

# 01-elec-to-tran-notes

## Course Introduction; Electricity to Transistors

### Agenda

- 1. Introduction
- 2. Electricity
- 3. Bits
- 4. The idea of a controlled switch
- 5. Getting empirical
- 6. Logic gates (maybe)

### 1. Introduction

#### Basics

course staff, email

- me
- TA tbd
- cs51@cs.dartmouth.edu

Canvas and piazza!

- lecture note commitment

standard: honor code

standard: Student Accessibility Services

standard: turn things in ON TIME.

#### Ground Rules

The Gremlins of Misunderstanding, and Destiny

(office hours)

#### What architecture is all about

What you've seen before (say, in CS1)

Physics and the subatomic universe

The importance of seeing through the layers

- "Keep secrets of the implementation. Secrets are assumptions about an implementation that client programs are not allowed to make" (Butler Lampson)



- But sometimes, we NEED to see through the abstraction.

## What this course is all about

A new book

- elements of course
- how they map to new book
- (and to the old books)

lab tools: LogiSim 2.7.1

- 003. And maybe 005
- but see the course resources page to install it on your own machines

## 2. Electricity



flow

voltage, current

schematic diagrams

- dots, crosses...

circuit... and shortcuts

switches

resistors

# 3. Bits

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simplify to two levels: "1" and "0"

traditionally...

- "1" was a big positive (e.g., +5v)
- "0" was ground
- sometimes.... 1 was wimpy, 0 was beefy

third-value: "open"

See basic0 in [democircs.circ \(https://ssl.cs.dartmouth.edu/~sws/cs51-s15/01-elec-to-tran/demo/democircs.zip\)](https://ssl.cs.dartmouth.edu/~sws/cs51-s15/01-elec-to-tran/demo/democircs.zip)

(LogiSim now has "pull-up resistors" built in. Except they permit "pulling" toward 0 or 1; in the real world, you almost always see only the latter.)

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# 4. The idea of a controlled switch

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ancient times: vacuum tubes

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diodes

<http://www-g.eng.cam.ac.uk/mmg/teaching/linearcircuits/diode.html> ↗ [\(http://www-g.eng.cam.ac.uk/mmg/teaching/linearcircuits/diode.html\)](http://www-g.eng.cam.ac.uk/mmg/teaching/linearcircuits/diode.html)

See main in [diode.circ \(https://ssl.cs.dartmouth.edu/~sws/cs51-s15/01-elec-to-tran/demo/diode.zip\)](https://ssl.cs.dartmouth.edu/~sws/cs51-s15/01-elec-to-tran/demo/diode.zip) for a simulation

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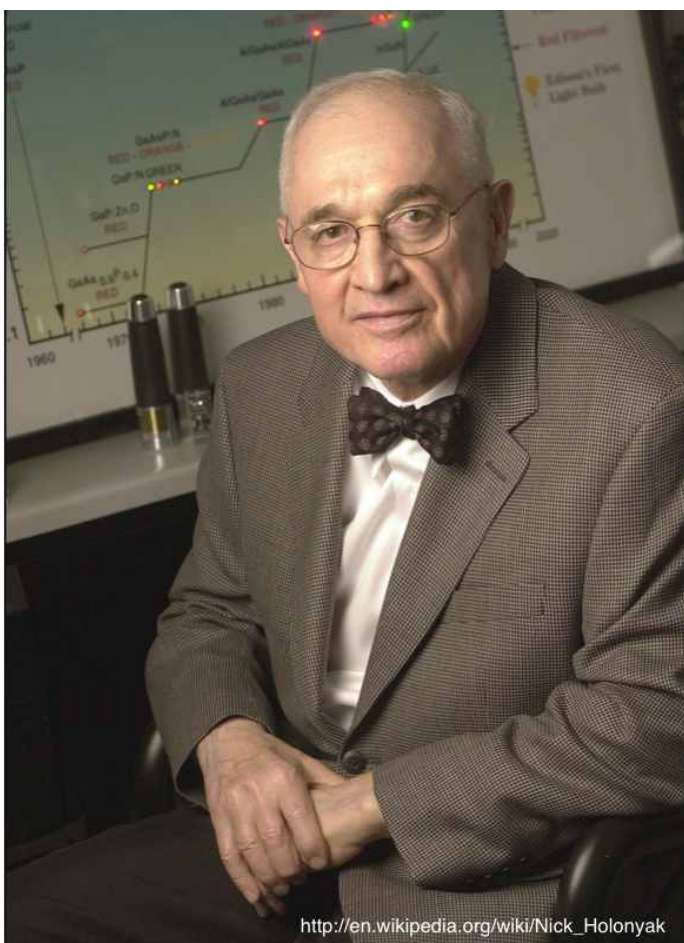




<http://history-computer.com/ModernComputer/Basis/images/TransistorInventors.jpg>

## transistors

- John Bardeen, Walter Brattain, and William Shockley,
- "what the BLEEP was that?"

