Lab 2

In [104…
```
%matplotlib notebook
import numpy as np
import scipy as sp
import matplotlib.pyplot as plt
import scipy.optimize
import seaborn as sns
import scipy.odr as odr
import matplotlib.ticker as mticker

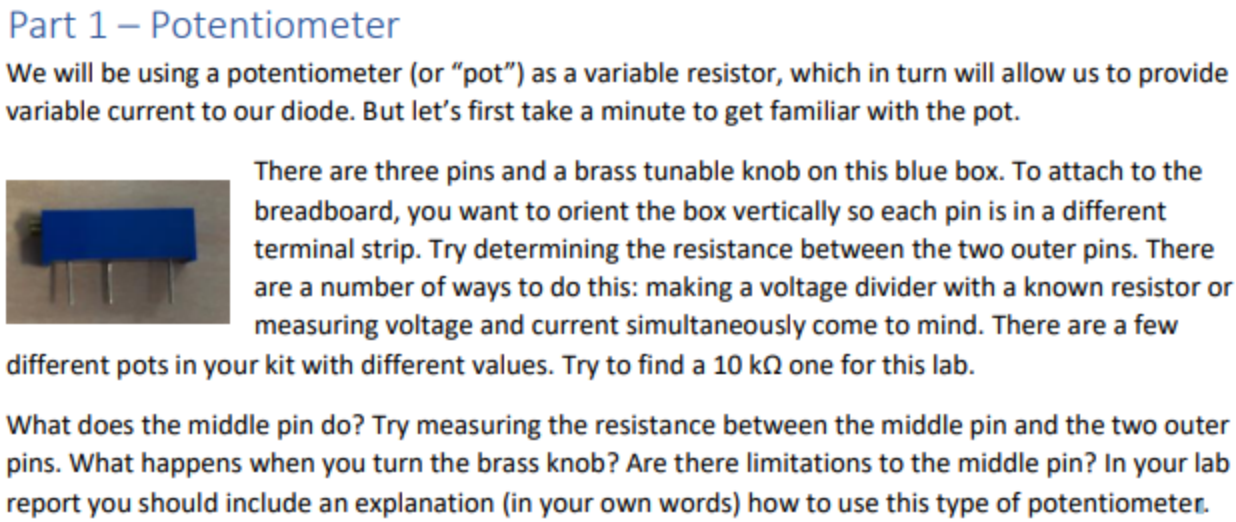
from IPython.display import Image
from decimal import Decimal
from astropy.modeling import models, fitting
from math import pi
```

Equipment

- Digital multimeter (DMM)
- Analog Discovery 2
- Laptop with WaveForms installed
- Breadboard adaptor
- Large breadboard
- Components
  - 1 kΩ resistors
  - 10 kΩ potentiometer
  - 1N4001 diode
  - Jumper wires

In [105…
```
Image("Part1.png")
```

Out[105]:



Part 1 – Potentiometer

We will be using a potentiometer (or "pot") as a variable resistor, which in turn will allow us to provide variable current to our diode. But let's first take a minute to get familiar with the pot.

There are three pins and a brass tunable knob on this blue box. To attach to the breadboard, you want to orient the box vertically so each pin is in a different terminal strip. Try determining the resistance between the two outer pins. There are a number of ways to do this: making a voltage divider with a known resistor or measuring voltage and current simultaneously come to mind. There are a few different pots in your kit with different values. Try to find a 10 kΩ one for this lab.

What does the middle pin do? Try measuring the resistance between the middle pin and the two outer pins. What happens when you turn the brass knob? Are there limitations to the middle pin? In your lab report you should include an explanation (in your own words) how to use this type of potentiometer.

