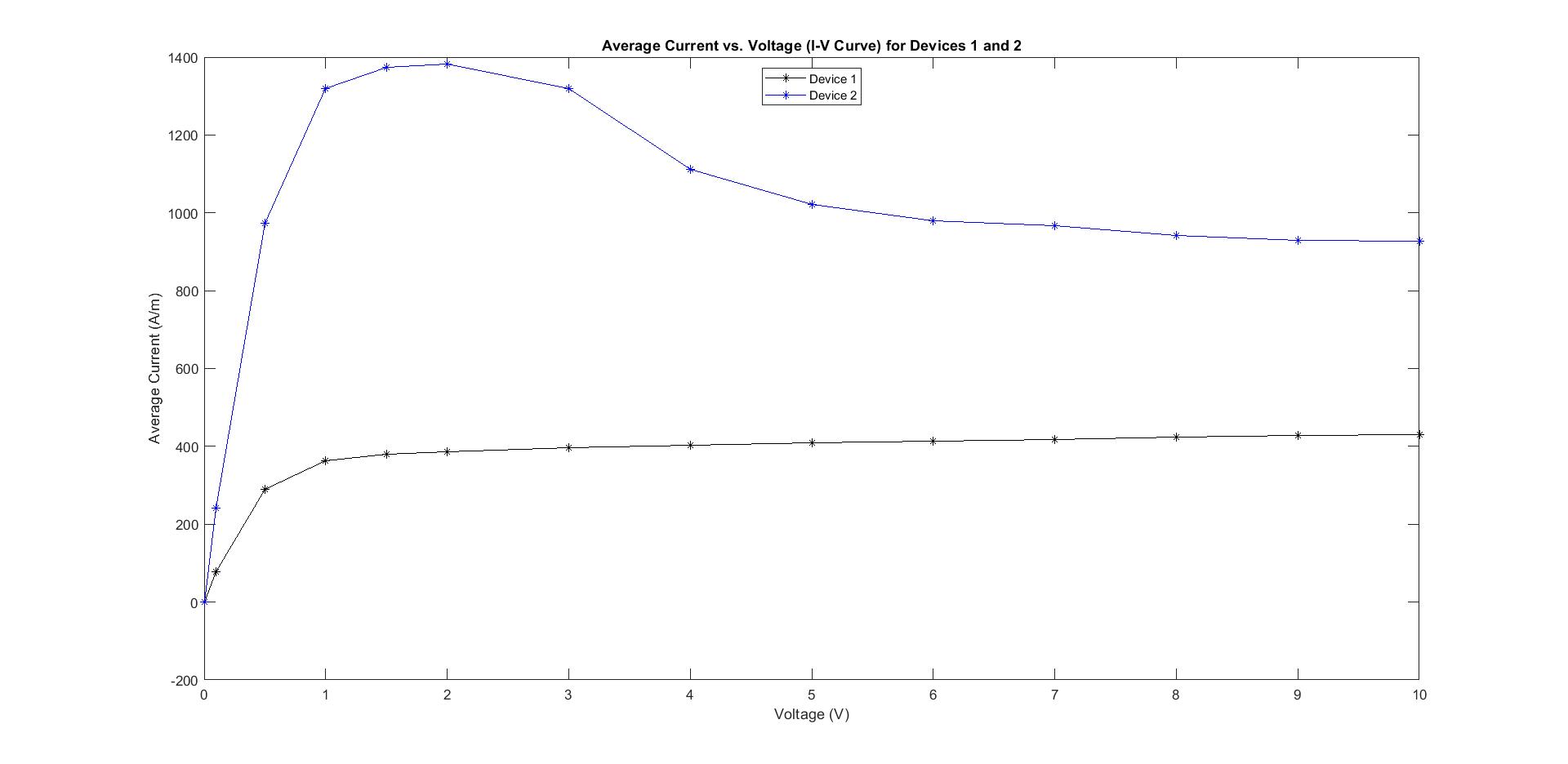
|  |  |  |  |
| --- | --- | --- | --- |
| UMass-Lowell-logo.png (295×358) | **Graphical Circuit Analysis**  **via Fourier Transforms** | |  |
|  | |  |
| Joseph Taylor  Thomas Tawadros | | |
| Signals and Systems  EECE 3620 - 201 | | |
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|  |

