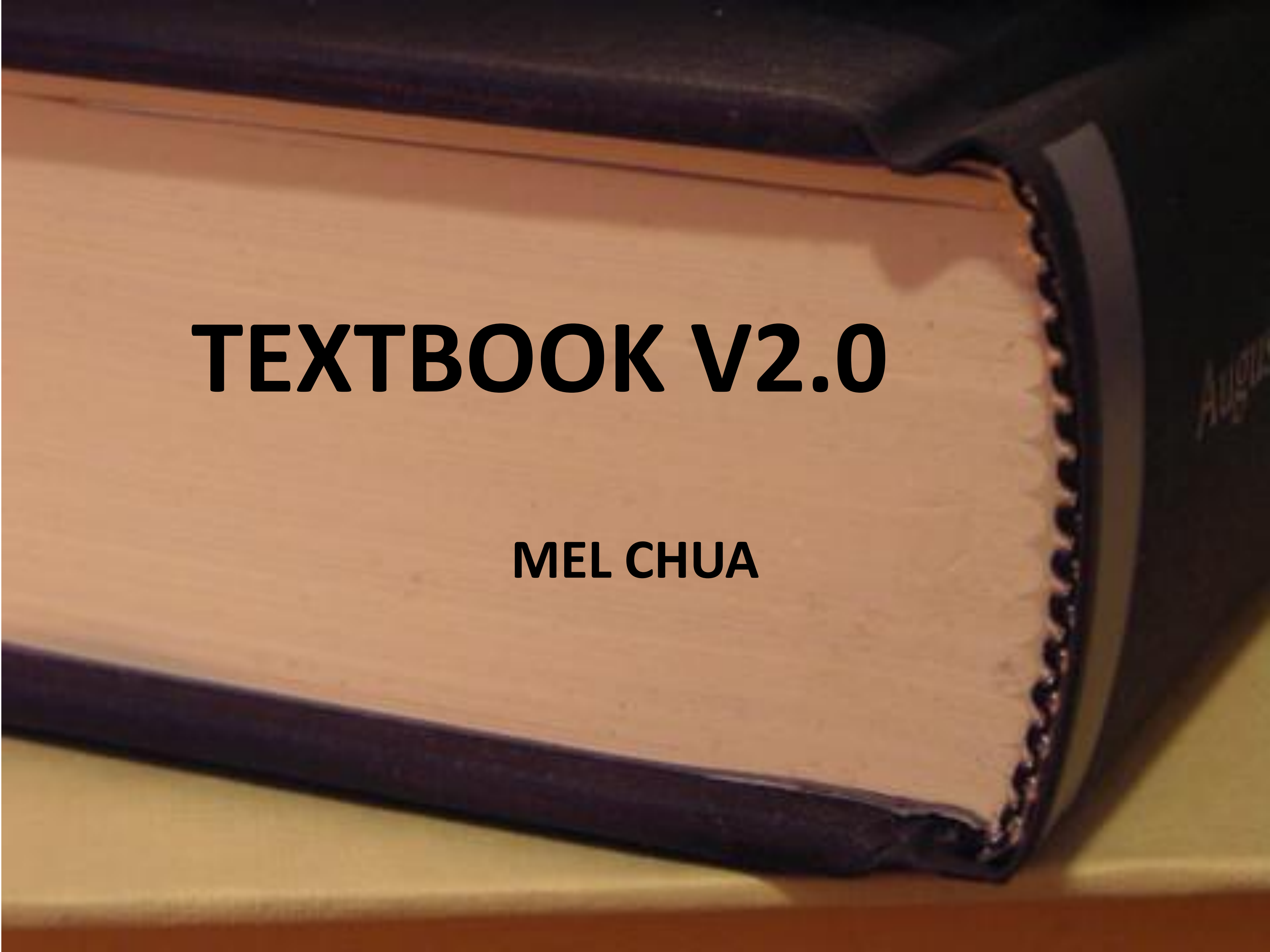

TEXTBOOK V2.0
MEL CHUA

WHAT DO WE HAVE NOW?

