

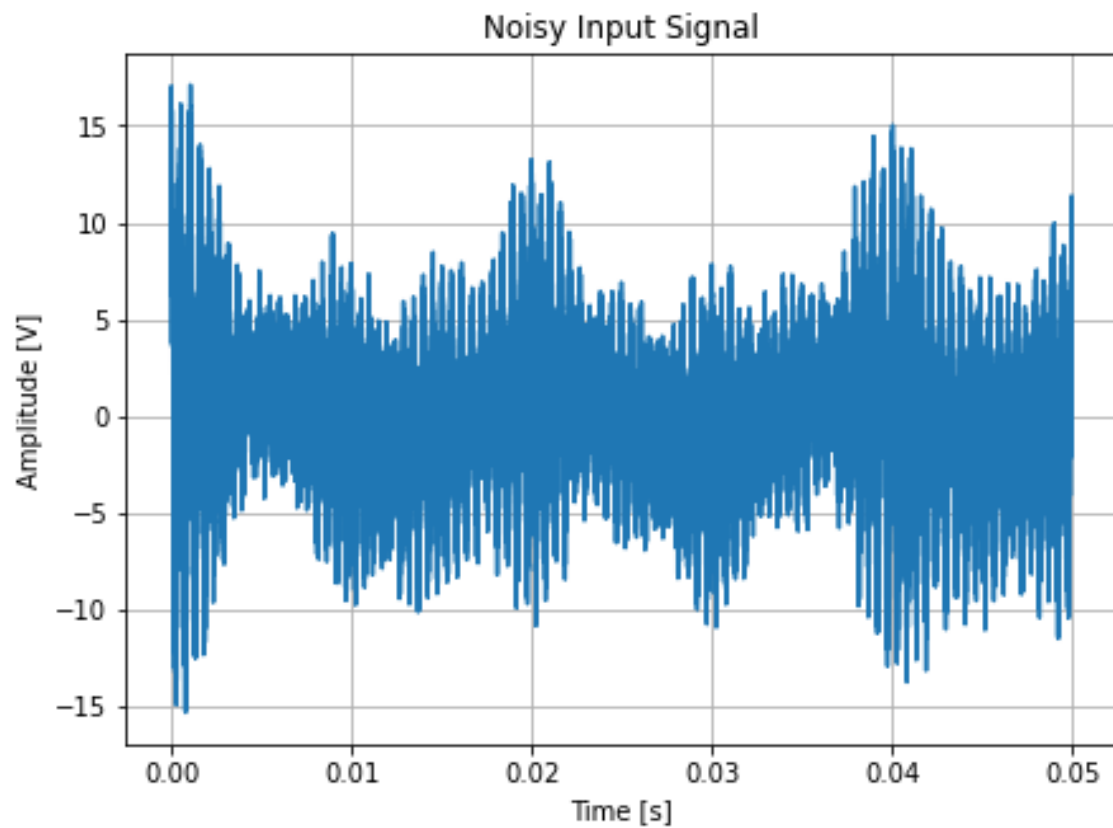
# 1 Introduction

The goal of this lab is to apply the skills and concepts from the course into a practical application and present the information in a professional report.

