CMPE 460 Laboratory Exercise 7

Filter Design and Simulation

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Lab Section: 2
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TA: Brunon Sztuba
Eri Montano
Connor Henley

Lecture Section: 1
Professor: Professor Beato

By submitting this report, you attest that you neither have given nor have received any assistance (including writing, collecting data, plotting figures, tables or graphs, or using previous student reports as a reference), and you further acknowledge that giving or receiving such assistance will result in a failing grade for this course.

Your Signature: _____

Lab Description

This lab explored different types of low pass filters by using LTSpice to design and simulate active and passive filters. In addition, a three op amp biquad band pass filter was designed and simulated. The purpose of this exercise was to solve for different circuit components to simulate passive and active filters with desired specifications like cutoff frequency or center frequency. This exercise was successful because all filters simulated performed with their design requirements in simulations.

Circuit Schematics and Graphs

First Order RC Passive Low Pass Filter

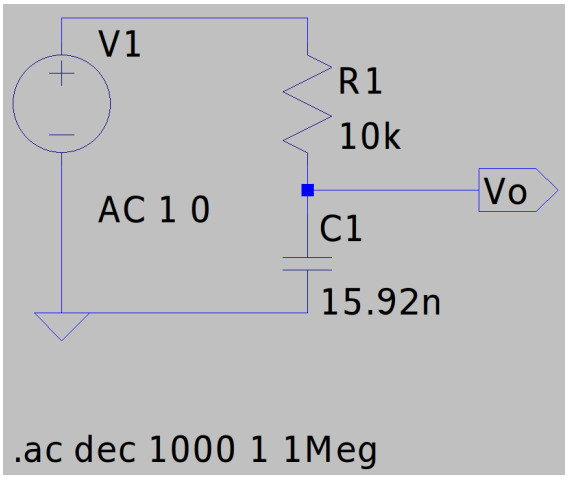

