Report for Fall 2020 EE 343L Lab

Assignment 1

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Abstract: The purpose of the first part of the lab is to analyze a few different signals including identifying the signal energy, their Fourier transforms, their centers, and their width. Additionally, the amplitude scale and time scale of the signals must be changed in order for their signal energies and widths to match. In the second part of the lab, the signals are put through different filters and the filtered signals are then analyzed.

1 Introduction

In the first part of the lab, our first task was to analyze three different signals in the frequency domain as shown in Figure 1. Using MATLAB, we plotted these signals as well as their inverse Fourier transforms. Using these graphs, we were then able to identify the centers and widths of these signals as well as their energies.

$$A(f) = \sin(\pi f)/\pi f$$

$$B(f) = (\sin(\pi f)/\pi f)^2$$

$$C(f) = \exp(-\pi f^2/2)$$

Figure 1. Signals A(f), B(f) and C(f)

The second task was to amplitude scale these signals so that their energies are identical. The third task was to both amplitude and time scale these signals so that their energies and widths are identical.

In the second part of the lab, our first task was to plot and analyze three more signals shown in Figure 2 in the time domain, as well as their Fourier transforms.

$$p(t) = \Pi(t)$$

$$c(t) = \cos(1.5\pi(t))$$

$$g(t) = \exp(-\pi t^2/2)$$

Figure 2. Signals p(t), c(t), and g(t)

The second task was to put these three signals through three different filters $h_1(t)$, $h_5(t)$, and $H_h(f)$and plot their output. These signals are then compared to the original. Section 2 will discuss the results of the first part of the lab and Section 3 will discuss the results of the second part. Section 4 will contain our conclusions.

2 Results, Part A

The three signals A(f), B(f), and C(f) are plotted in Figure 3.

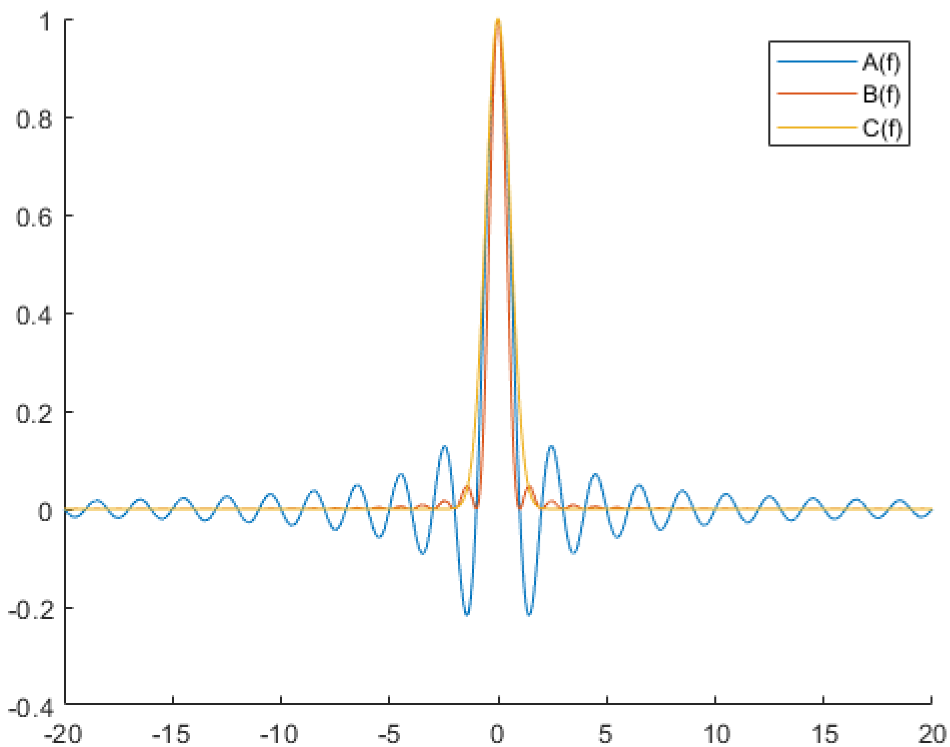


Figure 3. Plots of signals A(f), B(f), and C(f)

Signal A has the basic shape of the sinc() function. Signal B is similar to A, but does not contain any negatives. Signal C is the smoothest looking signal and looks similar to signal B. The inverse Fourier transforms are shown below in Figure 4.

