Experiment No. 5
Frequency Response of Active Networks
ECE 213

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1 Introduction

Filters are often used to modify and process analog signals. Filters are needed in electronic systems to amplify certain frequency components of a composite signal and to attenuate other frequency components. This lab had the experimenters build two types of active filters: the Butterworth and the Chebyshev.

2 Background

A second order voltage transfer function for a low-pass filter can be expressed as:

$$\frac{V_2(s)}{V_1(s)} = \frac{H_0 {\omega_n}^2}{s^2 + s\frac{\omega_n}{Q} + {\omega_n}^2} \tag{1}$$

When implementing this transfer function in hardware, an op-amp in non-inverting configuration is paired with external resistors and capacitors. Figure 1 is the diagram for the non-inverting amplifier, figure 2 is the external circuit. In figure 2, the op-amp with its input tied together is a stand in for the non-inverting amplifier circuit. In figures 3 and 4, the values for all components are listed.

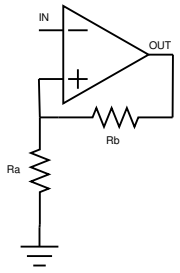


Figure 1: Non-inverting amplifier

ω_n	5287
Q	1.306
R	20 k Ω
C	9.4 nF
Gain	2.2243
R_b	240 Ω
R_a	200 Ω

Figure 3: Chebyshev Filter

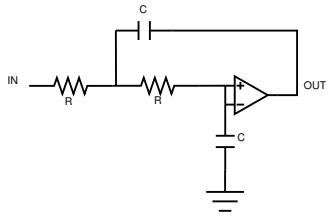


Figure 2: Second order filter

ω_n	6283
Q	0.707
R	15 k Ω
C	10 nF
Gain	1.585
R_b	240 Ω
R_a	470 Ω

Figure 4: Butterworth Filter

3 Procedure

a. Calculate resistance and capacitance values for each circuit.

b. Build circuits.

c. Set function generator to sweep output, with logarithmic sweep rate.

d. Set scope to a slow sweep rate.

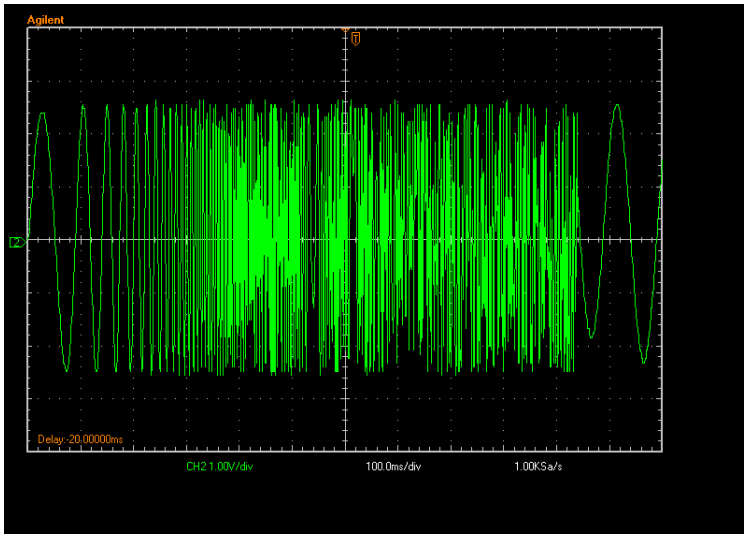
e. Time single sweep with scope with sweep out of function generator.

4 Equipment

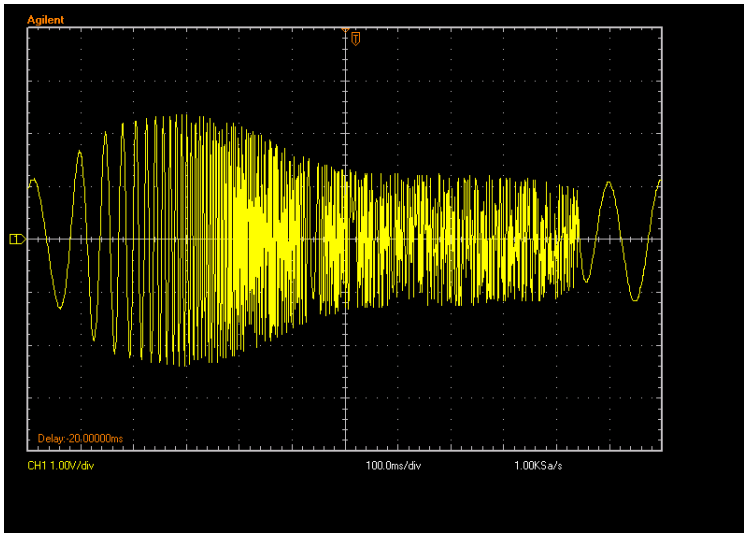
- Oscilloscope
- Function generator
- Resistors
- Capacitors

5 Data and Graphs

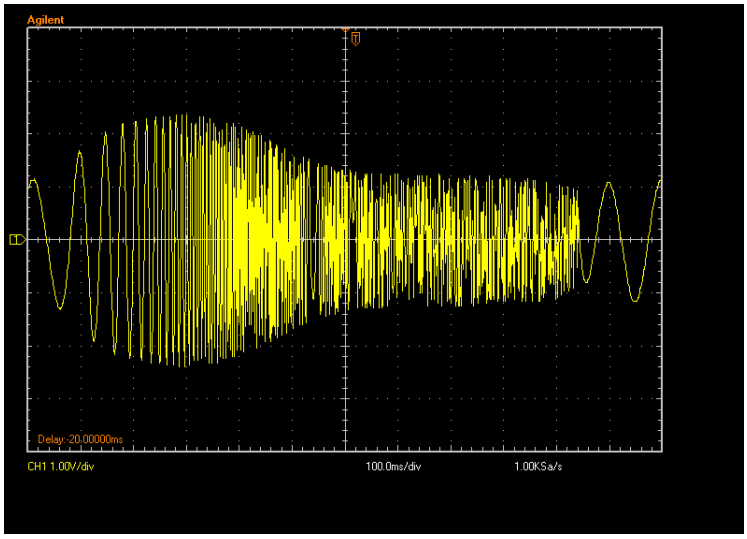
5.1 Input Function



5.2 Chebyshev Filter



5.3 Butterworth Filter



6 Conclusions

The purpose of this lab was achieved. A Butterworth and a Chebyshev fiter with a 1kHz cutoff were built and tested. Both filters seemed to have very similar responses.