ELC 433

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Lab 3A: Discrete-time Processing of Continuous-time Signals Using MATLAB

Submitted by: Haley Scott

Group Members:

Bryan Guner

Stephanie Fournier

Haley Scott

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Signal Processing Laboratory (ELC 433)
Lab 3A: Discrete-Time Processing of Continuous-time Signals Using MATLAB

Stephanie Fournier*
Bryan Guner*
Haley Scott*

** Electrical and Computer Engineering Department, The College of New Jersey, (e-mail: fournis1@tcnj.edu gunerb1@tcnj.edu scotth3@tcnj.edu)*

Abstract: The purpose of this lab is for students to study the effects of sampling in both the time-domain and the frequency domain. A continuous-time signal and a discrete-time signal are to be generated using MATLAB, and students will study the effects of undersampling and oversampling. The results are then to be plotted.

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1. INTRODUCTION

In this lab, our team studied the effects of sampling in both the time-domain and frequency-domain. We used MATLAB to generate the given continuous-time signal, and then converted the given signal into a discrete-time signal through the use of uniform sampling. The process was to be repeated with varying sampling rates in order to study the changes within the signal. Another equation, The Continuous-time Fourier Transform, was given to compute the magnitude spectra using the specified frequency for all cases. This was to be repeated with the same varying sample rates, and then plotted.

2. METHODS

In order to generate the continuous-time wave, the given equation was first inputted into MATLAB with the given frequency and plotted. Along with this signal is the computed sampled sequence and reconstructed signal, also plotted using subplots. The first step of this lab was repeated with the two given sampling rates. The continuous-time signal and reconstructed signals were then compared. In the next step, our team utilized the given Continuous-time Fourier Transform and computed the magnitude spectra of each signal with the given frequency. Finally, our team repeated the computation of the CTFT (1) using the same sampling rates from the second step, for each generated signal in the third step.

$$X_c(j\Omega) = \int_{-\infty}^{\infty} \cos(\Omega_o t) e^{-j\Omega t} dt = \pi\left[\delta(\Omega - \Omega_0 + \delta(\Omega + \Omega_0)\right]$$

Equation 1: CTFT

We then compared the spectra from both steps.

3. RESULTS

Our team approximated a continuous time signal and its discrete equivalent in MATLAB, represented in figures 1 and 2 below. Figure 3 below represents the reconstructed signal.

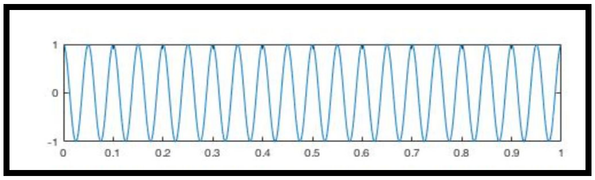

Figure 1: Continuous Time Signal

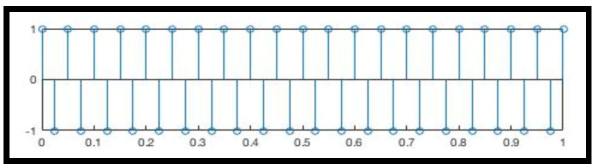

Figure 2: Discrete Time Signal

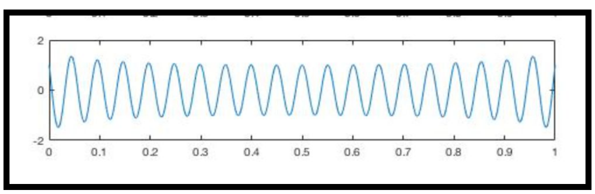

Figure 3: Reconstructed Signal

Our team then repeated the above procedure with 20 kHz, the results of which are shown below in figures 4, 5, and 6.

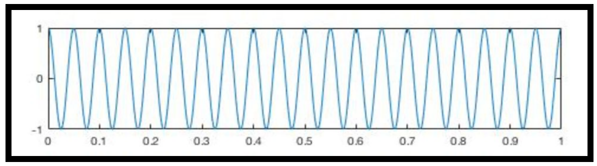

Figure 4: Continuous Time Signal

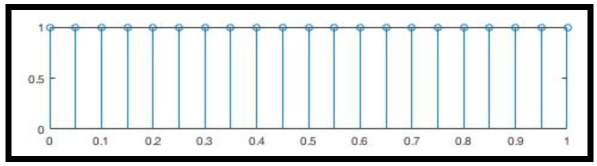

Figure 5: Discrete Time Signal

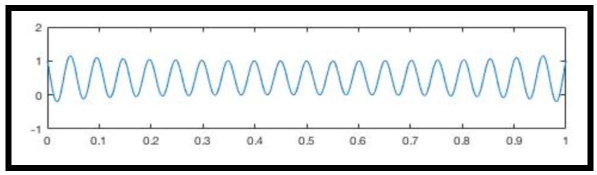

Figure 6: Reconstructed Signal

Our team then repeated the above procedure with 100 kHz, the results of which are shown below in figures 7, 8, and 9.

