

# Instrumentation In Astronomy

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*Instrumentation Lab:*

*Dr. Dan Marrone*

# Our Semester in one slide

## SKILLS AND KNOWLEDGE GAINED

- Soldering
- Learning about designing and building circuits.
- Learning about Operational Amplifiers
- Filters

## PROJECTS WE WORKED ON

- Designing a circuit to understand the result of including an OpAmp
- Adding diodes to the existing circuit to create frequency response graphs
- Creating filter response rate plots for high pass, low pass and band pass filters.

## A PROPOSAL

Surprise :)

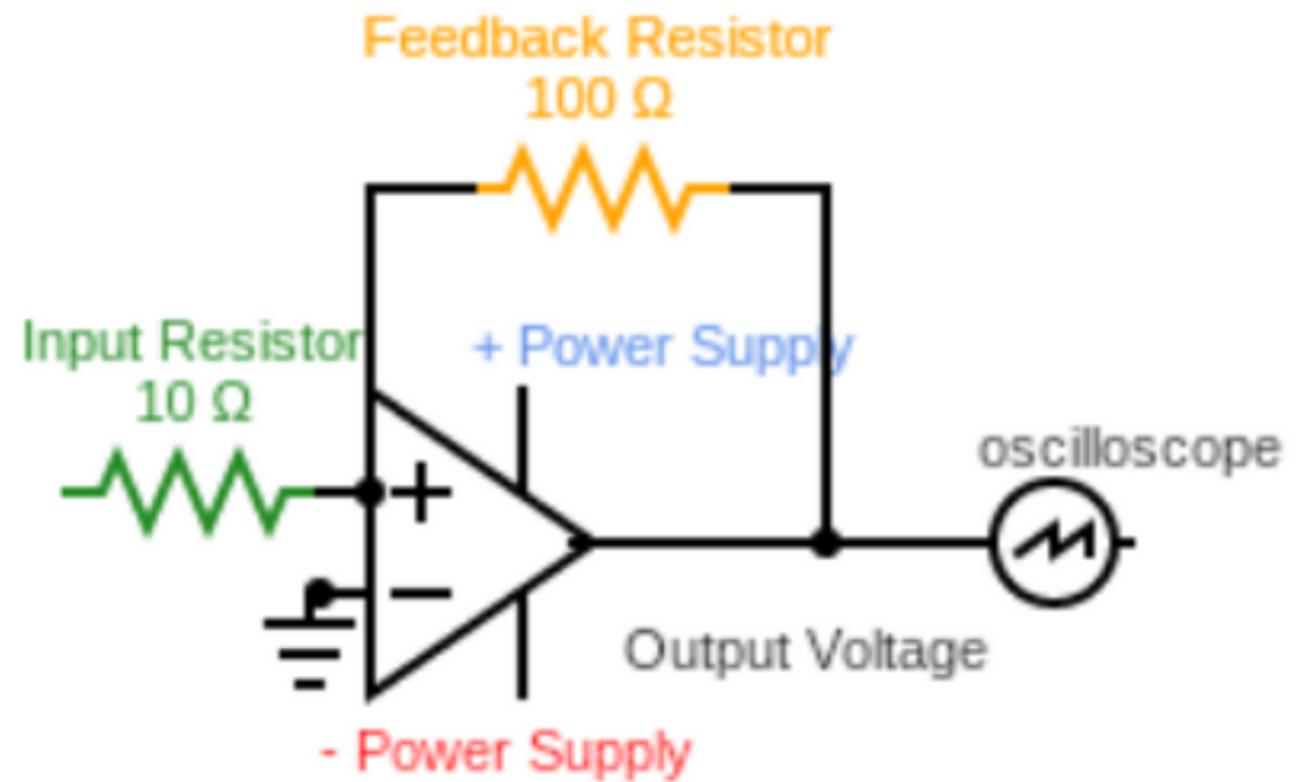
# CIRCUITS AND OPERATIONAL AMPLIFIERS.

