# Electronics 2

## Transistors

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# Overview

- This lecture will provide more foundation in electronics, preparing us to not only use them in our projects, but to understand how all components work together in the popular Arduino prototyping board.

- Series vs. parallel circuits

- Analog vs. digital signals

- The history of transistors

- Integrated Circuits

# Series vs. parallel circuits

- Series circuits are connected along a single path.

- The same current flows through all of the components.

- The voltage across the circuit is the sum of the voltages across each component.

- Parallel circuits are connected by more than one path.

- The total current is the sum of the currents through each component.

- In a parallel circuit, the voltage across each of the components is the same.
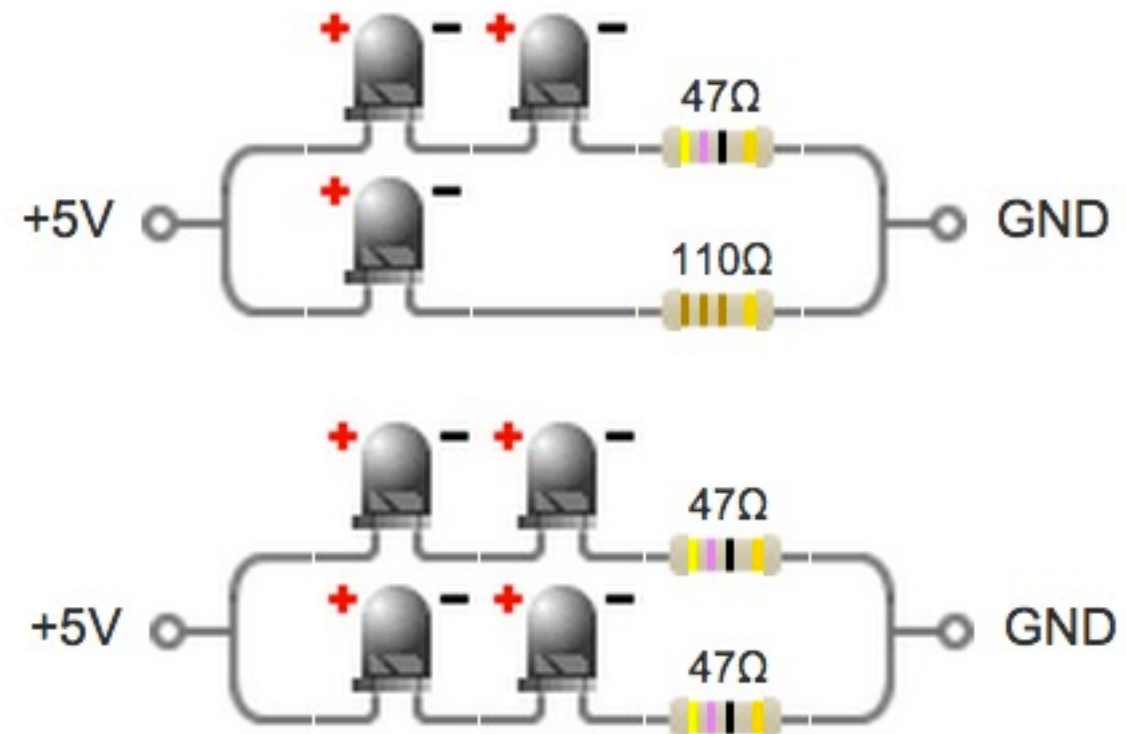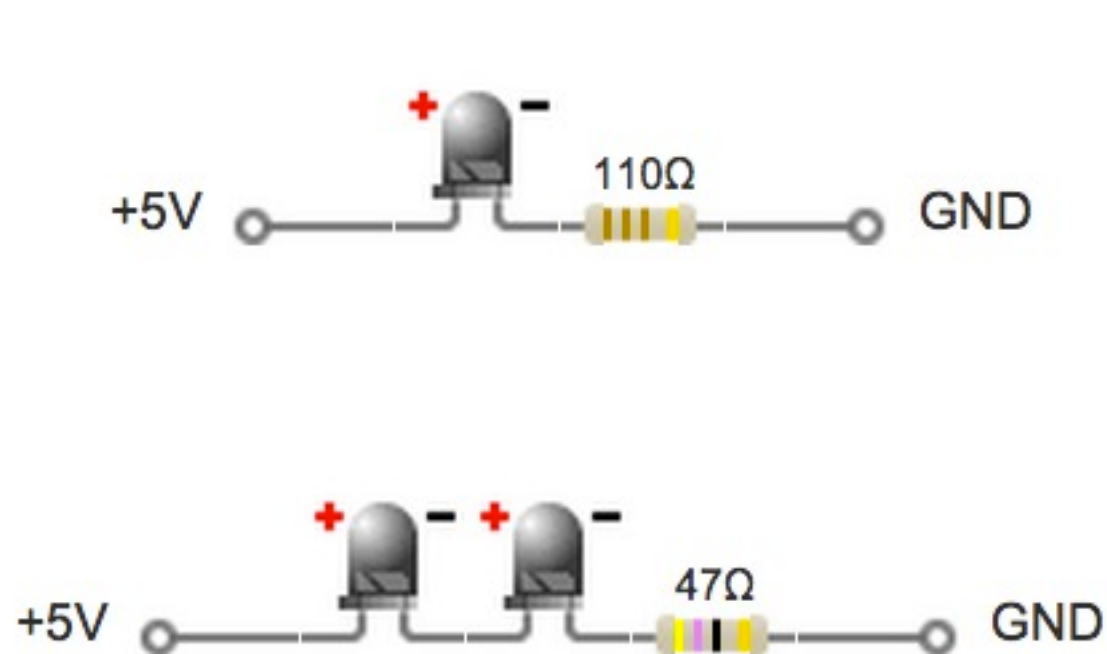
# Analog vs. digital