“CONVENTIONAL” SCHOOLING


THE OLIN WAY OF TEACHING

THE PROBLEM

When teaching in a “do learn” fashion, we must give students very good resources to find answers to their questions. We now realize that we need to write a new textbook (or at minimum a set of course notes) that presents the material in a manner appropriate for a “do learn” subject. Current text books, for example, explain synchronous detectors, but use language that depends on a semester or more of ECE. (Kerns, Kerns, Pratt, Somerville, & Crisman, 2002)

THE OPPORTUNITY

Engineering of Compartment Systems

Links

- Info
  - Policy and Grading
  - Staff
  - Learning Objectives
  - Syllabus
  - What to expect
- Work
  - Homework
  - Labs
  - Reading
- Resources
  - Software
  - Links

Announcements

[November 10, 2004]

- **Optional Session: Motors, Lecture, and Lab 7**
  Thursday, Nov. 11, 1:00, in AC 126

  We'll take a close look at the circuit in lab 7, the concepts involved in motors, and the mechanical/electrical isomorphism.

[October 27, 2004]

- **Optional Session: Control System Extravaganza**
  Tomorrow, Thursday, 1:00, in AC 126

  This will be a review of control system concepts from lecture, and a potpourri of other control methodologies, mechanisms, and examples, as time allows. Useful for putting these ideas into practice.

[October 21, 2004]

- **Optional Review Session: Circuits and Heat Transfer**
  Today, 1:00, in AC 126

  Depending on interest, we will spend time working through and expanding on the circuits primer, and discussing topics from last lecture: modes of heat transfer, modelling, and examples.

[October 17, 2004]

- Function written in MATLAB to compute temperature given the resistance.

[October 8, 2004]

- Example tex file for summative lab is now posted.

Past Announcements

- Experience the textbook creation process
- “Springboard” material (not info dump)
- “Fill gaps” in existing course (later: self-taught)
- No rubrics. No answers. Very little math.
- Get different learning styles to converse

GOALS

EXAMPLE 1: LAB

LAB: OLD VS NEW

OLD LAB

The first step in our control system is that we want to control the power supplied to the filament. Since power, voltage, and current are instantaneously related – we need to use integral control (why this is so will be explained in class).

NEW LAB

If the power of the filament is 0.2 watts, what must the voltage across and current through the filament be? How can you implement this relationship in your code? One idea is to use something called integral control to control the output voltage of your MATLAB code.

Take 5 minutes and the internet to see if you can find out what integral control is. Also look up proportional control and PID (proportional-integral-derivative) control - you don‘t have to spend too long on this, but try to get at least a rough sense of what the terms might mean.

MORE LAB FEATURES

- **SANITY CHECKS.** This lab should take somewhere between 5 and 10 hours to both do and prepare a deliverable for.
- **SELF CORRECTING.** For instance, you should notice that the temperature of the filament takes some time to reach equilibrium. Why is this? How fast does it approach equilibrium, and does the speed of its approach change over time? Why?
- **OPEN ENDED.** The most common deliverable is a lab report or engineering article with (well-labeled and explained) graphs of data, diagrams, and a mathematical analysis of the system. Don't feel limited by this; previous students have also turned in comic books, bedtime stories, and interpretative dances with annotations.
- **ALLOWS INTERDISCIPLINARY WORK.** You may combine the deliverable for this lab with any other deliverables you produce in this course. You may also combine the deliverable for this lab with any other deliverable you are producing in any of your courses or other activities, if your instructors for both classes approve.

STUDENT COMMENTS

- **ON SELF CORRECTING:** Nice. These are built-in feedback for students. "Oh! I'm doing this right...“
- **ON EXPLANATIONS:** …too much hand-holding here… If they need help, they can ask.
- **ON “SPRINGBOARDING”:** Looking things up is sweet. this makes it far more personal than being told.
- **ON DELIVERABLE FLEXIBILITY:** …it's important that all of our students be able to write up solid, formal lab reports….

DISCIPLINARY CONTEXT

DO-LEARN

In reality: do-learn-do-learn-do-learn…

PBL

Project-based learning.

SPIRAL LEARNING

You *will not* get it the first time.

ACTIVE LEARNING

Students are not empty vessels to be filled, but involved participants in the creation of their own learning.

CONSTRUCTIVISM

We learn by either adding to our mental models or breaking them completely.

CONSTRUCTIONISM

Often described as “learning by making.”

ARTIFACTS

These serve as “external memory” and points of discussion, solidifying what happened *at that moment.*

SELF-DIRECTED LEARNING

Also known as “passion-driven” learning.

BEHAVIORIST GRADING

If you do A, then you get B.

CLASSROOM AS STAGE

Learning materials don’t just provide lines; they provide meaning.

DIFFERENTIATED INSTRUCTION

Different people react differently to different ways of teaching.

