EE386 Digital Signal Processing Lab Jul-Dec 2021

4: Experiment

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1 Solution

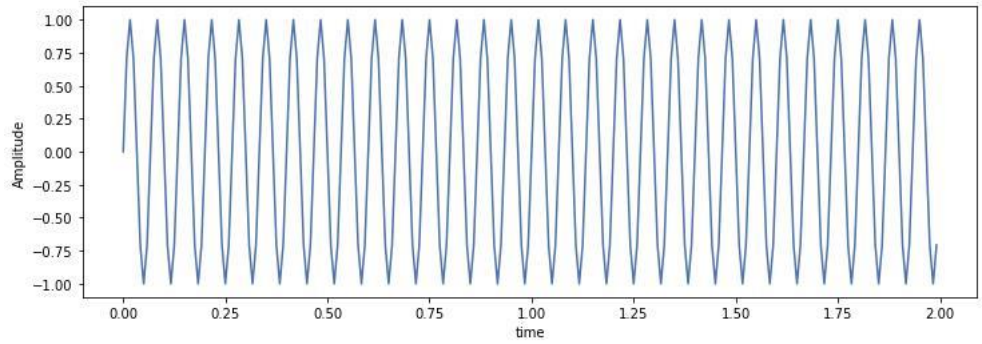
α= 1 + mod(x; 3) where x is the last three digits of registration number. Since x = 162,

$$\alpha = 1 + \mathrm{mod}(162; 3)$$

$$\alpha = 1$$

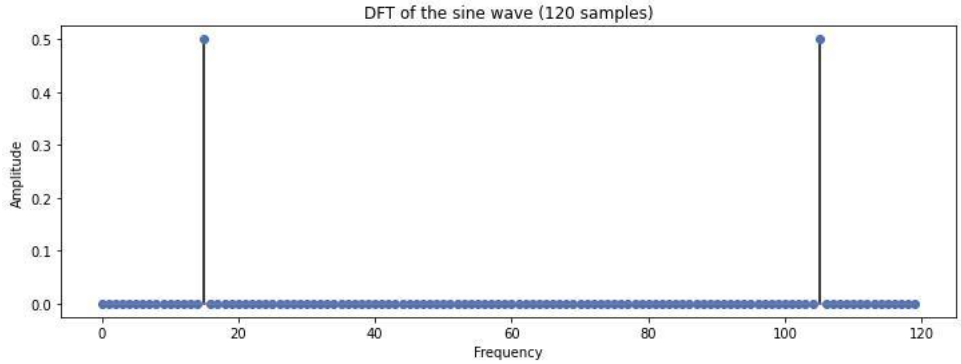
To find DFT

We have to generate a unit amplitude signal frequency 15Hz (15α) for the duration of 2 seconds with a sampling rate of 120 samples/sec.

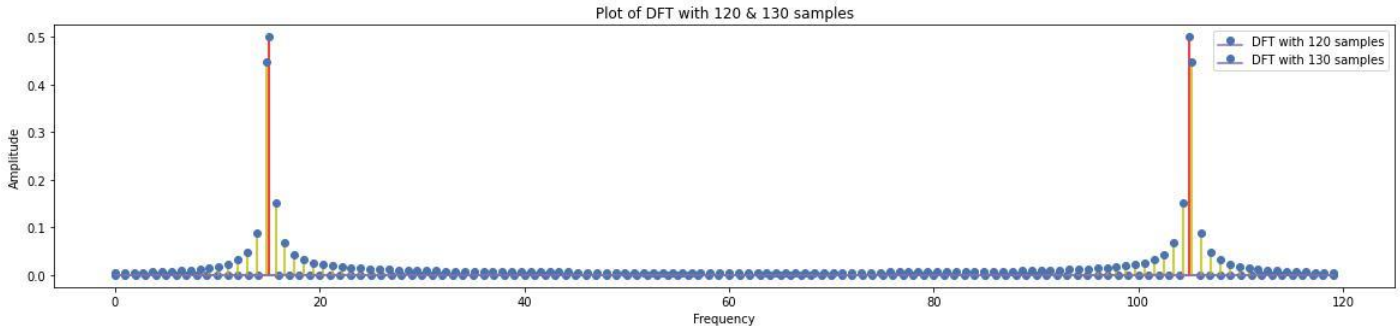


Q1 Plot of magnitude of DFT of the first 120 samples of the signal against frequency in Hertz.

