

Operational Amplifier Circuits, Design, and Limitations

Circuits & Signals

EECE2150

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0 Introduction

The purpose of this laboratory experimentation is to advance our knowledge of operational amplifiers and their abilities. By applying concepts of the transfer function and fast Fourier transforms, we were able to more thoroughly analyze operational amplifier response.

1 Part I

1.1 Q1

The calculations resulted in the following:

- The theoretical in-band gain ($|H(\omega)|$):
$$\frac{R_f}{\sqrt{R_s^2 + \frac{1}{(\omega C_s)^2}}} = \frac{200000}{\sqrt{10^{10} + \frac{10^{16}}{\omega^2}}}$$
- The time constant (τ): $\tau = R_s C_s = (100 \cdot 10^3)(10 \cdot 10^{-9}) = 1[\text{ms}]$
- The cutoff angular frequency (ω_c): $\omega_c = \frac{1}{\tau} = \frac{1}{.001} = 1000 \left[\frac{\text{rad}}{\text{s}} \right]$
- The cutoff frequency (f_c): $\frac{\omega_c}{2\pi} = 159.155[\text{Hz}]$

1.2 Q2

The measured gain is $\frac{1.11}{.45} = 2.467$

1.3 Q3

The cutoff frequency does not agree with the theoretical value (it becomes 86[Hz] instead of 159[Hz])

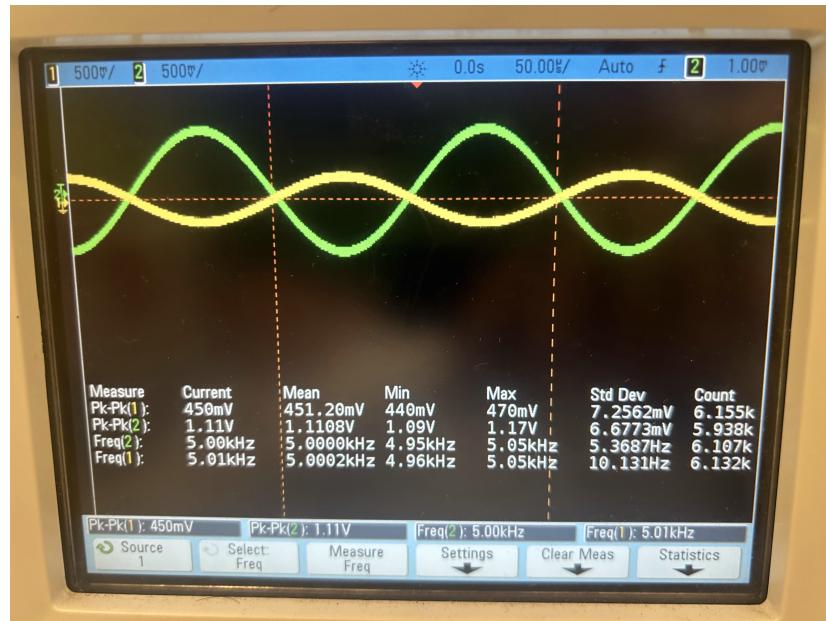


Figure 1: Oscilloscope Reading of Input and Output

1.4 Q4

That statement is incorrect — The gain increases with higher frequencies.

1.5 Q5

The input is square, while the output is like a combined exponential. The output wave looks as it does because, when the square wave is positive or negative, the capacitor is charging. In between, the capacitor voltage jumps to infinity as it shifts.

1.6 Q6

As the frequency increases, the capacitor is unable to discharge quick enough, so the output begins to look more and more like a square wave.

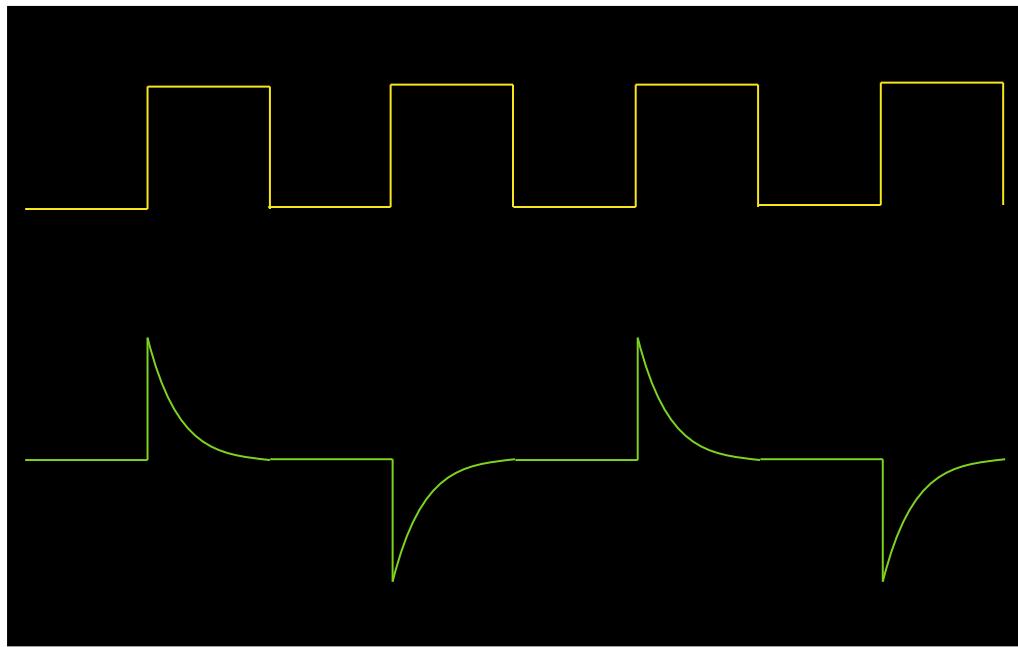


Figure 2: Input Wave (Top) and Output Wave (Bottom) Approximation

2 Conclusion

Overall, this laboratory experiment introduced us to the concept of physical active filters through transform and Fourier analysis. Furthermore, this time the operational amplifier was a real-world circuit component, making it easier to grasp the concept.