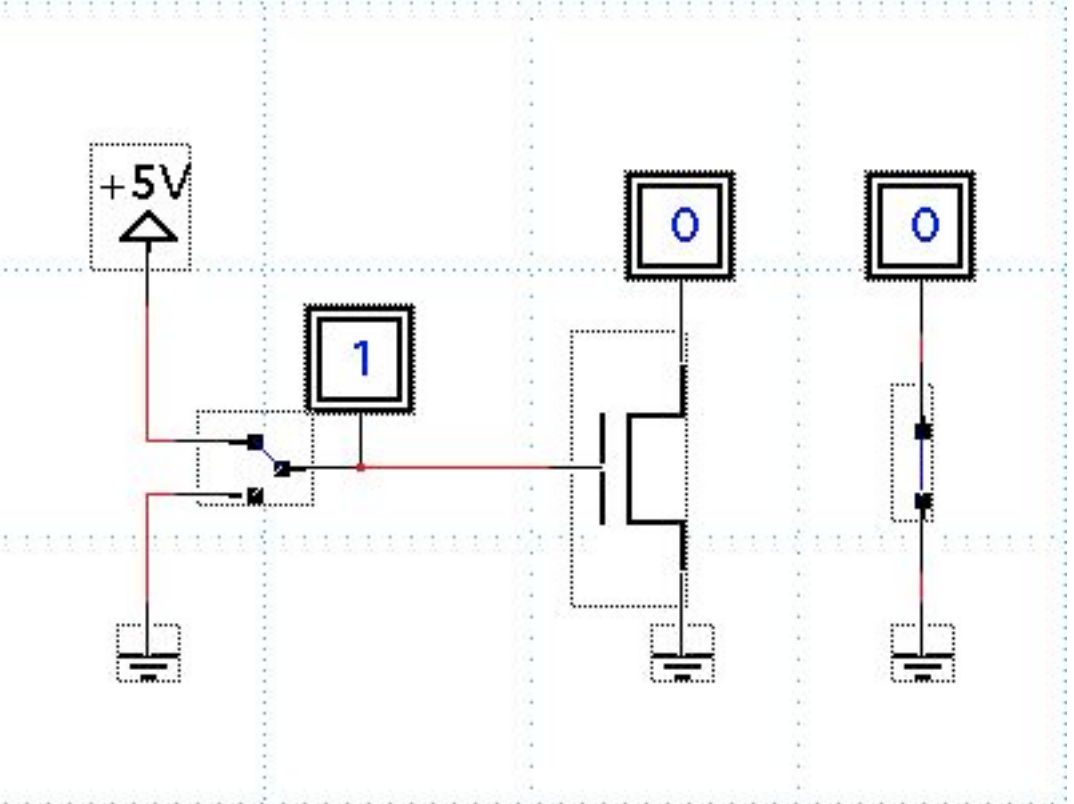
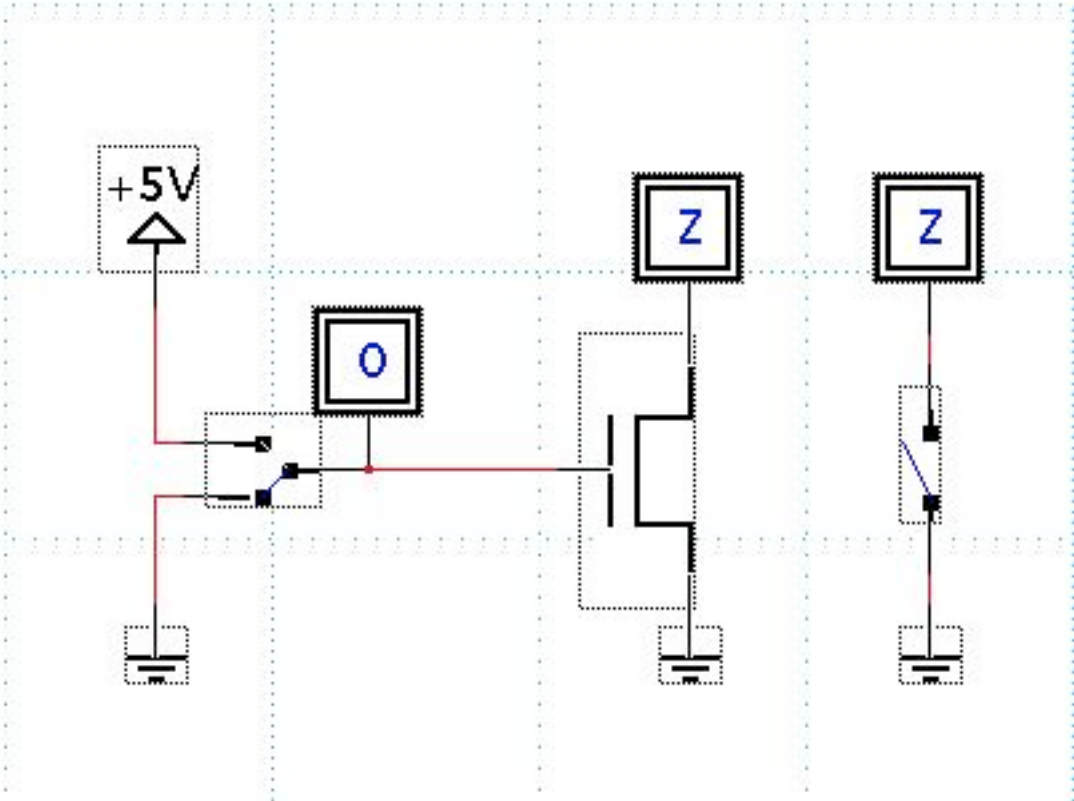