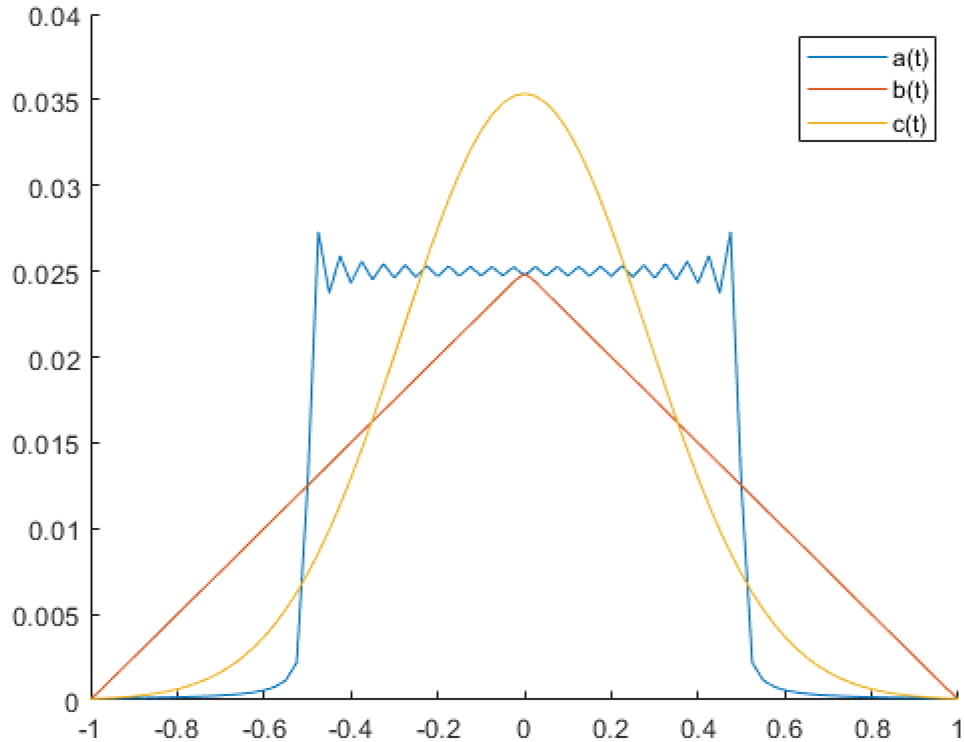


Figure 4. Inverse FT of signals A, B, and C

The inverse FT of A(f) looks like a pulse function, which was expected. The inverse FT of B(f) is a triangle pulse, and the inverse FT of C(f) looks like a round pulse. All of these signals are centered at 0 Hz. From the plot, the signal a(t) has a width of 1 while the signals b(t) and c(t) have a width of 2.

3 Results, Part B

The signals for the second part of the lab, p(t), c(t) and g(t), were successfully plotted using MATLAB, as well as their Fourier transforms as shown in Figure 5.