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

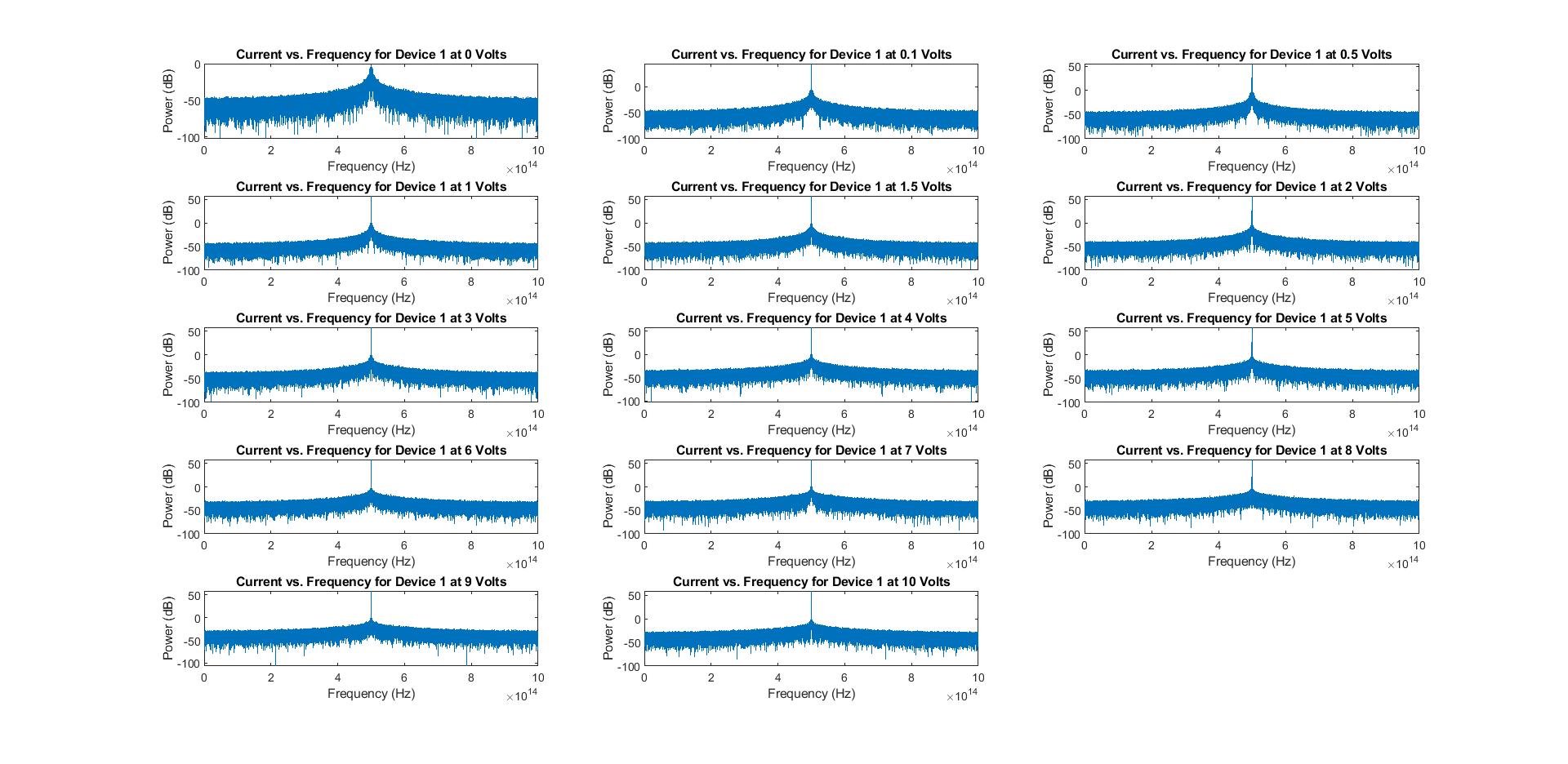
*Figure 1 – Plot of Average Current versus Voltage for Devices 1 and 2*

****

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.