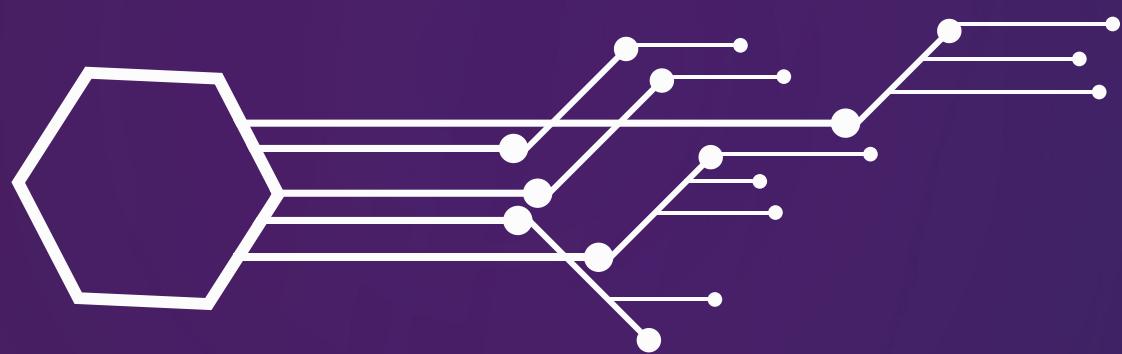
## What Is an Amplifier?

- An Amplifier takes a small input signal and delivers a larger output signal.
- By increasing the voltage or current, using the power it is supplied.
- Gain is the ratio between the input and output signals.
- An Op Amp is a type of amplifier that has a high gain.
  - It can use a small input voltage to control larger voltages

## Inverting Amplifier Circuit

- A circuit with an op Amp
- Returns an inverted output (180 degrees out of phase)