Figure 1: First Order Passive LPF Schematic with $f_c = 1\text{kHz}$

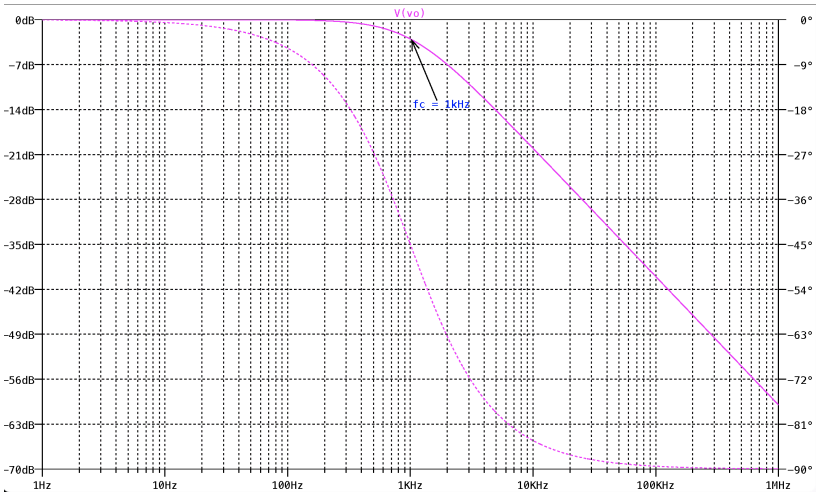

Figure 2: First Order Passive LPF Graph with $f_c = 1\text{kHz}$

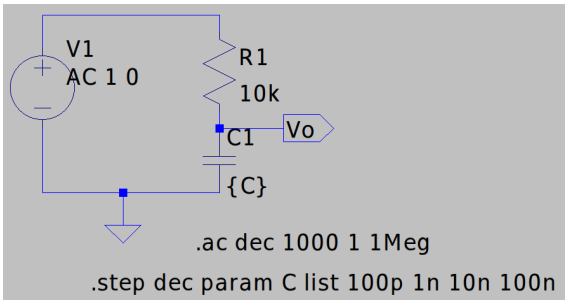

Figure 3: First Order Passive LPF Schematic with Capacitor Sweep

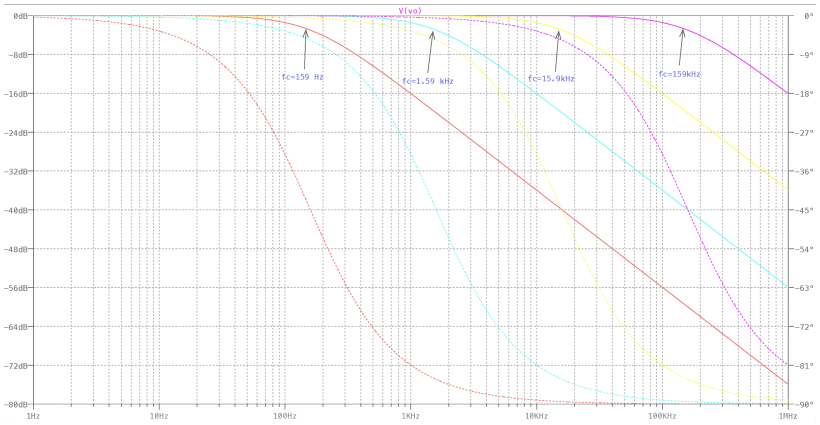

Figure 4: First Order Passive LPF Graph with Capacitor Sweep

First, Second and Third Order RC Passive Low Pass Filter

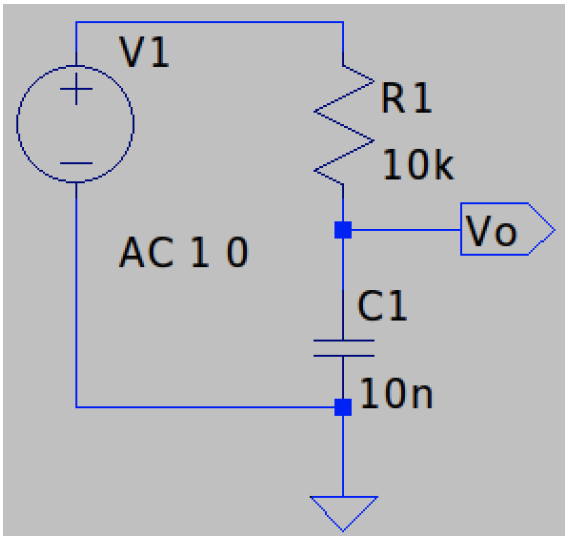

Figure 5: First Order Passive LPF Schematic

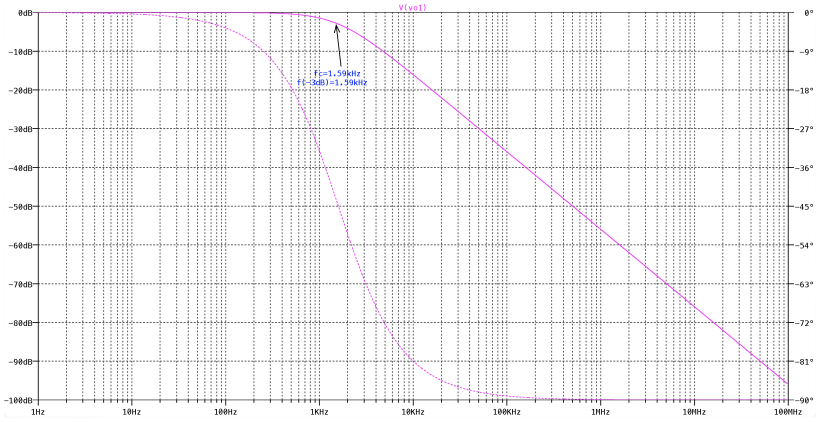

Figure 6: First Order Passive LPF Graph