Solution-

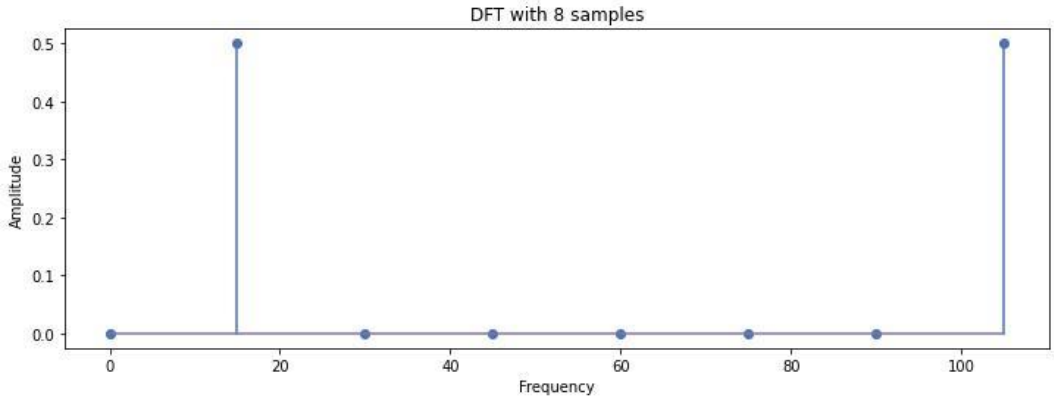


Q2 Plot of magnitude of DFT of the first 130 samples of the signal.
Solution-



As seen the spectral leakage is very less in case of 120 samples(stem plot in orange color) and is much higher in case of 130 samples(stem plot in yellow color). So, the spectral leakage is observed when the sampling frequency is not the multiple of periodicity.

Q3 Report N(N≠120) such that first N points of the signal matches with the DFT of the rst 120 samples of the signal.
Solution-



$$\frac{f}{Fs} = \frac{k}{N}$$
$$N = k\frac{Fs}{f}$$
$$N = 8k(Fs = 200, f = 15)$$

Periodicity is 8. So we would not find spectral leakage for all the values of N where N is multiple of 8.