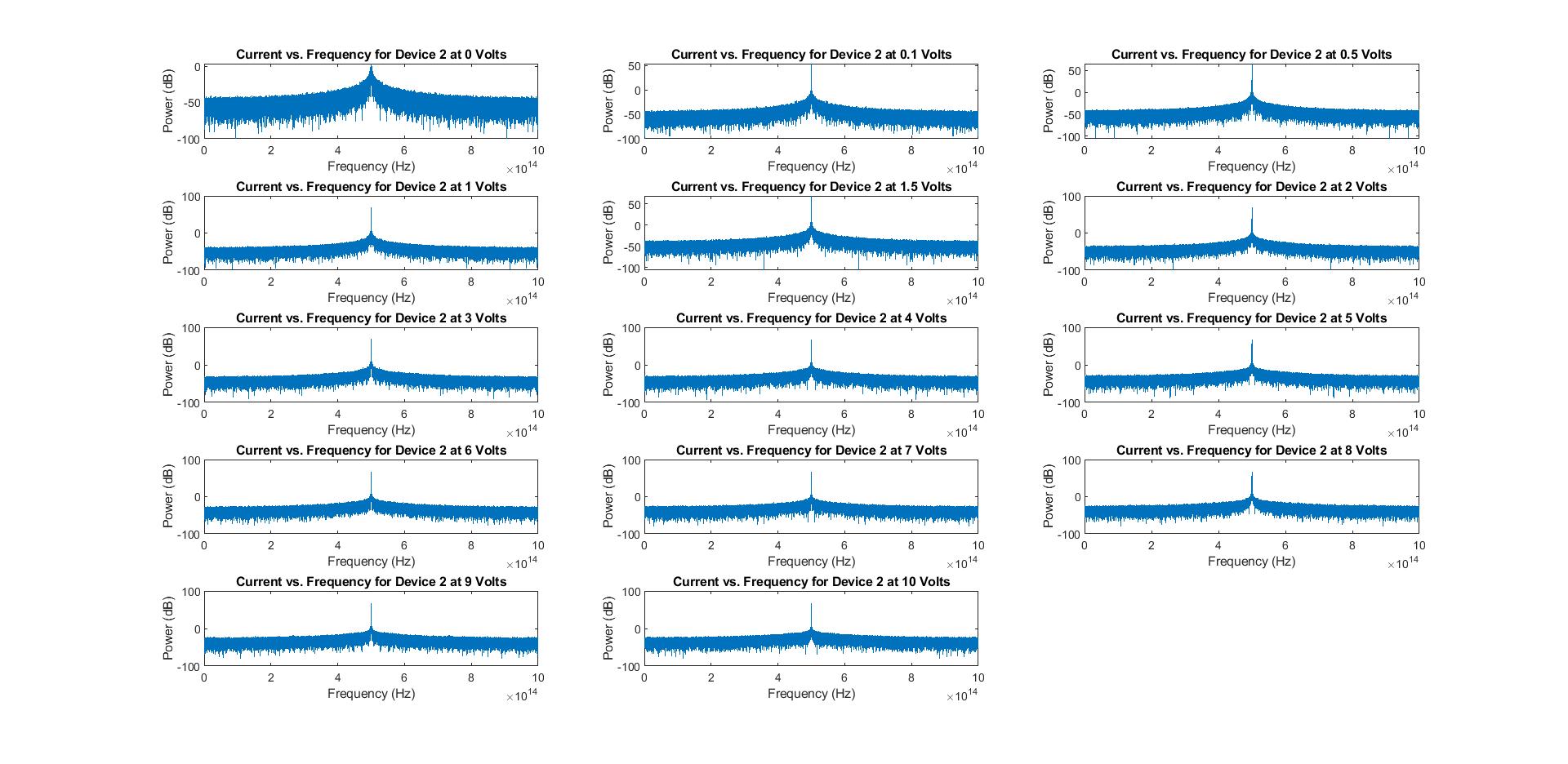
1. **Calculation of Fourier Transforms**

