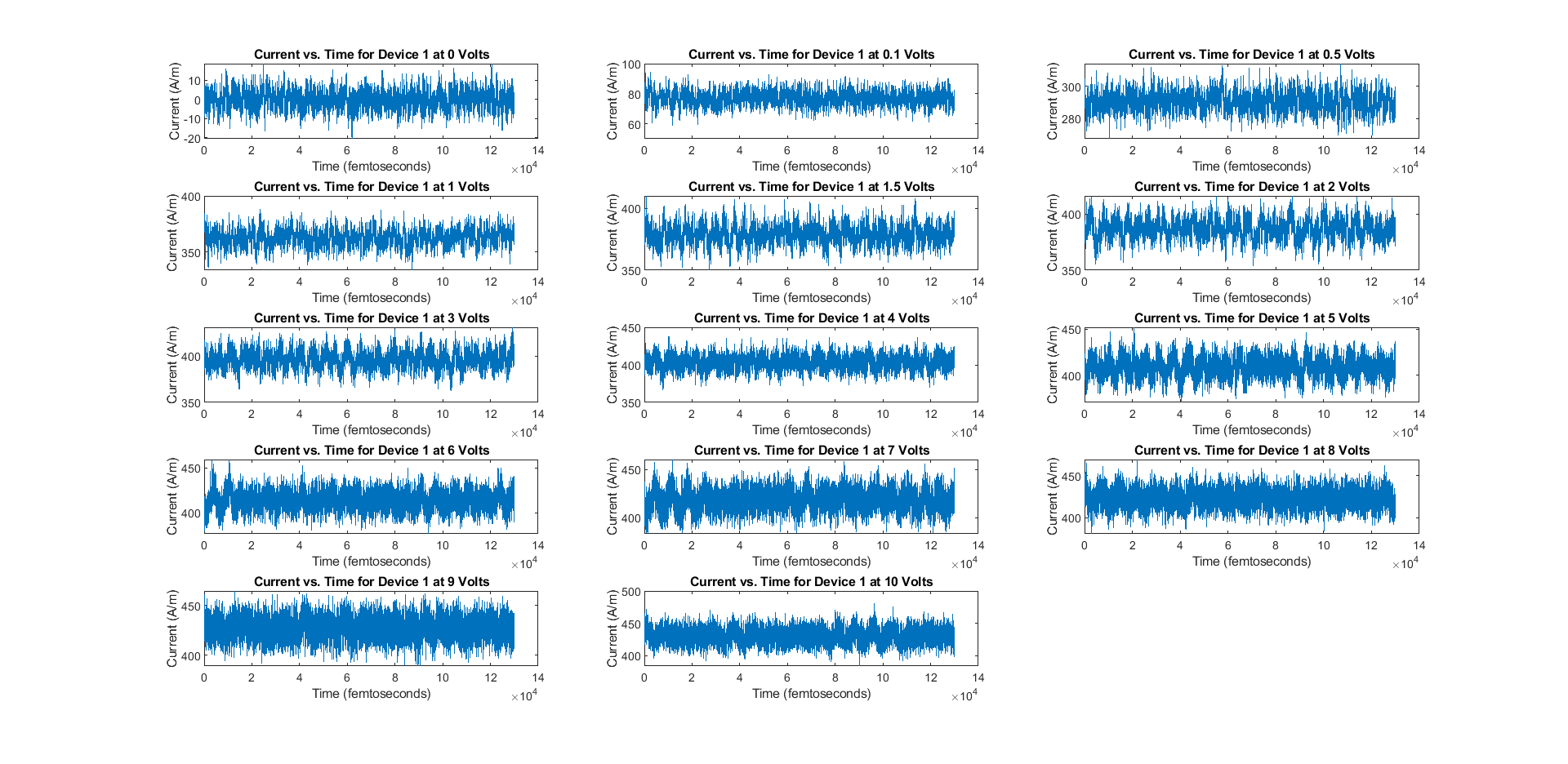
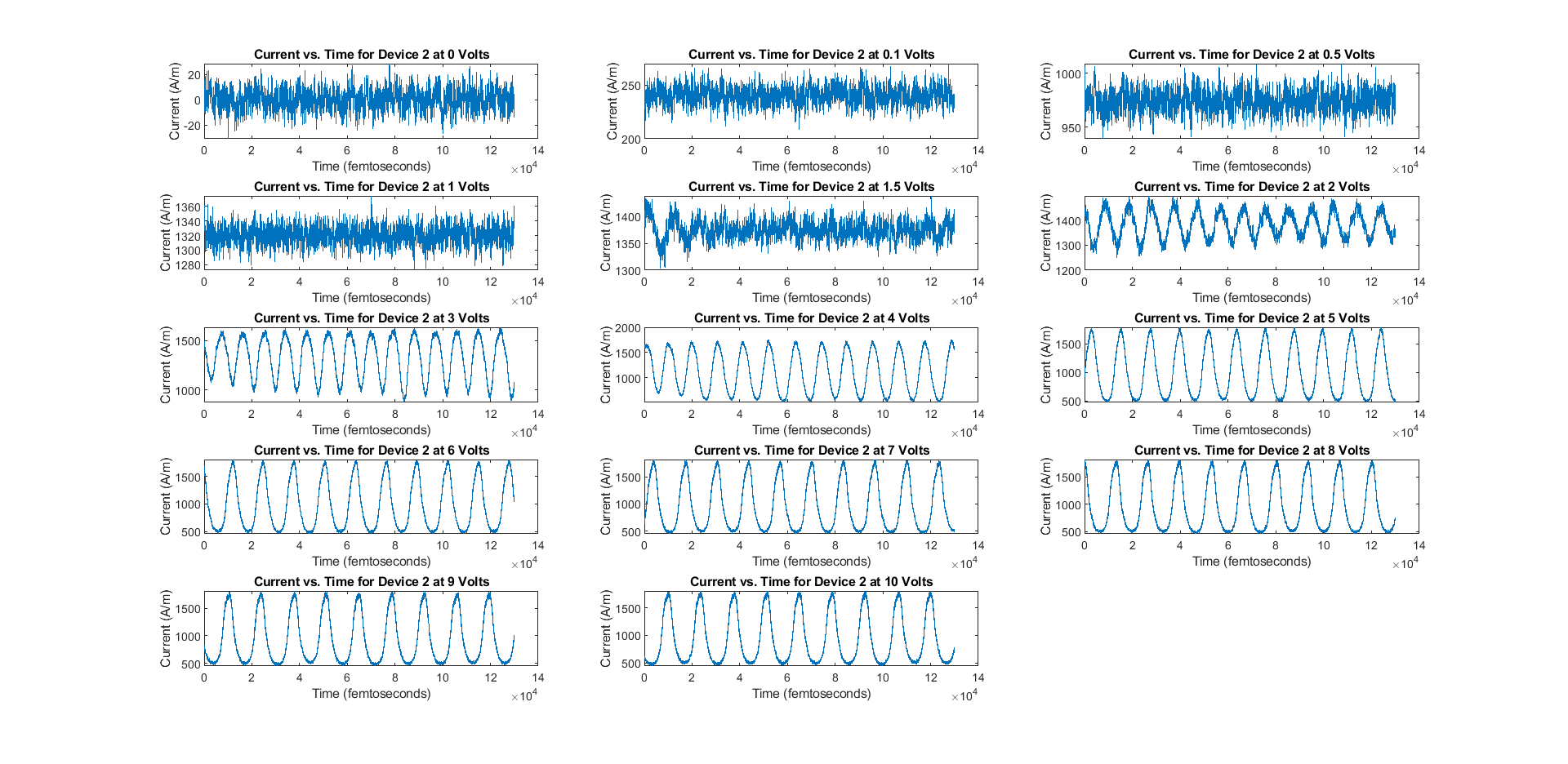
|  |  |  |  |
| --- | --- | --- | --- |
| UMass-Lowell-logo.png (295×358) | **Graphical Circuit Analysis**  **via Fourier Transforms** | |  |
|  | |  |
| Joseph Taylor  Thomas Tawadros | | |
| Signals and Systems  EECE 3620 - 201 | | |
|  | | |
|
|  |