I attempted to change the resistance by hooking it up to a multimeter and cranking the dial before hooking up a power source but it did not work

I then hooked up the power soure and checked the resistance accross the end furthest from the knob to the middle and it didn't seem to work

I hooked up the potentiometer with a Red LED off of the center pin so I can get a viual representation of changing the resistance

The middle pin is the out pin for the potentiometer. Basically you have a powered and grounded potentiometer with the other two pins and the middle pin allows a current to go at a decreased resistance depending on the screw setting. There was a maximum travel distance for the potentiometer in both directions. This seemed to corelate with the numbers on the potentiometer. I had 3 potentiometers 102, 103, 104. Each potentiometer had a different maximum resistance for the 102 it was 100, 1000 for the 103, and 10000 for the 104. image of my circut is below.

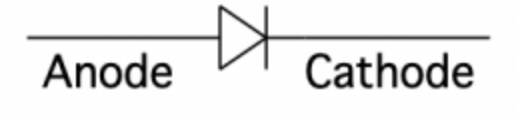
In [ ]:

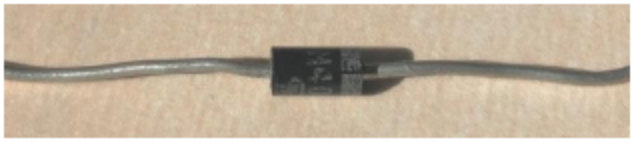
In [106…
```
Image("Part2.png")
```

Out[106]:

Part 2 – The Non-Ohmic Diode

Here we will make a voltage vs current curve to convince ourselves that diodes are not Ohmic (i.e. voltage is not proportional to current). Your diode looks a little like a resistor – a small cylinder with wires sticking out either end. But as we will see, it does not behave like a resistor. Note the directionality of it, and the painted band on the device.





