Lab 8:

Sinusoidal Steady State Response of a 2nd Order Circuit

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ECEN 214 – 302

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Performed: 28 July, 2016

Due: 4 August, 2016

I. PROCEDURE

TASK 1 – Sinusoidal Steady-State Response of a 2nd Order Low-Pass Circuit

First, we constructed the Sallen-Key circuit with the components that we determined from section A of the pre-lab. Using a function generator to construct a sine wave with 4 V_{pp}, we displayed the graph of the op-amp output and signal generator from the oscilloscope and logged the amplitude of the input, amplitude of the output and phase difference between input and output voltages. We then repeated this procedure for 10Hz, 18Hz, 32Hz, 56Hz, 100Hz, 178Hz, 316Hz, 562Hz, 1000Hz, 1778Hz, 3162Hz, 5623Hz, and 10kHz. We proceeded to adjust the amplitude until it was close to the cut off frequency of $\frac{1}{\sqrt{2}}$ and recorded its value.

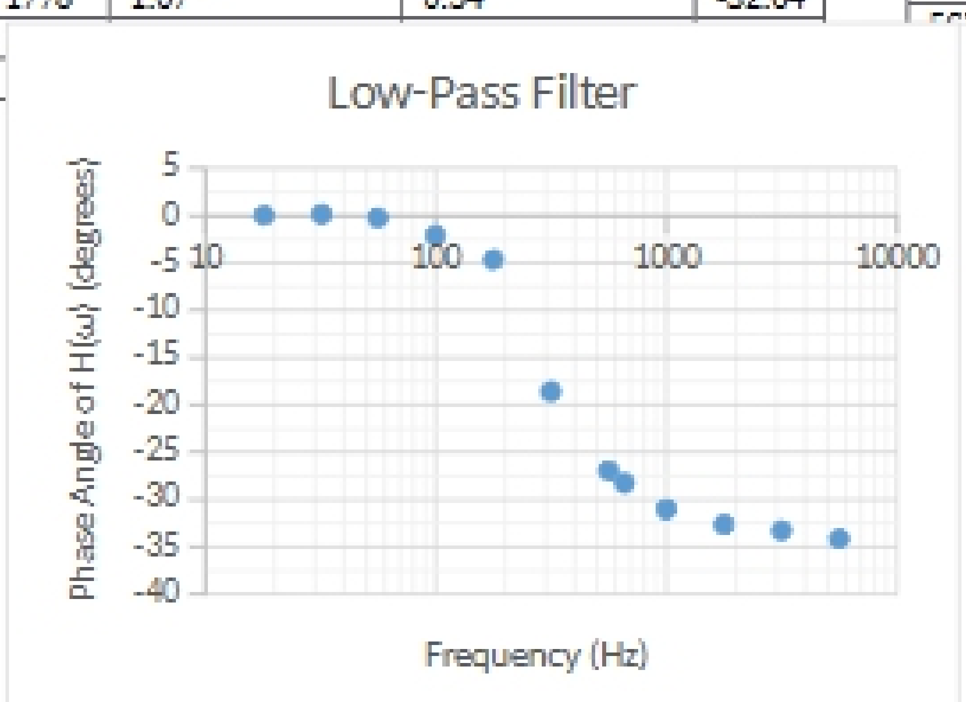
TASK 2 – Sinusoidal Steady-State Response of a 2nd Order High-Pass Circuit