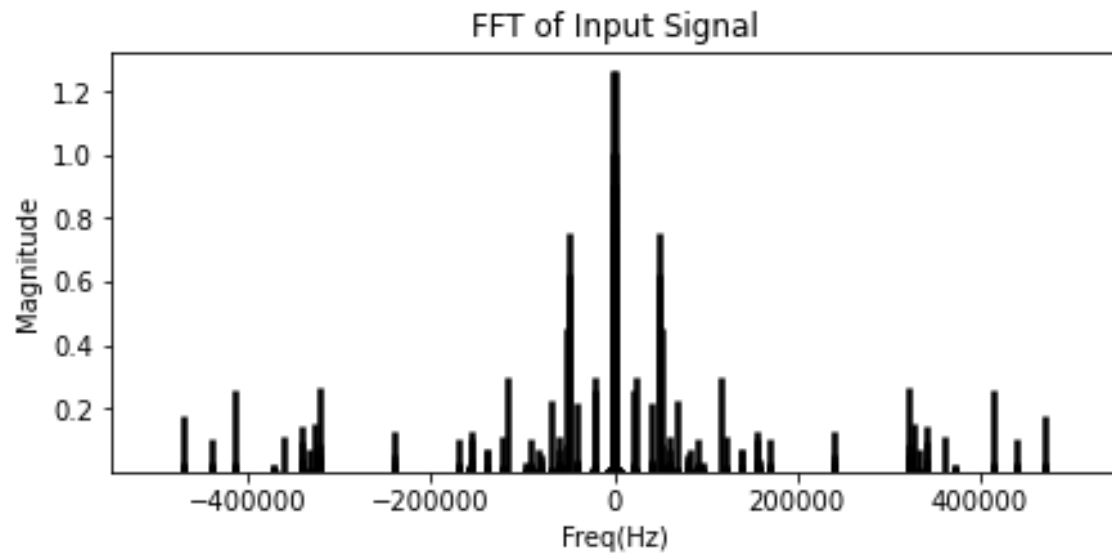
## 2 Signal Analysis

For this lab, first we have to analyze the signal in time domain and frequency domain and identify the noise magnitudes and corresponding frequencies due to the low frequency vibration and switching amplifier..

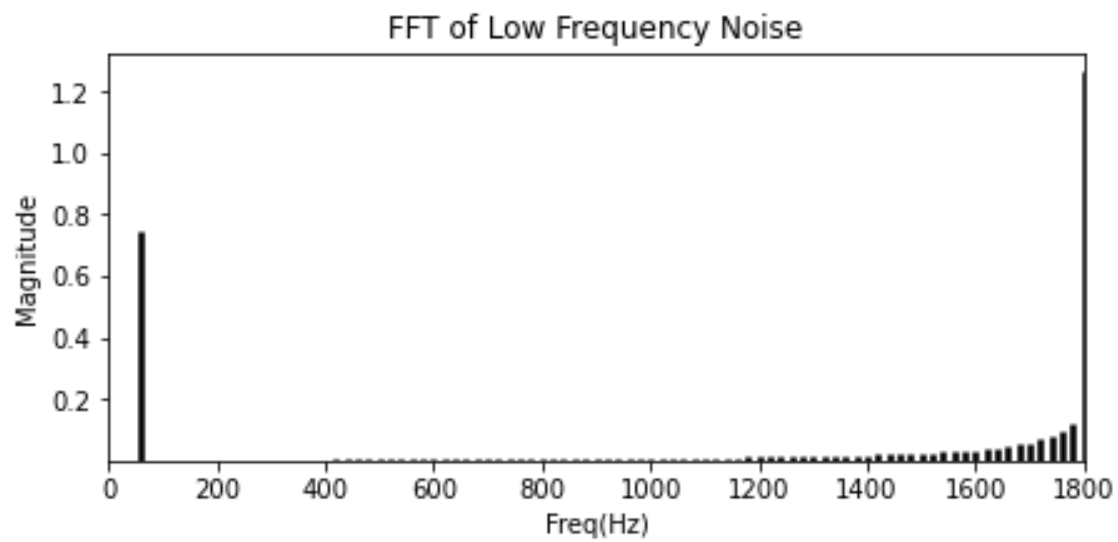
The input signal in time domain:



The input signal in frequency domain(fast fourier transform function was used):