- Analog and digital are two kinds of electrical signals that transmit information.

- In analog technology, information is translated into electric pulses of varying amplitude.

- While in digital technology, information is translated into binary format zero or one where each bit is representative of two distinct amplitudes.
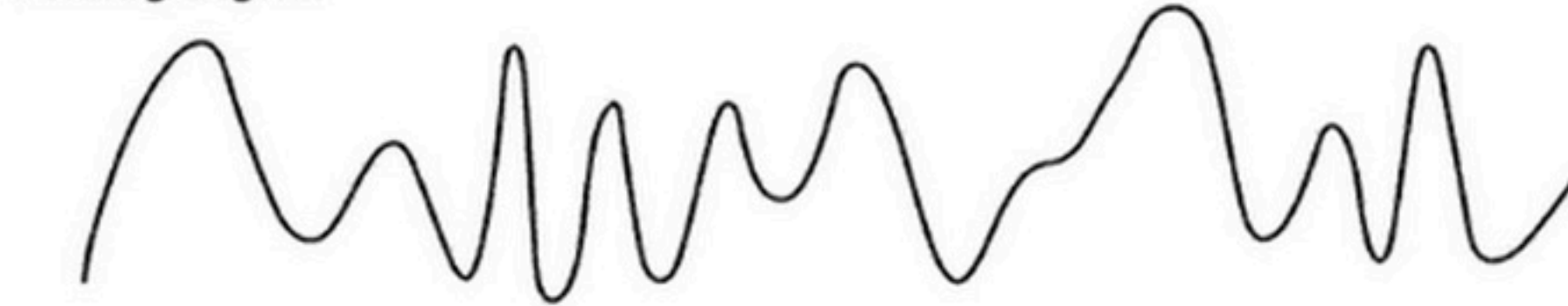
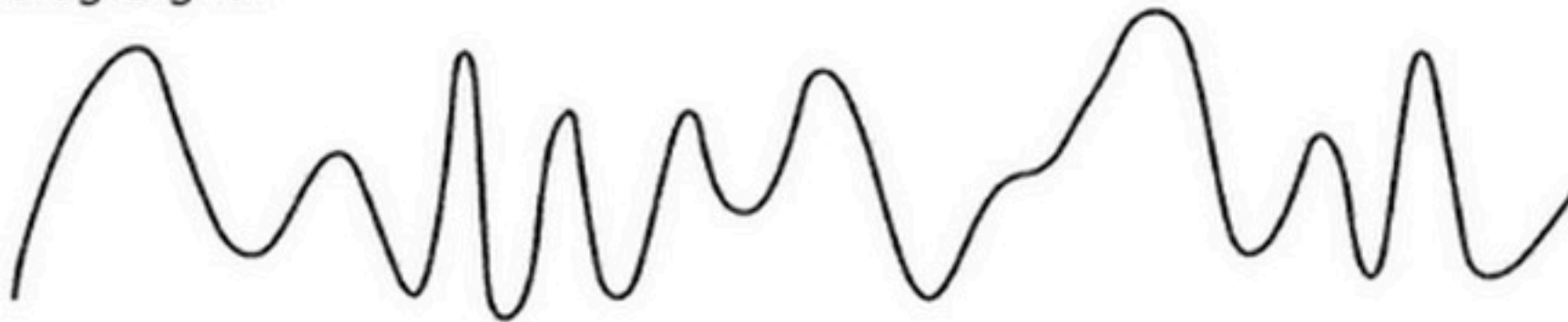**Analog Signal**