Resolution of DFT

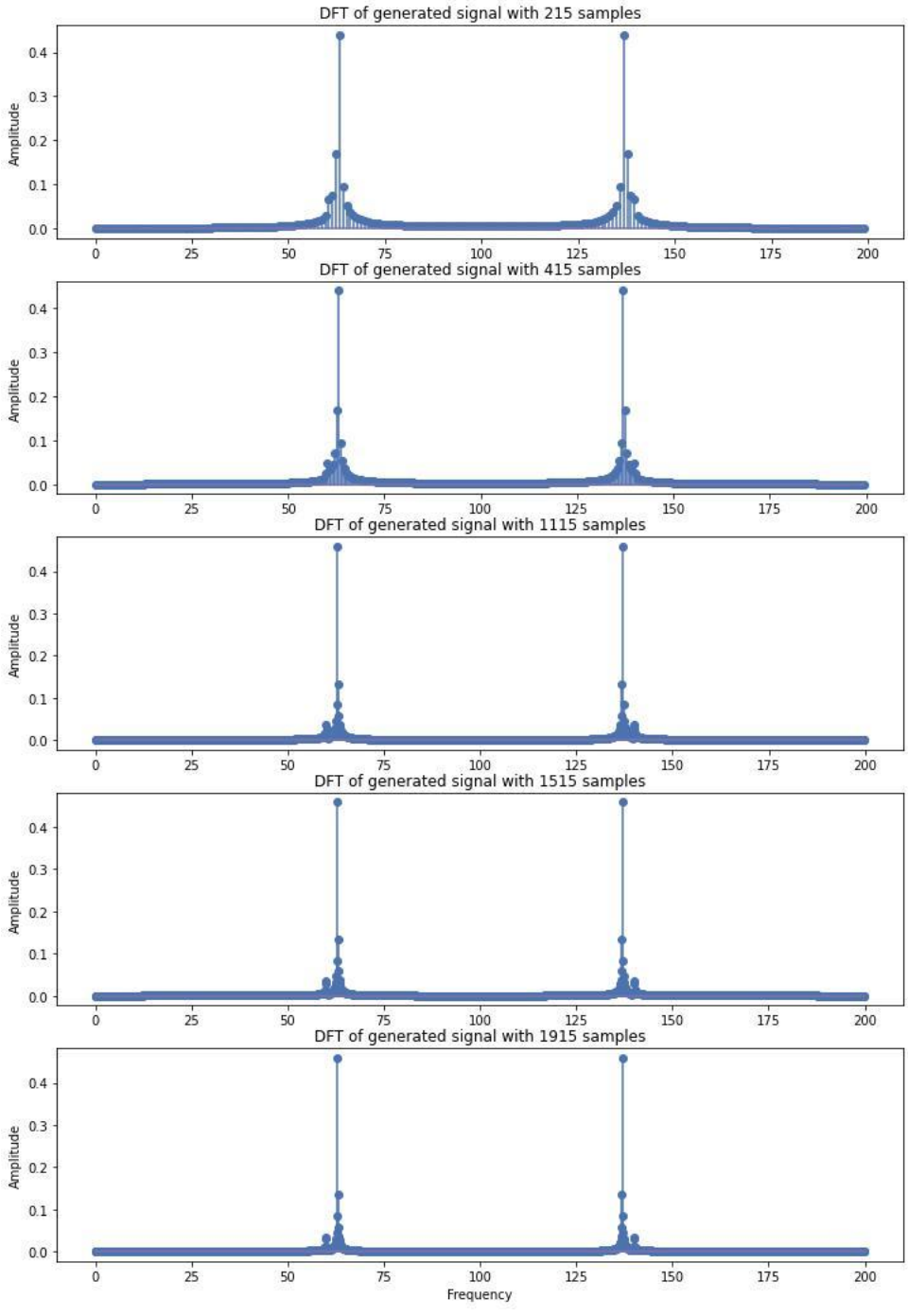
Plot of the DFT of signal for

1. 215 samples
2. 415 samples
3. 1115 samples
4. 1515 samples
5. 1915 samples in 5 separate figures.

$$\alpha = 1$$

$$A = 120, B = 126$$

$$x(a) = 0{:}1 \sin 120\, t + \cos 126\, t$$



With increase in the number of samples, the resolution of the DFT increases and spectral leakage decreases.

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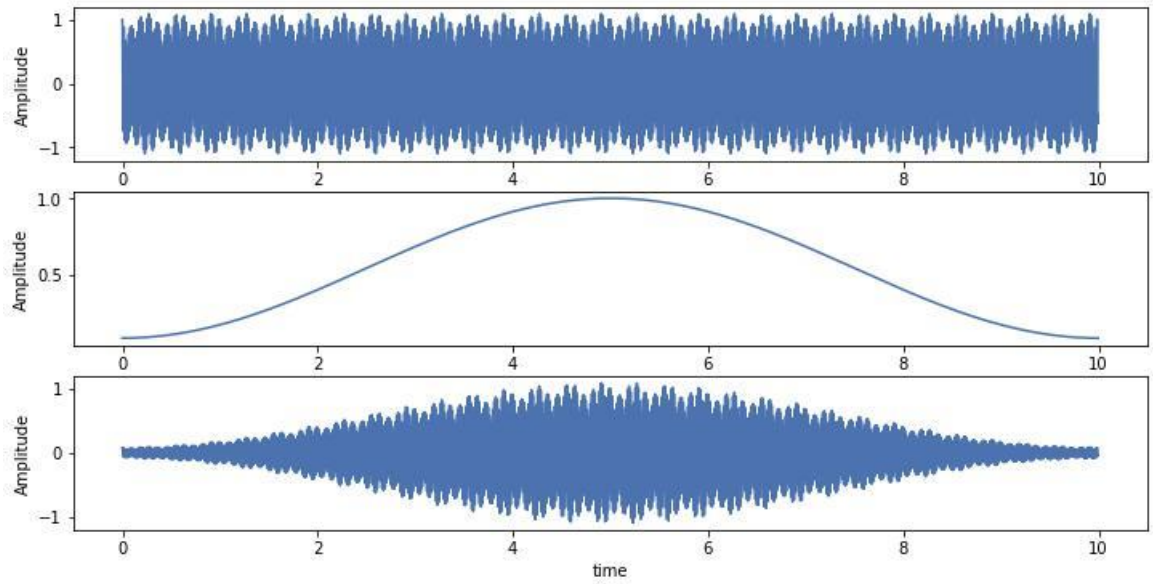
Resolution of DFT with windowing