I grabbed a resistor of 990Ω and a 1N4001 diode

In [107…
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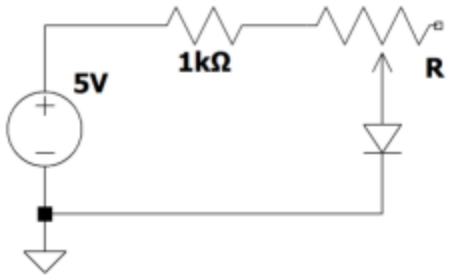
Image("Part2-2.png")
```

Out[107]:

Construct the circuit below. The arrow pointing to the center of resistor R represents the middle pin of the potentiometer. Note that we leave the third pin of the pot unconnected. We will use the potentiometer to vary the value for R.



We need to measure the voltage across and the current through the diode. How are you going to do that? Make sure you describe your setup in your lab notebook and report.

Think of this circuit as supplying a range of currents to the diode, and we are measuring the voltage drop (i.e. consider current to be the *independent* variable here). What is the lowest current you can provide? How might you change the setup to provide even lower current? What is the highest current you can reach? How would you get higher? (Don't do it! That is, unless you are confident you will not blow the diode.)

Once you are confident that you can measure current and voltage, sweep the potentiometer across many values (use the full range), and record V and I. Your lab report should include a plot of V vs I. How would you describe the shape? Try plotting with a log axis.

Look up the datasheet for your diode (ask me if you need help). Are your data consistent with the specifications?

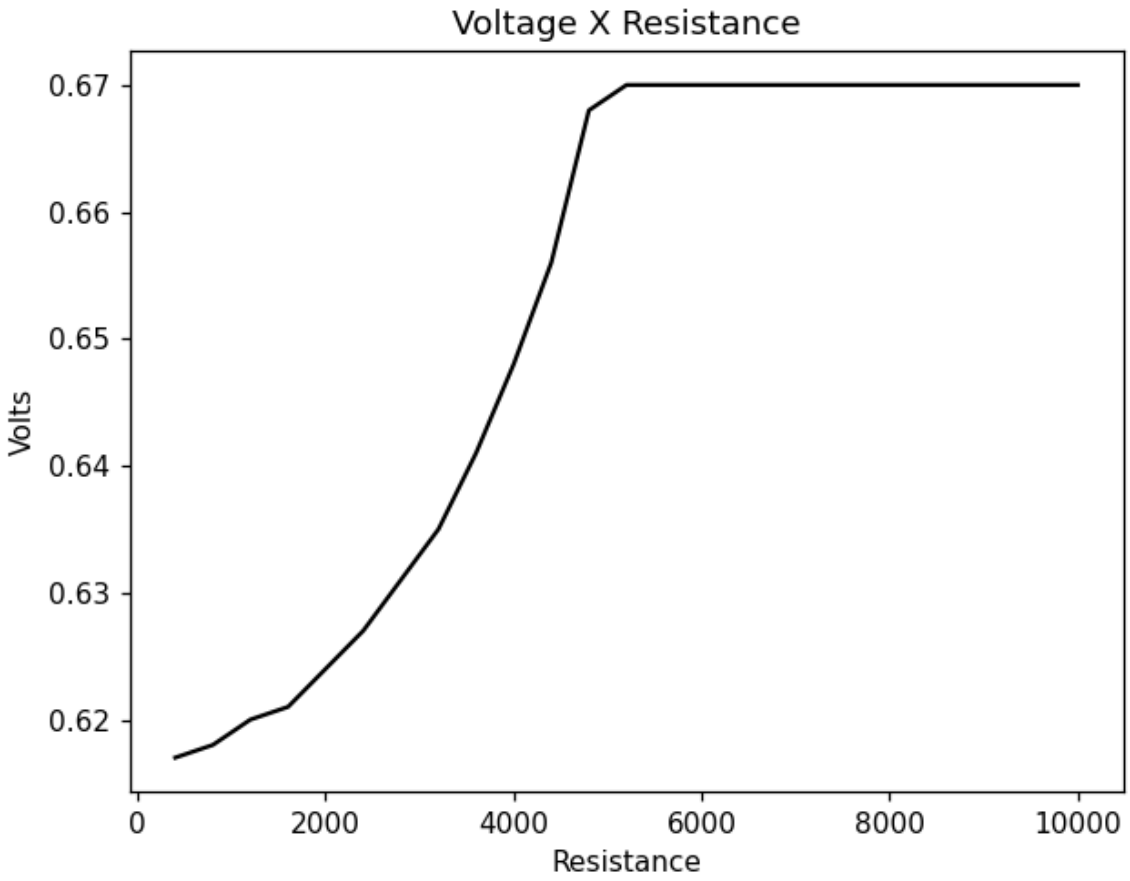
What happens if you reverse the direction of the diode?

I found it took roughly 25 turns to max out the resistance on my potentiometer thusly 1 turn is roughly 4 hundred ohms. using this I am going to make a chart that measures the changer in voltage against my predicted change in resistance

When I was dialing in the current X resistance I noticed that at about 4k ohms the current was at a low but before and after it was high.

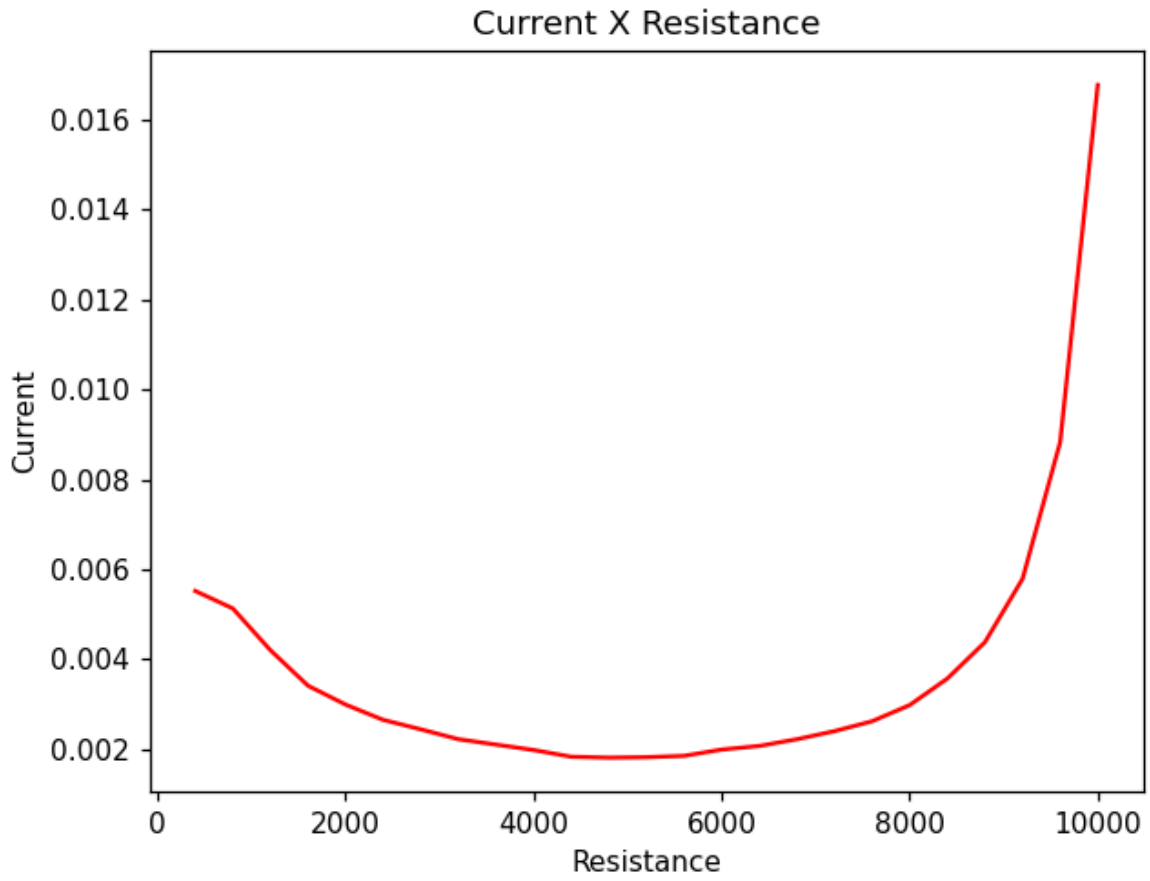
In [108…

