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EE 221L

Final Project

Fall 2013

Lab Handout

Goal:

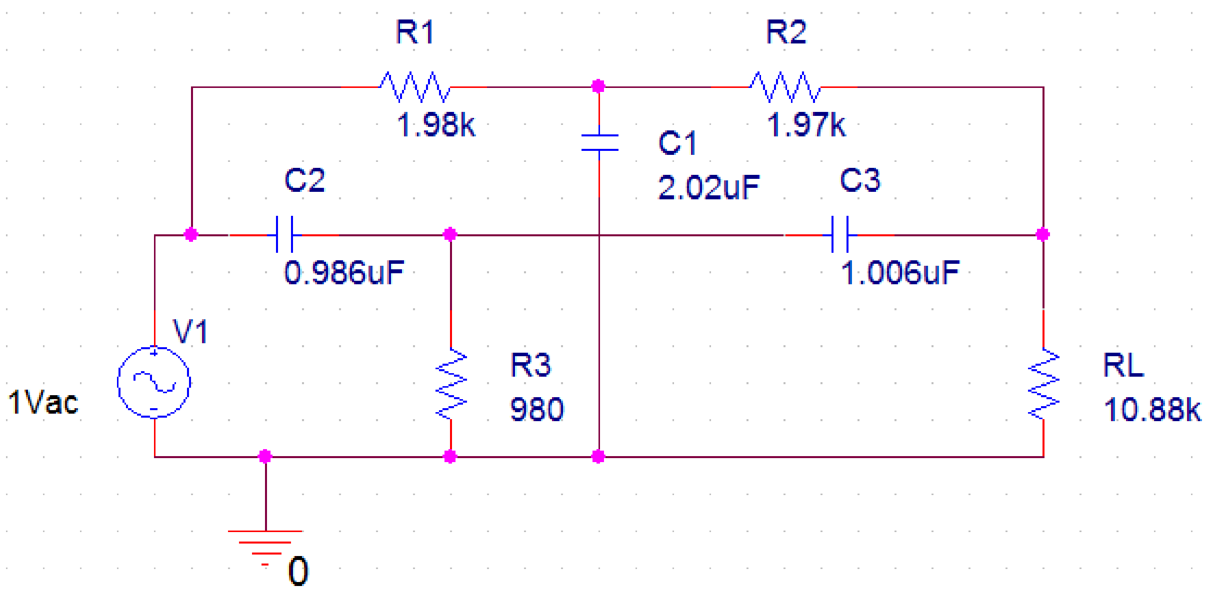
The goal of this experiment was to design a Band Stop Filter and demonstrate its capabilities.

Background Theory:

A Band Stop Filter, also known as a Band Reject Filter, is a type of Passive Filter that is used to reject a specified frequency range. For example, if there is some noise in your signal, and you find it to be at 80Hz, you can use a Band Stop Filter to eliminate that noise, while still letting the rest of your signal through. Basically the opposite of a Band Pass Filter, the Band Stop is designed by connecting a Low-Pass and High-Pass Filter in parallel with each other.

Experimental Procedure:

For the experiment, we wanted to eliminate an 80Hz noise from our circuit. We designed a "Twin-T" Band Stop Filter, which is one way to connect the High and Low Pass Filters, and is made from 3 Capacitors and 3 Resistors. Below is the schematic for our experiment (We measured the Voltage from the R_L):



The “Twin-T” design simplifies the Band Stop Filter and works when the following ratios are satisfied:

$R_1 = R_2 = 2*R_3$

$C_2 = C_3 = ½*C_1$

To achieve an 80Hz rejection, we used the following theoretical values for our Resistors and Capacitors.

R_1 = 2k = R_2 = 2k = 2*(1k) = 2*R_3

C_2 = 1uF = C_3 = 1uF = ½ (2uF) = ½ C_1

The actual values that we used for the Resistors and Capacitors are shown in the Schematic.

Data:

Frequency (Hz)	**V_{out} (mV)**
30	310
35	266
40	218
45	189
50	156
55	126
60	**97.7**
65	**71.8**
70	**47.7**
75	**25.2**
80	**4.66**
85	**16.2**
90	**34.9**
95	**52.8**
100	**68.9**
105	**86.1**
110	102
115	117
120	131
125	145
130	158
135	171

140	183
145	195
150	207

We used different frequencies and then measured the output voltage. From the table above, the **BOLD** data is the range in which the Filter is actually stopping. The ** around some of the data indicate that it is the exact frequency which is getting eliminated.

To further demonstrate that 80Hz is the targeted frequency that is rejected, we did some more precise measurements, as seen below:

Frequency (Hz)	**V_{out} (mV)**
80.5	3.12
80.6	2.90
80.7	2.70
80.8	2.54
80.9	2.44
81.0	2.42
81.1	2.47
81.2	2.58
81.3	2.72

As you can see, a frequency of 81.0 Hz is the lowest value, because at 81.1 Hz the V_{out} begins to rise again.