**Source Signals**

*Figure 1 – Plot of Current versus Time for Device 1*

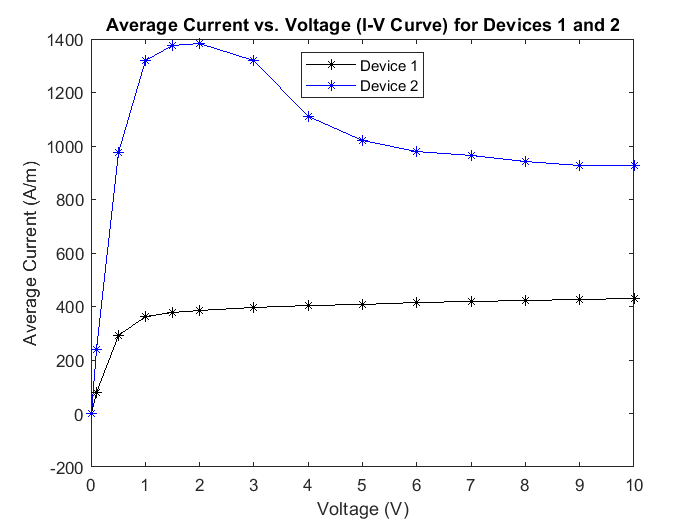
****

*Figure 2 – Plot of Current versus Time for Device 2*

****

1. **Current-Voltage (I-V) Characteristics**

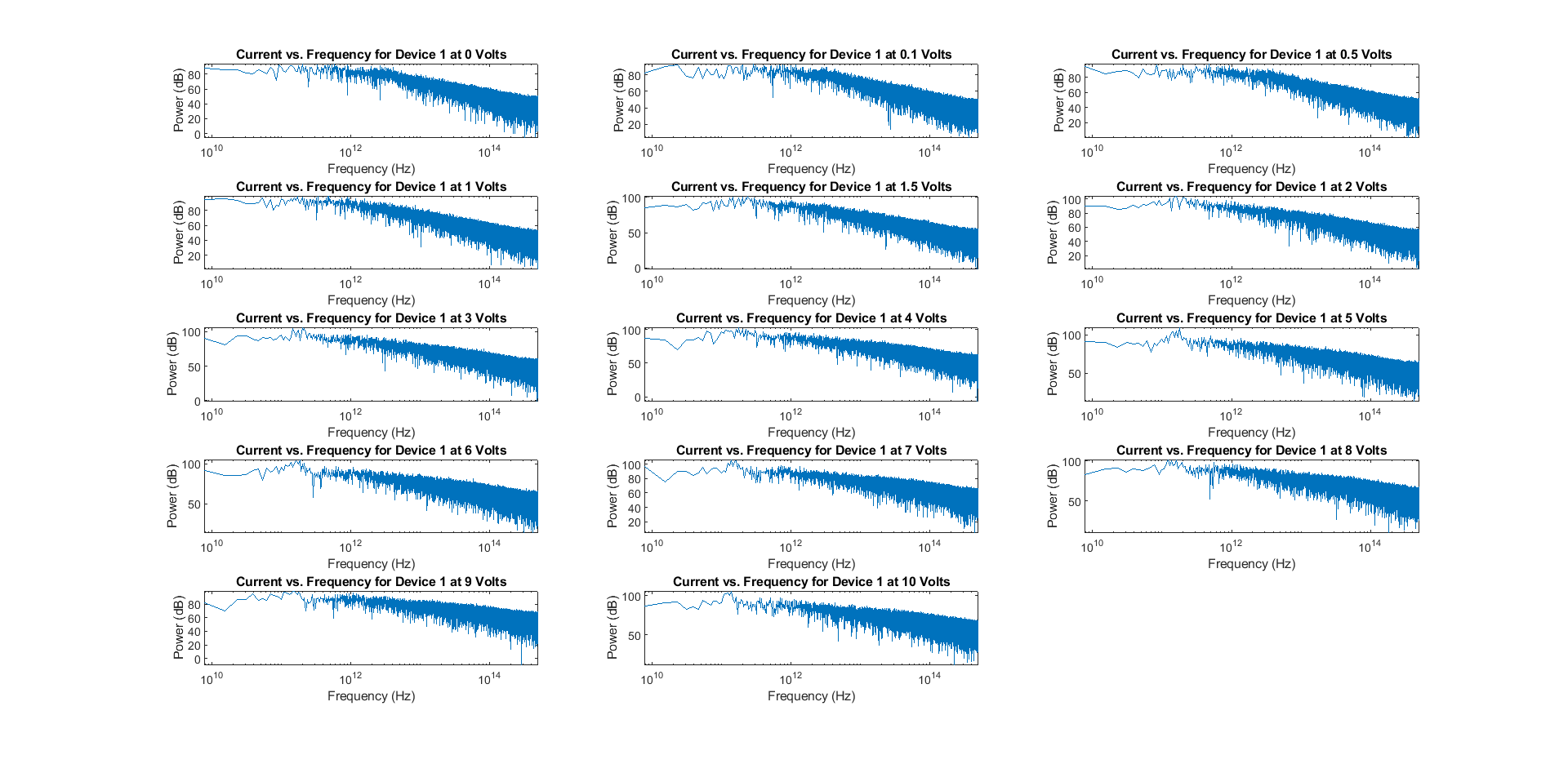
*Figure 3 – Plot of Average Current versus Voltage for Devices 1 and 2*