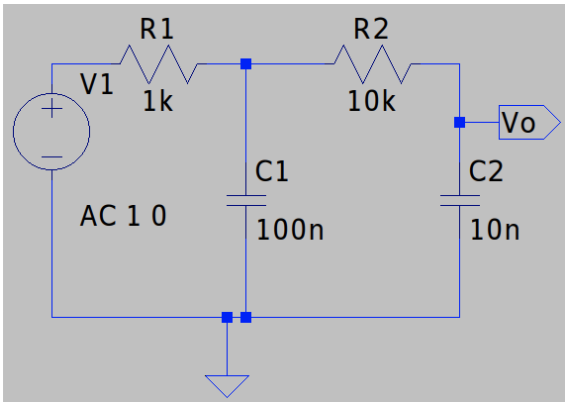

Figure 7: Second Order Passive LPF Schematic

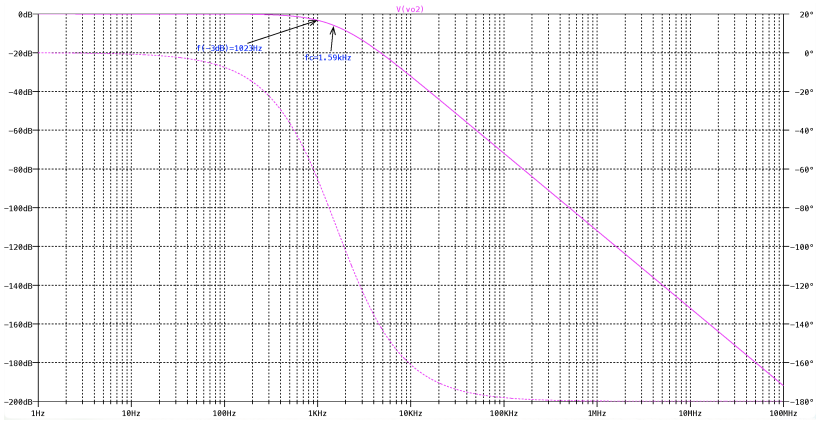

Figure 8: Second Order Passive LPF Graph

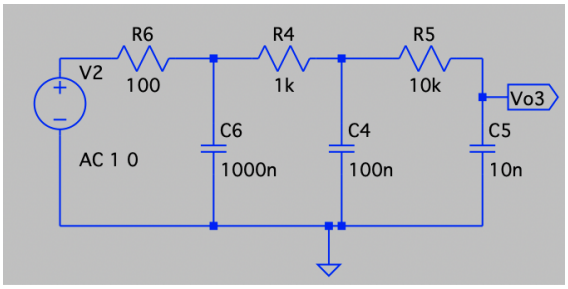

Figure 9: Third Order Passive LPF Schematic

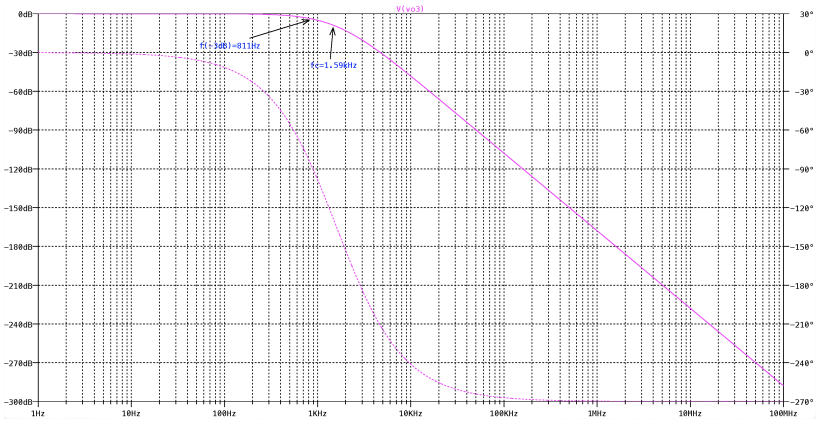

Figure 10: Third Order Passive LPF Graph

Sallen-Key Second Order Low Pass Filter

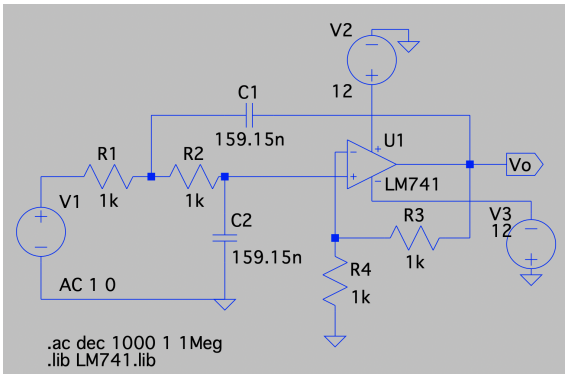

Figure 11: Sallen Key Second Order LPF Schematic

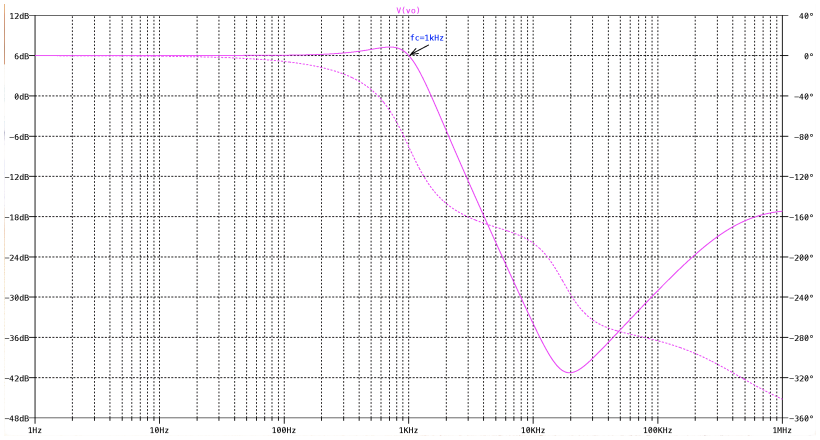

Figure 12: Sallen Key Second Order LPF Graph

One Op-Amp Second Order VCVS Low Pass Filter (Butterworth Filter)