The lowest value can be calculated from the following formula:

$f_{notch} = 1 / 4 * \pi * R_3 * C_3$

Analysis:

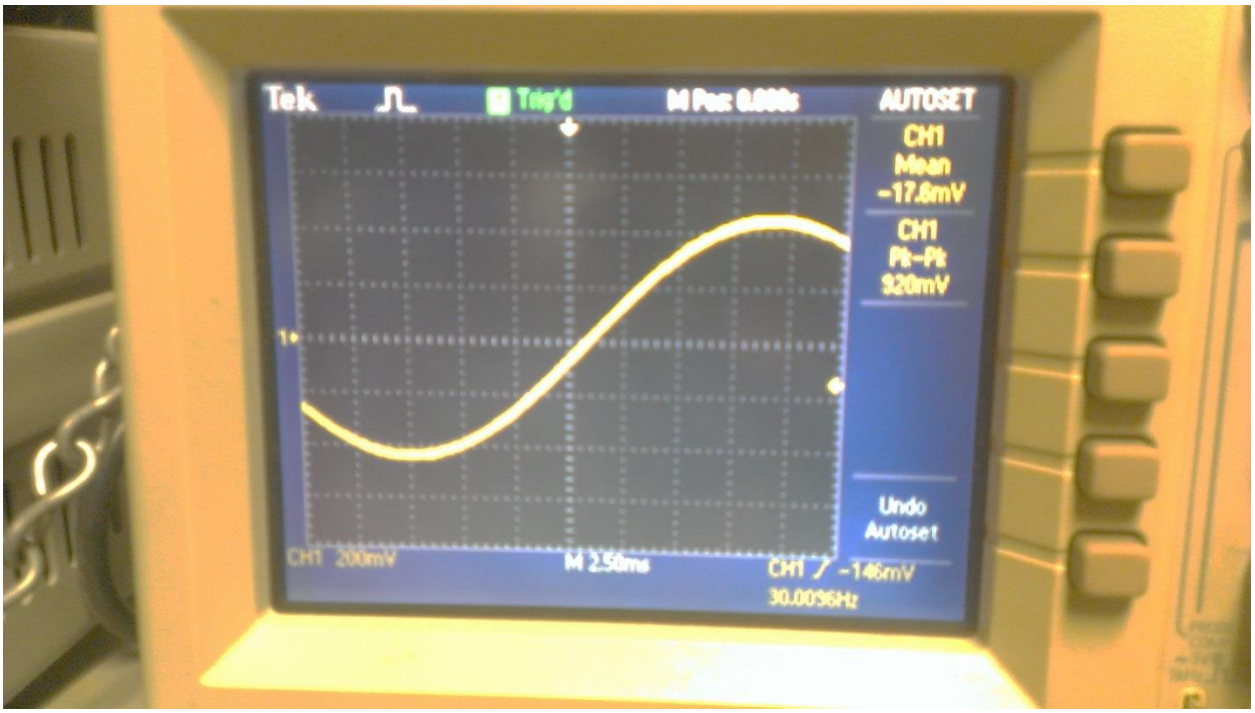
The following table shows the results of the analysis of our data.

Desired F (Hz)	Theoretical F (Hz)	Experimental F (Hz)	% Error
80	80.717	81.0	0.351

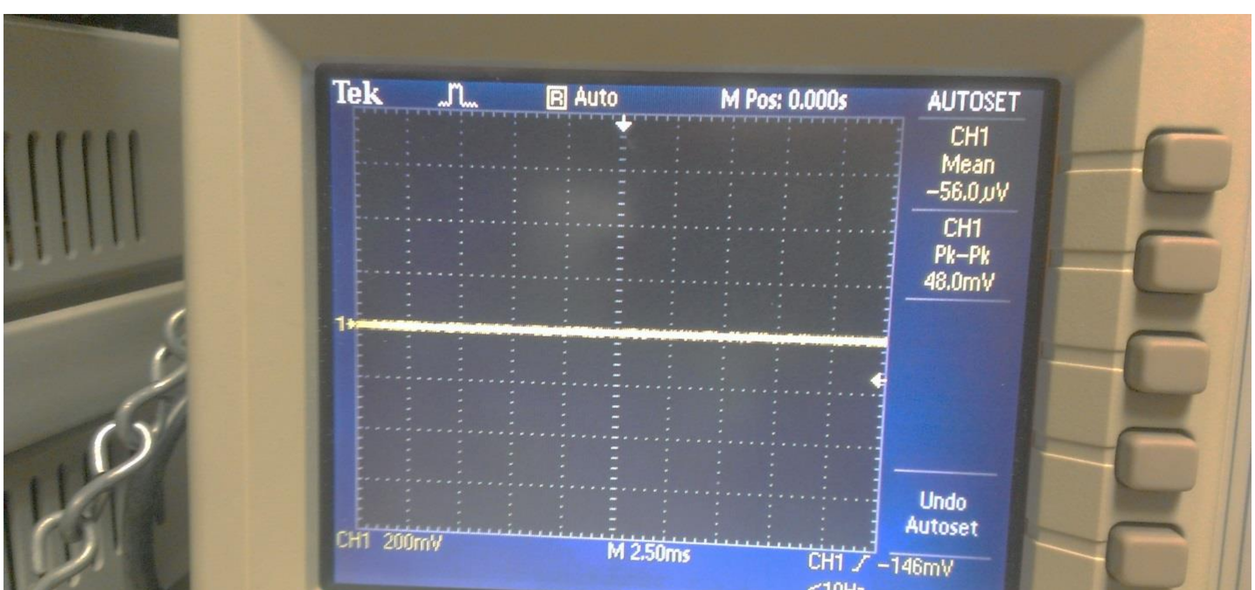
Due to the fact that we did not have perfect components, we were not able to exactly reject a frequency of 80Hz.