- Resistors reduce the electricity in the circuit:
  - in our purpose they control the gain
- Feedback resistor takes some of the output and feeds it to the input.





# Our Project

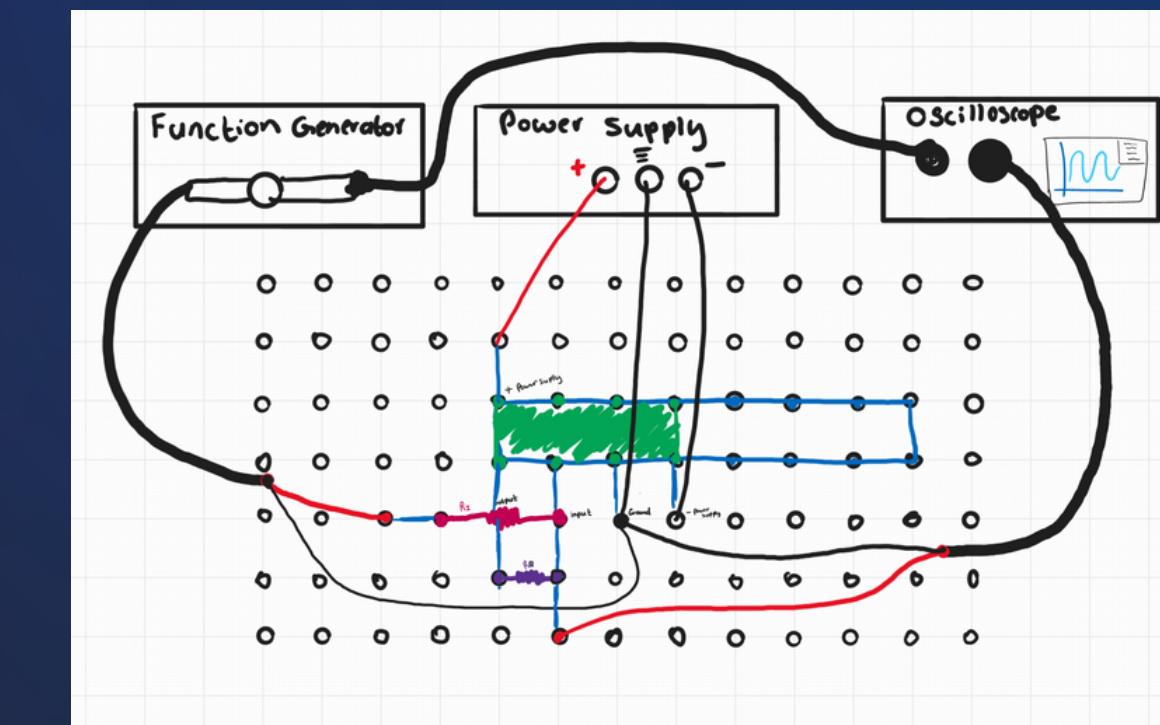
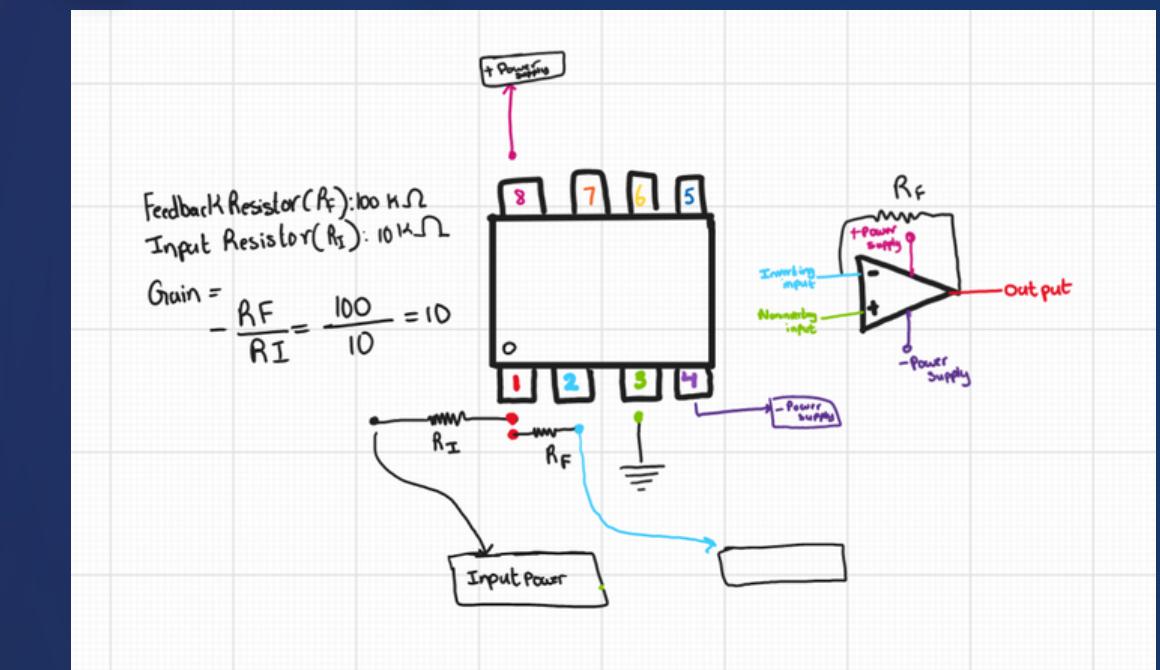
- Our first Project was creating and testing an Inverting amplifier circuit.
- Skills from our initial soldering workshop were used.
- Function Generator, power supply and oscilloscope
- Purpose: Learning about op amps through creating a frequency response plot.