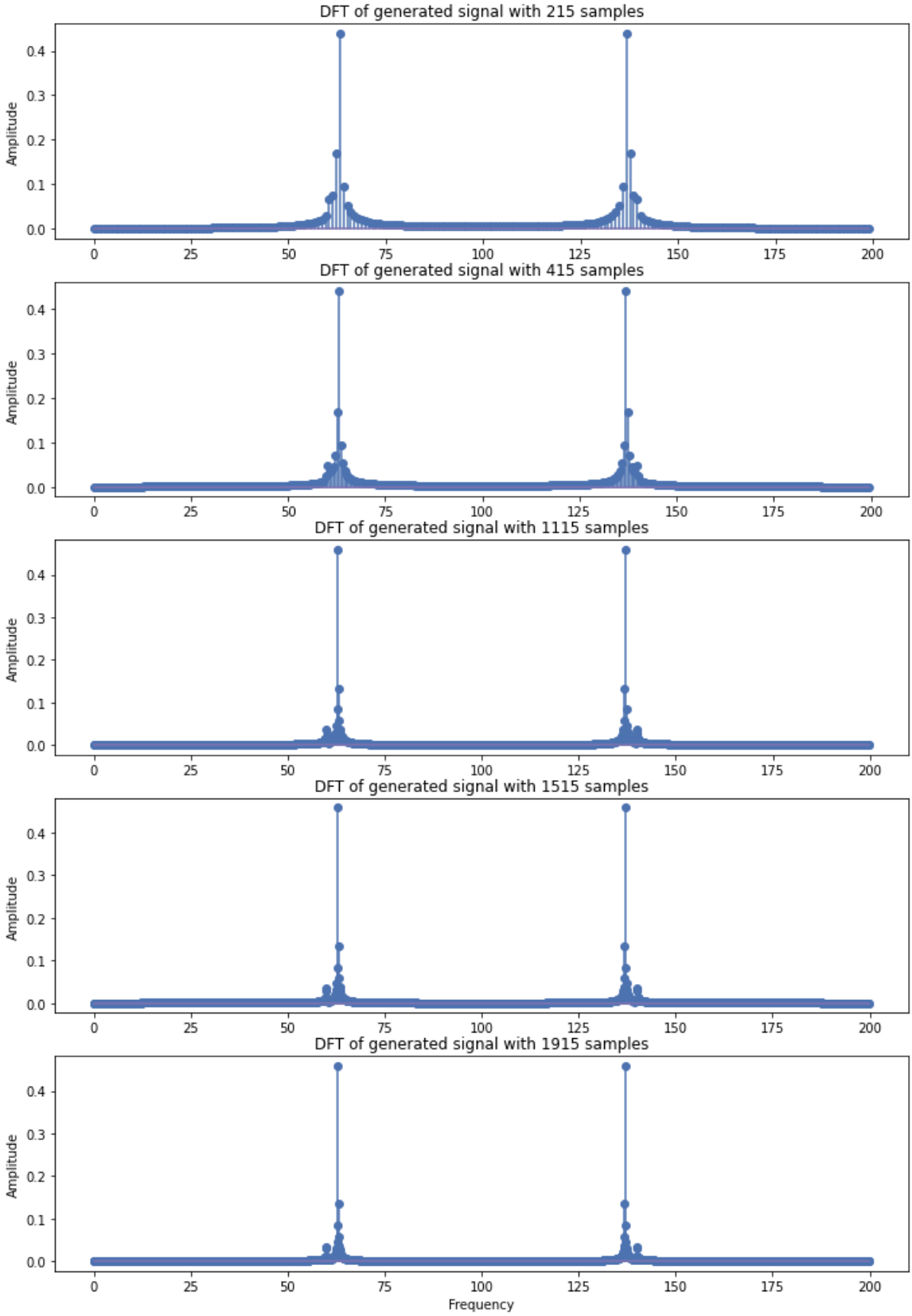
DFT signal by windowing the time domain signal using Hamming window as α= 1.



