

Circuit Abstractions

The Big Ideas:

- As a consequence of working with linear components, we can graph the relationship between voltage and current as a straight line.
- We can express the straight line using a linear equation; if we convert that equation back into a circuit representation, we get a simple circuit.
- Relatedly, we can reduce a more complex circuit to a simpler circuit using Thevenin/Norton equivalence.
- Linear components mean we can also combine simple circuits to solve for the properties of more complex circuits.

Introduction

Last week, we focused on op-amps. Op-amps enable us to sample a voltage from a particular subsection of a circuit, without disrupting the properties of the circuit in that subsection. This is powerful because it allows us to treat that subsection as independent from the rest of the circuit.

This week, we use what we've learned from the previous two weeks to allow even further circuit abstraction. We'll learn about Thevenin equivalence (as well as Norton equivalence) and superposition. Thevenin equivalence supplies a discipline for abstracting complex systems down into simple, equivalent representations, typically in order to substitute the simple representation back into a larger circuit. Superposition allows us to solve circuits more quickly (and for some, more intuitively).

Vocabulary

In order to engage the material, be able to communicate about the topic with others, and in particular ask questions, we encourage familiarity with the following terms:

Theory

- Current-Voltage relation
- One-Port element
- Linear Equation
- Thevenin Equivalent
- Norton Equivalent
- Open-Circuit Voltage
- Short-Circuit Current
- Superposition

Practice

- `io`
- `Sensorinput.analogInputs`

Check Yourself

Note that this week, the theory we've been introduced to has few practice problems. Make sure you are comfortable with Thevenin/Norton Equivalence as well as superposition for the midterm.

Theory: you should understand:

- What equivalence is and why it's powerful
- Why equivalence and superposition are possible in our current framework

Practice: you should be able to:

- Find the Thevenin/Norton equivalence of a circuit
- Solve a circuit using superposition
- Describe how the reference and alternative designs fare with respect to speed, stability, accuracy, and uniformity

Resources

Theory: 6.5 of the 6.01 Course Notes is relevant to the theory presented this week. All of Chapter 6 is relevant to this unit.

Practice: The 6.01 Software Documentation will come in handy, in particular modules `io` and `sm`.

The Homework Tutor contains some optional Op-Amp and Equivalence problems. Most midterms contain examples of circuits that can be solved using superposition.

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