**Digital Signal**
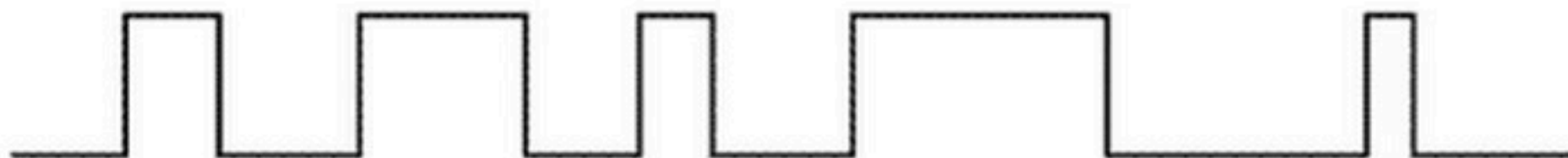
# Analog vs. digital

- Analog signal is a **continuous signal** which represents physical measurements.

- Denoted by sine waves

- Examples: Human voice in air, analog electronic devices like speakers and microphones.

- Digital signals are discrete time signals generated by digital modulation.

- Denoted by square waves

- Example: Computers, CDs, DVDs, and other digital electronic devices.

Analog Signal

Digital Signal

# Analog vs. digital: Which is it?

- <u>Mini photocell</u> a.k.a. "light sensor" increases in resistance between 1k ohms and 10k ohms.

- <u>Mini Push Button Switch</u> a miniature, single-pole switch.

- <u>TMP36 - Temperature Sensor</u> provides a voltage output that is linearly proportional to ambient Celsius temperature. Operating Range: −40°C to +125°C.

- <u>Rotary Potentiometer - 10k Ohm</u>. Turn the pot and the resistance changes. Hook the center pin to an ADC on an Arduino and get a variable input.

- Coaxial cable, which provide TV and home internet.

- Network cable? WiFi?

- RCA? HDMI? USB?

# Serial communication

- Serial communication is the process of sending data one bit at a time, sequentially, over a communication channel or computer bus.

- Practically every type of cable you can imagine uses serial communication. In order of speed (reference Wikipedia: List of device bit rates):

  - Morse code telegraphy - 0.056 kbit/s
  - RS-232 (serial port) - 230.4 kbit/s
  - T-1 - 1.544 Mbit/s
  - T-2 - 6.312 Mbit/s
  - T-3 - 44.736 Mbit/s
  - Wifi 802.11g - 54 Mbit/s
  - Ethernet (100Base-T) - 100 Mbit/s
  - OC3 ATM link (155Mbps) FSU
  - FireWire 400 - 393.216 Mbit/s
  - USB 2.0 - 480 Mbit/s
  - FireWire 800 - 786.432 Mbit/s
  - USB 3.0 - 5 Gbit/s x 2
  - Thunderbolt - 10 Gbit/s × 2

# Vacuum tube computers

- The invention of the computer couldn't have happened without vacuum tubes. They needed a reliable way to process single bits of data using the binary system.

- When the vacuum tube is on, that == 1, while off == 0.