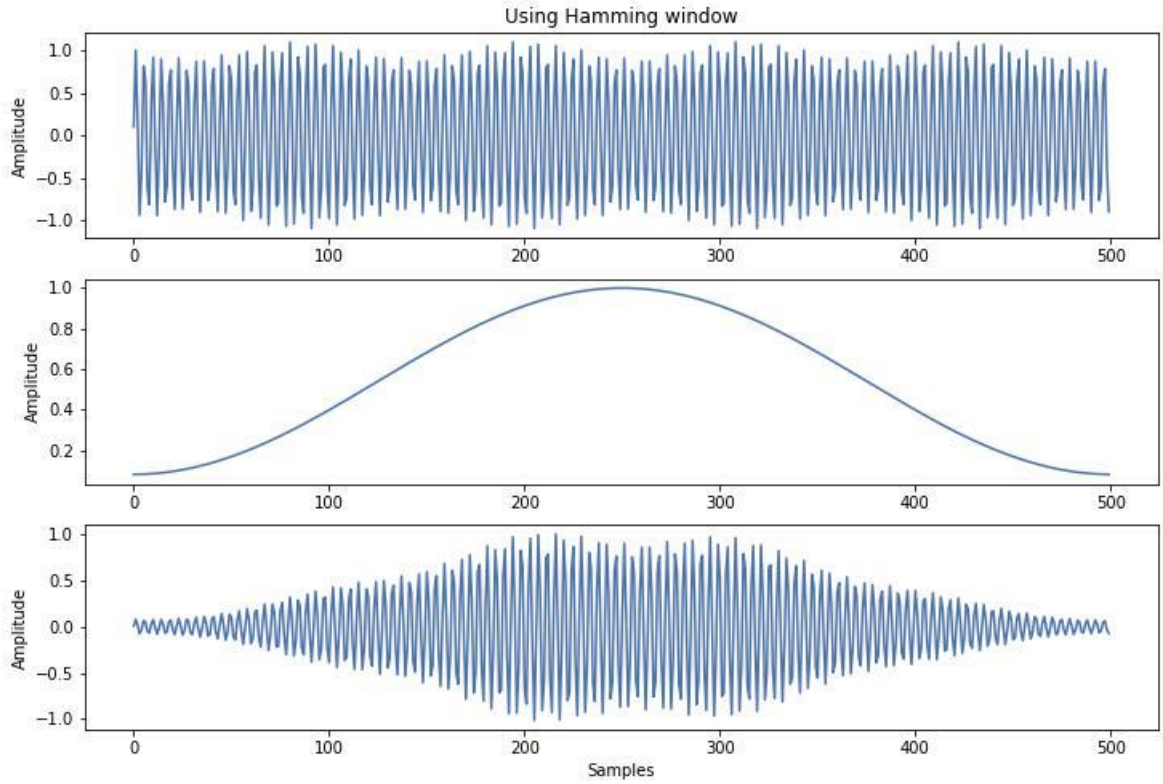
Signal windowed using hamming window technique

$$h(n) = 0.54 - 0.46 * \cos \frac{2\pi}{N} n$$

It is observed from figure below that in the DFT windowed using hamming window, the spectral leakage and the resolution is also less when compared to that of rectangular window as shown in the Q2.

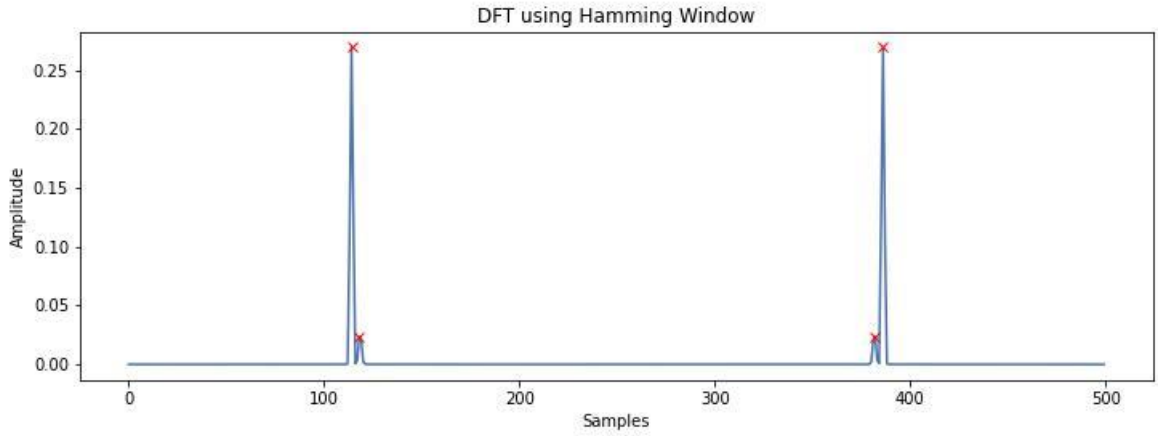


Frequency Estimation using windowing 500 samples in the data from Exp4Data1.txt. The signal is loaded and multiplied by a hammer window. Plot for it:



Q1

Windowed signal is translated to frequency domain and plotted.
scipy:signal.find$_p$eaks is used to detect the peaks in the DFT.



The peaks marked correspond to the samples: 114,118,382,386. The last two peaks are caused by the symmetry characteristic of signal. Hence, because samples 114 and 118 correspond to two frequency components of the dual tone out of a total of 500 samples, the dual tone frequencies in terms of sampling frequency are:

$$F1 = \frac{114}{500} * Fs = 0.228 * Fs$$
$$F2 = \frac{118}{500} * Fs = 0.236 * Fs$$

A Code Repositories

Refrain from including any or all code in this document. Upload codes to your repository and include the links to executed files here as -The codes to reproduce the results can be found in the GitHub repository - https://github.com/TanmayRanaware/DSP_Lab_Experiment4