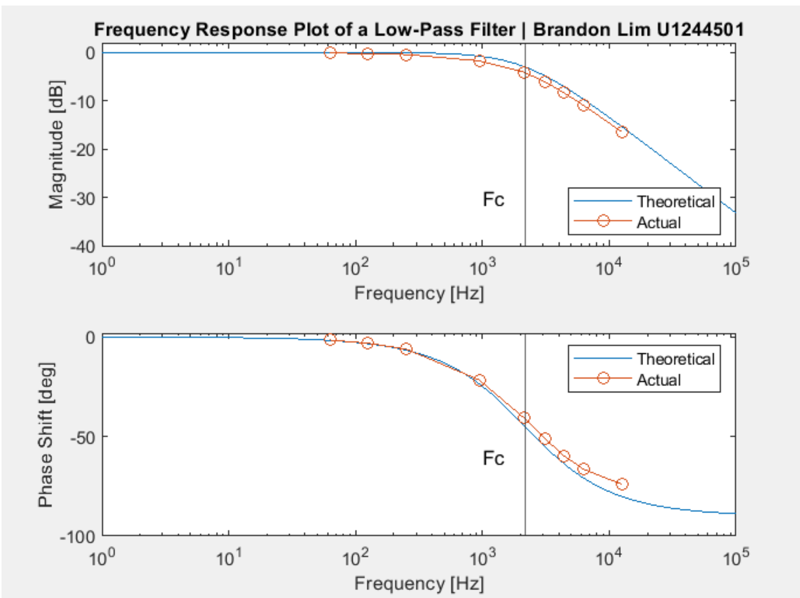
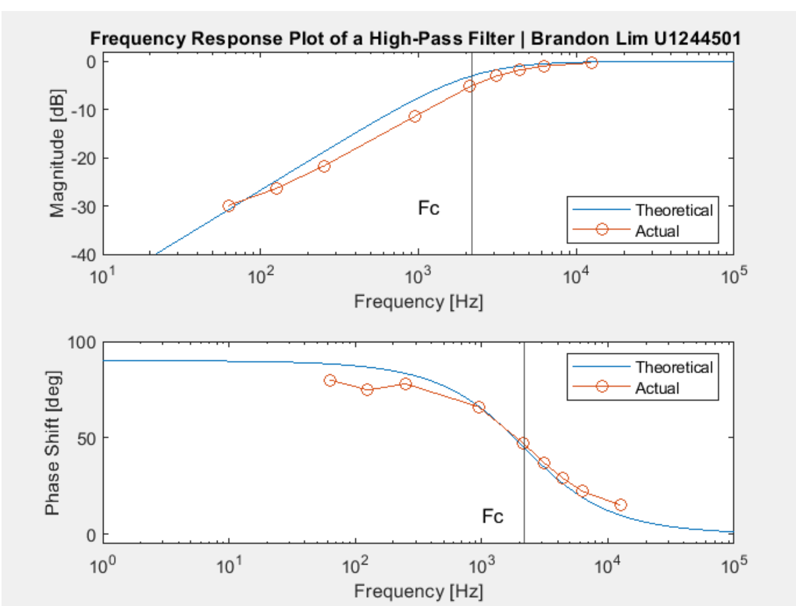
5 Post-Lab Exercises