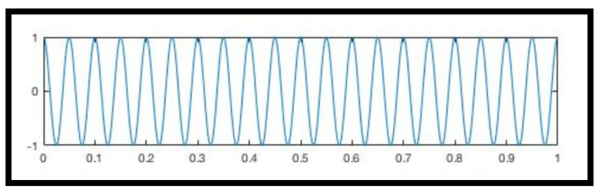

Figure 7: Continuous Time Signal

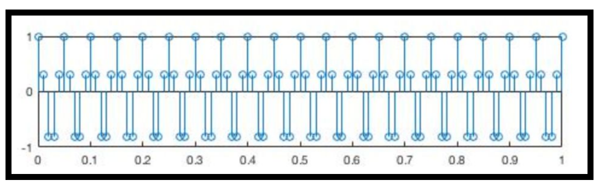

Figure 8: Discrete Time Signal

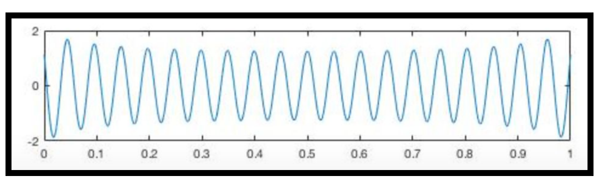

Figure 9: Reconstructed Signal

Next, our team found the CTFT (1) of Xc(t) and Xr(t) at T = 40kHz. These results are shown below in Figures 10 and 11.

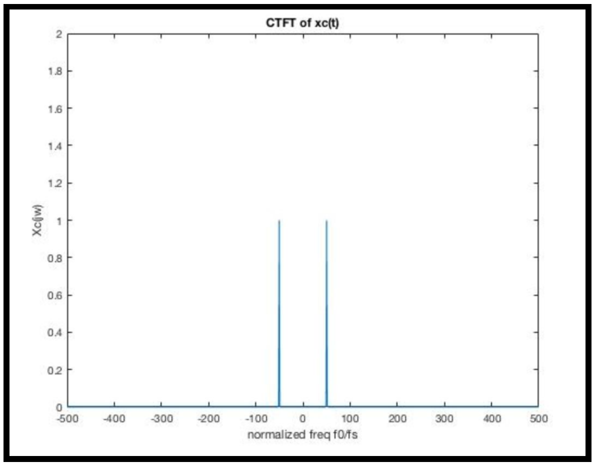

Figure 10: CTFT of Xc(t)

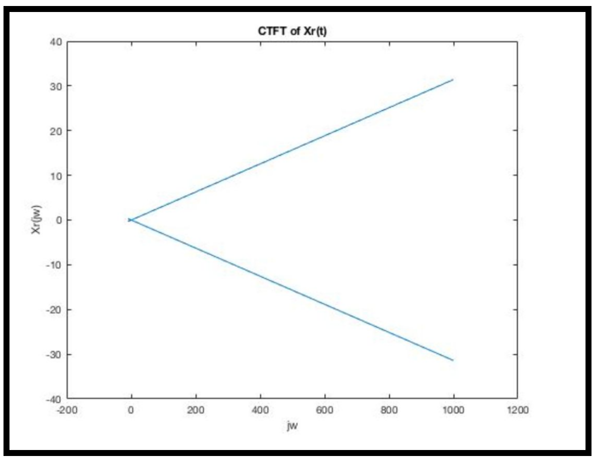

Figure 11: CTFT of Xr(t)

We also found the discrete fourier transform, as shown below in Figure 12.