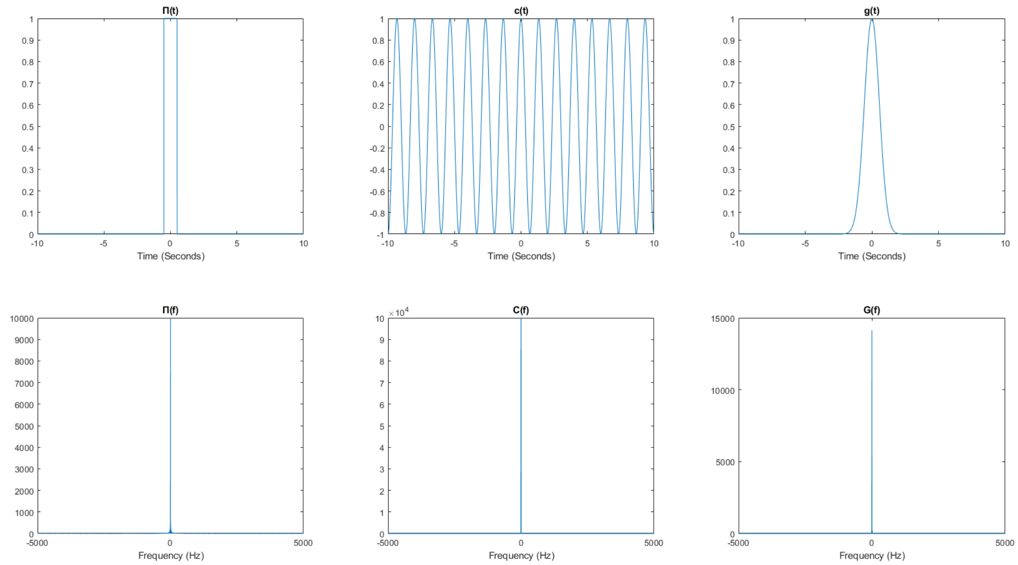


Figure 5. Plots of signals p(t), c(t), and g(t) and their Fourier transforms

The filters we will be using to process these signals are the ideal filter with a bandwidth of 1 Hz, $h_1(t)$, the ideal filter with a bandwidth of 5 Hz, $h_5(t)$, and $H_h(f) = -j\, sign(f)$. The impulse responses of these filters is shown in Figure 6.