[http://en.wikipedia.org/wiki/Nick\\_Holonyak](http://en.wikipedia.org/wiki/Nick_Holonyak)

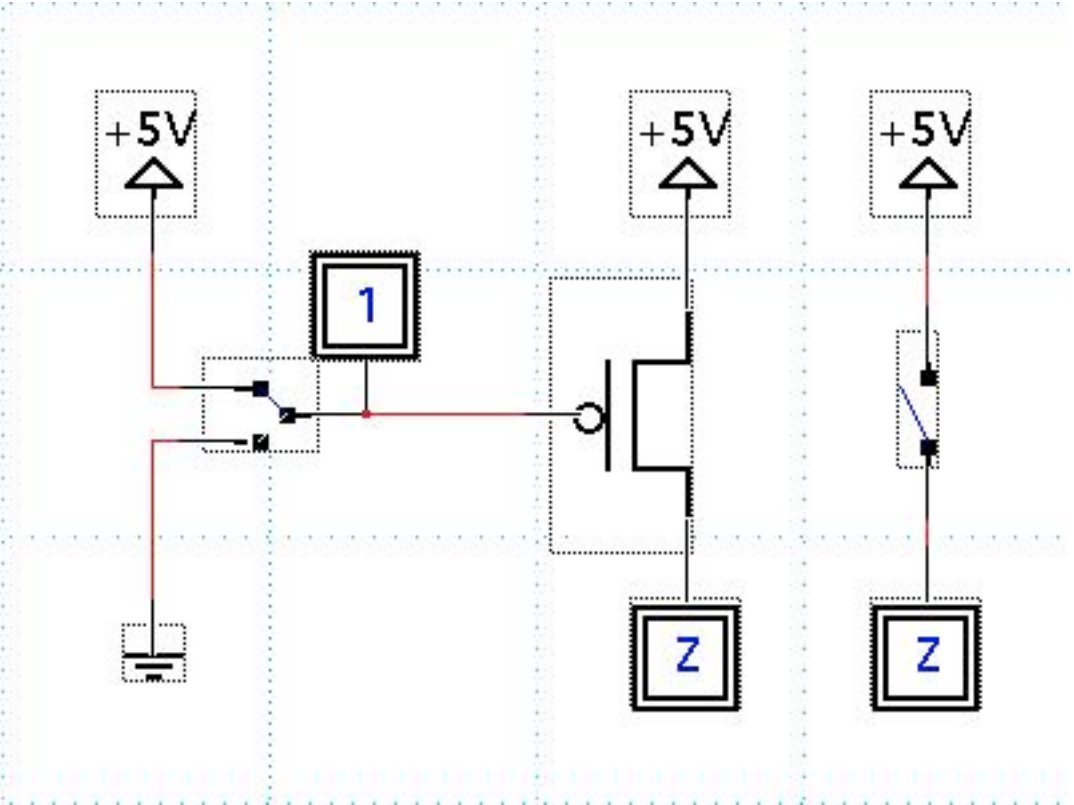
- the physics: try <http://www-g.eng.cam.ac.uk/mmg/teaching/linearcircuits/jfet.html> (http://www-g.eng.cam.ac.uk/mmg/teaching/linearcircuits/jfet.html)
- But note: this is not the ONLY type of transistor out there. See, e.g., the older Patt & Patel textbook (used a few years ago) for some discussion of others.