****

Looking at this chart, we can see a few differences between Device 1 and Device 2 regarding their average current values across the range of voltages. Device 1 has a lower average current at all voltage levels, and takes on an exponentially slowing increase in average current as the voltage is increased. Device 2 has a higher and more sporadic current value, which starts off nearly vertical but crests a “hill” at 2 volts and settles down to about 1000 A/m.

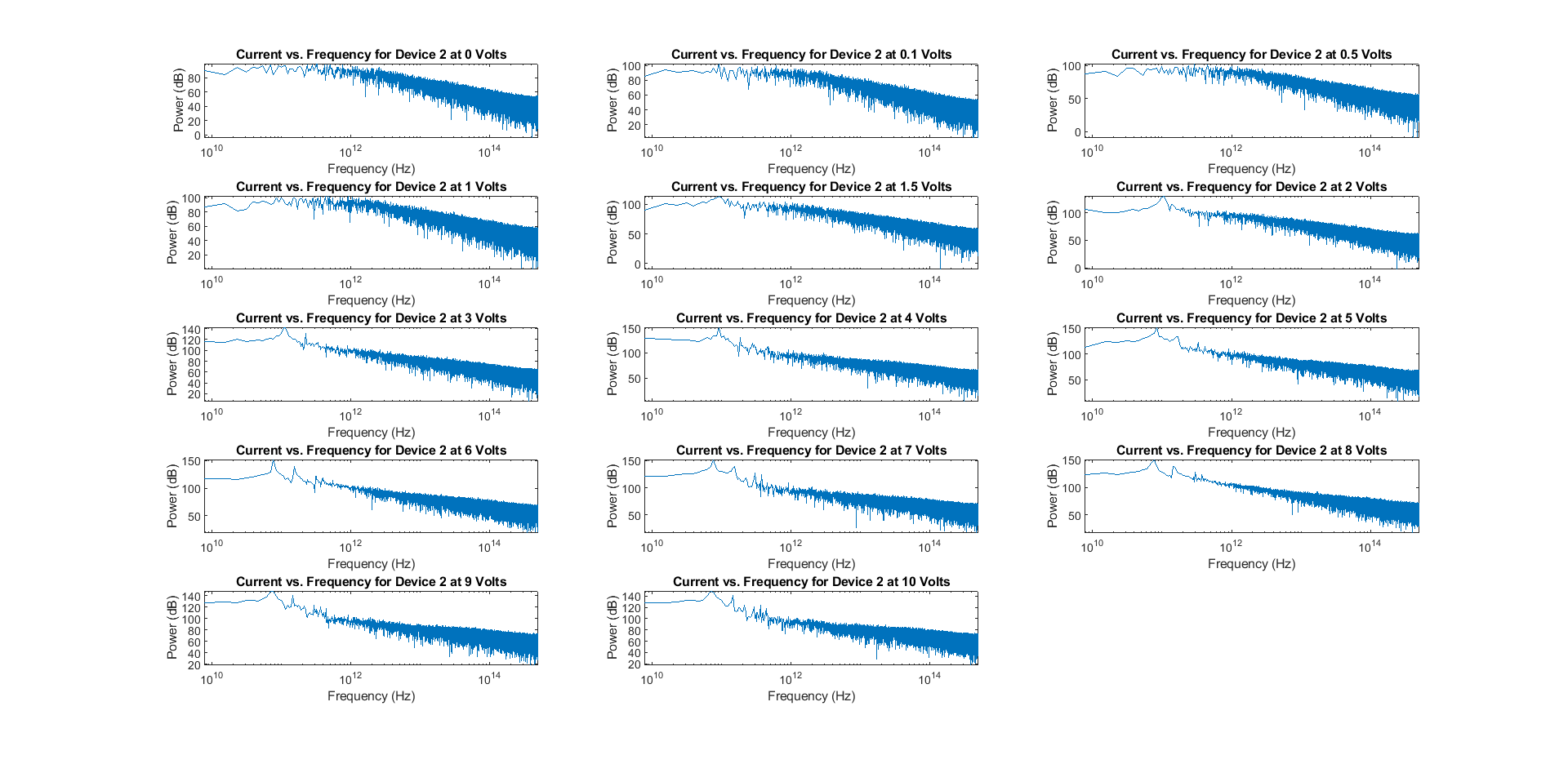
1. **Calculation of Fourier Transforms**