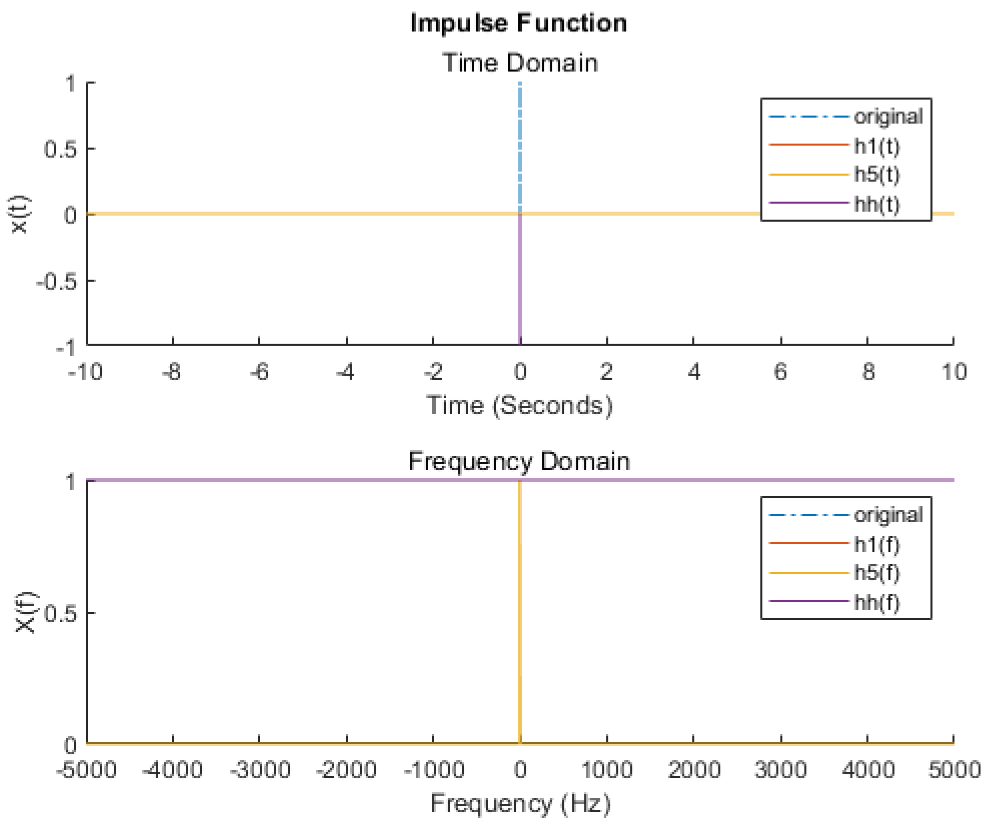
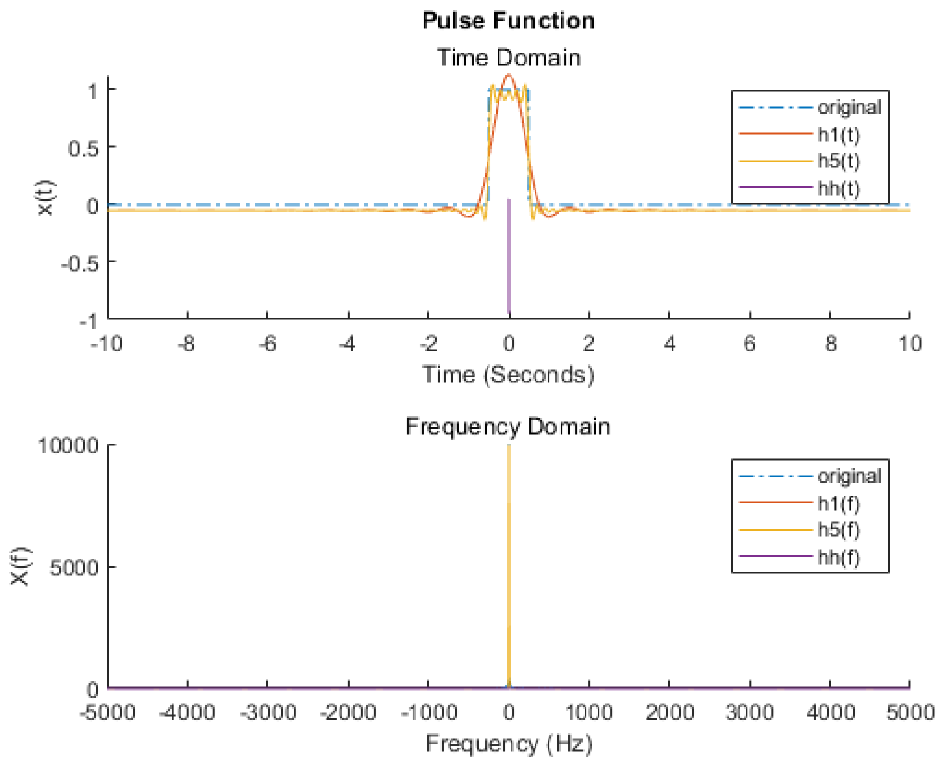
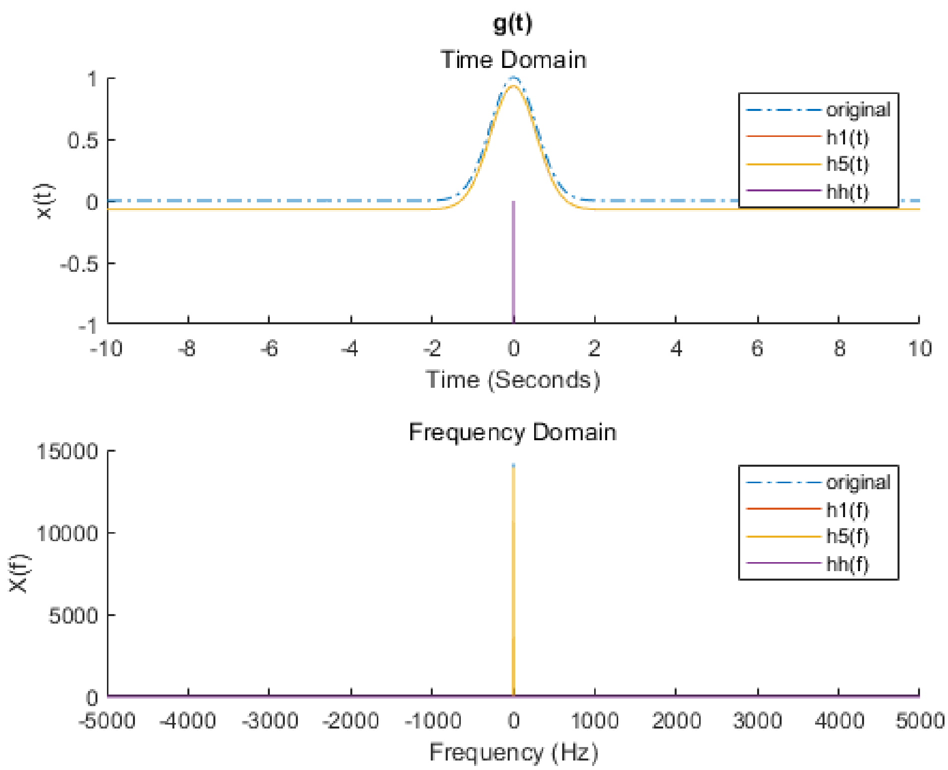


