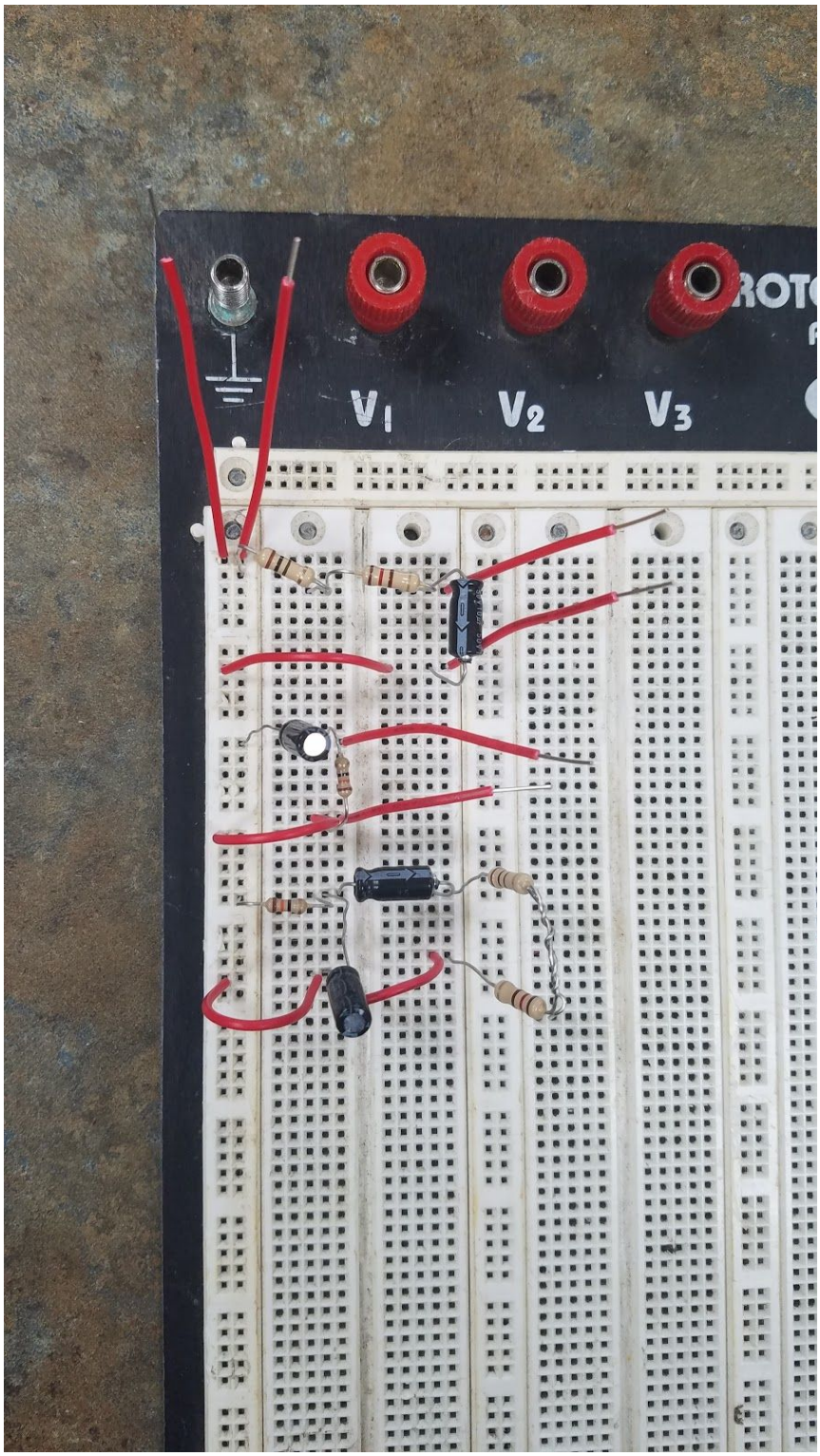
High Pass, Low Pass, Band Pass Filters



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Objective:

The objective of this lab is to construct a high pass, low pass, and band pass filters using standard capacitors and resistors in multisim and physically. Another objective is the learn how to calculate the value of resistors when given capacitor values and the frequency cutoff.

Procedure:

To start this lab, I chose two capacitor values from the list of standard capacitors that my team partners were not using. I finally decided on a 4.7μF capacitor for the high pass filter, and a 10μF for the low pass filter. Next, I had to calculate the resistor value required for the low pass filter, and this calculation is shown in **Computation 1**. The schematic for the completed low pass filter is shown in **Schematic 1**.

Next, I had to calculate to resistor value required for the high pass filter, and this calculation is shown in **Computation 2**. The schematic for the completed low pass filter is shown in **Schematic 2**.

The final step of this lab is to create a bandpass filter. To do this, one must combine a low pass and a high pass filter to yield something that only passes the frequencies between the high and the low cutoffs. For this to work, the low pass filter must use a new cutoff frequency of 2500 Hz, and the high pass filter must use a cutoff frequency of 120 Hz, which is the reverse of what was calculated previously. Since these values were already computed, and the frequency cutoff formula is universal as long as a capacitor and resistor are used, one can simply swap the values of the low pass circuit with the values of the high pass circuit and vice versa for the high pass portion. The final circuit is shown in **Schematic 3**.