*Figure 4 – Current versus Frequency of Device 1*

****

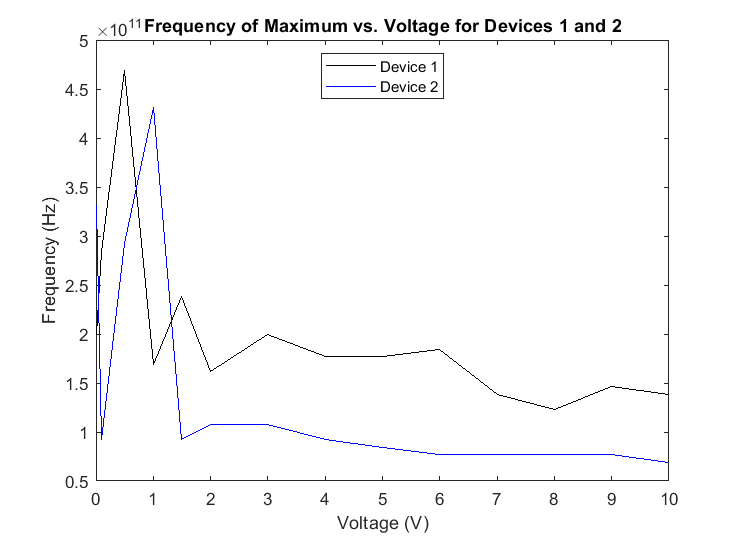
Looking at this graph, we can see that the peak in frequency is somewhere in the 1011 Hz range for most voltage levels. Compared to Device 2, this is a much less obvious peak frequency.

*Figure 5 – Current versus Frequency of Device 2*

****

Looking at these graphs, we can see that they take the same basic shape as the Device 1 graphs. However, there is a much better defined peak in frequency at about 7.5 x 1010 Hz. This is perfectly in line with the visually calculated frequency from Figure 2.