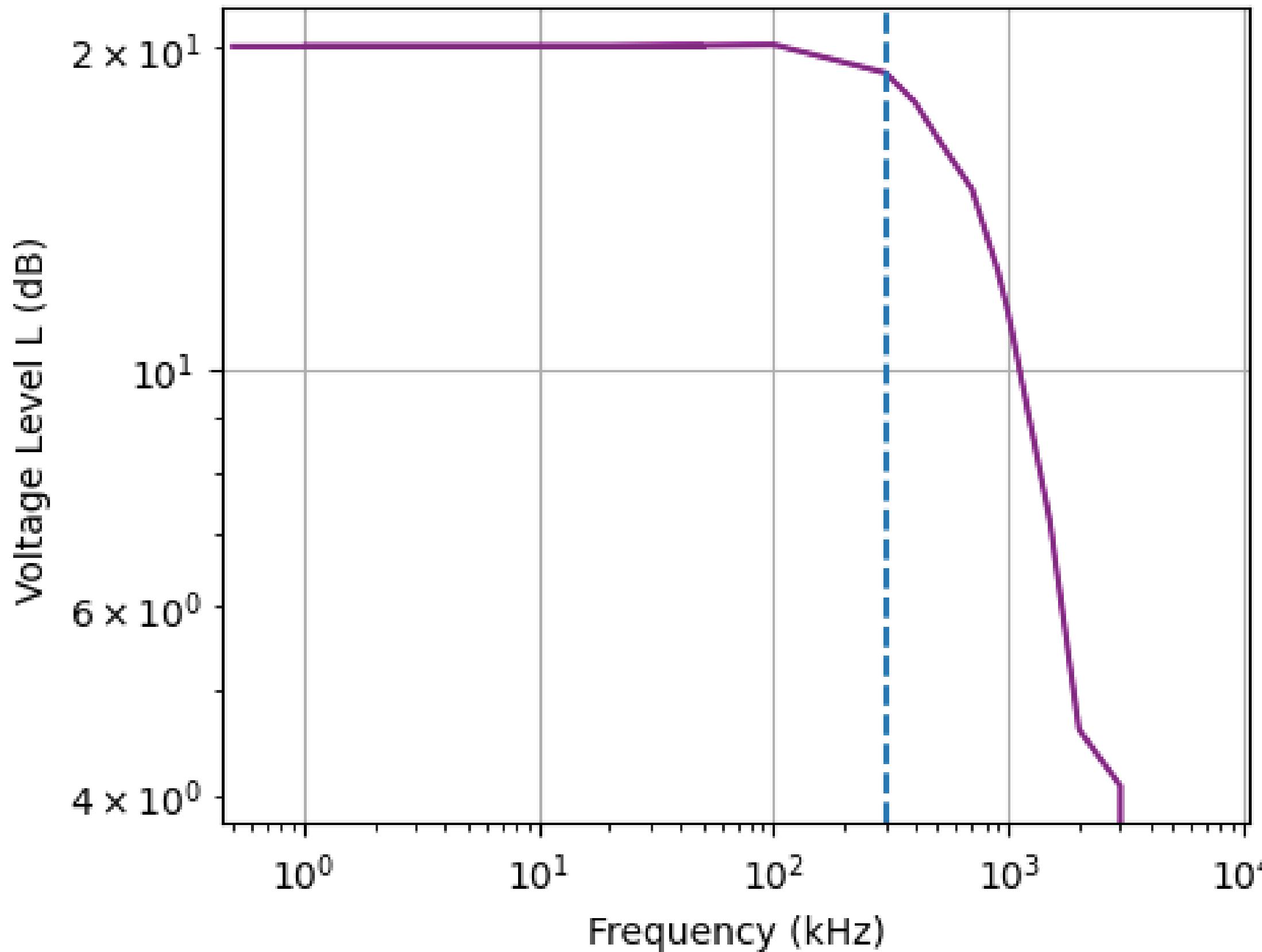
## Challenges, Mistakes and lessons learnt