1. Using your m-file and data from the prelab (3.a and 3.b), plot the gain and phase of the theoretical frequency response and the experimental response collected in lab. Don't forget to change the theoretical R and C values from the prelab to the actual measured values when making the plot. Use a line for the theoretical data and markers for the experimental data. Include screenshots of your code and plots in line with this question with your name indicated. Also submit your .m files to canvas.





```
% Brandon Lim
clear, clc, close all
%Low Pass Filter
w = logspace(0,5);
R = 4.6*1000; %ohms
C = 0.1 * 10^-6; %farads

freqVec = 2.*pi.*[10,20,40,150,338,500,700,1000,2000];
MagVec = [-0.14,-0.21,-0.428,-1.73,-4.08,-6.12,-8.36,-10.95,-16.43];
phaseVec = [-1.5, -3.079, -6.019, -21.54, -40.57, -51.31, -59.67, -66.4, -74];

wc = 1/(R*C); %Cutoff Frequency
magnitudeNorm = 1./sqrt(1+((w.^2)/(wc.^2)));
magnitudeDB = 20*log10(magnitudeNorm);

phaseShift = -atan(w./wc) .* 180./pi;

figure
subplot(2,1,1)
semilogx(w,magnitudeDB)
ylim([-40,2])
title("Frequency Response Plot of a Low-Pass Filter | Brandon Lim U1244501")
xlabel("Frequency [Hz]")
ylabel("Magnitude [dB]")
hold on
subplot(2,1,1)
xline(wc)
hold on
subplot(2,1,1)
```

```
semilogx(freqVec,MagVec,"-o")
text(10^3,-30,0,"Fc")
legend("Theoretical","","Actual", "Location","southeast")

subplot(2,1,2)
semilogx(w,phaseShift)
ylim([-100,2])
xlabel("Frequency [Hz]")
ylabel("Phase Shift [deg]")
hold on
subplot(2,1,2)
xline(wc)
hold on
subplot(2,1,2)
semilogx(freqVec,phaseVec,"-o")
text(10^3,-60,0,"Fc")
legend("Theoretical","","Actual", "Location","northeast")

%% High Pass
clear, clc, close all
w = logspace(0,5);
R = 4.61*1000; %ohms
C = 0.1 * 10^-6; %farads

freqVec = 2.*pi.*[10,20,40,150,338,500,700,1000,2000];
MagVec = [-29.88 -26.38 -21.71 -11.45 -5.24 -3 -1.77 -0.935 -0.3];
phaseVec = [80 74.8 77.98 66.12 47.37 36.9 29.11 22.26 15.13];

wc = 1/(R*C); %Cutoff Frequency
```

```
magnitudeNorm = (w./wc)./(sqrt(1+((w.^2)/(wc^2))));
magnitudeDB = 20*log10(magnitudeNorm);

phaseShift = atan(wc./w) .* 180./pi;

figure
subplot(2,1,1)
semilogx(w,magnitudeDB)
ylim([-40,2])
title("Frequency Response Plot of a High-Pass Filter | Brandon Lim U1244501 ")
xlabel("Frequency [Hz]")
ylabel("Magnitude [dB]")
hold on
subplot(2,1,1)
xline(wc)
hold on
semilogx(freqVec,MagVec,"-o")
text(10^3,-30,0,"Fc")
legend("Theoretical","","Actual", "Location","southeast")


subplot(2,1,2)
semilogx(w,phaseShift)
ylim([-5,100])
xlabel("Frequency [Hz]")
ylabel("Phase Shift [deg]")
hold on
subplot(2,1,2)
xline(wc)
```

```
xline(wc)
hold on
semilogx(freqVec,phaseVec,"-o")
text(10^3,10,"Fc")
legend("Theoretical","","Actual", "Location","northeast")
```

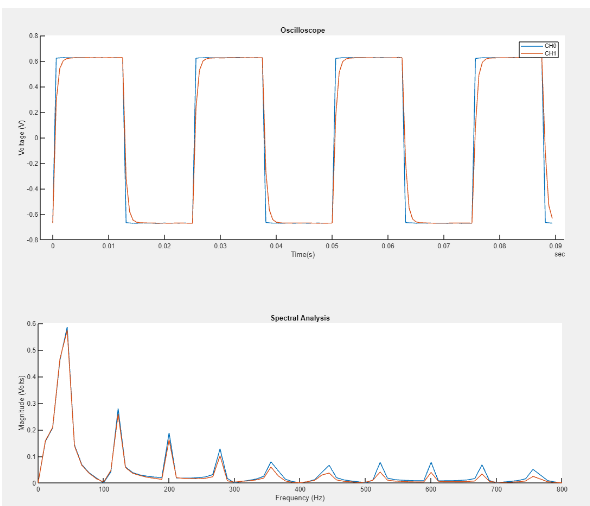
2. Comment on the agreement of the theoretical and experimental response of the low-pass filter. What could be the causes for any disagreement?

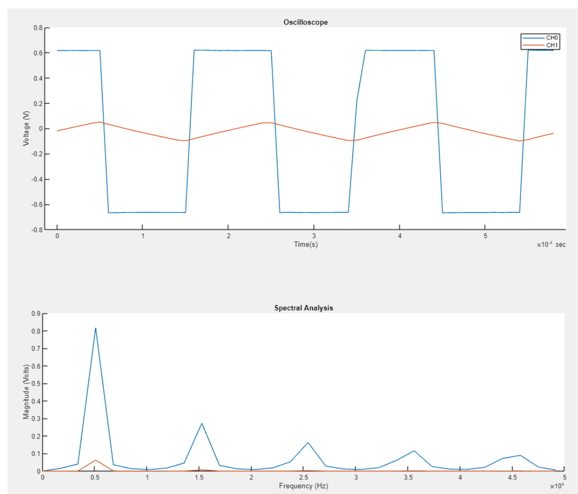
- The theoretical and experimental response of the low pass filter agreed very well. Some magnitudes and phase shifts of the experimental response fell a little short of the theoretical values but this can be explained by the dynamics of the hardware like imperfections in the resistor and capacitors.

3. Comment on the agreement of the theoretical and experimental response of the high-pass filter. What could be the causes for any disagreement?

- The theoretical and experimental response of the high pass filter agreed very well. Again, some magnitudes and phase shifts of the experimental response fell a little short of the theoretical values but this can be explained by the dynamics of the hardware like imperfections in the resistor and capacitors.

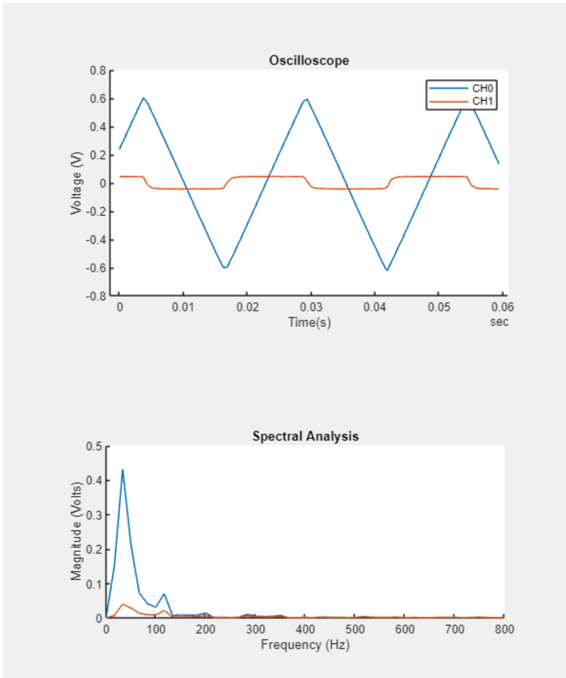
4. Can you interpret the reason for the shape of the resulting signals from the square-wave response to the low-pass filter?

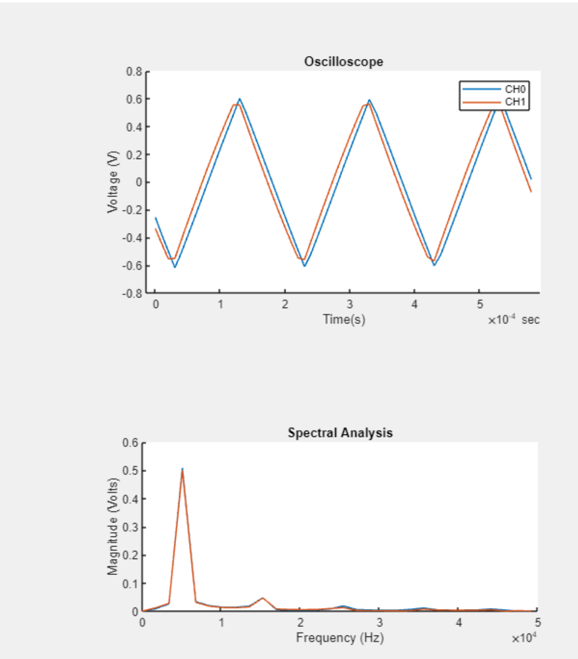




- As seen from the left image, when a small frequency is used, most of the signals pass through and we get a good signal representation. The reason why the corners of the Vout square wave aren't sharp like the direct output is because the higher frequencies are responsible for creating those sharper approximations near the edges of a square wave but they are being attenuated down by the low pass filter. As seen from the right image where a large frequency is used, most signals are attenuated down resulting in a poor approximation due to the higher frequencies being above the cut off frequency.

5. Can you interpret the reason for the shape of the resulting signals from the triangular wave response to the high-pass filter?





- As seen from the left picture where a low frequency is used, most of the signal is attenuated down and doesn't pass through the high pass filter. So, only the higher frequencies that make up a smaller part of this signal are passed through resulting in a poor representation of the signal. As seen from the image on the right where a high frequency is used, the higher frequencies are passed through the filter giving us a good representation of the signal. Although we can see some phase lag induced by the dynamics of the circuit.