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December 15, 2022

Active Filter Design

Objectives:
In this lab we were asked to design an active filter, which will satisfy the assigned frequency domain characteristics and specifications.

Preliminary Calculations: The preliminary calculations required us to refresh our memories on the structure of filter circuits, and review class material about these subjects.

Results and Discussions:

1. **ACTIVE FILTER TI-TINA SIMULATIONS**
    a. For this part of the lab we were given our specifications and we were asked to use the TI-TINA spice simulator to simulate our filter. We were asked to use simple single pole active RC Low Pass Filters or/and High Pass Filters to create your active filter. From our specifications which can be observed within **Figure 1** we determined that we would need the use of high pass filters only. We then used variations of the formulas given within **Equation 1** below to determine our resistance and capacitor values as well as our gain and frequencies. Our first simulation of a 1 pole simulation can be observed within **Figure 2.** From this simulation we realized we needed more poles within our circuit to increase the roll off rate. Our second simulation was close to our given specifications but we realized that the circuit settled above the 41 db for 39kHz. We decided that we needed to add 1 more pole to the circuit which can be observed within **Figure 3** of which contains our final resistor and capacitor values as well**.** This was our last marco polo trial for our given specification, of which the results can be observed within **Figure 4.**

Equation 1: Frequency and Gain

$$A_v = -\frac{R_2}{R_1}$$

$$f_c = \frac{1}{2\pi R_1 C}$$

Figure 1: Group Specifications

6	41 dB gain for frequencies ≥ 39 kHz and >18 dB attenuation for frequencies ≤ 1000 Hz