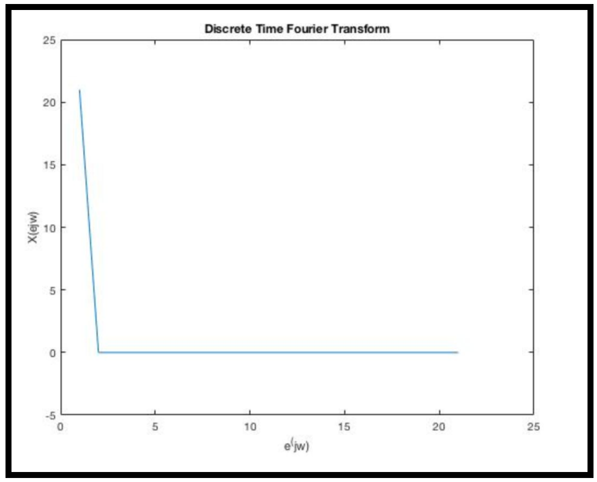

Figure 12: Discrete Fourier Transform

Our team then repeated this process at 20 kHz and 100 kHz respectively.

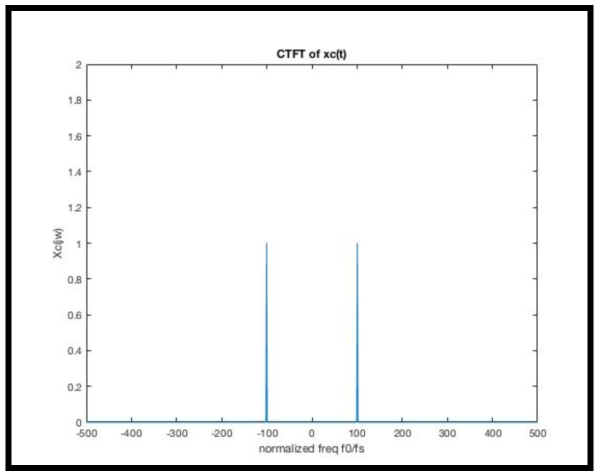

Figure 13: CTFT of Xc(t)

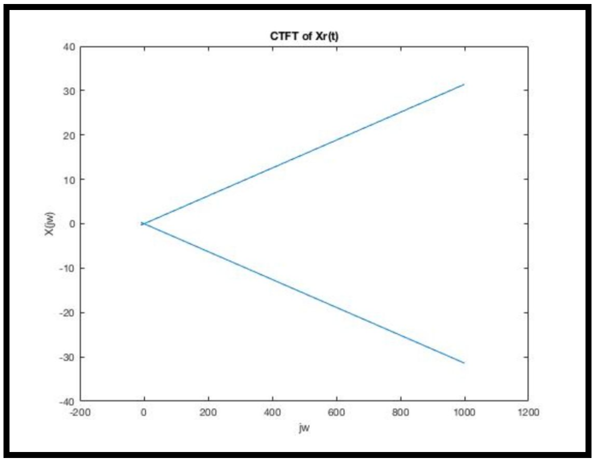

Figure 14: CTFT of Xr(t)

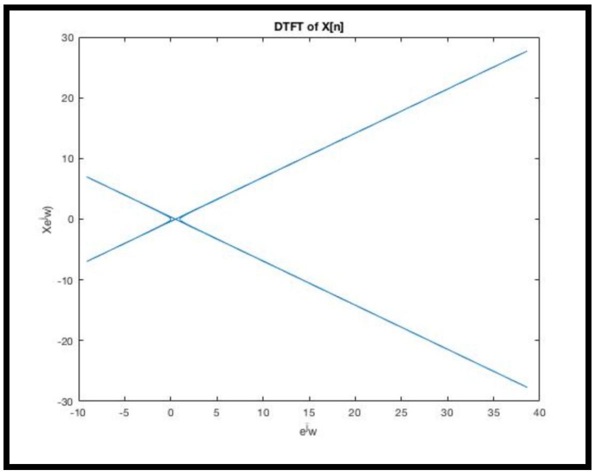

Figure 15: DTFT of X[n]

4. DISCUSSION

Through our graphical results, we can see that our calculations aligned with our expected outcomes. We can also recognize an aliasing effect with some of our results. More specifically, we can identify the 20 kHz examples as somewhat inaccurate due to aliasing issues.

5. CONCLUSION

This lab was successful in terms of completing the tasks to the specifications of each step. The continuous-time, sampled sequence, and reconstructed signal were properly computed and plotted, as well as the repeated signals with various sampling rates. The CTFT was computed properly, as well as the magnitude spectra for all cases. The various sampling rates for the CTFT were also properly computed.

6. REFERENCES

Winser, Alexander. Williams, Cranos. (2016). *Digital Signal Processing: Principles, Algorithms and System Design*. Academic Press, North Carolina State University, NC.