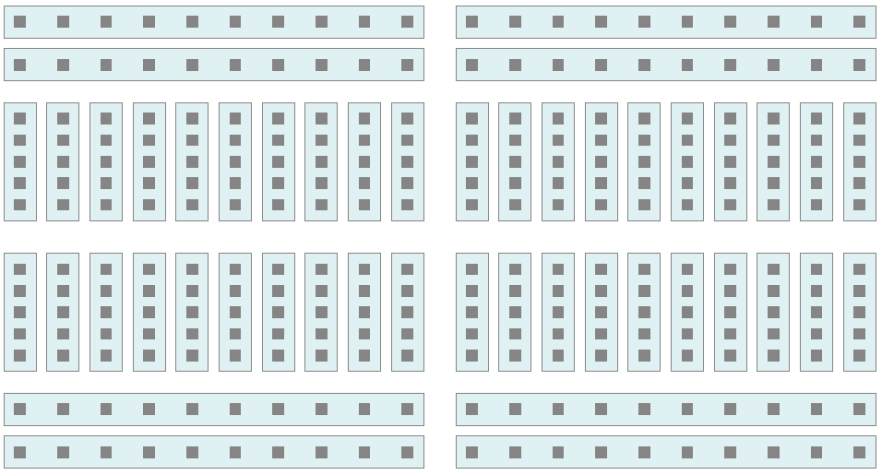
PS 12b Lab 3
IV Curves

Names:
1.) _____
2.) _____
3.) _____

Learning Goal: Understand I-V curves for ohmic and non-ohmic devices (light bulb, resistor, Light Emitting Diodes (LED's), and Thermistor. Work with a Field Effect Transistor (FET) to see how it can operate as a switch.

Warm Up:
Build a circuit on the breadboard with a light bulb. Below is a picture of how a breadboard is wired.

1. Draw how you would wire up the breadboard to light a bulb. Include where and how the voltmeter and ammeter should be placed to track the current and voltage. Keep in mind the ammeters that we will use prefer to be connected to the ground side of the circuit.



2. Now wire up the circuit to light the bulb.
3. Include the voltmeter and ammeter.
4. Use the AC function generator provided. Set it on a 10 Hz triangle wave.
5. Set Logger Pro to take 100 data points per second for 2 seconds. (This may change as the lab progresses. Be careful because Logger Pro has a difficult time with high data rates for longer trial lengths.
6. Record some data to make sure everything is working.
7. Try increasing the (max/min) voltage (output level) and repeat. Be careful not to go above 6 volts.
8. Show this graph and your circuit to the TF to make sure everything is working.

Measuring Current vs. Voltage characteristics (I-V curves)

100 Ohm Resistor

We will first analyze a simple 100 ohm resistive circuit. Replace the light bulb with a 100 ohm resistor. Choose a triangle waveform on the AC voltage source.

- How does an AC voltage supply make our life easier than using a DC voltage supply?

- Now measure voltage vs. current for a 100 Ohm resistor. **Include the current vs. voltage graph.**

- From the graph determine the resistance of the resistor. How did you find this?

Light Bulb

Now replace the resistor with the light bulb provided. Take the data at a very slow frequency so that you can watch how the curve is traced.

- **Include the voltage vs. current graph for the light bulb.**
- **Explain why the curve is different than a simple resistor. How does heating and cooling play a role in the behavior of the bulb?**

LED's (Light emitting diodes)

Replace the light bulb with the light emitting diode and explore its IV characteristics. Try a few different LED's. Use Command+L to save individual runs and overlay the plots.

- **Include the voltage vs. current graph for the LED's.**
- **Explain the characteristics of the LED graph here. What does this imply about the direction the current can travel? What could account for the difference from one LED to another?**

Thermistor (Temperature dependent resistor)

Replace the LED with a thermistor. Increase the data collection time to 30 seconds or so. Lower your data rate to 100 pts/sec or Logger Pro might crash. Collect data and try heating the thermistor up with your fingers.