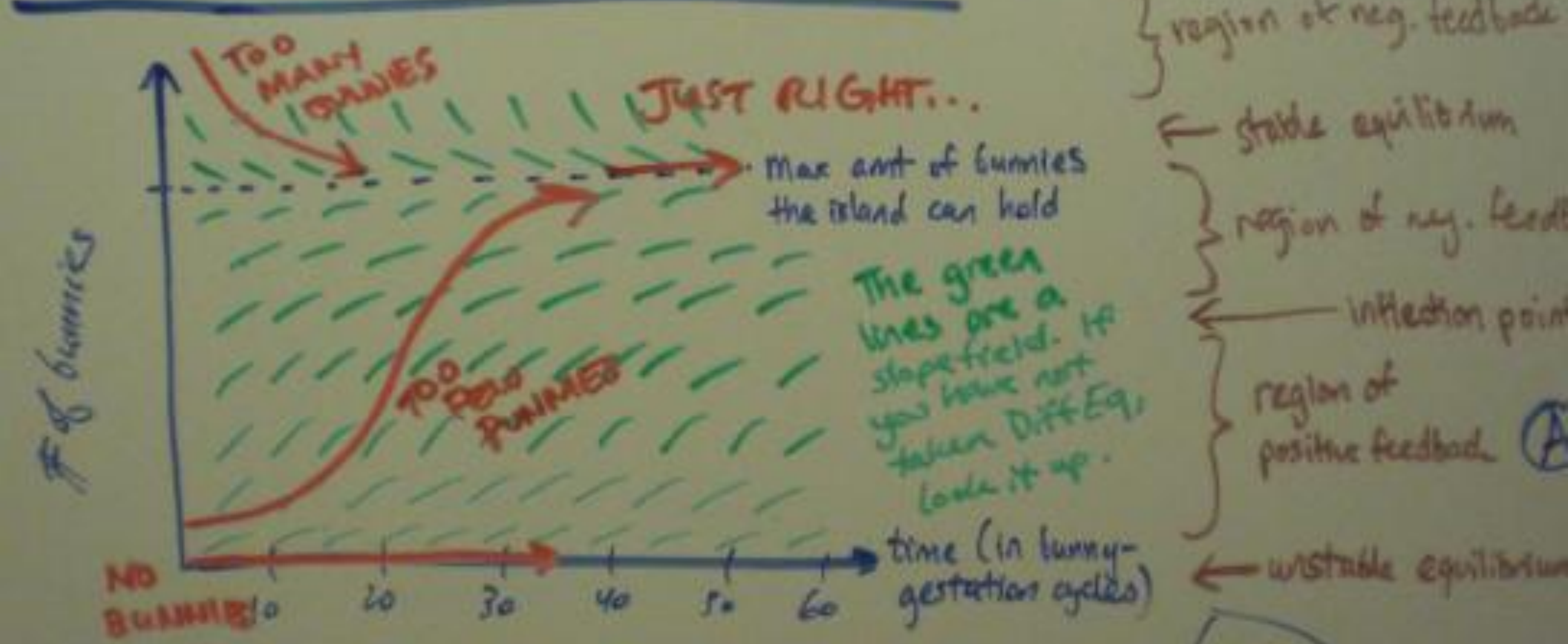
SUBJECT AS CULTURE

Join the conversation in a field by learning its tacit “ways of thinking.”


BURRELL SCHOOL
EXAMPLE 2: FIRST SPIRAL

④ Feedback in population

← see also: fibonacci sequence



Bunny population on Easter Island. A couple cases we can look at here.

DO NOT ERASE

① No bunnies → No baby bunnies → no bunnies. Right, so.

② Too many bunnies → too little food → bunnies die → not too many bunnies.

CHAPTER 6: FEEDBACK

PROLOGUE

> ***In times of change, learners inherit the Earth, while the learned find themselves beautifully equipped to deal with a world that no longer exists.***
>
> ***–Eric Hoffer***

In this chapter, we're going to be talking about how systems respond to changes in themselves and their environments at the most basic levels by introducing the idea of the feedback loop. Ideally, you'll be reading this chapter in the middle of doing Lab 5; that is, you should have started the experiment and gone as far as you can by yourself before hitting this book to see if you can find answers to some of your questions.

After working through this chapter, you should be able to walk around in your normal life pointing out feedback loops in different types of systems, both engineering and non-engineering. You should be able to formulate and present a plan for learning about the feedback loops you identify so that you can understand, model (mathematically, in computer simulation, in small-scale physical simulation, or otherwise) and ultimately change that part of the world to be more like what you'd like it to be.

