EE128 MagLev Lab Tips

General:

- Units are SUPER important! Always try to keep them straight. You can always use the equations to try to derive what units certain constants need to be.
  - Consider: x, y, a, K_i, K_x
  - Don't forget that there is an implied K_a = 1 A/V conversion through the voltage-to-current amplifier
  - Additionally, try to remember the difference between mass and weight.
- Given constants (for SMALL ball): $|a|$ = 600 V/m, $|K_x|$ = 29 N/m, $|K_i|$ = 0.04 N/A
- Hardware:
  - You keep (for now): breadboard, ball, 3 dual op-amp packages (AD822), 3 potentiometers
  - Leave in lab: scale, lifts, rulers
  - In lab: cables (in-between stations 204-02 and 204-03), resistors & wires (wall near window)
- Your sensor is a photoresistor! This means that ambient lighting conditions will affect readings! Try to perform all measurements and experiments in the same conditions (lighting, positioning of maglev system, etc.)

Controller Design:

- For controller design, use MATLAB `sisotool` command.
- Units of maglev system are mm/A (input is current, output is position of ball). This means that the rest of our system must have units of A/mm. **This is the DC gain constraint given**! As you follow the signals around our given system, we see that the position is sensed (V/mm), then acted upon by the controller (V/V), then amplified (Ka = 1 A/V). so it makes sense that the overall gain of the rest of our system will be $a*K_c*K_a$, where K_c is the gain of your lead or lag controller.
- How do you design your controller? You're given 3 unknowns: R_1, R_2, and C. Given that you want a certain Phase Margin, you should be able to determine good locations for your pole (b) and zero (a) of your controller, giving you two equations to work with. You get your third equation by setting the DC Gain to about 1.

Hardware Debugging:

- Do NOT move the wires connecting the voltage-to-current amplifier and its power supply!!! (It's color-coded, so don't mix them up)
- Make sure there is a common ground (circuit, amp, amp power supply, DC power supply, electromagnet, LED, sensor).
- If something starts to smell funny or something starts to get hot, TURN OFF THE POWER IMMEDIATELY.
- Common mistakes to check for:
    - Sensor output should be connected to rest of circuit (and sensor needs to be hooked up, too)
    - All outputs from DC power supply need to be on (+7/-7)
    - V_- port of op amps needs to be set to -7 V (why?)
    - I_o (current offset) is a NEGATIVE voltage (why?)
    - Circuit output needs to be connected to amp input
- **Easiest indicator of circuit problems:** cover the sensor entirely with your hand and the output DOESN'T change (bad)
- Best way to debug is methodically. Start at the beginning of your circuit (the sensor), and probe your way forward (voltage offset, then controller, then current offset, then finally output), making sure everything is behaving as it should.