The next step was to construct these three circuits on one breadboard. I connected the positive and negative leads of the function generator to the positive and negative input of the circuits, and connected the probe of the oscilloscope to the output of each filter. The measurements are shown in **Table 1**. The ratios were all supposed to be about 70.7 percent, and are mostly pretty close. **Table 2** shows the multisim values that were measured.

Computation 1:

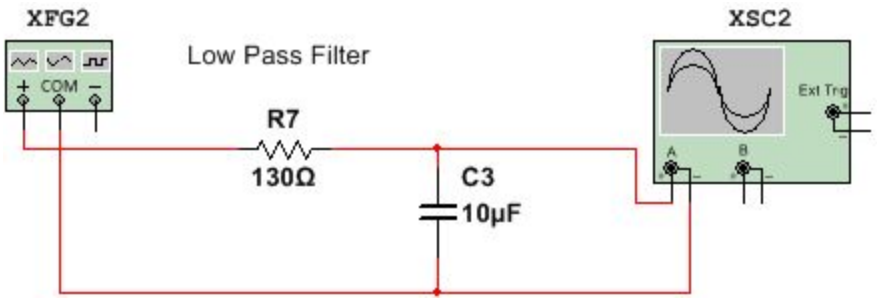
120 Hz = 1/((2)(π)(R)(C))
120 Hz = 1/((2)(π)(10*10^-6F)(R))
1/120 Hz = (2)(π)(10*10^-6F)(R)
R = 132.654Ω
Standard Resistor Value = 130Ω

Computation 2:
2500 Hz = 1/((2)(π)(R)(C))
2500 Hz = 1/((2)(π)(4.7*10^-6F)(R))
1/2500 Hz = (2)(π)(4.7*10^-6F)(R)
R = 13.547Ω
Standard Resistor Value = 13Ω

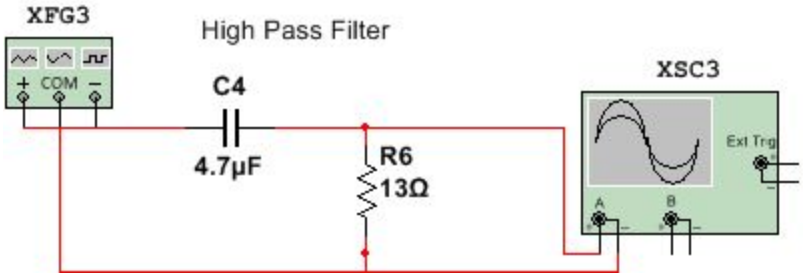
Table 1: Physical Measurements of High Pass, Low Pass, and Band Pass			
Low Pass Filter	**High Pass Filter**	**Bandpass Filter**	
Max Voltage: 5 V Peak	**Max Voltage:** .6V Peak	**Max Voltage:** 2.1V	
120 Hz Voltage: 3.5 V Peak	**2500 Hz Voltage:** .5V Peak	**120 Hz Voltage:** 1.8V	**2500 Hz Voltage:** 1.2V
Ratio: 70%	**Ratio:** 83%	**Ratio:** 86%	57%

Table 2: Multisim Measurements of High Pass, Low Pass, and Band Pass			
Low Pass Filter	**High Pass Filter**	**Bandpass Filter**	
Max Voltage: 9.985 V Peak	**Max Voltage:** 9.8V Peak	**Max Voltage:** 8.465V	
120 Hz Voltage: 7.129 V Peak	**2500 Hz Voltage:** 6.874V Peak	**120 Hz Voltage:** 6.414V	**2500 Hz Voltage:** 6.748V
Ratio: 71.4%	**Ratio:** 70.1%	**Ratio:** 75.8%	79.7%

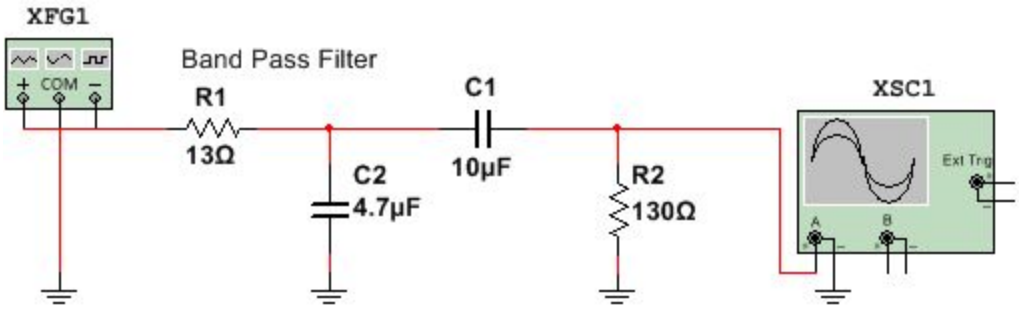
Schematic 1:



Schematic 2:



Schematic 3:



Discussion:

This lab was time consuming because it took me a while to concepualize the band pass filter and to find the right values for it in multisim. I also had to recalculate my values due to partners using the same capacitor as me, or because of a lack of certain chosen capacitors.

Conclusion:

A low pass filter uses a capacitor as the shunt because at high frequencies, the capacitor acts as a wire and shorts the circuit. A high pass filter uses a resistor as the shunt because at low frequencies, the capacitor in series acts as an open and does not allow current to pass. The cutoff frequency should yield a voltage of 70.7% of the maximum voltage when measured. A bandpass circuit uses both a low pass filter and a high pass filter. To gain only the middle section of the sine wave, the high pass filter and low pass filter must exchange their values. The low pass filter must come before the high pass filter in the bandpass circuit to function properly.