Assignment No 9

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EE20B084

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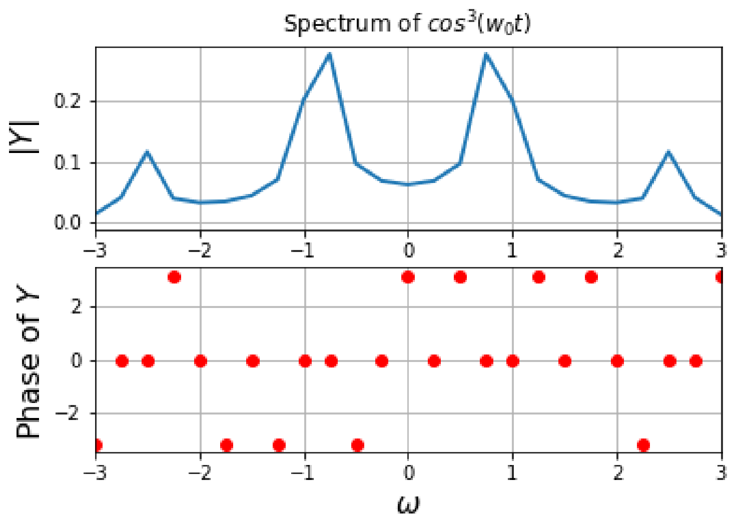
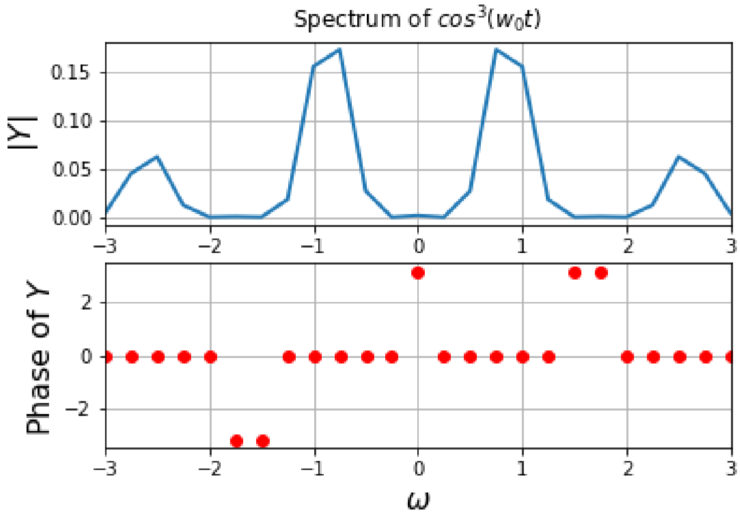
1 Questions

1.1 Question 2

In this question, we shall plot the FFT of $cos^3(0.86t)$ The FFT without the hamming Window:



The FFT with the hamming Window:



We notice that a lot of the energy is stored in frequencies that aren't a part of the signal. After windowing, these frequencies are attenuated and hence the peaks are sharper in the windowed function.

1.2 Question 3

We need to estimate ω and δ for a signal $\cos(\omega t + \delta)$ for 128 samples between $[-\pi, \pi)$. We estimate omega using a weighted average. We have to extract the digital spectrum of the signal and find the two peaks at $\pm\omega_0$, and estimate ω and δ.

We estimate omega by performing a Mean average of ω over the magnitude of $|Y(j\omega)|$. For delta we consider a widow on each half of ω (split into positive and negative values) and extract their mean slope.

1.3 Question 4

We repeat the exact same process as question 3 but with noise added to the original signal.

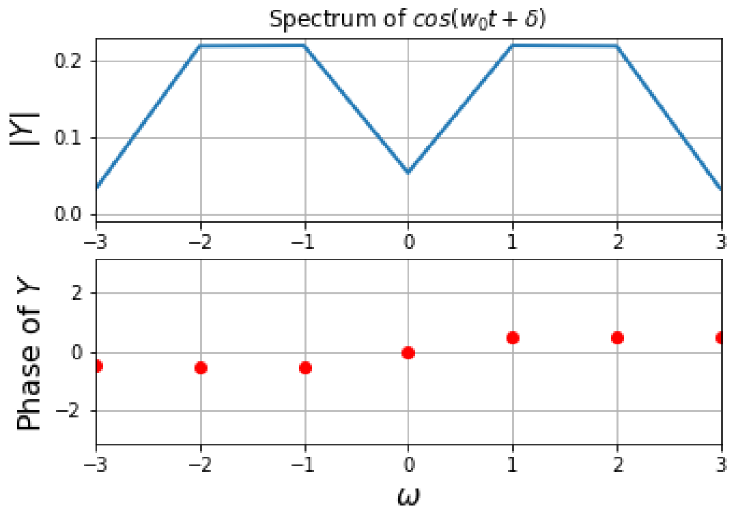


Figure 1: Fourier transform of $cos(1.5t + 0.5)$

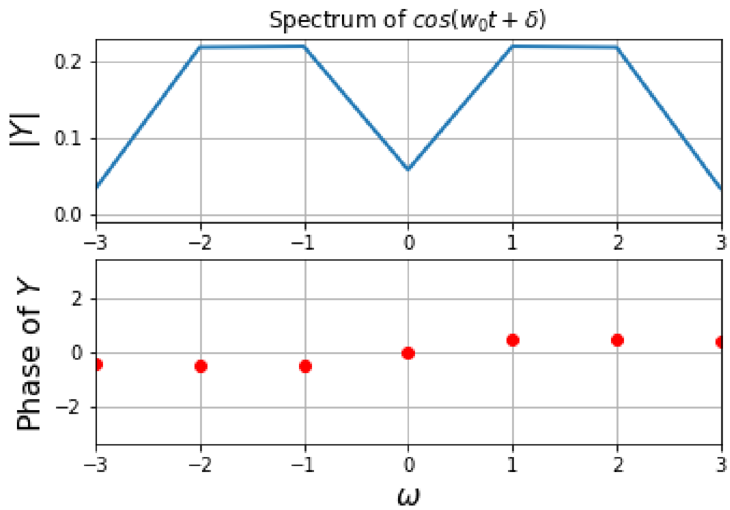


Figure 2: Fourier transform of noise + $cos(1.5t + 0.5)$

1.4 Question 5

In this question we analyze a chirp signal which is an FM signal where frequency is directly proportional to time. A chirp signal we shall consider is given by