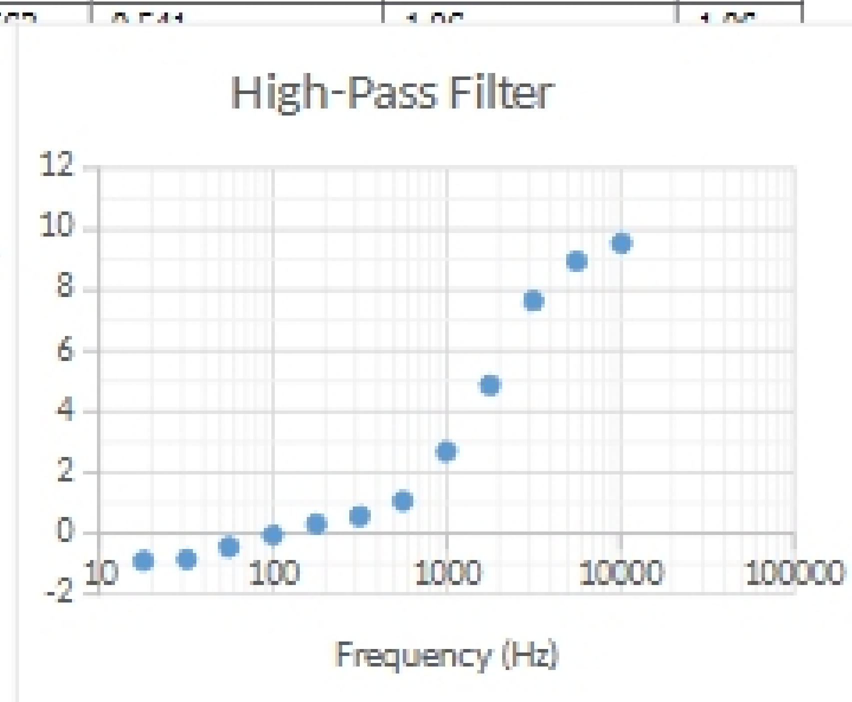
In this portion of the lab, we repeated task 1 with the modified Sallen-Key circuit described in our prelab.

II. DATA/RESULTS

Low-Pass Filter			
f (Hz)	**V2(peak to Peak)**	**V1(peak to Peak)**	**Phase**
18	8.1	8.3	0.02
32	8.4	8.6	0.17
56	8.4	8.4	-0.22
100	8.4	8.4	-2.12
178	2.17	2.01	-4.63
316	2.13	1.97	-18.56
562	1.07	0.78	-26.93
1000	1.07	0.62	-31.03
1778	1.07	0.54	-32.64

High-Pass Filter			
f (Hz)	**V1(peak to Peak)**	**V2(peak to Peak)**	**Phase**
18	0.174	1.07	-0.91
32	0.181	1.07	-0.86
56	0.205	1.07	-0.45
100	0.242	1.05	-0.06
178	0.283	1.07	0.31
316	0.396	1.07	0.56





III. POST-LAB QUESTIONS

• Comment on the pass and stop bands of each circuit. That is, what frequencies pass through the circuit relatively unaltered and which frequencies are highly attenuated.

In the low-pass filter, the graphs suggest that the pass band would be around 110 Hz or less and the stop band would be somewhere near 700 Hz and greater. In the high pass filter, the data suggests that the pass band would lie around 10 kHz and greater and the stop band would span 100 Hz and less.

• Given what you have learned about this circuit, what component values could you change (and how) to adjust the ranges of the pass bands and stop bands?

In order to adjust the range of the stop and pass bands, you must be able to adjust the input voltage which relies on R1, R2, C1, and C2. As you increase those components, the Transfer Function (H(ω)) will decrease calling for greater range for the bands.

• You should have observed that there are some frequencies where the output is stronger than the input. Discuss how that is even possible from a conservation of energy standpoint. Also, can you relate this behavior to the transient (natural) response of the circuit that you observed in the previous lab.

This may occur when the frequency is extremely low in a low-pass filter or extremely high in a high-pass filter. In this case the op-amp may produce a small spike in voltage that makes the output greater than the input due to the small capacitance that the transistors have within the component. Once the output voltage is greater than the input voltage, the wave will act like an underdamped response and oscillate with a decaying envelope.

• Be sure to point out any changes you could make to the procedure to make your results come out better if you had to do it all over again.

During this procedure we had to constantly adjust the V_{PP} of the sine wave input in order to prevent the op-amp from being saturated. The saturation was making a visible effect on the oscilloscope graph.