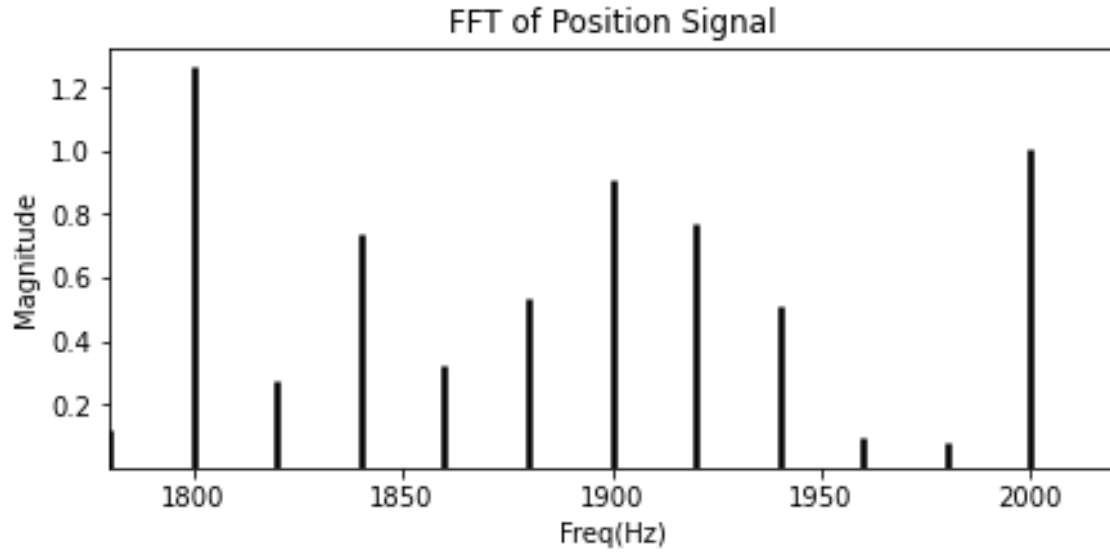


Low frequency noise:

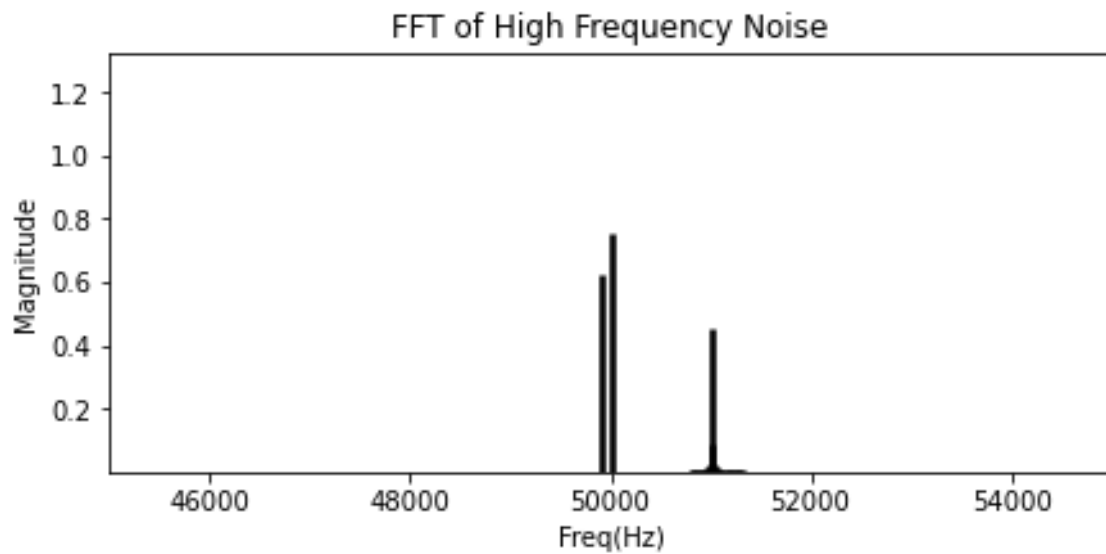


At 60Hz the amplitude of noise is 0.75

Position signal:



High frequency noise:



At 48.6kHz the amplitude of noise is 0.18

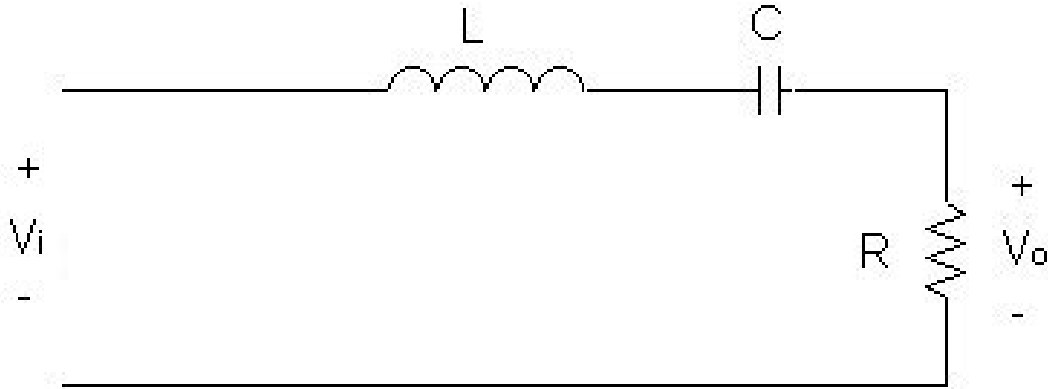
At 50kHz the amplitude of noise is 0.75

At 51kHz the amplitude of noise is 0.5

From the above figures we can observe that input signal is mixture of actual signal, low frequency noise and high frequency switching amplifier noise and some unaccountable very low amplitude noise.

