Lab Report 0: Filters

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ECE 331 L03

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Introduction/Purpose: The purpose of Lab0 was to reintroduce us to filters as well as get us started simulating circuits in Cadence.

Design: The low pass (See 2nd attached page marked Low Pass) was designed based on the cut off frequency of 10k Hz. 1/(2Pi\*10k Hz) = RC. I decided to use a value of capacitor equal to 100 nF, but the closest I could find was 96.63nF. Using the aforementioned formula, I calculated that I needed a resistor value of 162 Ohms.

The High Pass filter used the same equation, but I changed the cut off frequency to 75k Hz. This lead me to a resistor value of 21 Ohms, with the same capacitor.

The Band Pass Filter was just a high pass filter attached to the beginning of a low pass filter. See the page marked Band Pass Filter(4th attached page). I reversed the orientation so that the 10k was high pass, and the 75k was low pass. This made it so the first section of the filter took out all of the high frequencies, and the second part took out all low frequency signals.

Procedure: To complete this lab we needed to calculate the values of Resistors and Capacitors for specified filters. We then needed to combine the high and low pass filters into a single band pass filter. This required us to realize that a low pass filter with a cutoff of 10k Hz and a high pass of 75k Hz would actually be a band stop filter, so we needed to create a 10k Hz high pass and a 75 k Hz low pass filter. Many students struggled with this. I personally figured it out on accident due to switching the positions of the Resistors and capacitors by mistake. This allowed my circuit to work, but confused me greatly when I noticed my mistake. After gathering the data we compared the results of the many circuits to see what we had built. Almost everybody was successful in their circuit building process.

Simulation Results: The week one simulation went very well. I have not used Cadence in a long time, so the lab allowed me to get back into it. We saw that the voltage drop across the resistor increased as the resistance went up. We see that it approaches a maximum, because it cannot have a larger voltage drop than supply. The curve shows that as the value gets much larger than the other resistor, nearly all of the voltage drop is across the “sweep” resistor.

The low pass filter worked very well. It cut the voltage in the same manor that it was supposed to. The first Low pass image attached shows the filter at a low frequency, and that the voltage amplitude is still high. The middle shows a much smaller amplitude, and the final low pass image shows almost no voltage passing the filter at all.

The high pass filter worked well, but not nearly as well as the low pass. I think that this is because I could not find perfect RC values. The low frequency image for the High Pass filter shows that very little voltage makes it through, while the second is close to the cut off frequency, so we see a higher voltage allowed to pass. The last image for the high pass shows the most voltage pass out of any measured.

When I combined them into a band pass, the same problems arose. The band was a little bit wider than it should have been (by about 15 k Hz) but still worked really well with the adjusted band. Very low frequencies allowed little of the voltage through, while the middle frequencies were all relatively high voltages. The very high frequency also let little voltage pass through the filter.

When a square wave was passed through the filters, the oscilloscope actually showed the charging and decharge curves of the capacitor. We used a frequency of 5k Hz, so the low pass filter showed these curves very well, because it had nearly enough time to fully charge/decharge. The band pass however behaved strangely because this was below the bottom cutoff frequency, and so very little voltage was seen. Only very small spikes were seen when the low pass allowed current through, but the high pass capacitor had not fully charged to disallow the current from flowing. The high pass filter had the strangest curve. You can see the capacitor charge very quickly, and immediately after stop the flow of current. This is because 5k Hz is well below the cut off frequency of this filter. The peak voltage was very low, and almost nonexistent.

Conclusion: Lab 0 was a very good lab. It got students back into the swing of things. It forced me to think about the circuit design process rather than solving a pre build circuit. This is something that I have rarely done up until this point. It was interesting to me that I was able to do so well at designing them, even if they were really simple circuits. It showed me a different way of thinking about circuits. When I made a mistake building the band pass filter it was beneficial, but progressed me to a point I should not have been at. It showed me that I have to think about the circuits very carefully before building them from now on. I had intended to build a band stop filter thinking it was a band pass. I mistakenly however built the correct one. Either of those mistakes alone could have been catastrophic if it were in an important circuit.