- **Insert the voltage vs. current graph for the Thermistor.**
- **Explain the characteristics of the Thermistor graph here. How is the thermistor similar and different than a resistor and a light bulb.**

Open Circuit and short circuit.
Now repeat the measurement of the IV curve for an open circuit and a short circuit.

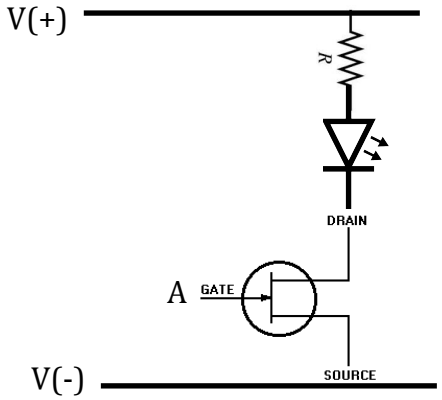
- **Include the voltage vs. current graph for the open circuit.**
- **Include the voltage vs. current graph for the short circuit.**
- **What do the slopes of these graphs tell us about the circuits?**

Classification of the IV curves:
For each of the IV curves, classify the circuit element as either symmetric/non-symmetric, hysteretic/non-hysteretic, or linear/non-linear by labeling each graph appropriately.

Black Box Forensics:
You are given a two terminal device that has been recovered from an Alien spacecraft that has crash-landed in Cambridge Commons. This alien species has limited technology, i.e. its circuits only contain the elements we've analyzed above (resistor, diode, light bulb, etc.). Analyze this two terminal device and determine which circuit elements, or combination thereof, are in the box.

- **Include a graph of the Alien Data**
- **What do you think is happening and why?**

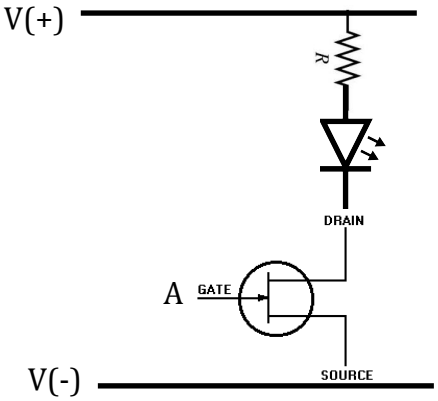
Transistor



Build the following circuit using the FET (field effect transistor) and LED (light emitting diode) provided. The LED should have a 100 ohm resistor in series it to limit the current and preserve the transistor and LED. Find the IV curves for the drain to source when A is held to a low potential (ground) and then for A held to a high potential. Include your graphs here.

What is happening when A goes from low to high?

Transistors Challenge



Build a transistor circuit on the breadboard. Place the drain at a high potential (5 V) with a 100 ohm resistor to limit the current. Place the source at the ground. The Gate (input = A) voltage will be switched between the high and the low potential. Watch the output of the circuit with the LED .

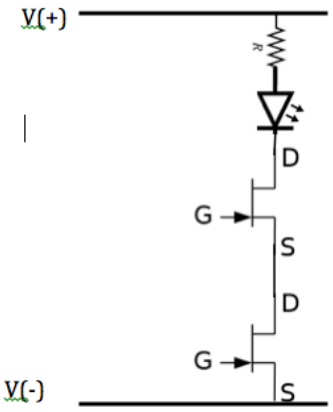
- **If the LED is on what does that say about the voltage at the drain? How about the current from drain to source? What if it is off?**

- A binary number can is a number that can represent either zero (0 volts) or one (5 volts). Complete the following truth table, using these conventions.

Input A	Output X
0	
1	

Challenge: Build the following circuit and create a truth table for a circuit with two inputs and one output.

A	**B**	**X**
0	**0**	
0	**1**	
1	**0**	
1	**1**	



This circuit correspond to which of the following logical operations.

OR, XOR, NOR, AND, NAND, NOT