Figure 2: First test of 1 Pole High pass active filter

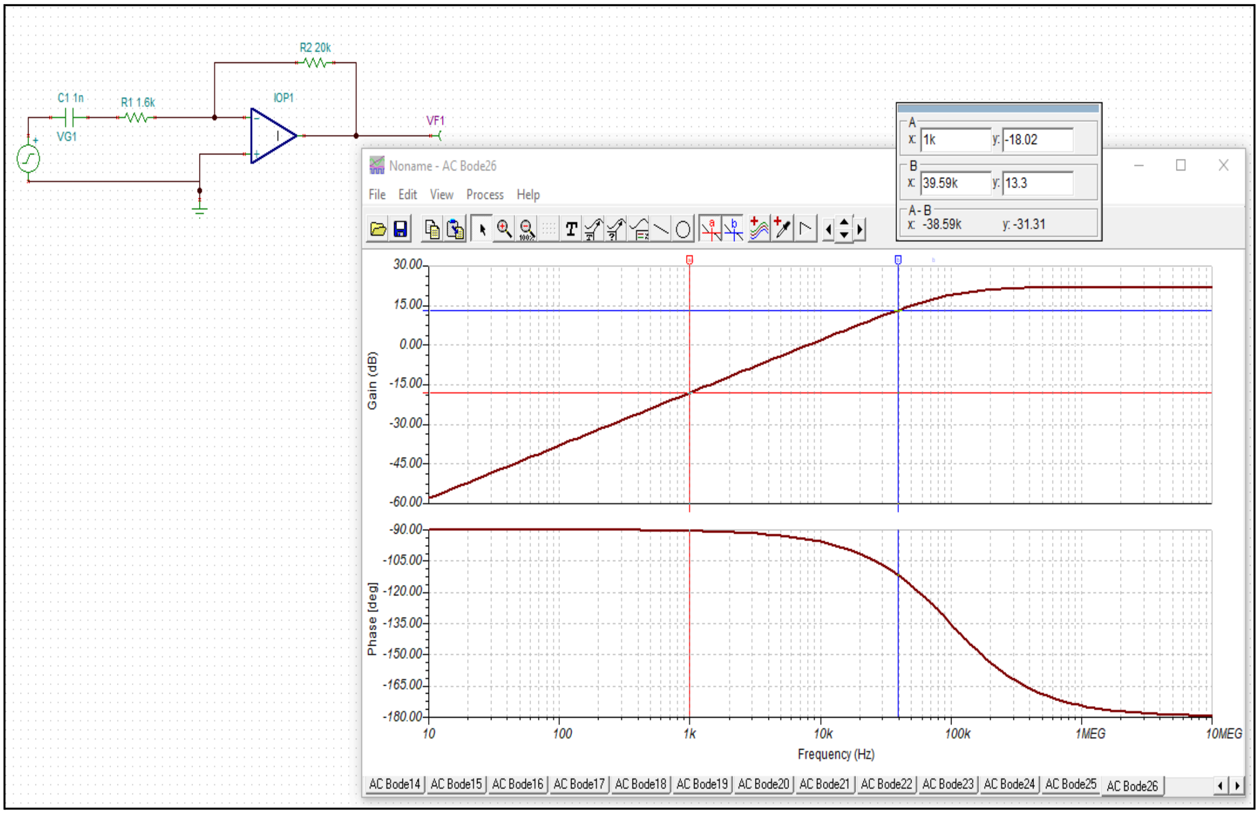

Figure 2: Second simulation

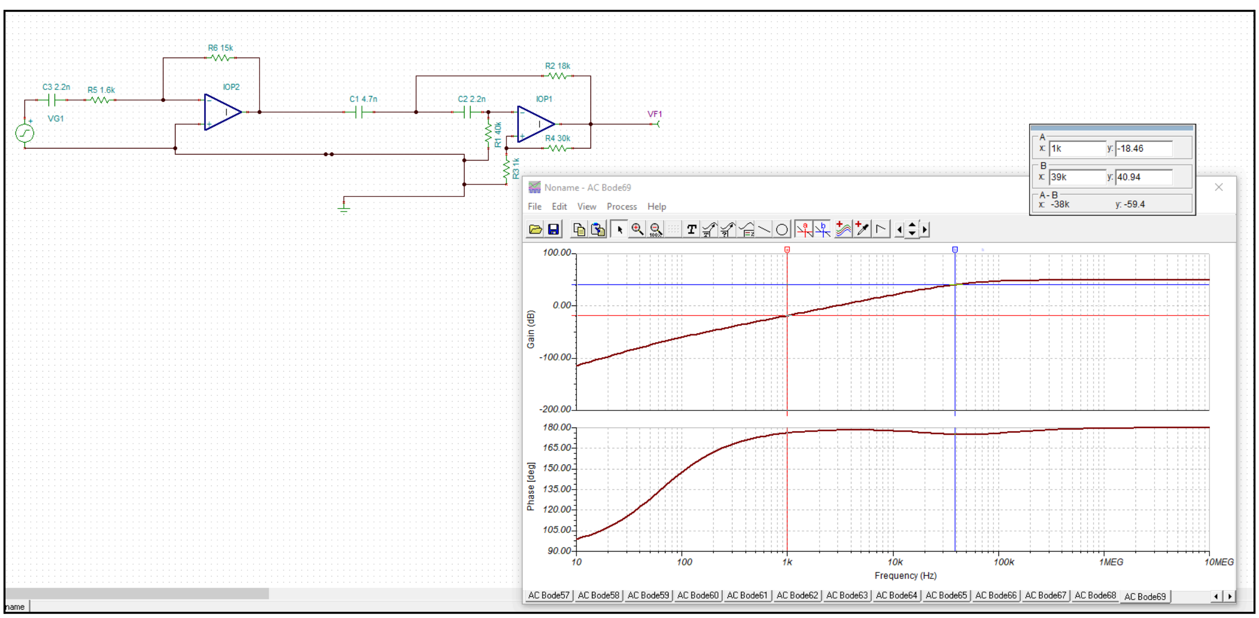

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Figure 3: Final working circuit design with inverter