See tran-demo in [democircs.circ](https://ssl.cs.dartmouth.edu/~sws/cs51-s15/01-elec-to-tran/demo/democircs.zip) (<https://ssl.cs.dartmouth.edu/~sws/cs51-s15/01-elec-to-tran/demo/democircs.zip>)

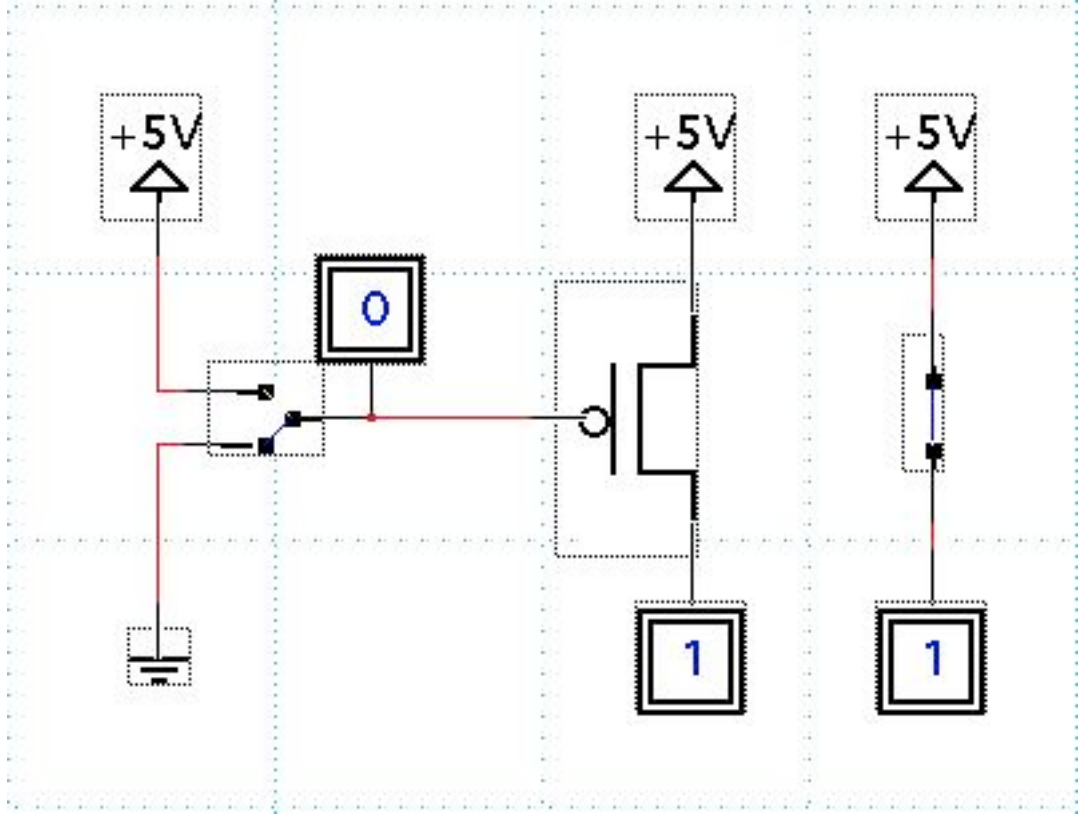
n-type MOS transistor: closes the "switch" when the gate has a sufficiently positive voltage:



p-type MOS transistor: closes the "switch" when the gate has a sufficiently negative voltage:







Note that:

- this just one of many families and types of transistors
- the above functionality is a bit abstracted
- ...and the simulation in LogiSim is even more abstracted...

## 5. Getting empirical

(contemplate **these inspirational words**)

switches

ground, +5v

binary probes

pull-up resistors

n-type MOS

p-type MOS