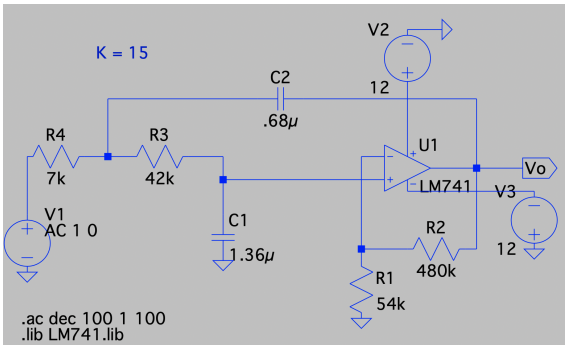

Figure 13: Butterworth LPF Schematic

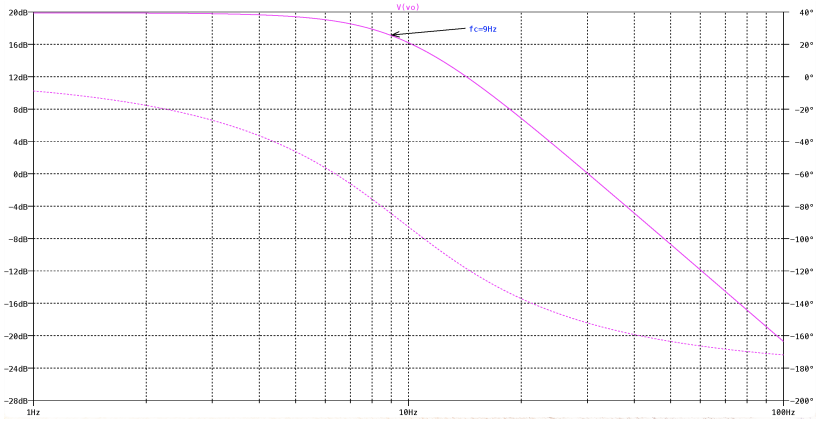

Figure 14: Butterworth LPF Graph

Three Op-Amp Biquad Band Pass Filter

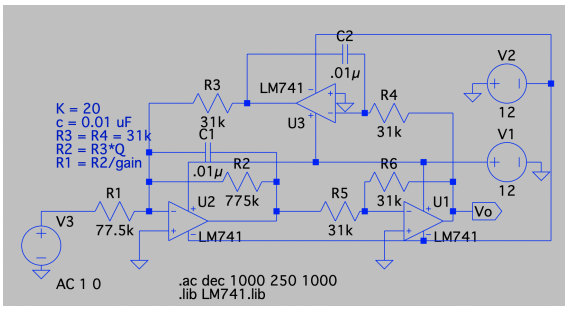

Figure 15: Three Op-Amp Biquad Band Pass Filter Schematic

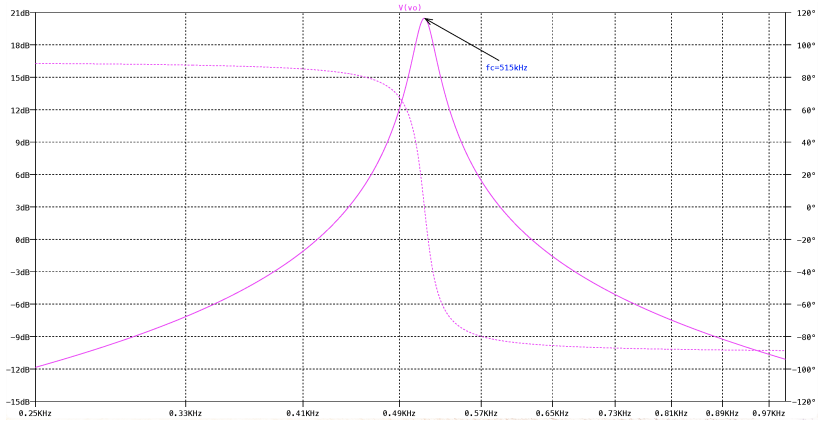

Figure 16: Three Op-Amp Biquad Band Pass Filter Graph

Questions

Step 2) The capacitor value was found to be 15.92 nF.

Step 3) The slope of each magnitude plot during the descent is -20 dB/dec.

Step 4a) To keep f_c unchanged, the R value of the previous stage is the R value of the final stage divided by a factor of 10, so it becomes 1 kΩ. The C value of the previous stage is the C value of the final stage multiplied by a factor of 10, so it becomes 100 nF. The new value of f(-3 dB) is 1023 Hz.

Step 4b) The same pattern continues, where the new R value is scaled down by a factor of 10 from the stage directly to the right of the new stage being added. This new R value is 100 Ω. The C value is scaled up by a factor of 10 from the stage directly to the right of the new stage being added. The new C value is 1000 nF. The new value of f(-3 dB) is 811 Hz.

Step 4c) As more stages are added, this pattern continues, where R will continue to decrease by a factor of 10 and C will continue to increase by a factor of 10.

Step 4d) A voltage follower (op amp with a gain of 1) could be an ideal buffer between stages of the filter as its order continues to increase.

Exercise 7: Filter Design and Simulation

Student's Name: Jacob Meyerson Section: 2

Demo		Point Value	Points Earned	Date
Demo	1st , 2nd, 3rd Order Passive Low Pass Filters	20	20	XB 3/26/21
	LP Parametric Sweep	10	10	XB 3/26/21
	Butterworth Filter	20	20	XB 3/26/21
	BiQuad Filter	20	20	XB 3/29/21

To receive any grading credit students must earn points for both the demonstrations in addition to the Worksheet submission containing the Schematics/Plots/Question Answers.