*Figure 6 - Plot of Frequency versus Voltage of Devices 1 and 2*

****

This graph confirms the trends seen in the previous graphs. In the graph of the supplied data, we observed a sinusoidal waveform in Device 2 with a frequency of about 7.5 x 1010 Hz. Once we took and graphed the Fourier transform of Device 2, we observed a peak at roughly the same frequency. In this final graph, we can see that the frequencies of peak current indicated by the Fourier Transform started off very erratic with lower voltages, but gradually settled to their final values. This can also be observed in Figures 1 and 2 (and especially for Figure 2) where the sine wave gets visually cleaner as voltage is increased.

1. **MATLAB Code**

Main File, SignalsProject.m:

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

% Joseph Taylor, Thomas Tawadros

% EECE 3620 - Signals & Systems

% Software Project

% 12/5/18

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

% Preallocate space for arrays

voltage = [0 0.1 0.5 1 1.5 2 3 4 5 6 7 8 9 10];

avgcurrent1 = zeros(14,1);

avgcurrent2 = zeros(14,1);

maxfreq1 = zeros(14,1);

maxfreq2 = zeros(14,1);

% Load device 1 data

if exist('device1','var') == 0

device1 = zeros(14,130001);

for i=1:1:14

device1(i,:) = load(['Device-1/CURRENT-',num2str(voltage(i),'%.1f'),'V.dat']);

end

end

% Load device 2 data

if exist('device2','var') == 0

device2 = zeros(14,130001);

for i=1:1:14

device2(i,:) = load(['Device-2/CURRENT-',num2str(voltage(i),'%.1f'),'V.dat']);

end

end

% Graph current versus frequency for device 1

figure

for i=1:1:14

avgcurrent1(i) = mean(device1(i,:));

subplot(5,3,i)

maxfreq1(i) = SpectrumAnalyzer(device1(i,:),1E15);

title(['Current vs. Frequency for Device 1 at ',num2str(voltage(i)),' Volts'])

end

% Graph current versus frequency for device 2

figure

for i=1:1:14

avgcurrent2(i) = mean(device2(i,:));

subplot(5,3,i)

maxfreq2(i) = SpectrumAnalyzer(device2(i,:),1E15);

title(['Current vs. Frequency for Device 2 at ',num2str(voltage(i)),' Volts'])

end

% Graph average current versus voltage for both devices

figure

plot(voltage, avgcurrent1, 'k-\*', voltage, avgcurrent2, 'b-\*');

title('Average Current vs. Voltage (I-V Curve) for Devices 1 and 2')

xlabel('Voltage (V)')

ylabel('Average Current (A/m)')

legend('Device 1', 'Device 2','Location','north')

% Graph frequency at max versus voltage for both devices

figure

plot(voltage, maxfreq1, 'k-', voltage, maxfreq2, 'b-');

title('Frequency of Maximum vs. Voltage for Devices 1 and 2')

xlabel('Voltage (V)')

ylabel('Frequency (Hz)')

legend('Device 1', 'Device 2','Location','north')

Function SpectrumAnalyzer.m:

function maxfreq = SpectrumAnalyzer(signal,fs)

% Calculate FFT

N = length(signal);

X\_mags = abs(fft(signal));

bin\_vals = 0 : N-1;

fax\_Hz = bin\_vals \* fs / N;

N\_2 = ceil(N/2);

xaxis = fax\_Hz(2:N\_2);

yaxis = 20\*log10(X\_mags(2:N\_2));

% Plot FFT

semilogx(xaxis, yaxis)

xlabel('Frequency (Hz)')

ylabel('Power (dB)');

title({'Single-sided Power spectrum' ...

' (Frequency in shown on a log scale)'});

axis tight

% Determine and return frequency at maximum value

[~,maxindex] = max(yaxis);

maxfreq = xaxis(maxindex);

end