- Vacuum tubes were not known for their dependability and had to be replaced often.
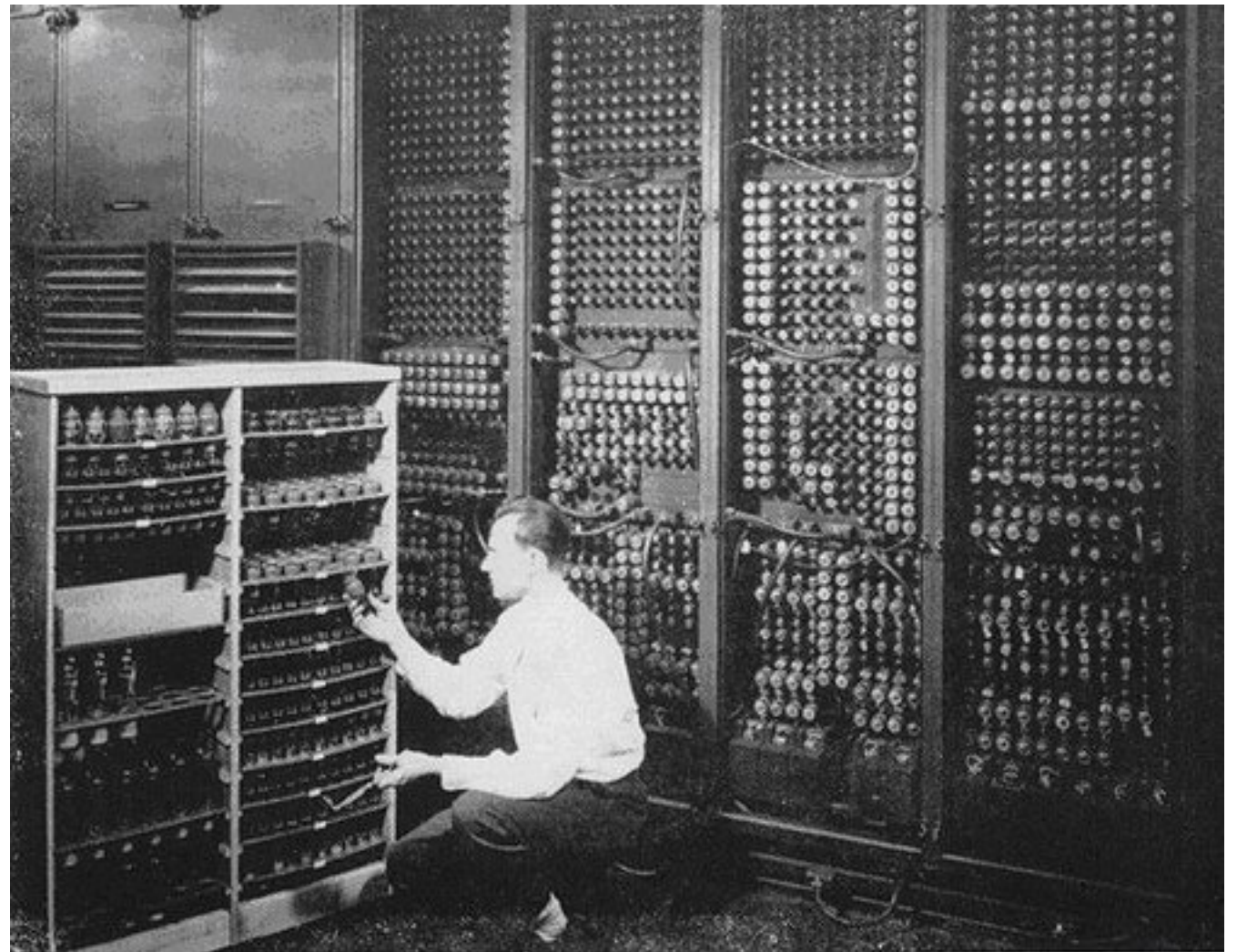
# Transistors

- In the 1950's the transistor came on the scene.

- A transistor uses a semiconductor to amplify and switch electronic signals and power.

- In this simple model >, current from C can't reach E unless B is switched on.

- It is the fundamental building block of modern electronic devices, and is ubiquitous in modern electronic systems.
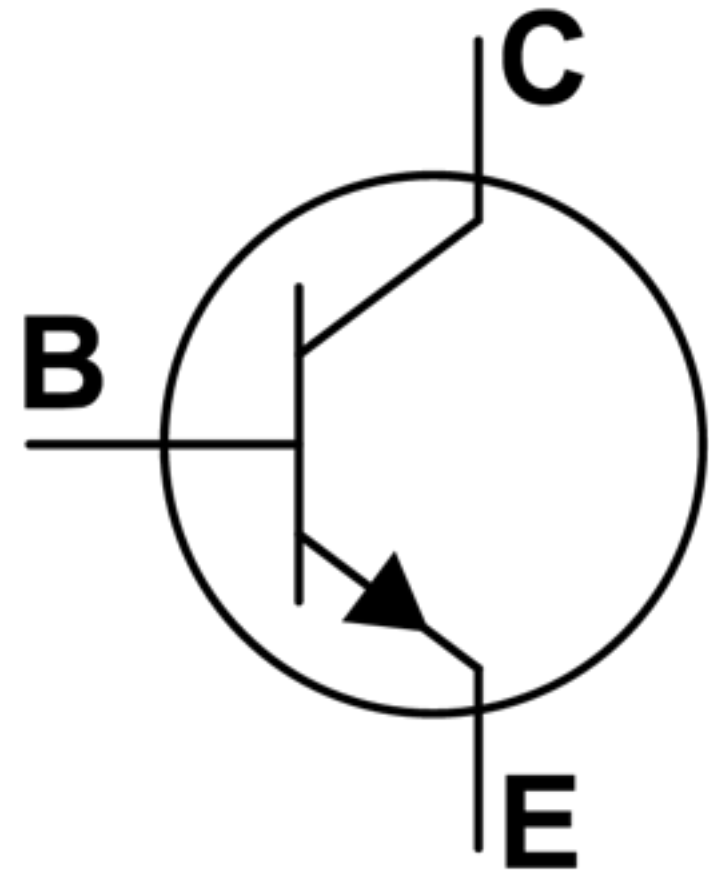
# History of transistors

- <u>AT&T Archives: Genesis of the Transistor</u> 0:00-5:40

- Overview <u>http://www.youtube.com/watch?v=YYiT-uBsUjA</u>

- <u>MAKE presents: The Transistor</u>

- <u>MAKE presents: The Integrated Circuit</u>