```
plt.figure(1)
R = np.array([400,800,1200,1600,2000,2400,2800,3200,3600,4000,
              4400,4800,5200,5600,6000,6400,6800,7200,7600,8000,
             8400,8800,9200,9600,10000])
V = np.array([.617,.618,.620,.621,.624,.627,.631,.635,.641,.648,.656,.668,
             .670,.670,.670,.670,.670,.670,.670,.670,.670,.670,.670,.670])
I = np.array([5.52,5.13,4.2,3.41,2.99,2.65,2.44,2.22,2.1,1.98,1.83,
              1.81,1.82,1.85,1.99,2.07,2.22,2.4,2.62,2.98,3.57,4.38,
              5.79,8.83,16.78])*10**(-3)
plt.plot(R,V,color = "black")
plt.title("Voltage X Resistance")
plt.xlabel("Resistance")
plt.ylabel("Volts")
```



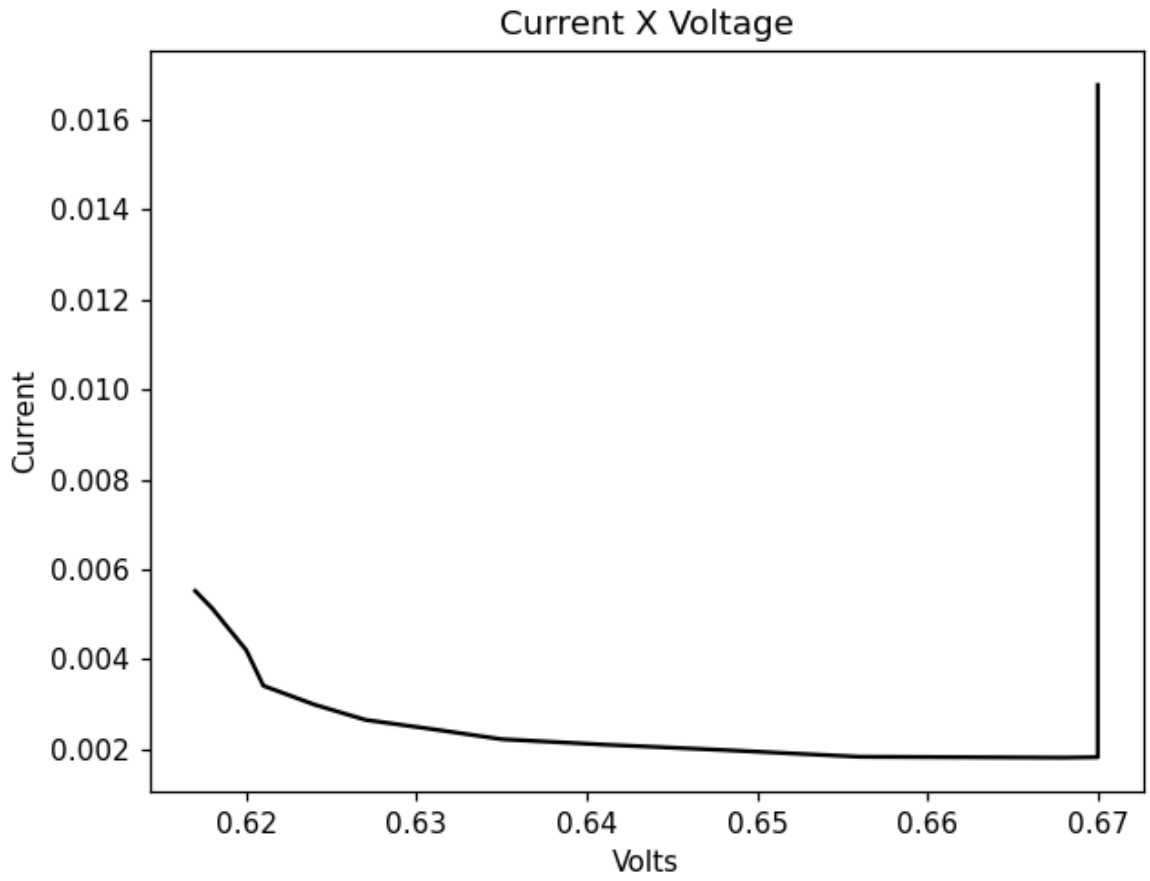
Out[108]:
```
Text(0, 0.5, 'Volts')
```

In [109…
```
plt.figure(2)
plt.plot(R,I,color = "red")
plt.title("Current X Resistance")
plt.xlabel("Resistance")
plt.ylabel("Current")
```



Out[109]:
```
Text(0, 0.5, 'Current')
```

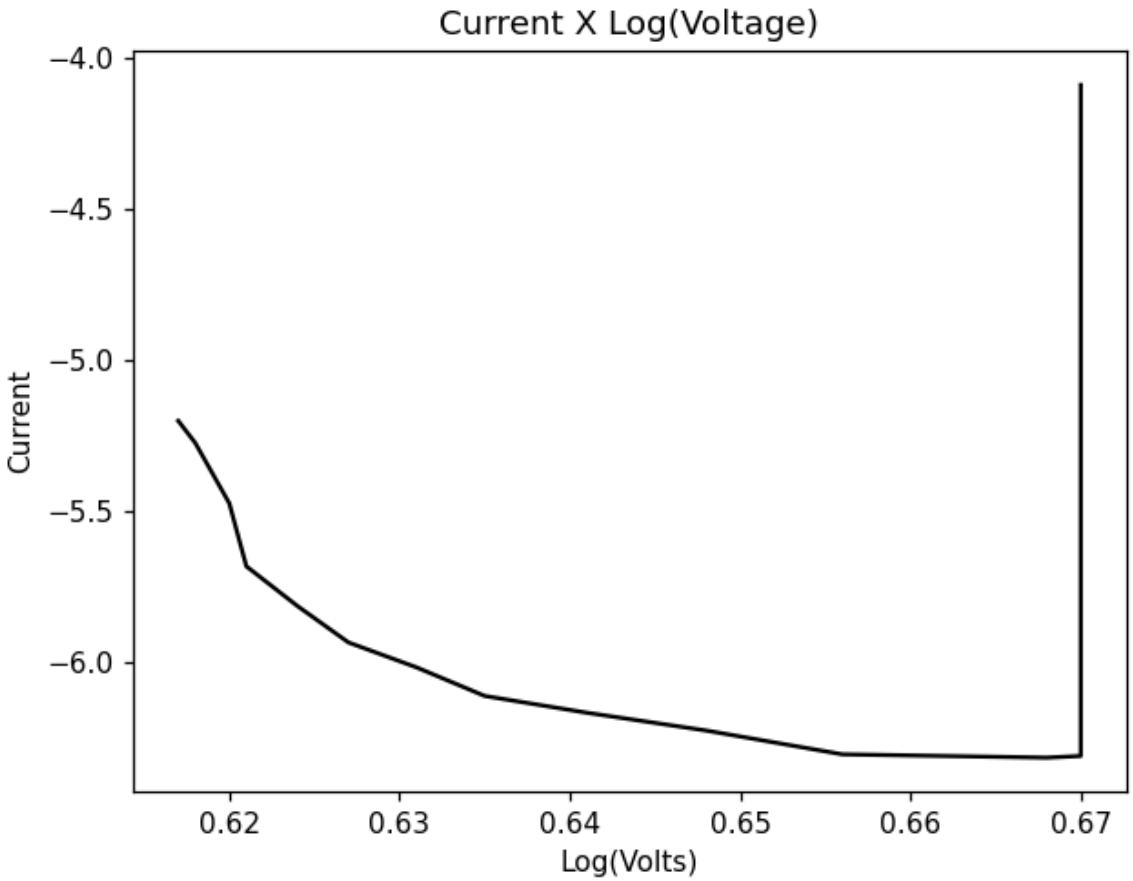
In [110…
```
plt.figure(3)
plt.plot(V,I,color = "black")
plt.title("Current X Voltage")
plt.ylabel("Current")
plt.xlabel("Volts")
```



Out[110]: Text(0.5, 0, 'Volts')

In [111…