$$f(t) = cos(16t(1.5 + \frac{t}{2\pi})) \tag{1}$$

The FFT of the chirp is given by: We note that the frequency response is spread between 5-50 rad/s. A large section of this range apears due to Gibbs phenomenon. On windowing, only frequencies between 16 and 32 rad/s remain.

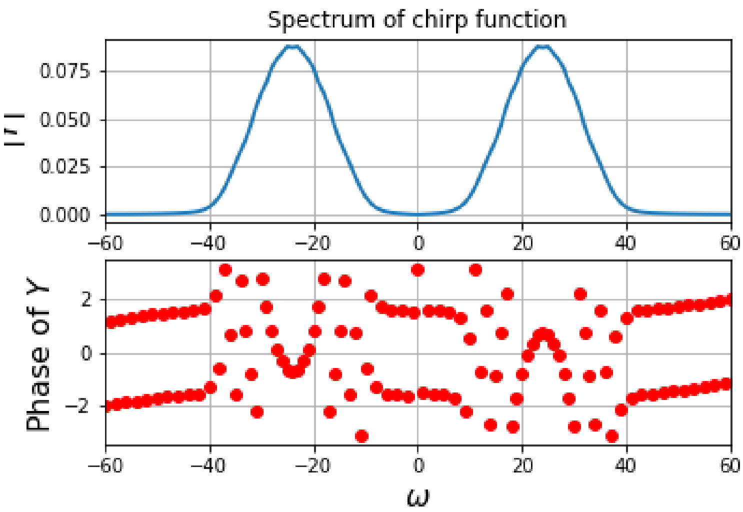


Figure 3: Chirp function fourier transform, windowed

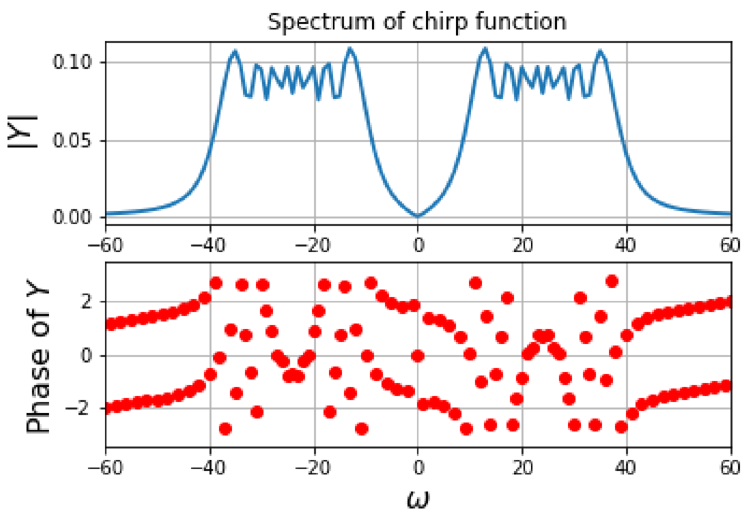


Figure 4: Chirp function fourier transform

1.5 Question 6

For the same chirped signal, we break the 1024 vector into pieces that are 64 samples wide. Extract the DFT of each and store as a column in a 2D array. Then plot the array as a surface plot to show how the frequency of the signal varies with time.

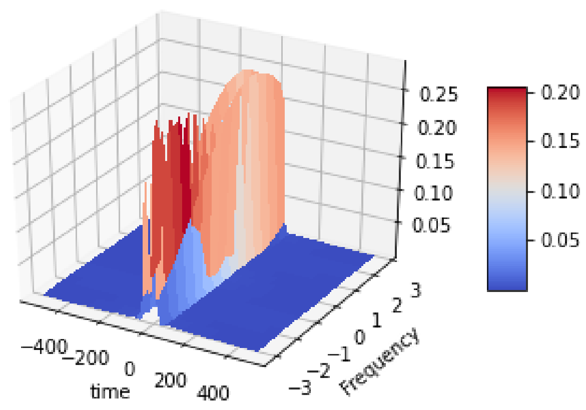


Figure 5: Chopped Chirp function, —Fourier transform—,windowed

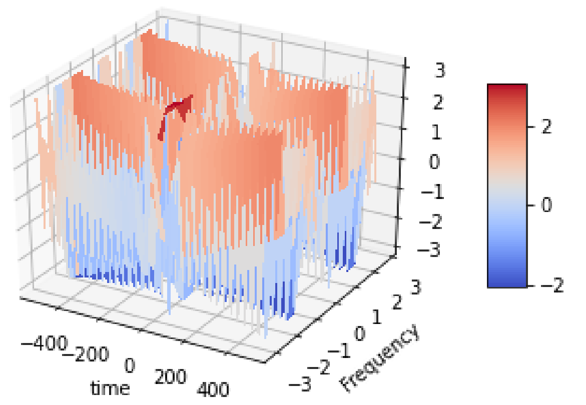


Figure 6: Chopped Chirp function, Phase of Fourier transform