EEE 117 Laboratory

Instructor: Mike Saghaimaroof

Lab 5: Band Pass Filter Analysis & Simulation

Lab Report by Luis Rivera

Lab Session: Monday (6 PM - 9 PM)

Due Date of Lab: 4/11/2016

Date(s) of the lab: 4/4/2016

Lab Partners: Huy Nguyen, Joel Pankito

Introduction:

In this lab, we were to become familiar with a band pass filter which was the second week of this lab where we were using our prior knowledge of an OP amp and low pass filter, except now we were using an Active circuit which was stated to be a band pass filter wjere we were to find the response while also looking at the bode plot to see the ranging magnitude and phase angle on a changing frequency

Purpose:

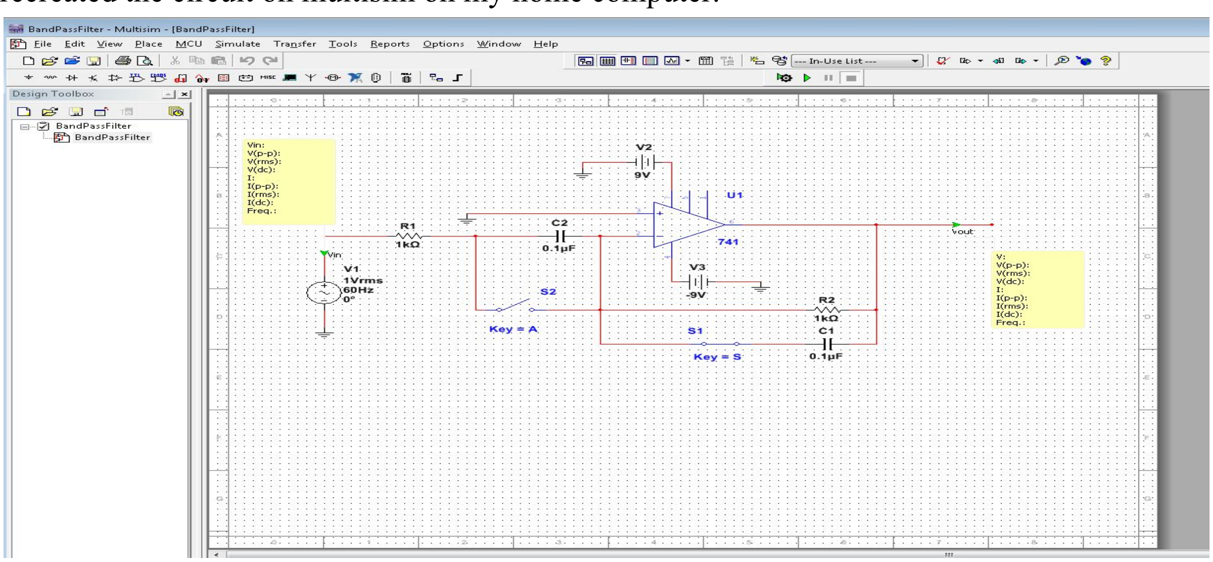
For this lab we needed to become somewhat experts with the OP amps and RC circuits. We needed to be able to create a circuit on either multisim or PSPICE and then provide a simulation in which we could analyze the given results and provide an explanation as to why and how the results are correct. We would need to become efficient at reading body plots and explain how and why the magnitude and phase angle values are why they are.

Discussions and Results:

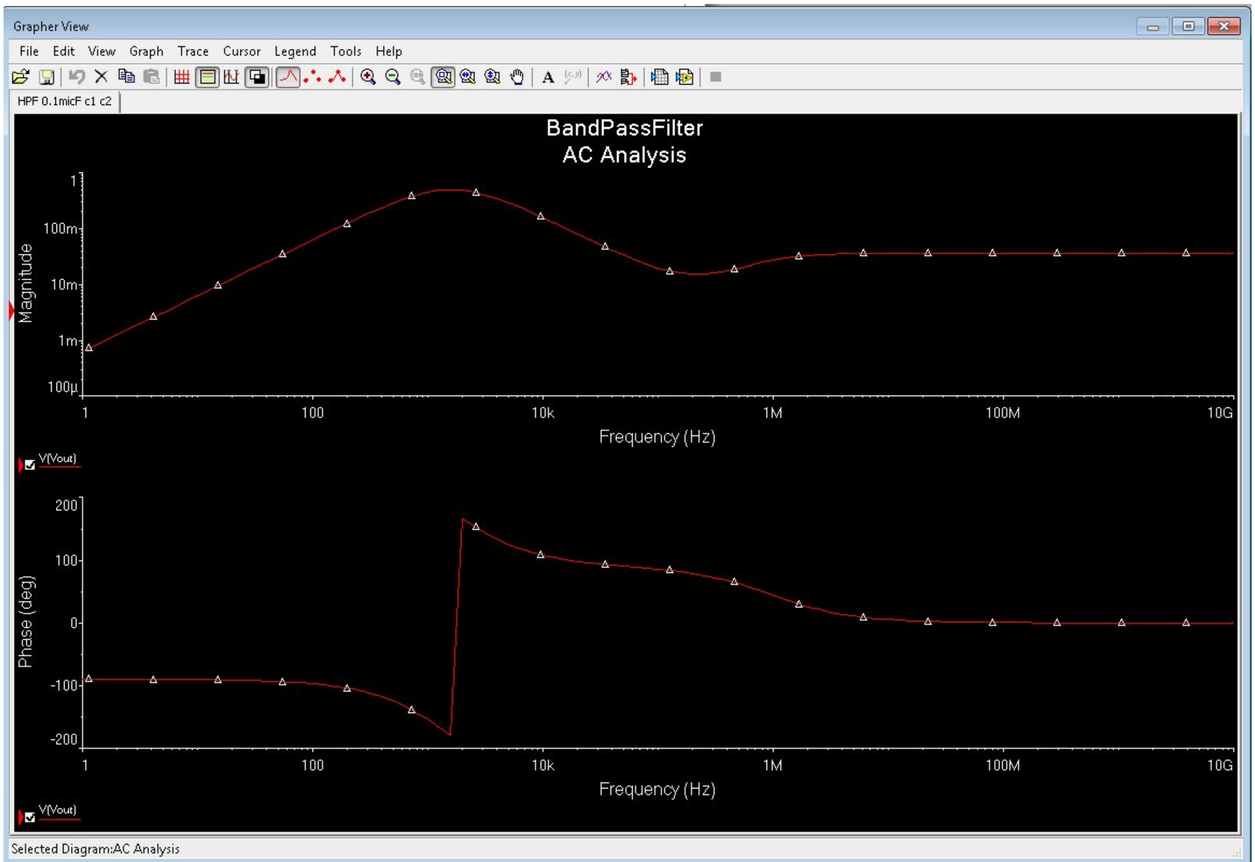
We needed to use the circuit provided to us in the document, this was a relatively easy circuit to simulate using multisim we have a 1k resistor that branches out into the OP amp, another 1k resistor and a 0.1 microF capacitor.

Resistor Value	Capacitor Values
1000Ω	0.1 µF

Unfortunately, I was absent for this lab session due to an exam for this class the following morning, but I did get filled in by my lab partners and other classmates on what we did. I recreated the circuit on multisim on my home computer.



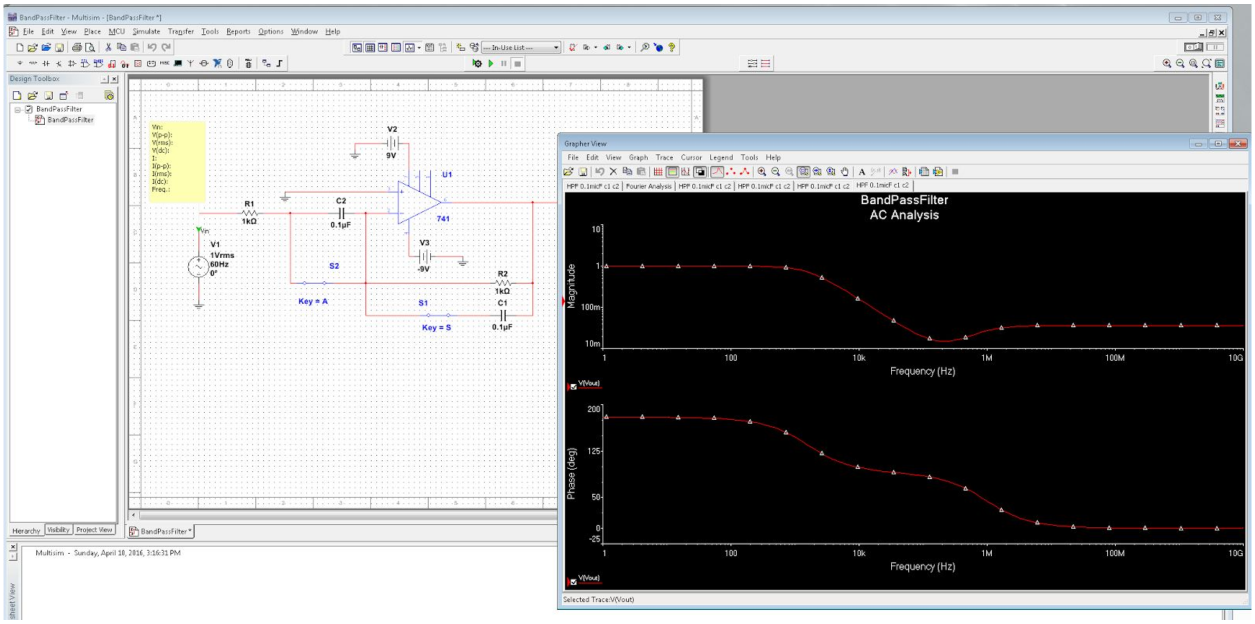
Here we had many different variables to take into account for the AC analysis of this band pass filter. We had a Voltage (Peak to Peak), a RMS Voltage, and a DC Voltage while also finding the current (Peak to Peak), RMS current, and DC voltage at different frequencies. This was not difficult to do as we were just running simulations.