*Figure 2 – Current versus Frequency of Device 1*

****

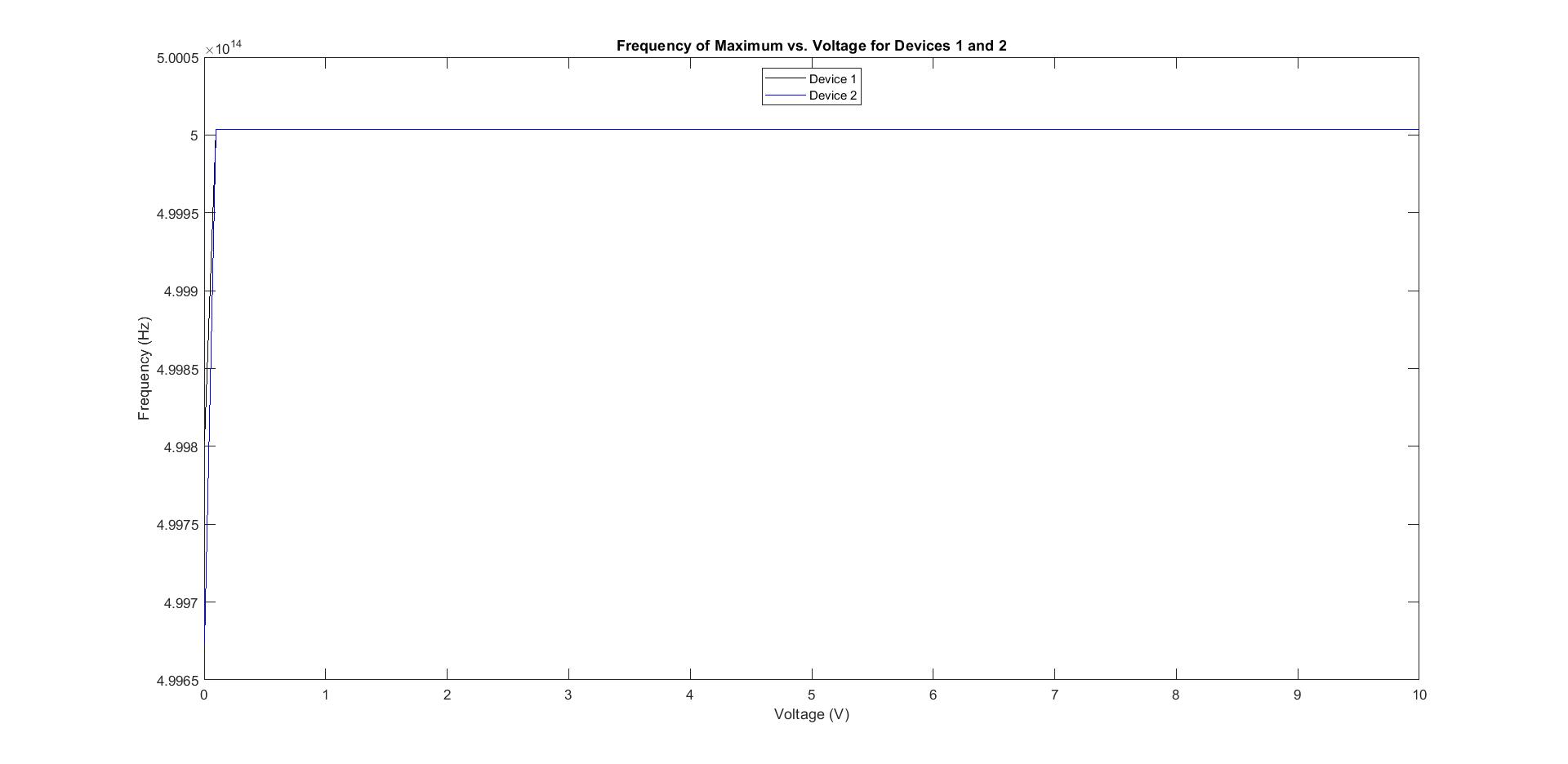
These graphs all look very similar, with a distinct peak at 5x1014 Hz with consistently decreasing amplitudes as the frequency reaches either side of that peak. These graphs were generated by taking the FFT of the input signal and centering the transform on the peak value.

*Figure 3 – Current versus Frequency of Device 2*

****

These graphs look exactly like the graphs for Device 1, with no notable differences. The same procedure was followed for creating these graphs as Device 1.

*Figure 3 - Plot of Frequency versus Voltage of Devices 1 and 2*

****

Looking at this chart, we can see that both devices have peak currents at precisely 5x1014 Hz. The only variation to this is at zero volts, there both devices have peak currents at frequencies *slightly* lower than 5x1014 Hz.

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(InputArray,Fs)

Yaxis = abs(fftshift(fft(InputArray)));

Yaxis = Yaxis.\*Yaxis;

v = size(Yaxis);

if v(1) == 1

V = size(Yaxis,2);

Xaxis = -Fs/2+Fs/V:Fs/V:(Fs/2);

else

V = v(1);

Xaxis = -Fs/2+Fs/V:Fs/V:(Fs/2);

Xaxis = Xaxis.';

end

Xaxis = Xaxis + Fs/2;

Yaxis = 10\*log10(Yaxis\*4/(V.\*V));

plot(Xaxis,Yaxis)

xlabel('Frequency (Hz)')

ylabel('Power (dB)')

[~,maxindex] = max(Yaxis);

maxfreq = Xaxis(maxindex);