STEP BACK: HOW'S THE CLASS GOING FOR YOU?

> ***If you don't like the way the world is, you change it. You have an obligation to change it. You just do it one step at a time.***
>
> ***–Marian Wright Edelman***

Before we launch into new material, let's take some time to step back and look at how your learning is going.

Comment [m1]: Before reading this chapter, one should have read Lab 5. This lab would occur perhaps one-third of the way through a semester.

Comment [m2]: I was hoping to find the origin of the idea of epigraphs, which appear to be a common practice in textbooks – I wasn't able to find this and am still looking.

Comment [m3]: Giving hints as to the "suggested" usage of the book without constraining people to it.

Comment [m4]: You'll notice that for an engineering text, this chapter is curiously devoid of formulae. It's deliberately meant to be. The short version is that the mathematics and engineering are usually the focus of the other portions of the class, and the context ("why do I care about this?") is the part I most often heard was missing from the mix.

Comment [m5]: From *Understanding By Design* comes the idea that learning objectives ("beginning with the end in mind") are tremendously important. What are you setting out to accomplish?

Comment [m6]: An explicit implementation of "learning about learning." I found it curious that most of the education books I read seemed to have teachers, not students, as their main audience. This is an attempt to present the same material to students in context so they will engage in reflective learning.

Comment [m7]: Students tend to learn something better when they think they're competent at it.

Comment [m8]: Throughout this chapter I will be attempting to promote social learning behavior in an attempt to engage students in dialogue with one another and become speaking practitioners of "the language of engineering." An added

WAYS OF PRESENTING DATA

Professors: "We're going to do a small interpretative dance to explain this abstract mathematical concept."

Students: "Wow, that was awesome!"

Professors: "That worked so well that we're going to do a longer dance explaining lab 4!"

Students: "That was fantastic!"

Professors: "And now a fully choreographed 2-act ballet on Maxwell's equations!"

Students: "Hurrah!"

Take a minute right now to write down your own definition for feedback in the space below. No peeking on the next page until you do this. Go on, now.

< blank space >

Now grab two people… compare your answers with theirs and the definitions below…

1. The return of a portion of the output of a process or system to the input…

FIGURE 2: WHAT KEEPS THE SOUND FROM BECOMING INFINITELY LOUD?[4]

Fudge

Have you ever made fudge? Because of the crystallization of the sugar determines the final properties of the batch of fudge you end up with, it's very important to monitor and control the temperature of the syrup in the pot. You stand with one hand on the dial and one eye on the thermometer. If you see (according to the thermometer) that the fudge is too hot, you turn the dial so the flames die down; if you see it is getting too cold, you turn the dial so the flames shoot up.[5] The raising and lowering of flame intensity heats or cools the chocolate accordingly, and the thermometer adjusts to read the temperature of the chocolate; you then see the thermometer…

Now imagine that you want to have fresh fudge every day, but don't want to stand over a hot stove for hours to get it. How could you design a system that would be able to monitor and adjust the fudge temperature by itself without your intervention? (Could you do it with the equipment you've been using to make your labs? What more would you need?)[6]

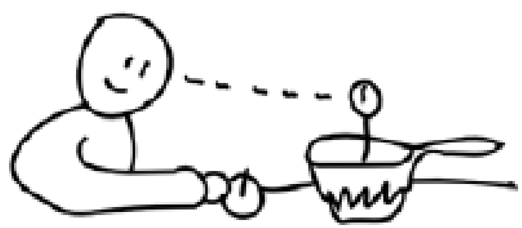


FIGURE 3: WHAT ARE THE SOURCES OF LATENCY IN THIS SYSTEM?[7]

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---

[4] Look up various definitions of the word "rails." Try to find the one that fits this example best.

[5] What are the "sensors" and "actuators" in this system? Hint: you count as part of the system. Is it possible for something to simultaneously be a sensor and an actuator? At the same time?

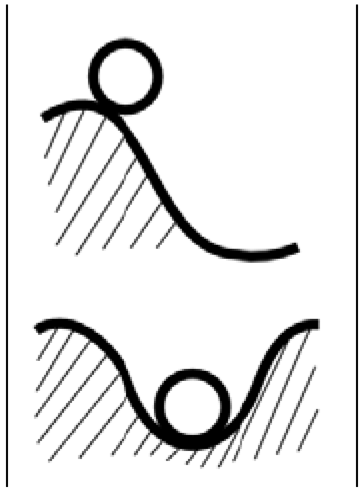
[6] Also, how much would it cost? Would it actually be cheaper to buy fudge from the local candy store? Look up the meaning of the acronym COTS; how does that definition relate to this discussion?