```
plt.figure(4)
plt.plot(V,np.log(I),color = "black")
plt.title("Current X Log(Voltage)")
plt.ylabel("Current")
plt.xlabel("Log(Volts)")
```



Out[111]:
```
Text(0.5, 0, 'Log(Volts)')
```

It looks like Log voltage looks a little better but not much. I still have that long verticle line from when the voltage topped off the resistance and the current sky rocketed.

In [112…
```
Image("datasheet.png")
```

Out[112]:

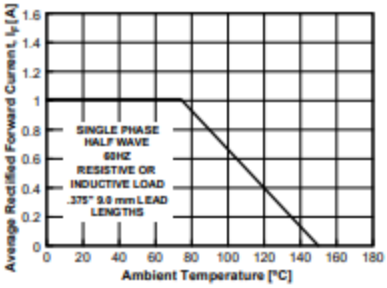


Figure 1. Forward Current Derating Curve

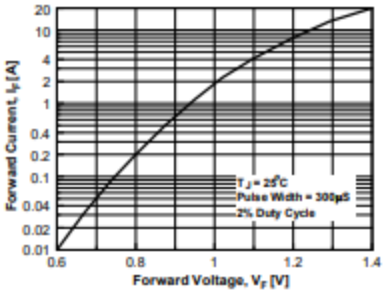


Figure 2. Forward Voltage Characteristics

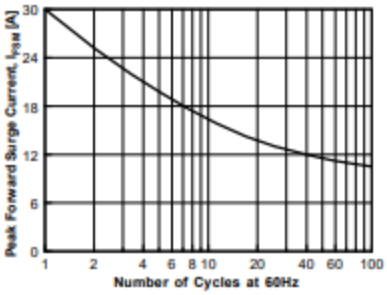


Figure 3. Non-Repetitive Surge Current

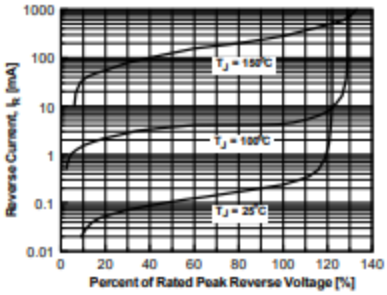


Figure 4. Reverse Current vs Reverse Voltage

My results don't seem to be remotely close to the datasheet which pardon my french pisses me off. I have

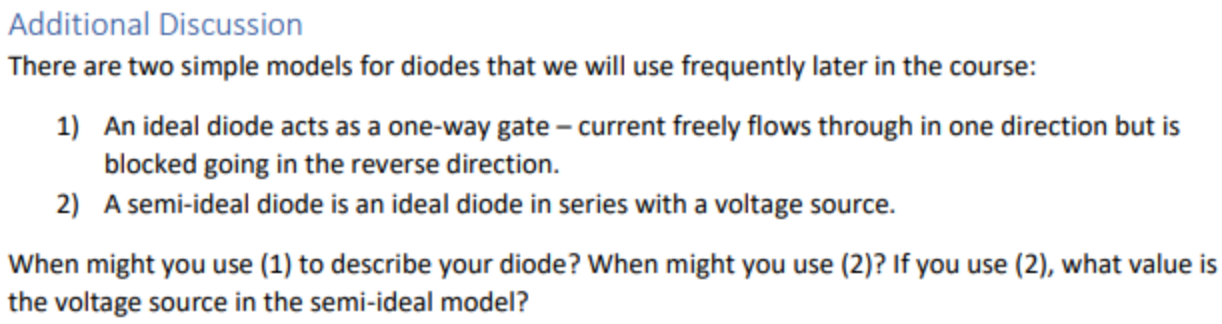
been working on this everyday for hours trying to figure out what I am using to make measurements, How to use this waveform thing, and trying to figure out why the hell I am so lost. This entire lab felt like things I should be able to know and figure out quickly. So come to my suprise I have to spend 3 hours fiddling around with this hunk of junk before figuring out I never turned on the source voltage BECAUSE I NEVER KNEW I HAD TO DO THAT.

This was a less than enjoyable lab however, i learned a lot about the tools I am handling througn my fruitless efforts. and I learned for whatever reason diodes have a peak minimum resistance then they lull as resistance is slowly increased and according to all my experimentation the current sky rockets after you hit a certain resistance. Is that true short answer kind of. The datasheet i was reading had 4 different graphs none of which looked like mine but each had parts of my graph within it.

It is a diode if you revers its direction current is not allowed to flow I don't even need to test that. I swear to god if I get this wrong I am gonna lose it.

In [113…
```
Image("Part3.png")
```

Out[113]:



Additional Discussion

There are two simple models for diodes that we will use frequently later in the course:

1) An ideal diode acts as a one-way gate – current freely flows through in one direction but is blocked going in the reverse direction.
2) A semi-ideal diode is an ideal diode in series with a voltage source.

When might you use (1) to describe your diode? When might you use (2)? If you use (2), what value is the voltage source in the semi-ideal model?

If I wanted to make a simple circut that limited the maount of times I would need to use kchikoffs law I would slap oodles and oodles of one way gate in my system. This makes calculating a lot easier and possibly current splitting.

If I had a voltage sourec in series with a diode I would be able to limit the amount of flow back and from my source voltage. this might make it easier to use more sensitive electronics. The quantity is gonna be some combination made by my diode and voltage source.

In [114…
```
Z = 1/(1j*2*pi*1000*10*10**(-9))
i = (900+Z)/(1900+Z)
print(i)
```

```
(0.9926044991789721-0.06194897433193542j)
```

In [ ]:

In [ ]: