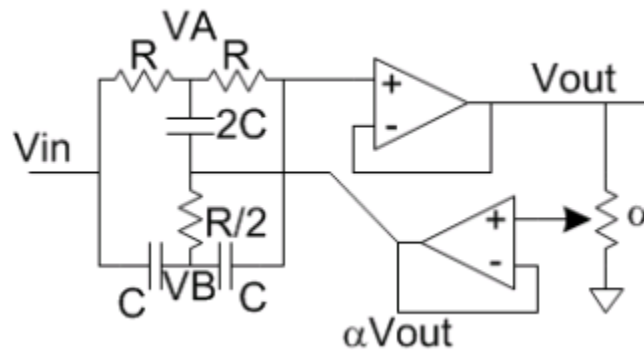


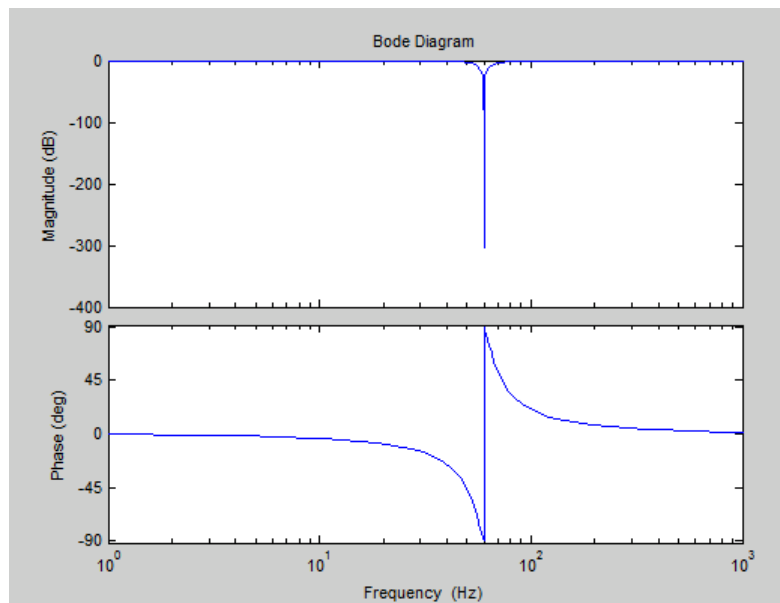
Lab 10: Active Filters

Time Spent: 5 Hours

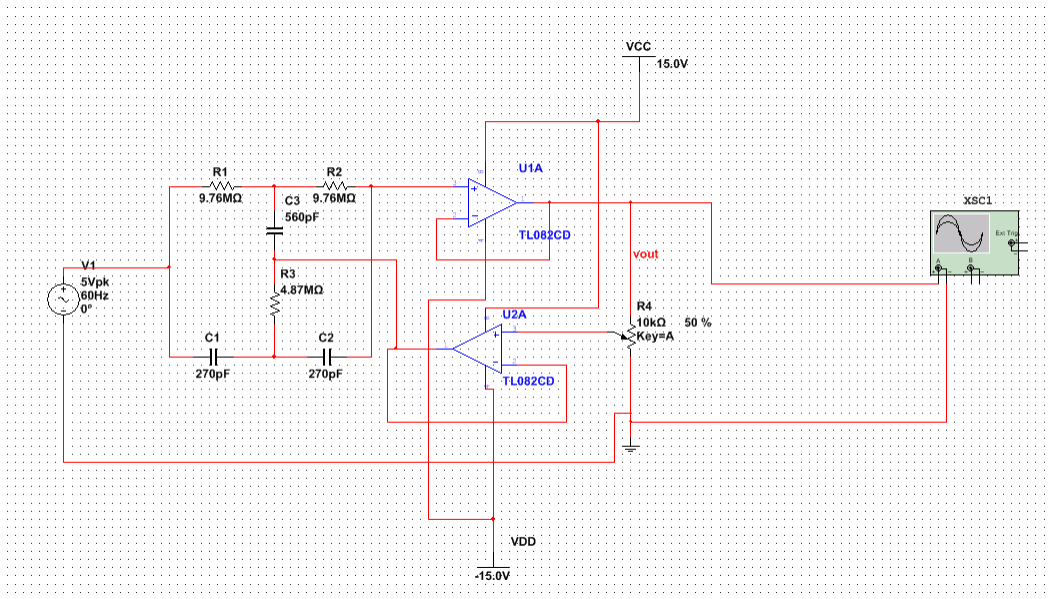
Notch Design To design the Notch Portion of the filter I used the same design as the warmup so that I would not have to rederive the transfer function. The design is shown below:



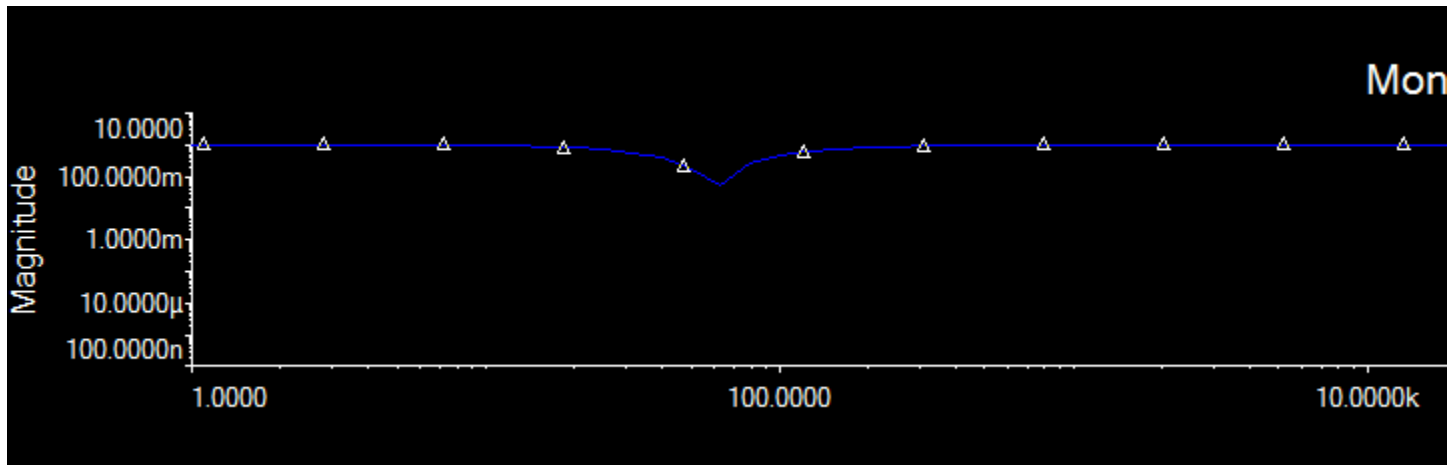
After analysis in the warmup my transfer function was: $\frac{s^2 + \frac{1}{R^2 C^2}}{s^2 + \frac{4(1-\alpha)}{RC} + \frac{1}{R^2 C^2}}$. With this transfer function $f_0 = \frac{1}{2\pi RC}$ With this information we want to eliminate the 60Hz noise so we set $f_0 = 60$ and we are given that $C = 270pF$. We solve for R and find R to be $9.82M\Omega$. Using matlab I generated the following Bode plot:



Note the phase looks interesting because the bodeplot function probably doesn't use atan2. As we can see the bode plot dips at approximately 60 Hz. I then simulated the circuit in Multisim.

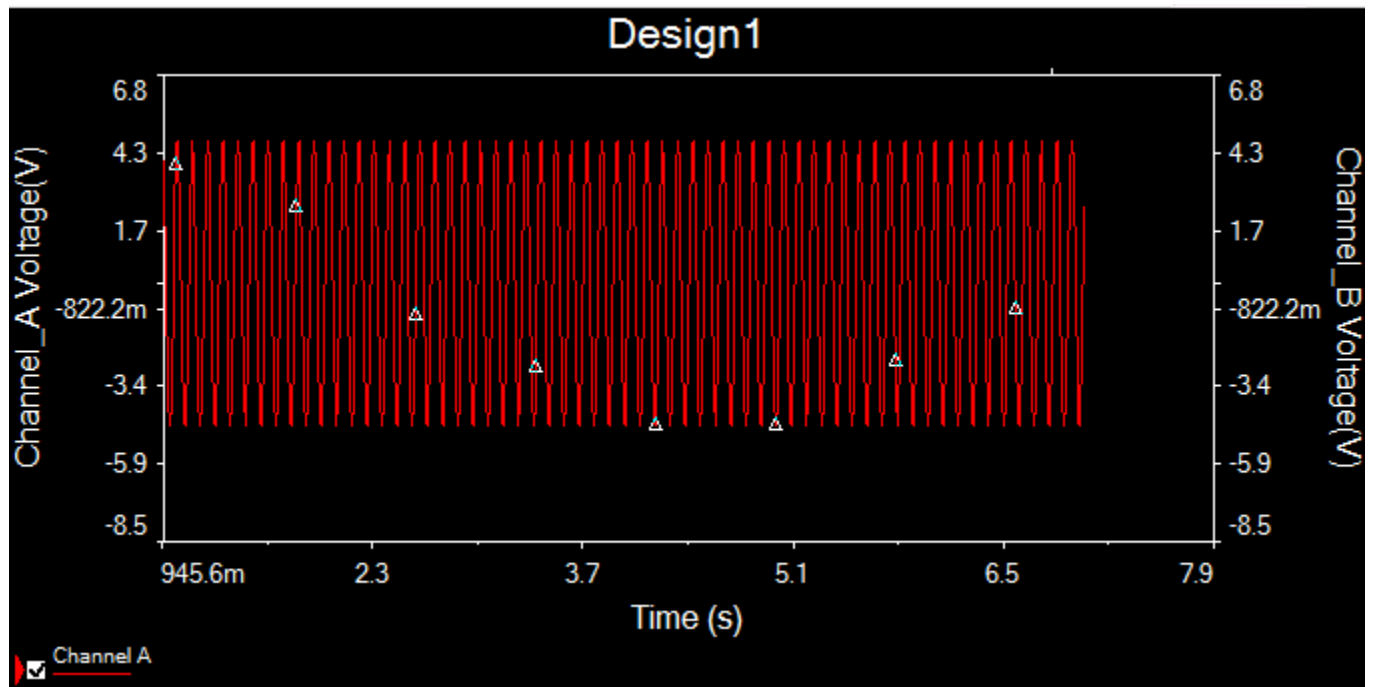


First I ran a montecarlo simulation:

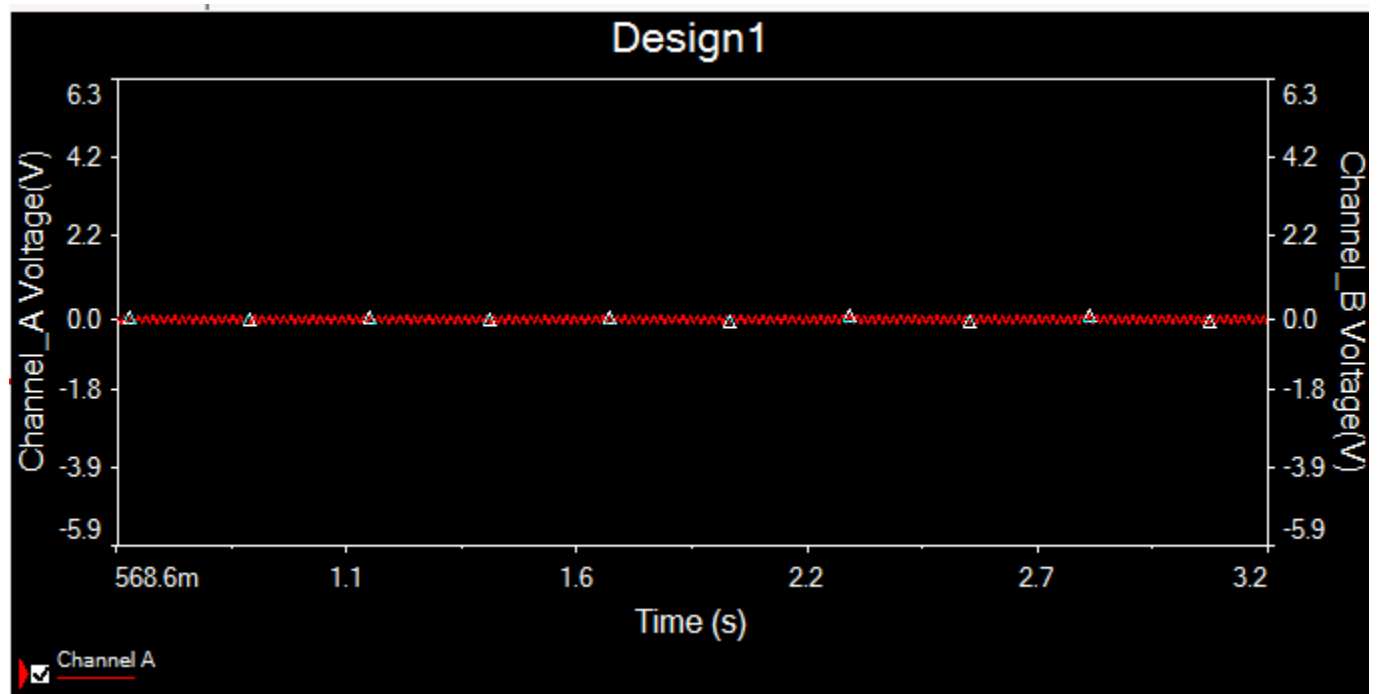


The filter has a dip around 60 Hz which is what we want. The reason for the small dip is because I didn't tune the potentiometer in multisim, I left it at the default value of 50%

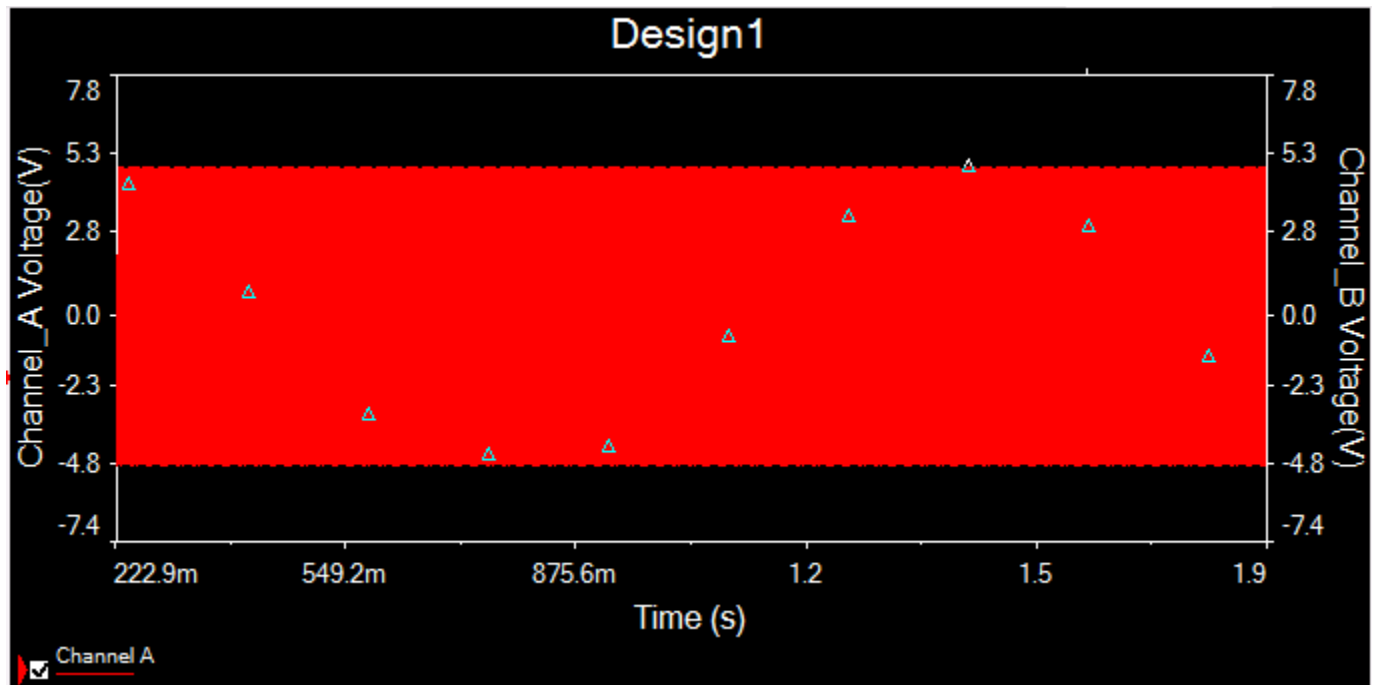
I then fed 3 different AC signals into the filter 10Hz,60Hz, and 500Hz.
10Hz:



60Hz:

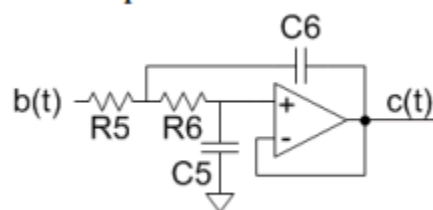


500Hz:

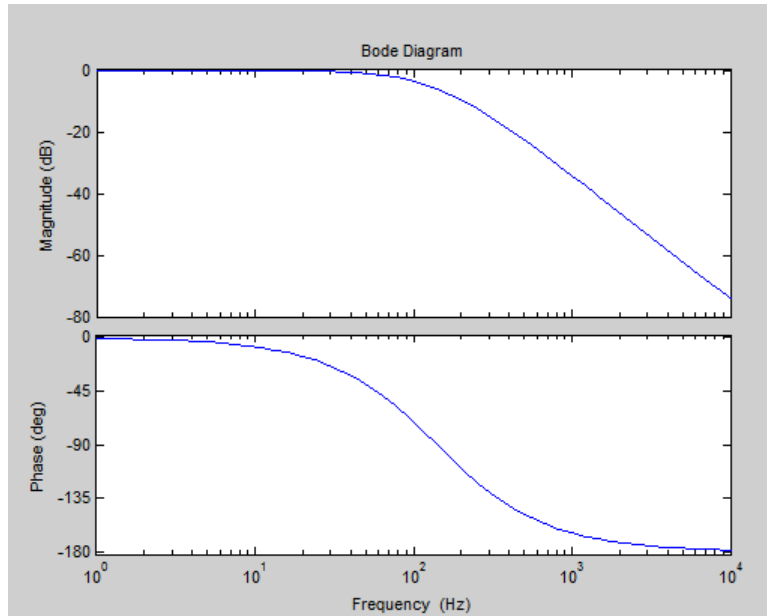


As we can see 10Hz and 500Hz retain their amplitude while 60Hz gets cutoff.

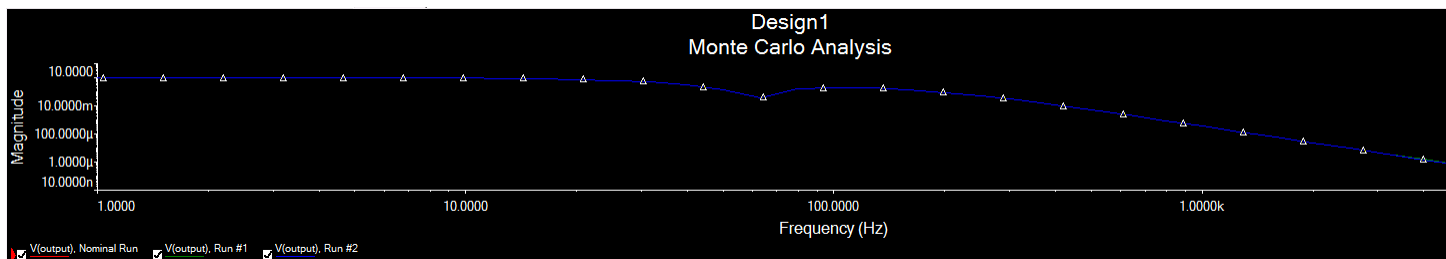
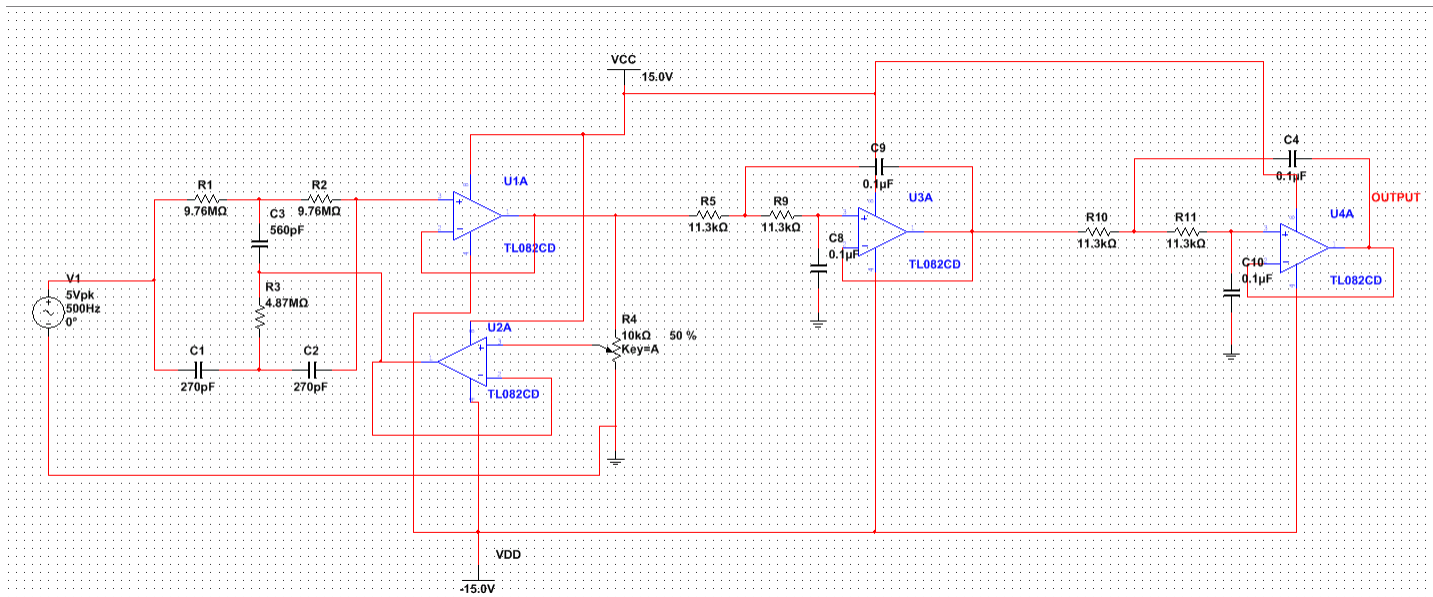
Sallen Keys For the Sallen Keys Portion I again used my transfer function from the warmup questions and got: $\frac{1}{s^2 + s \frac{R6+R5}{R6 \cdot C6 \cdot R5} + \frac{1}{R6 \cdot C6 \cdot C5 \cdot R5}}$ From this we get $\omega_n = \sqrt{\frac{1}{R6 \cdot C6 \cdot C5 \cdot R5}}$ and $\zeta = \frac{R6+R5}{2 \cdot (R6 \cdot C6 \cdot R5)} \cdot \sqrt{R6 \cdot C6 \cdot C5 \cdot R5}$ To come up with values for the Sallen Keys filter I knew I wanted the cutoff frequency to be 140Hz and that we want the filter to decay quickly so we need a critically damped system $\zeta = 1$. I set the capacitors to $0.1\mu F$ and solved for the resistors and got both resistors should be $R = 11,368\Omega$. The filter looks like the following:



I used matlab to generate the Bode Plot:

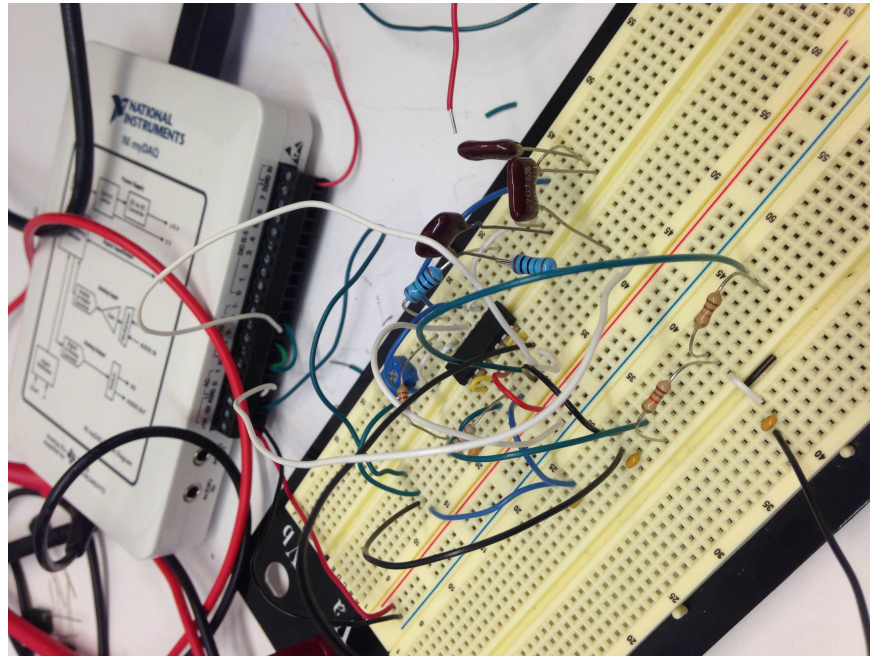


I then ran a montecarlo simulation on the full circuit:



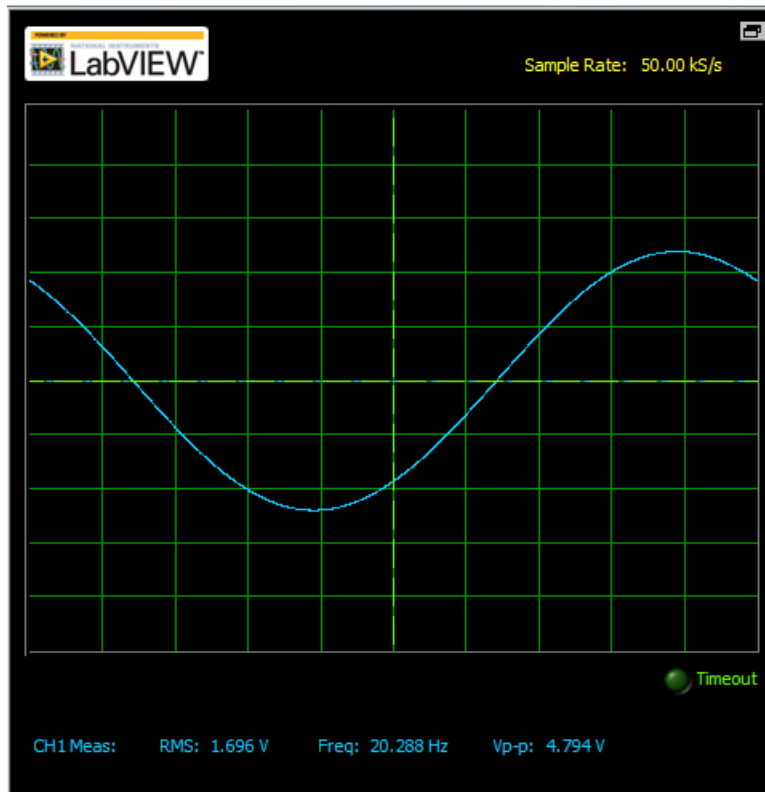
We have the cutoff at 60Hz as well as the dive downward at around 140 Hz from the simulation.

Lab For the lab I tested my circuit on a breadboard as shown below:

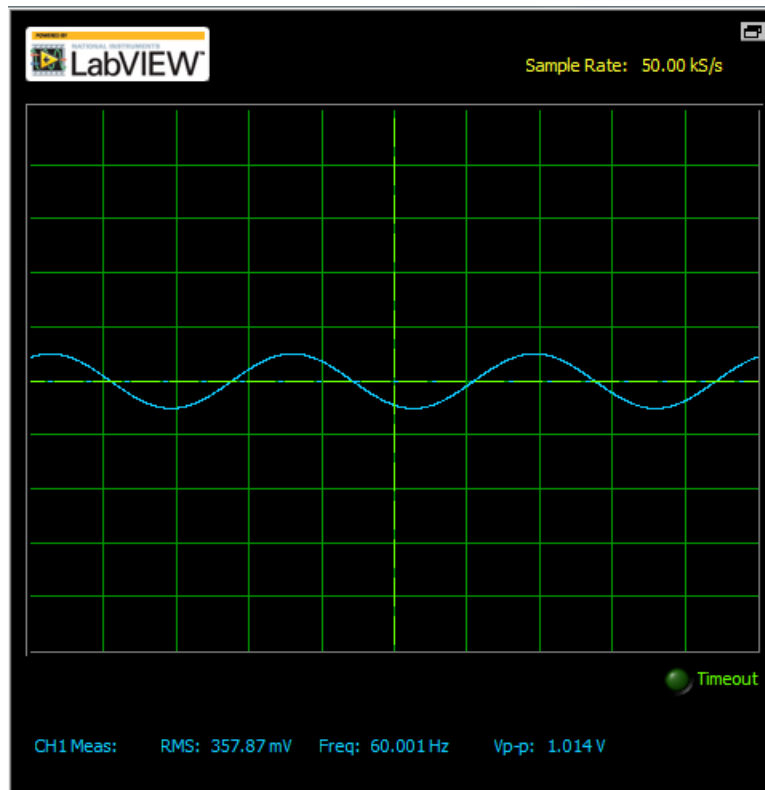


I tested the circuit on a number of frequencies from 20Hz to 200Hz with 20Hz intervals. Here are a few of the outputs:

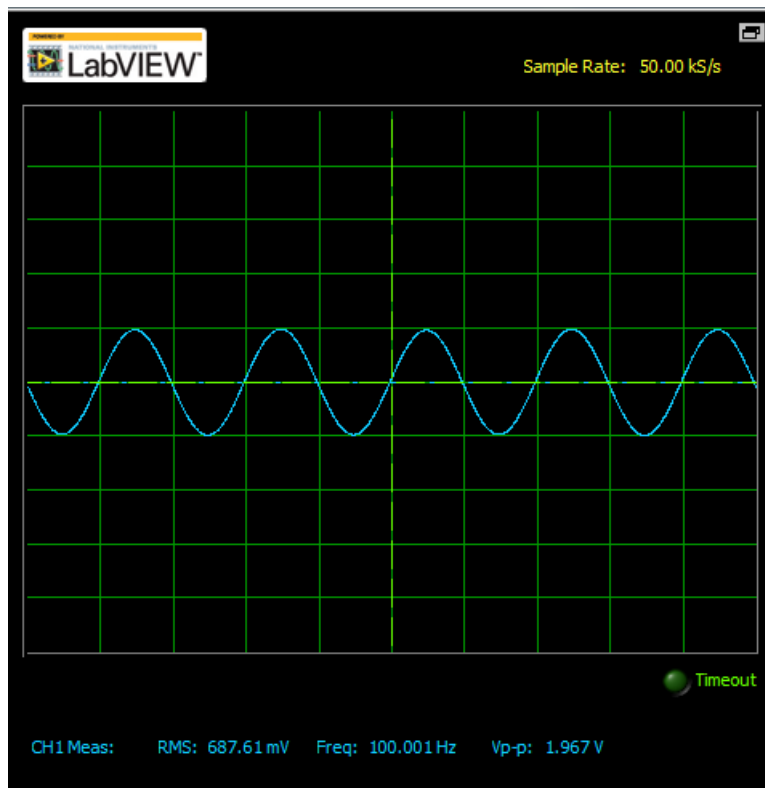
20Hz:



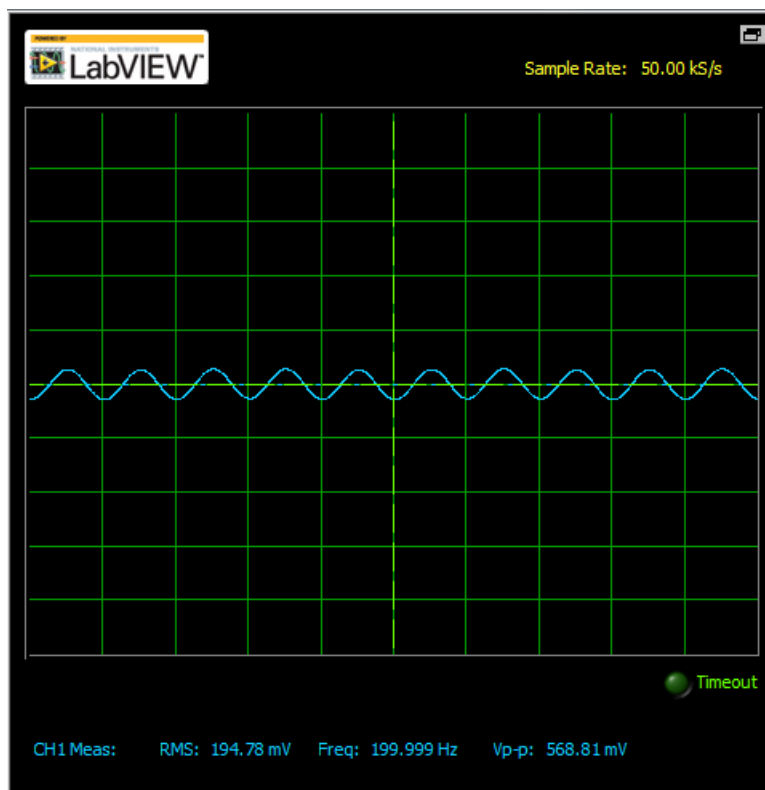
60Hz:



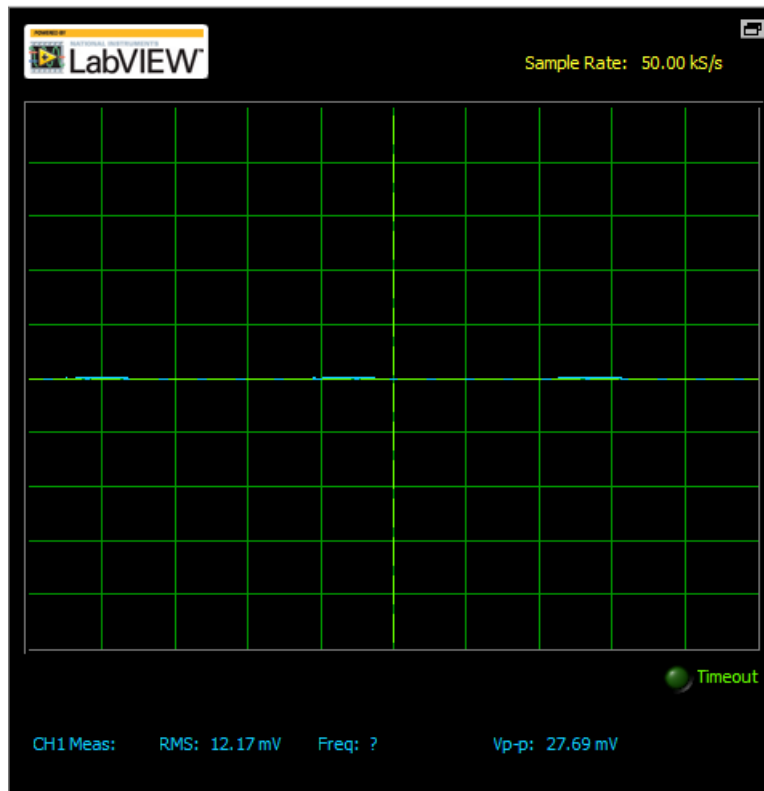
100Hz:



200Hz:



1000Hz:



From the graphs shown It appears that the filters are working the way they are supposed to. Prior to 60Hz we see little attenuation, at 60Hz we see a severe drop in magnitude. After 60Hz we see a rise in magnitude until 140Hz where we see a decline in magnitude. My plots don't show very steep cutoffs for 60Hz and 140Hz and I believe it is because I forgot to tune the potentiometer when testing my circuit, however my plots show that my circuit followed the expected behavior.