[7] You may not have heard the word "latency" before. Behold the power of spiral learning. For now, take 10

"HOMEWORK" PROBLEMS

This last question is a group assignment your entire class should coordinate however you see fit… Design and evaluate a metric to evaluate the effectiveness of the following components… In-class lectures, lab sessions… You may, of course, modify any of these instructions so long as you provide justifications for the modifications.

How would you model these two systems in Simulink or MATLAB? Some variables you might want to think about are the mass of the ball…



LOOKING AT OUR BREADBOARDS

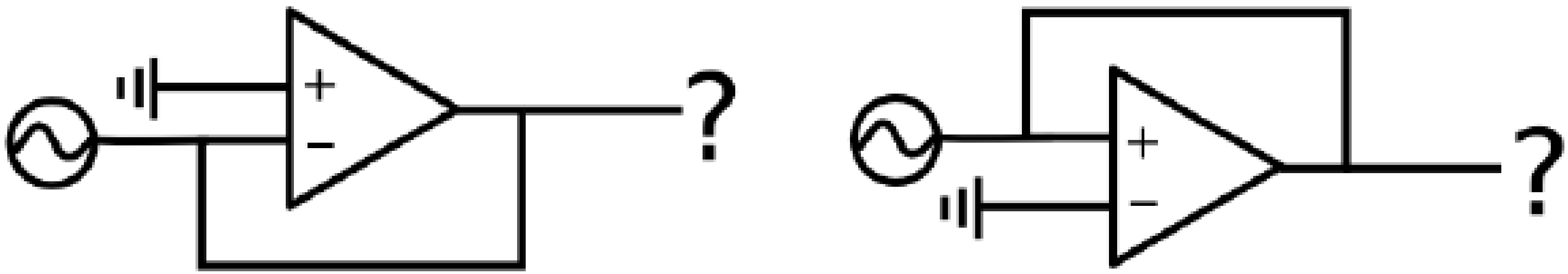


FIGURE 5: OP-AMPS

1. Can you find either of these op-amp[15] systems[16] on your circuit diagram?
2. What do they do?[17]
3. Remember the image of those two balls on hills earlier in this chapter? How do these diagrams relate?
4. What have we left out of this picture?[18]

In Chapter 2, we discussed a mathematical model of an op-amp and implemented it in Simulink. Can you model this system mathematically or in Simulink as well?[19] If you can do this, you're well on your way to completing the simulation portion of Lab 5.

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[14] If not, sit down with your NINJA and teach him/her about feedback. Teaching is a great way to learn.

[15] You should have learned what an op-amp does in Chapter 2. If you need a refresher, skim the section again, then take 10 minutes to either ask a neighbor, your NINJA, or to do some online research to remind yourself.

[16] By the way – the circle with the squiggle inside it is a signal source (a function generator, in your circuit).

[17] This is a broad question with a wide range of possible answers. It's your choice as to how you interpret it.

SAMPLE FOOTNOTES

If you're trying to figure out what happens when two wires [in the above diagram] are attached together, look up "Kirchoff's Current Law" and "Kirchoff's Voltage Law." If you find these intriguing, see what you can find on the conservation of energy, symmetry, and a mathematician named Emmy Noether.

You may not have heard the word "latency" before. Behold the power of spiral learning.

For fun, look up the term "Calculus of variations" and the word "brachistochrone."

Take a moment and look up the definitions for "amplify" or "amplifier" and "dampen" or "damper." Check out the etymology while you're at it; the history behind engineering terminology is often amusing. (Why are we called "engineers" in the first place?)

FEEDBACK

"The chapter feels a little fuzzy and like there is a huge proportion o[f] lead up till you actually get to the engineering stuff."

"I very much like it… I would have loved to have that many easy to understand analogies thrown at me."

"I think your textbook would make people living ECS much less lost and bewildered (though… you might [later lose the] ability to fake your way through Olin classes that totally lose you!)"

LESSONS

- The perfect *is* the enemy of the good.
- Feedback and revision takes a long time.
- Hack your beta. Feedback *will* change it.
- You *do* need math… in context.
- In order to make it “one size fits all,” make something that’s “make your own.”

- I feel like I can talk to educators now.
- I know what *not* to do.
- I have an artifact seed.
- What’s next? Well…

ON THE PLUS SIDE


ANY QUESTIONS?