Here is the AC analysis of the Band Pass filter where the switch was closed, as the frequency grows from 1 to about 700hz where the magnitude increases linearly and at ~700hz, we see the circuit reach its max magnitude at about 1V and then at about 7k Hz it has a shift where it begins to decrease up until about 500k Hz then evens out at about 10mV.

This fits in with the potential transfer function of the circuit and through the bode plot we can also see the sudden change in phase shift where it starts at about -90 degrees and at the same frequency of 700hz we can see the dip in phase angle where it goes all the way down to -180 degrees. Then immediately it increases to about + 150 degrees where we can see the sudden capacitance change in the phase angle shift which then slowly starts to decay down to zero after "a long time" or 5 time constants.

Once we change the circuit by closing the switch on the capacitor near V_{out} we can see a totally different bode plot of magnitude and phase angle.



With the switch closed, we can observe a totally different type of AC analysis which gives us almost the opposite of the previous AC analysis in which our magnitude is about 1V up until about 700 Hz where we observe a negative slope in which the voltage begins to decrease rather dramatically up until about 10mV then at about 700k Hz we see the increase to about 30mV where the voltage then stays constant.

In terms of the Phase angle, it starts at +180 degrees and stays constant up until the same 700Hz where we see the decrease of phase angle down till about 75 degrees. Once we reach 700k Hz we see the further decrease in phase angle down to zero degrees after 5 time constants.

Analysis:

In order to find these values, we used excel but in order to make sure they were correct we needed to do some math instead of just blindly following values. The frequency was given to us based on the function generator we used with the circuit which ranged from 100 hz all the way up to 1,000,000 hz and the multimeter was constantly feeding in 1 V Peak to Peak while we used the multimeter to see what our output voltage through the capacitor while the frequencies changed.

To find ω (rad), we multiplied our frequency by 2π

Our Magnitude was just our V_{out} divided by V_{in} -> (V_{out} / V_{in}) which always resulted in the value being the output voltage as we always divided by 1. We used our digital multimeter to read the output but also hand calculated to make sure we were getting reasonable numbers by multiplying

$$V_{out} = V_{in}\left(\frac{Zc}{RL+Zc}\right)$$

To find our Zc value we needed our capacitor value which we found earlier through measurements which resulted in our capacitor being 0.1 x 10^{-6} F which we can use the equation for equivalent capacitance

$$Z_c = \frac{-1}{j\omega C}$$

Doing this with the first value of 1hz, we get 0.964 mV which is extremely close to the measured output of 0.9634 mV

To find our ωRC we needed to use the provided Resistor and Capacitor values which we 1kΩ and 0.1μF and our ω was constantly changing due to changing frequency but for 1 Hz, we would multiply those values together then take the negative arctan to get our phase angle in radians. Once we had that value we could then convert to our phase angle in degrees by multiplying by

$$180/\pi$$

$$(-4.99235)^* \,(180/\pi)$$

$$= -89.897°$$

Summary

For this lab, as i was unable to attend, I did not get the full experience as my lab partners did with the hands on aspect of the lab, but from my understanding of doing this on my own free time, I did get a way better understanding of how a band pass filter will react due to variables like the capacitor values. We saw from the simulation graph results that the body plots were fairly accurate in which we were able to analyze much more in this lab than in previous ones without so many calculations.