- Soldering mistakes
- Challenges with the Oscilloscope.

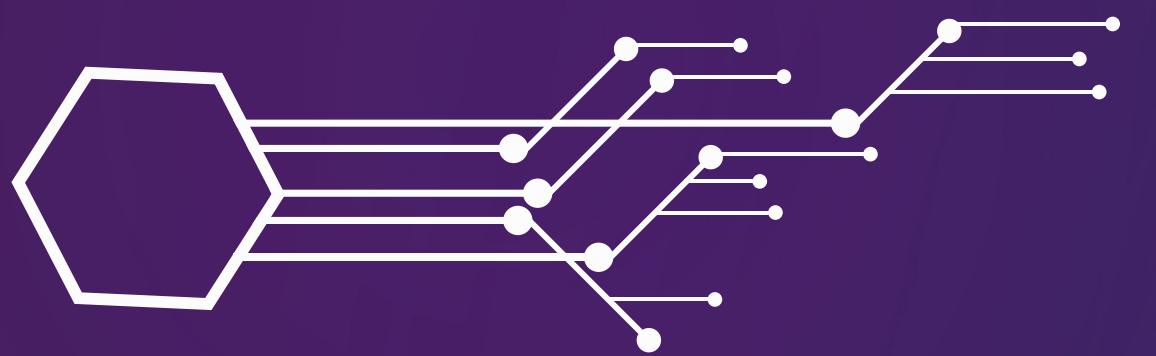


# Project 1: Inverting Amplifier Circuit





**This plot represents gain vs frequency, with an op-amp that results in a gain of 10.**



## Our Project

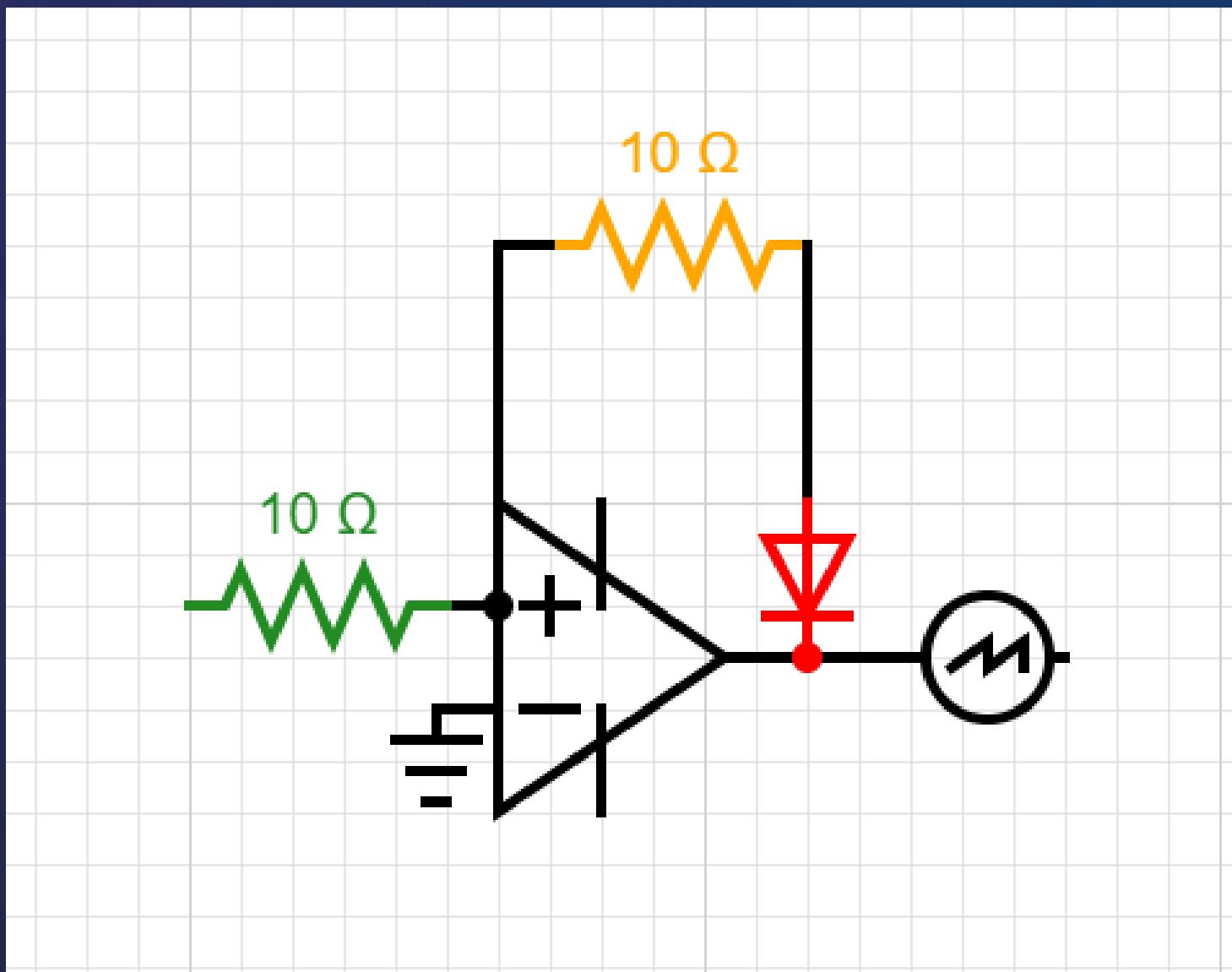
- For this experiment, the same operational amplifier circuit was used, however, a resistor and diode were added to the circuit.
- Our initial experiment used a red LED, an then we used a yellow LED. The frequency, wave pattern, voltage supply, amplitude and offset were set constant.
- Purpose: I-V Curve of a red and yellow diode were obtained from the data.