### 3 Filter Design

To clear the noise, we have to pass the signal through a band-pass filter. The filter I used is the following series RLC circuit:

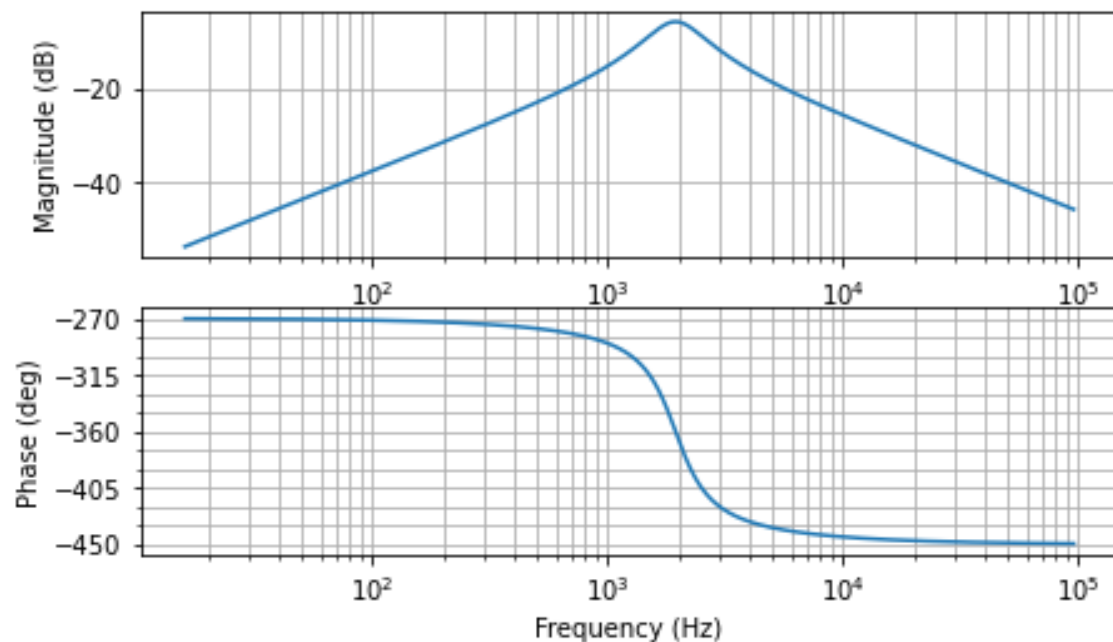


Filter transfer function:

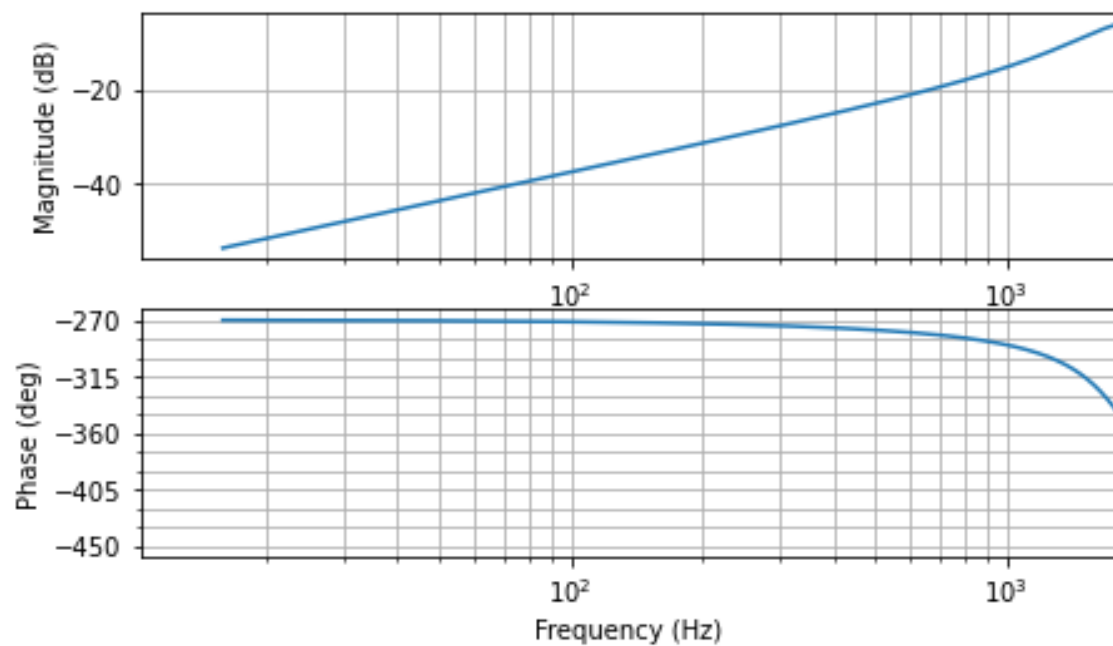
$$H(s) = \frac{\frac{R}{L}s}{s^2 + \frac{R}{L}s + \frac{1}{LC}} \quad (1)$$