Figure 6. Impulse response of the three filters

Our input signals are then put through this filter, then plotted using MATLAB. These output signals are shown in Figure 7.


Pulse Function
Time Domain
x(t)
Time (Seconds)
original
h1(t)
h5(t)
hh(t)
Frequency Domain
X(f)
Frequency (Hz)
original
h1(f)
h5(f)
hh(f)


g(t)
Time Domain
x(t)
Time (Seconds)
original
h1(t)
h5(t)
hh(t)
Frequency Domain
X(f)
Frequency (Hz)
original
h1(f)
h5(f)
hh(f)

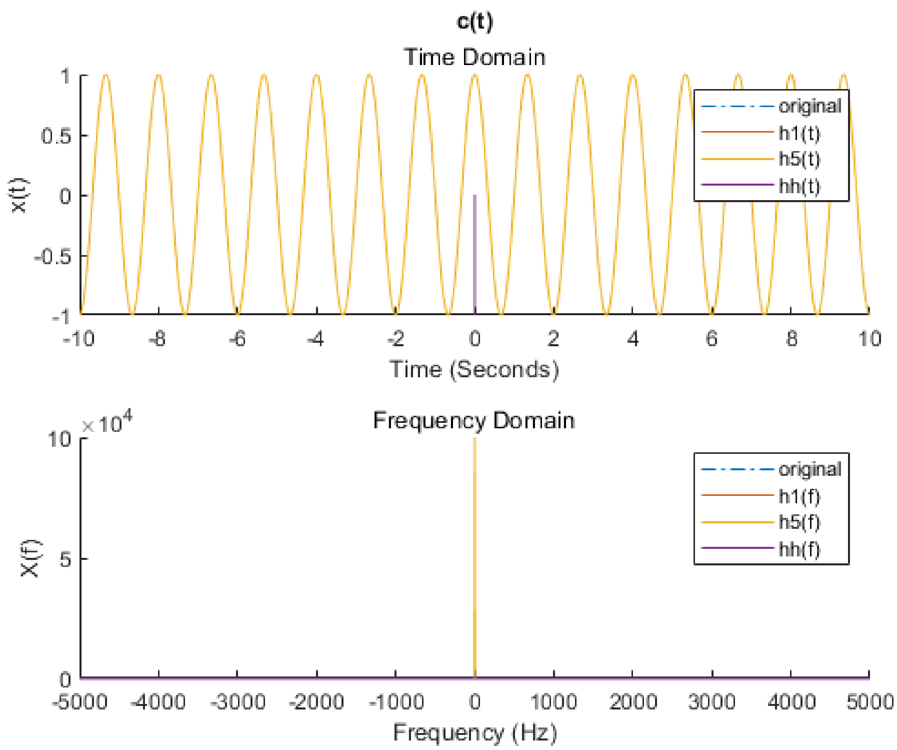


Figure 7. Plots of the output signals using each filter

4 Conclusion

We were able to successfully plot each signal and filter, as well as successfully Fourier transform and inverse Fourier transform our signals as needed. Some technical difficulties were encountered while using MATLAB causing a lack of sufficient results for certain tasks. Hopefully in the future through practice, we can learn more about how to use MATLAB to do these computations.