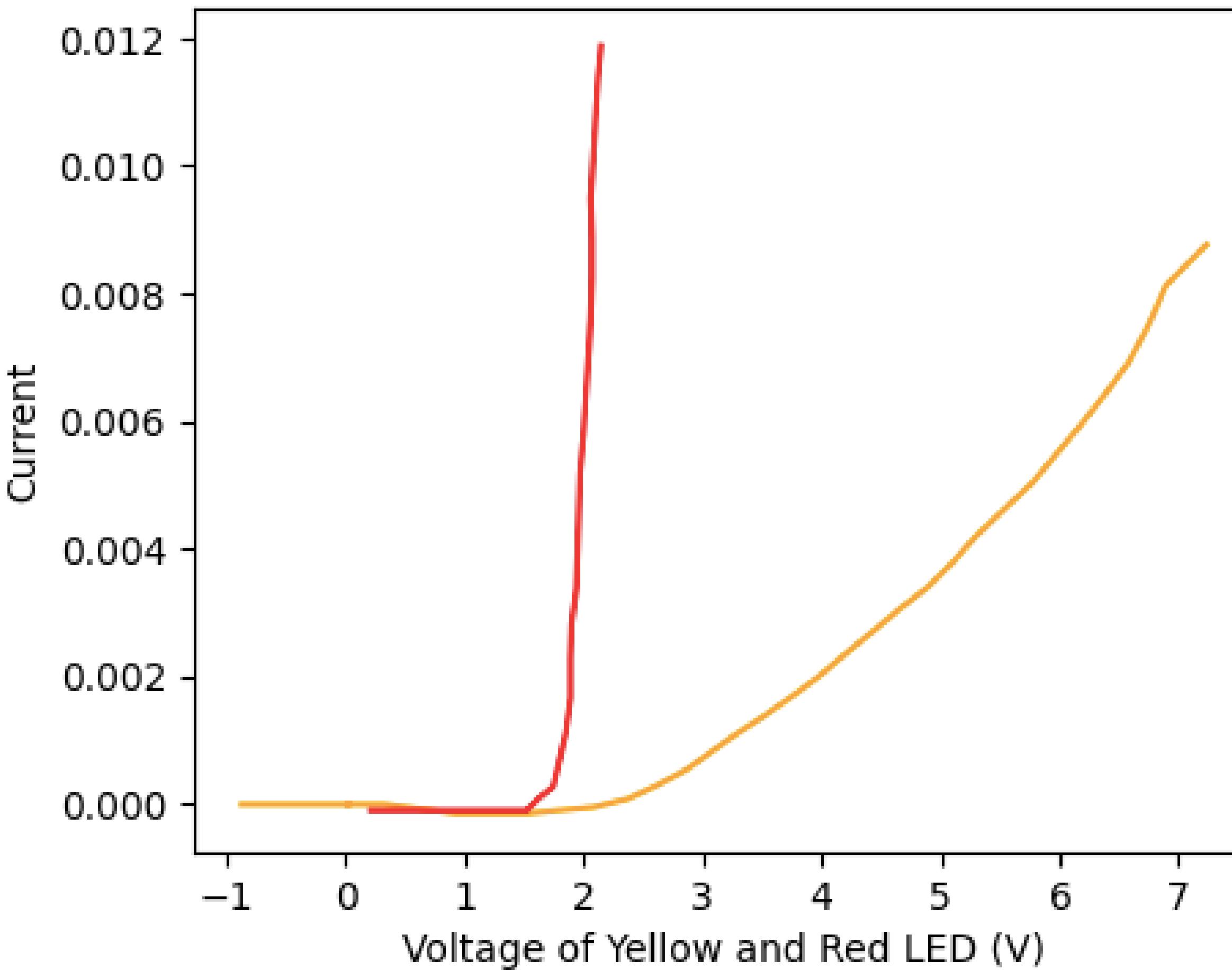
## Challenges, Mistakes and lessons learnt

- Challenges with translating the circuit design in our mind to practical circuits.
- After changing the circuit design a little bit, we faced issues with obtaining the data and changing our calculation formula.