Where  $L=1\text{H}$ ,  $C=6.75\text{nF}$ ,  $R=6283\text{ Ohm}$

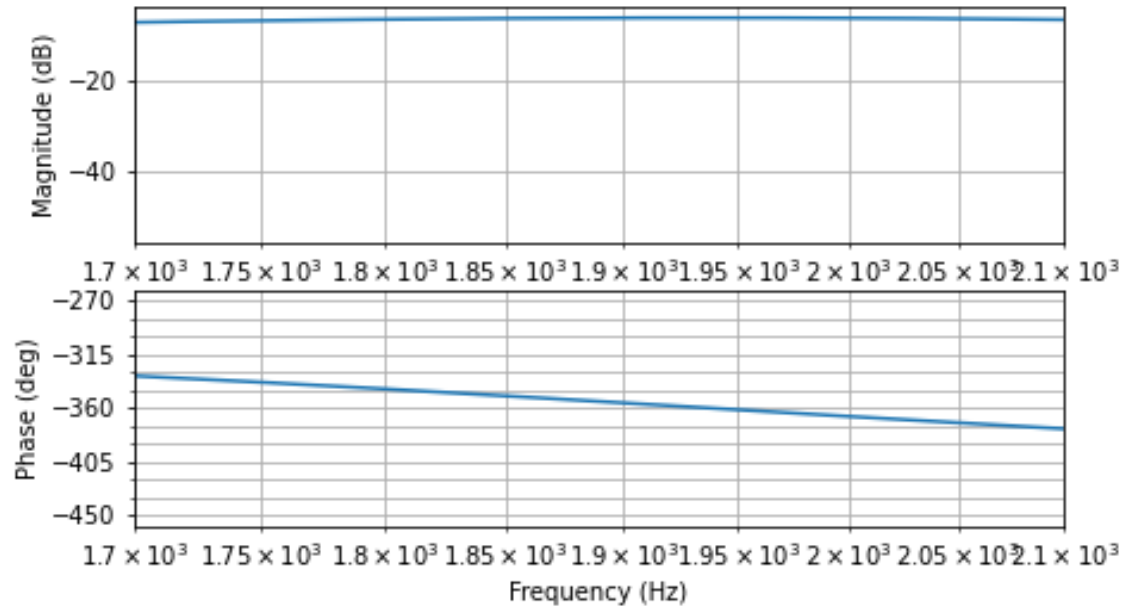
Filter Bode Plot:



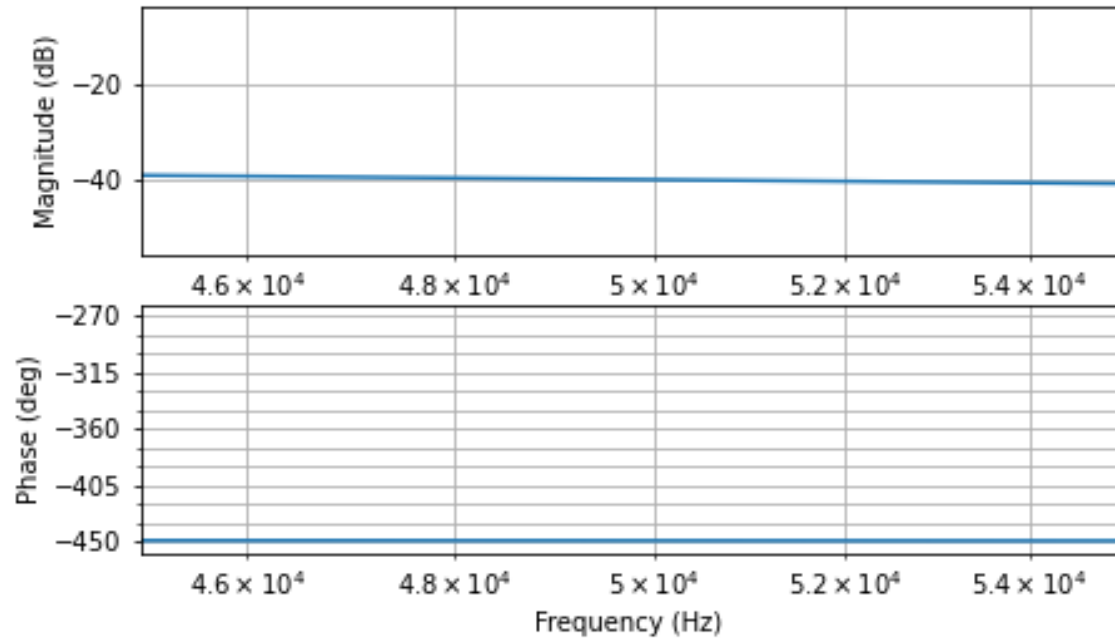
Here, we can see the attenuation by at least -30dB at low-frequency vibration noise is met:



We can see here the position information of the filter is attenuated by less than -0.3dB:



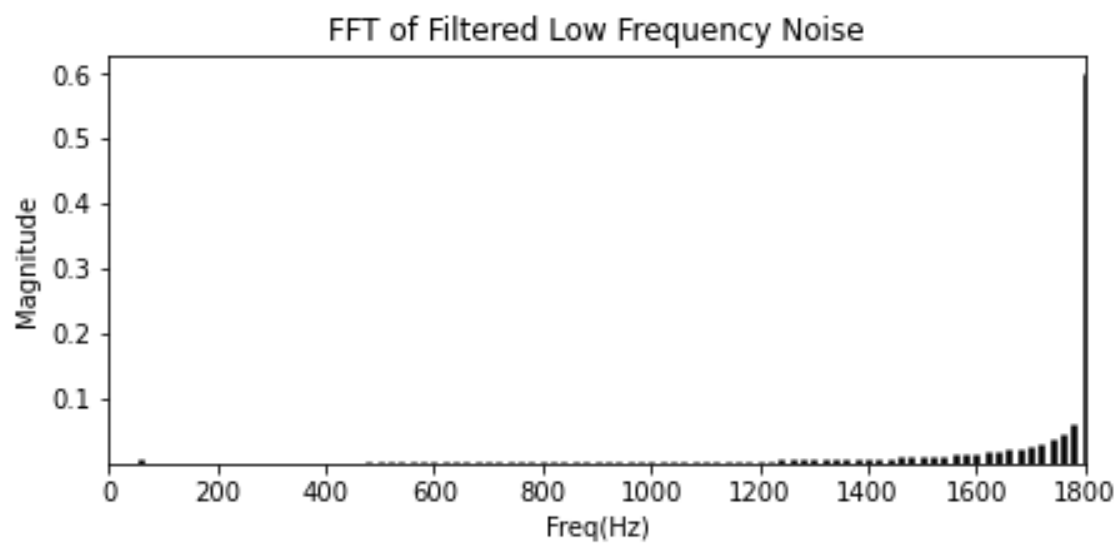
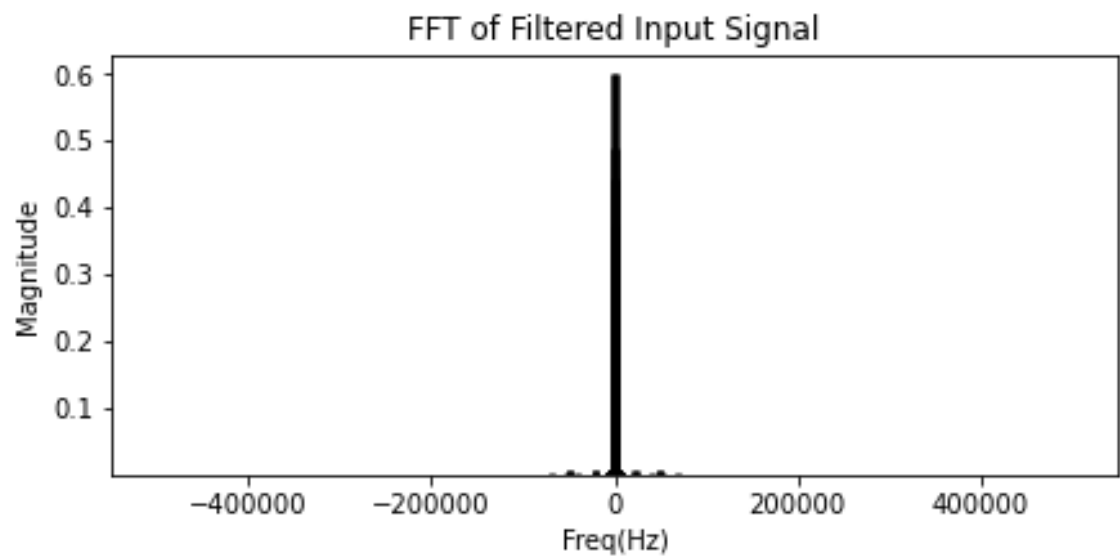
Here, we can see the attenuation by at least -21dB at switching amplifier noise is met:

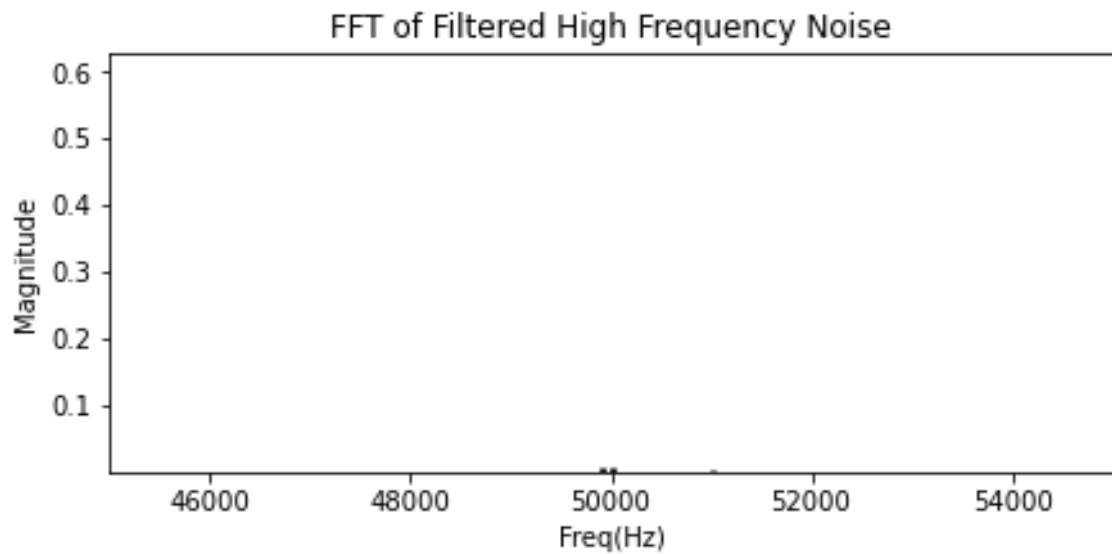
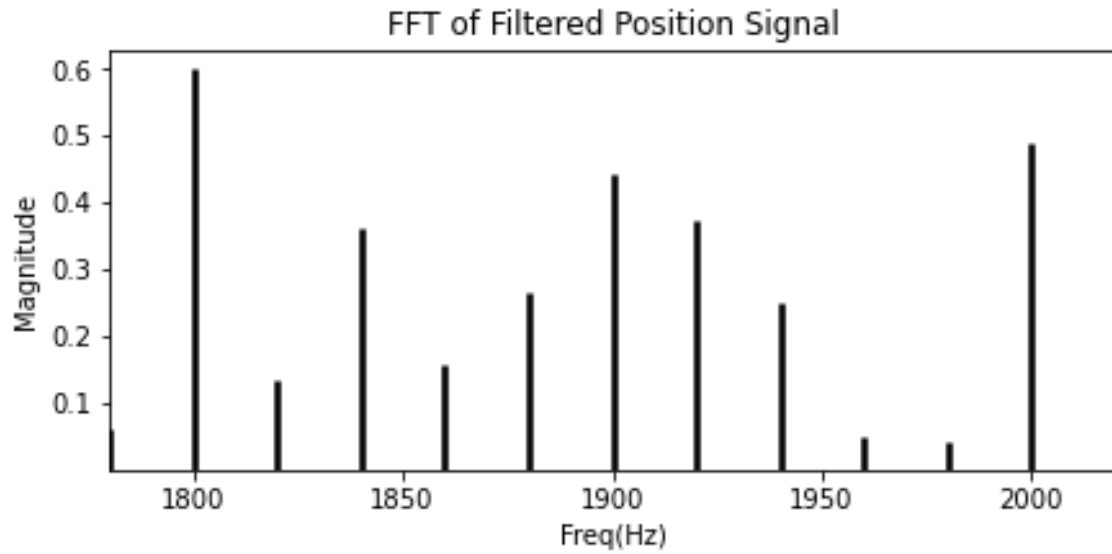


