ECE 345: Linear Systems and Signals

Fall 2020

**Lab #4 Report**

Note: you can use the equation editor in MS Word or a tool such as LaTeXiT to generate formulas for questions which ask about formulas. Alternatively, you can write your derivation and put a photo into the box.

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| **Mini-Lab 1 (54 points)** |  | **Mini-Lab 2**  **(36 points)** |  |  | **TOTAL (90 points)** |
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Group members:

* A
* B
* C
* D

**Minilab 1: Sampling above the Nyquist rate (54 points)**

1. (2 points) What is the Nyquist rate for this signal?
2. (8 points) Use a point FFT to approximate the CTFT of . Plot the magnitude as a function of the frequency in Hz.
3. (10 points) Sample the signal at half the Nyquist rate. Plot the original signal from to using plot and the sampled signal using stem on the same plot. Play your sampled signal using soundsc with the sampling rate . Can you hear the original signal? How does the plot show that you should not expect to hear the original signal?
4. (8 points) Plot the magnitude of the DTFT of the signal from (c) using fft and fftshift.
5. (10 points) Now sample the signal at times the Nyquist rate. Play your downsampled signal using soundsc with the sampling rate . Can you hear the original signal? Plot the DTFT of the resulting downsampled signal. What do you see?
6. (10 points) Use lowpass to filter the signal from the previous part with cutoff equal to twice the Nyquist rate. Play the resulting signal. How does it compare to the original signal from part (a)?
7. (6 points) Repeat the previous two parts with . What differences do you see and hear?

**Mini-lab 2: Audio manipulation and filtering (36 points)**

1. (3 points) Read in the file mysteryclip.wav, extract the left channel, and listen to the clip. Can you tell what is being said?
2. (8 points) Compute the STFT and save the resulting image.
3. (8 points) Design a DT filter to remove the reverb of the signal. Plot the STFT.
4. (8 points) Design a notch filter using iirnotch and use filter to remove the tone. Plot the STFT of the result.
5. (8 points) Use the lowpass function to filter out the highpass noise and listen to the result. Adjust your cutoff for the lowpass filter appropriately to make the audio signal understandable. Plot the STFT of the result.
6. (1 point) What is the person saying in the clip?