# Project 2: Light emitting diodes



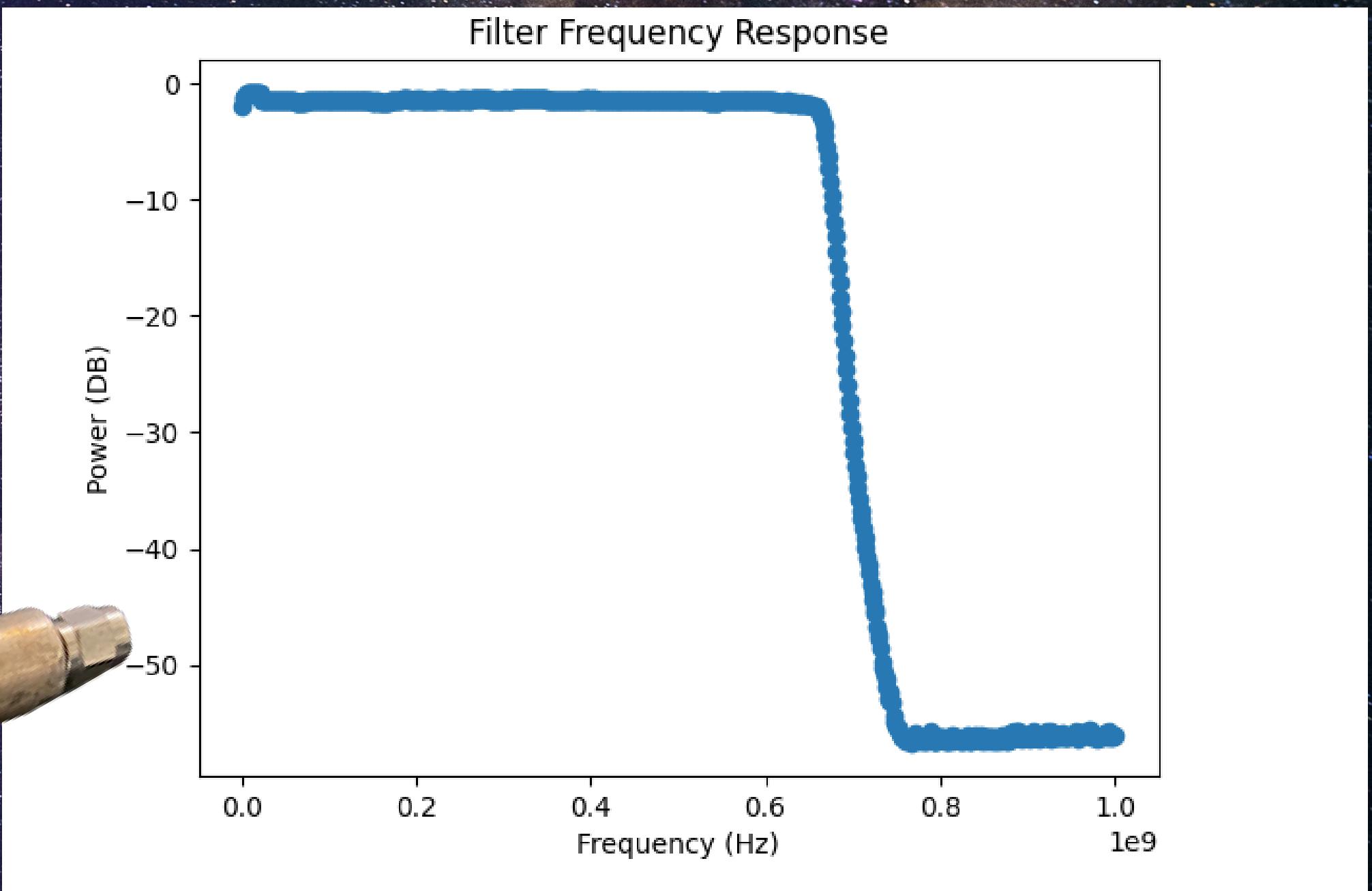


**I-V Curve of a Diode:** The above plot shows typical characteristics of a red and a yellow diode.

# CREATING FILTER FREQUENCY GRAPHS

## Use of a filter frequency graph?

- Frequency Response Curves are used to understand the behavior of a filter.
- It gives the quantitative analysis of the output spectrum of a system/device in response to an input.
- It gives a measure of the Magnitude (Amplitude/Gain) and Phase response w.r.t frequency.



An example of a low pass filter frequency response plot

# Skills helpful in our work so far

1. Notetaking
2. Safety instructions,
3. LaTeX
4. Matplotlib
5. Jupyter Notebook
6. Oscilloscope
7. Creating digital circuits.

# Connections with Astronomy

- Circuits are the basis of electronic control systems in Astronomy:
  - CCD cameras
  - Spectrographs
  - Radio Recievers
    - amplifying and filtering
  - Telescope Control Systems
  - Adaptive Optics

And many more.....

- Filters:
  - Low-Pass Filter:
    - Skyglow suppression and Atmospheric effects
  - High pass filter:
    - Isolating emission and absorption lines
  - Transit Photometry



# PROPOSAL

- An Interactive Website for the lab
- Including Interactive graphs
- Documented information from our lab work
- Resource for Dr. Marrone's lab
- A project that could utilize our combined skills