As can be seen from bode plots, the obtained frequency response of filter meets our requirement.

## 4 System Response and Results

We pass the signal through the filter we designed to obtain the following results:

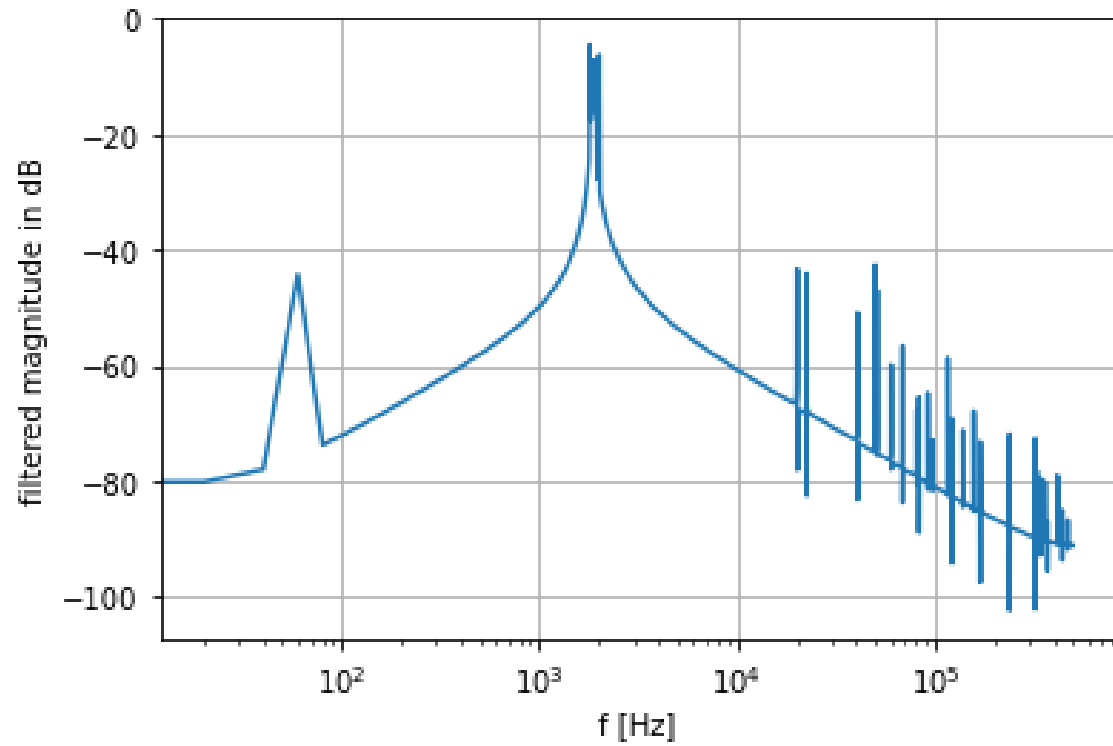




As can be seen from plots, noise was eliminated by the filter and the obtained output signal is clean.

Bode Plot of Filtered Signal:





As can be seen, the obtained output has been correctly attenuated.

## 5 Conclusion

In this lab, we applied the skills and concepts from the course into a practical application.