by the start of lecture tomorrow**!

Grab handout by the door (participation sheet).

Course Staff

Instructors:

- Adam Hartz
- Dave Perreault
- Negar Reiskarimian

TAs:

- Josh Feliciano
- Mozi Guobadia
- Lydia Patterson

Demo/Infrastructure Support:

- Dave Otten
- Anthony Pennes

and lots of LAs!

Classroom Expectations

No laptops.

Take notes and review them later.

Try to ask (and answer) questions.

Participation: bring a pen/pencil!

First-week Logistics

Problem set 1 is out now through the web site.
Due Monday night at 10pm, **except** for “pre-lab” assignment due before lab this Friday.

Some problem sets have a hardware component (including problem set 1).
Please pick up a kit (and multimeter) on your way out **and don’t lose it!**

Please review course information and schedule at `https://circuits.mit.edu`
(please plan travel, interviews, etc., around exams)

First lab (and nanoquiz!) on Friday.
We’ll do section assignments tomorrow afternoon and let you know sometime that evening.

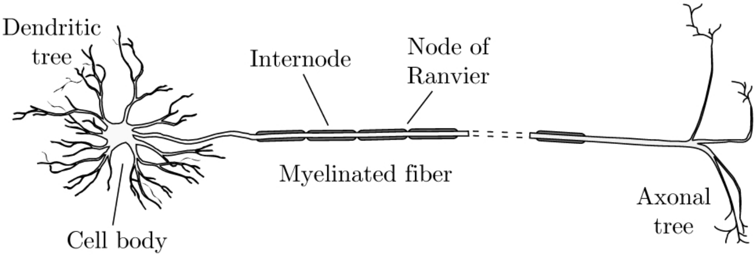
The Power of Circuits

Circuits are useful and important for (at least) two very different reasons:

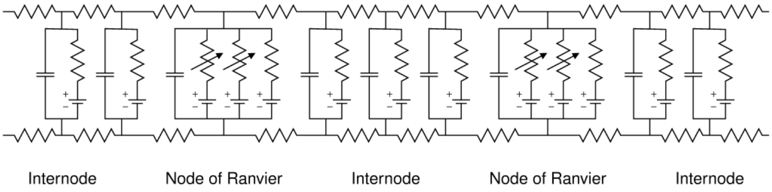
- as **models** of complex systems, e.g.,
  - biological models
  - thermodynamic models
  - fluid models
- as **physical systems**, e.g.,
  - power (generators, transformers, power lines, etc)
  - electronics (computers, etc)
  - communication and filtering (cell phones, audio processing, etc)
  - sensors (sonars, glucose sensors, etc)

Also, they're fun :)

The Power of Circuits

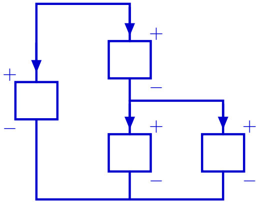


Model of myelinated nerve fiber



The Lumped-element Abstraction

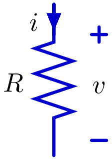
In 6.200, we will model systems as networks of interconnected idealized components connected by ideal conductors. Each component has a *current* flowing through it and a *voltage* that develops across it. Our idealized components are described by the constraints they impose on their current and voltage.



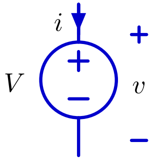
What are we (intentionally) ignoring with this model?

Primitive Components

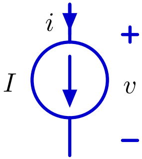
For the first few weeks of 6.200, we'll focus on a small number of types of components:



Resistor
Parameter: R (Ω)
$v = iR$



Voltage Source
Parameter: V (Volts, V)
$v = V$



Current Source
Parameter: I (Amps, A)
$i = I$

Check Yourself!

Consider the "i/v" curves on the participation sheet, where the vertical axis represents the current through a device (in Amps) and the horizontal axis represents the voltage across it (in Volts). What single component does each graph correspond to, if any? For those that don't correspond to a single component, why not?

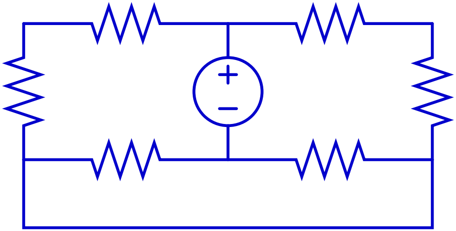
Terminology

Node: a set of points connected only by wires

Branch: a connection between nodes (by way of a component)

Loop: a closed path through components

How many nodes, branches, and loops are in the circuit below?



Combining Components

The constitutive equations describe how each component individually constrains its current and voltage, but when combining them, we have some additional constraints:

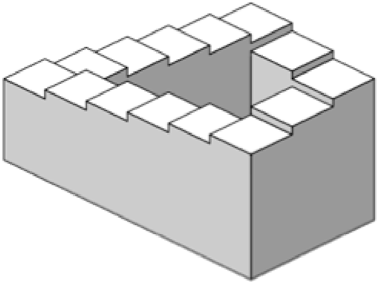
- Kirchoff's Voltage Law
- Kirchoff's Current Law

These are idealized rules in the lumped-element model!

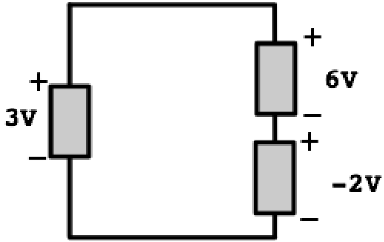
Combining Components: KVL

KVL: The sum of the voltages around any closed loop in a circuit is 0.

Impossible Things



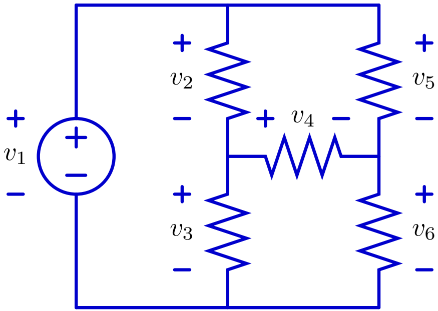
Penrose Staircase



$3V - 6V - -2V \neq 0V$

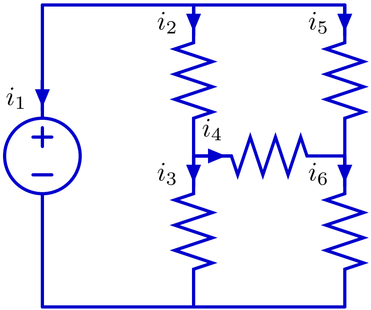
Combining Components: KVL

KVL: The sum of the voltages around any closed loop in a circuit is 0.



Combining Components: KCL

KCL: The total current flowing into any node must equal the total current flowing out of that node.



Putting It Together: “Brute-force” Method