Below are images of our final results measuring the V_{out} at certain frequencies.

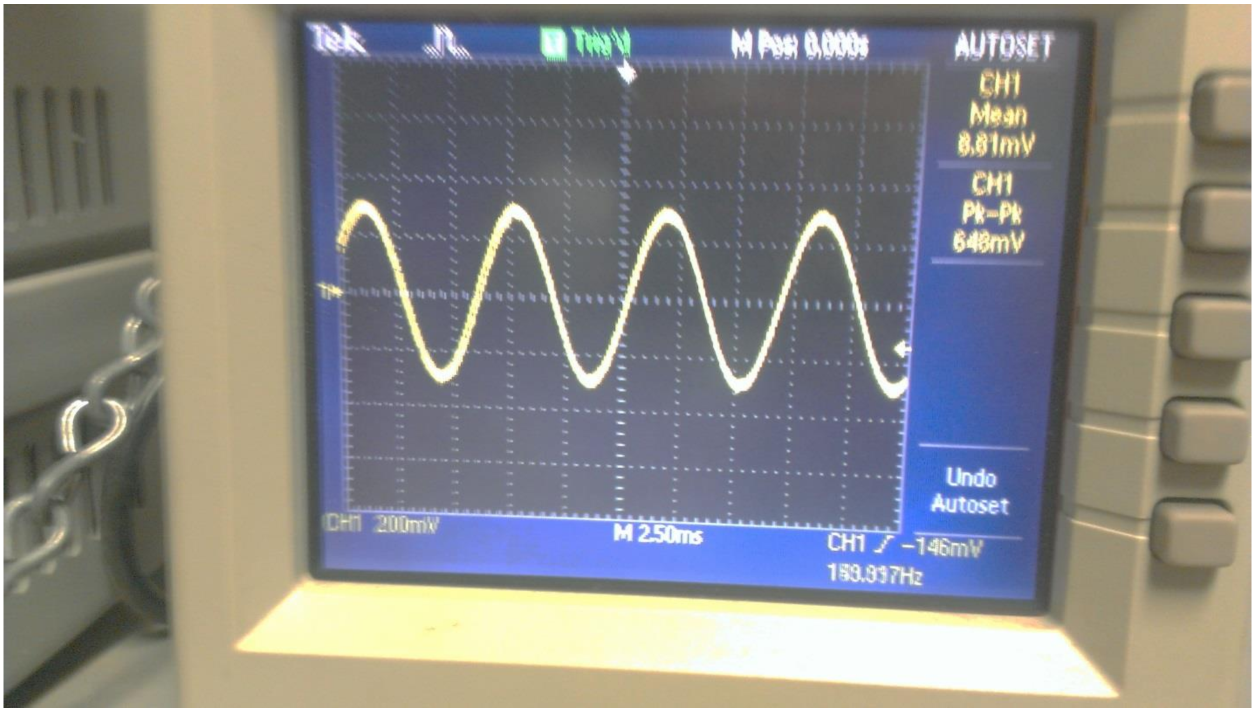
30 Hz



80 Hz



150 Hz



As you can see from the images, signals above and below 80Hz get through, but a signal of 80Hz will not get through the filter.

Conclusion:

In this lab we were able to test out a Band Stop Filter using the “Twin-T” design. We chose to eliminate a frequency of 80Hz and were able to successfully reject the frequency from getting through. You can see in our calculations and images that the experiment was a success. We had some error due to not having precise values for our Capacitors and Resistors. Even still, we had some error simply due to line noise in the copper wires. Overall the experiment was a success, and we learned the full process of designing and implementing a successful idea.