ECE231: Safety Guide

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In this course we use 5V and that's pretty safe. This document summarizes what is unsafe so you know for the future. A little exposure to risks in the lab is not a big deal, but you should know what they are.

Voltage

- Only a few volts across the heart can kill.
- 5V outside your skin is very safe.
- Increasing voltage ionizes a path through your body, increasing the current nonlinearly. In other words, you aren't a resistor.
- Distilled water is a pretty good insulator.
- A little salt in the water makes it conduct much better.
- Above 24V, it conducts much, much better.

Current

- A big current at low voltage is safe for electrocution, but it can heat wires. A 3V power supply could not kill you because 3V would not cause 50A to flow through you. But 3V could cause 50A to flow through a thick copper wire, causing it to get very hot.
- The power supplies in the lab are limited to 5A, still a lot.
- They should shut down automatically if they sense a short circuit.
- Don't try to test it, always turn off the power while working on your circuit. The risk is more burning out components that getting hurt yourself.

Passive Components

- Capacitors can remain charged for months to years. A capacitor rated for 200V should be considered to be that voltage unless you know otherwise. A small capacitor may lack the charge to do real damage, but a big one can kill.
  - Good rule of thumb: 1J is yellow.
  - Capacitors can release their energy very quickly (high power density) see the video showing arc-welding with one. Molten metal can obviously hurt you.
  - $C = 560\mu\text{F}$, $V = 200V$, $E = 0.094J$, $\frac{1}{2}CV^2 = 1.08J = 11.2J$ (DANGER)
  - $C = 15nF, V = 500V, E = 1.8x10^{-3}J = 1.8mJ$ (SAFE)
- Resistors can get very hot from current
- Inductors: $V = L\frac{di}{dt}$
  - In theory, when $dt \to 0$, $V \to \infty$
  - $L = 10mH, V = 10V, \frac{di}{dt} = 1A/s$ (SAFE)
  - $L = 10mH, V = 10V, \frac{di}{dt} = 100A/s$ (DANGER)

Chemicals

- Lead is extremely bad for you. Watch the video.
  - Half-life of lead in blood is about a month
  - Half-life of lead in bone is about 10 years, so it will keep coming back.
  - Try to avoid lead!
  - Interested in learning other sources of lead? Check out `https://nutritionfacts.org/topics/lead/`
- Residence time of lead in blood
- Good practices: don't eat or drink in the lab.
- Use a fume extractor while soldering.
- Wash your hands after soldering.
- non-toxic solders include tin, copper, sometimes a little silver.
- They also could include Stibium (antimony) which is toxic.
- The problem with heavy metals is that they accumulate in the body.
- Lead is extremely toxic and is no longer used in solder industrially.
- You should always use lead-free solder.
- Rosin (flux) cleans oxides off the surface of metals to make a good contact. Flux is a carcinogen, so you should always use a fume extractor or hood.
- See wikipedia: `https://en.wikipedia.org/wiki/Argyria`
- Some semiconductors are toxic
  - Silicon is fairly benign.
  - GaAs is Gallium Arsenide (Arsenic is a carcinogen and poison in large quantites)
  - Quantity of dopants in semiconductors is very small, ppb (part per billion)
  - Just try to avoid burning components if you can help it.
  - Packaging is often epoxy and burning plastic is also not good.