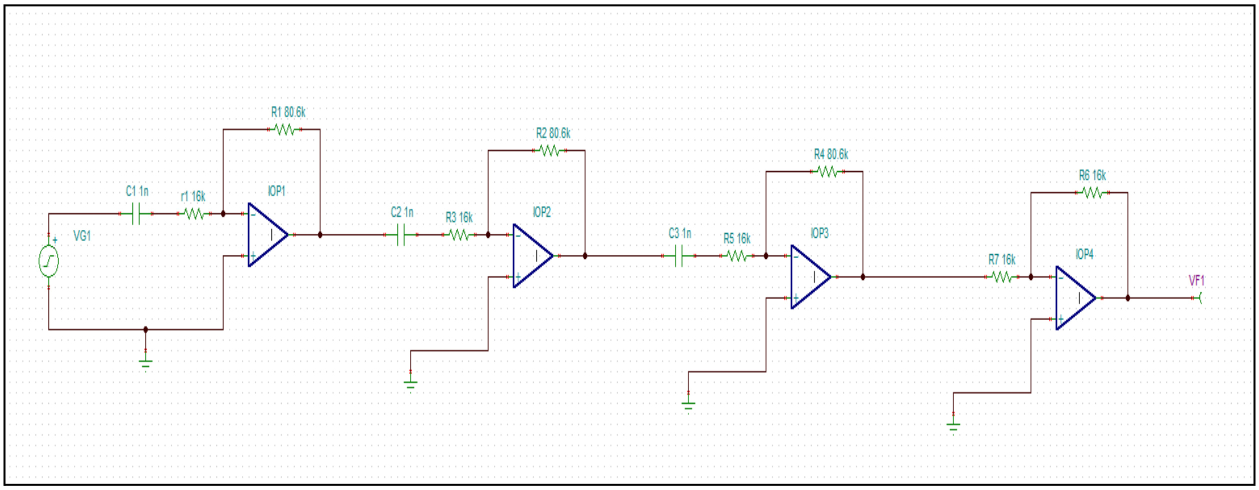
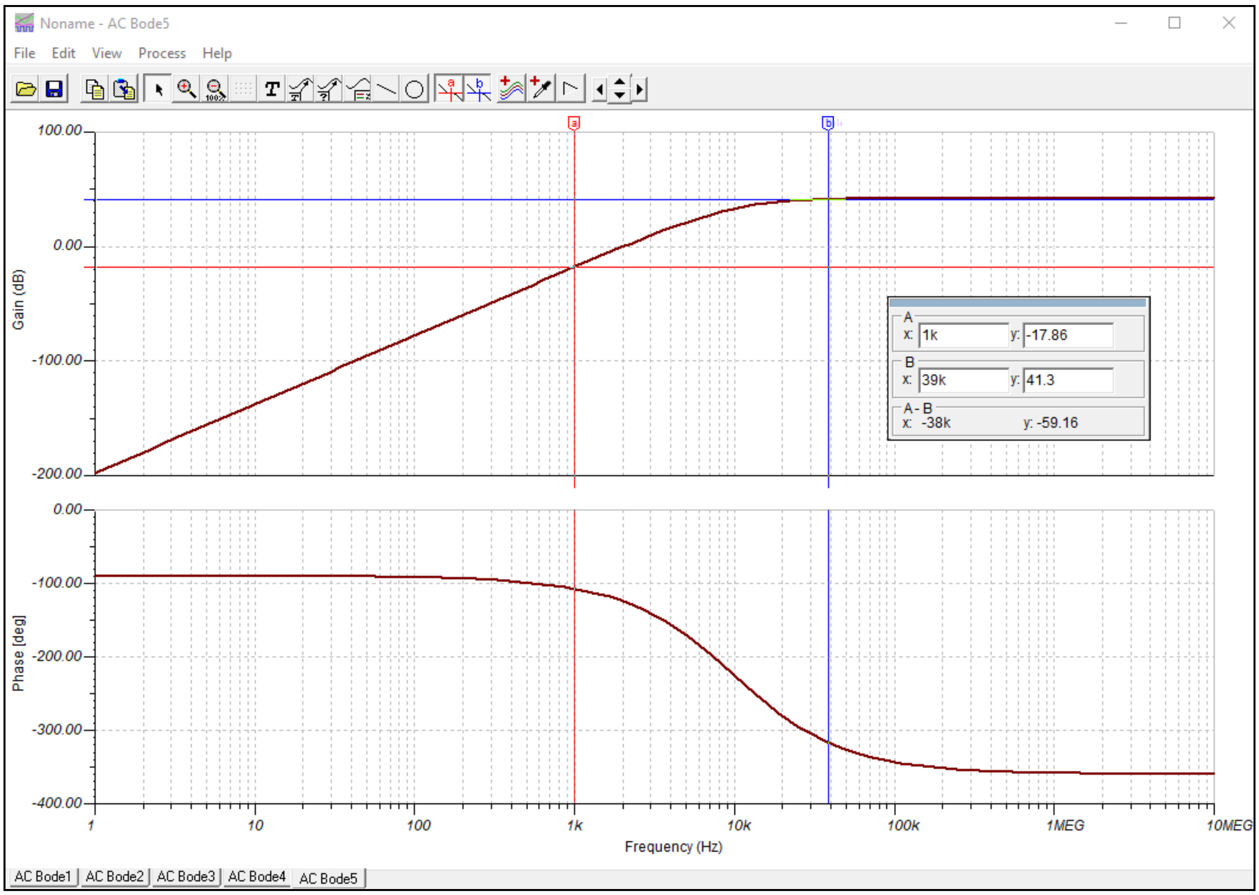


Figure 4: Final tina output from circuit design



2. Hardware Construction

a. The next part of our project required us to build and test real world results. We used the circuit design given within **Figure 3** above to assemble our HPF on a breadboard which also includes a 4th inverter stage. Using a power supply, various resistors and capacitors, an oscilloscope, signal generator and wires we constructed our circuit. The first test, as expected, did not work properly due to incorrect wiring. My final circuit design can be observed within **Figure 5.** Next we tested our channel outputs for our low end frequency of 1Khz on the oscilloscope. We then used **Equation 2** to calculate our gain. My results for this can be observed within **Figure 6.** The results were very close to falling within our specifications with plus or minus 0.5 db, but we had to take an average of the peak to peak value to get the desired results. Finally, we tested the 39 KHz signal and used the same formula to calculate whether or not the output was correct. This result also fell within our specifications and can be observed within **Figure 7.**

Equation 2: Output formula

$$\boxed{db = 20\log_{10}\left(\frac{V_{out}}{V_{in}}\right)}$$

Figure 5: Hardware Circuit design

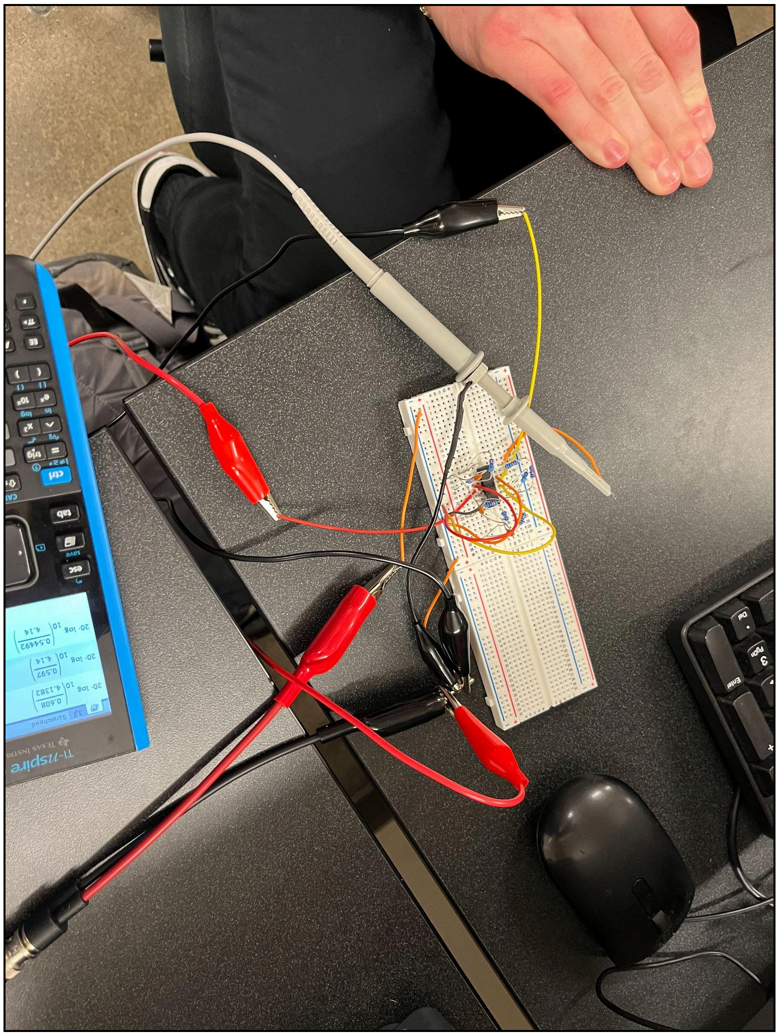


Figure 6: 1 KHz Output

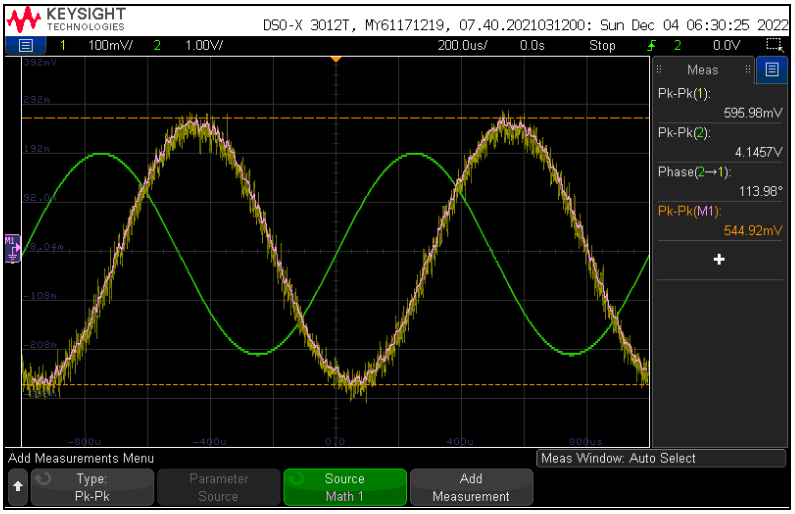
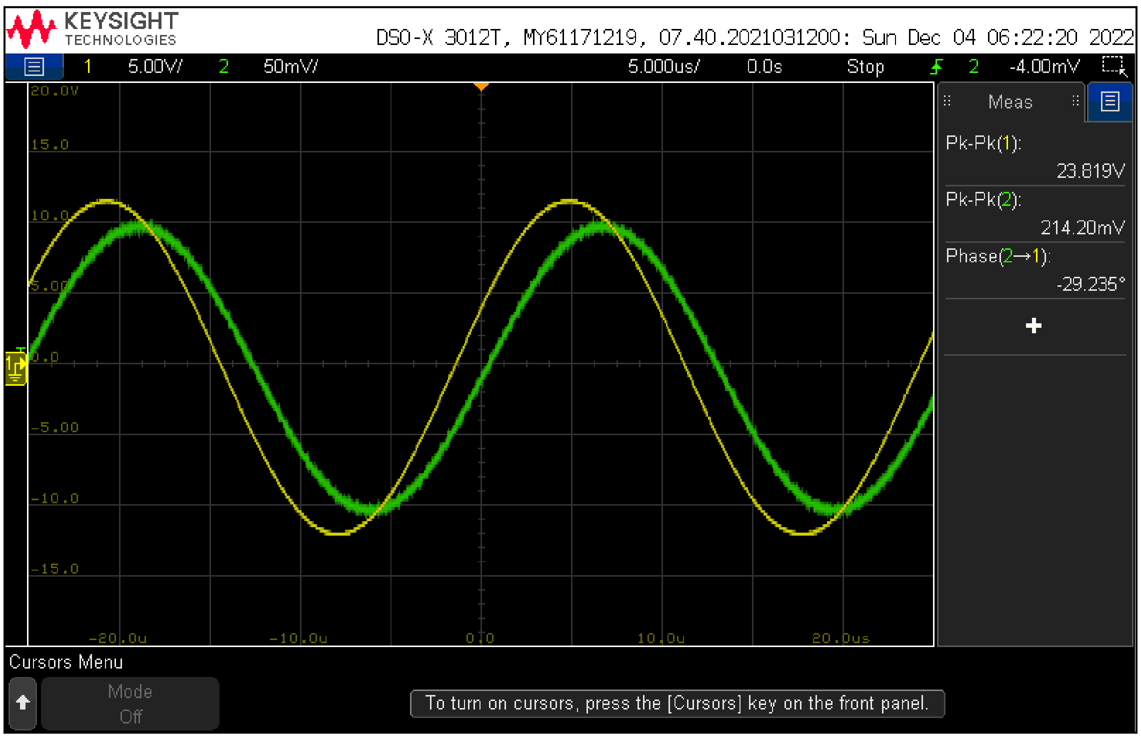


Figure 7: 39 KHz Output



Conclusion: In this class we learned how the introduction of electromagnetism and circuits creates a world full of digital communications and the processes needed for certain communication scenarios.