EE2703 : Applied Programming Lab
Assignment 6B
SPECTRA OF NON PERIODIC SIGNALS

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May 24, 2021

Objective

In the last Assignment, we analysed period signals using the FFT library in python. In this Assignment, we will be using non periodic signals as inputs and try to minimize the error that we obtain via the gibbs phenomenon. A techinique called hamming window is used to achieve this goal.

Section 1

Hamming window - It is a technique used to reduce inaccuracies caused at endpoints of the interval of a function. It is defined as such:

$$w[n] = \begin{cases} 0.54 + 0.46cos(\frac{2\pi n}{N-1}) & |n| \leq \frac{N-1}{2} \\ 0 & else \end{cases}$$

We shall use this logic in order to solve our questions.

Section 2

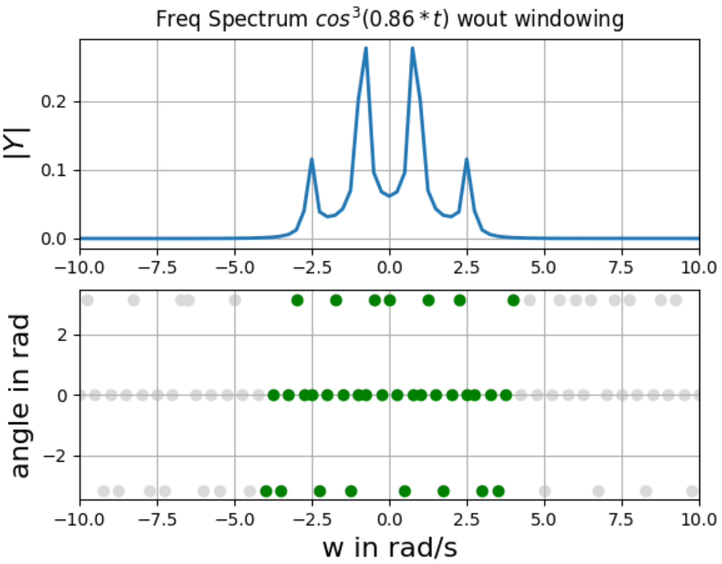
let y = $cos^3(wt)$ with w = 0.86. The cubic sinusoid can be split up and written as

$$cos^3(0.86t) = \frac{1}{4}cos(3(0.86)t) + \frac{3}{4}cos(0.86t)$$

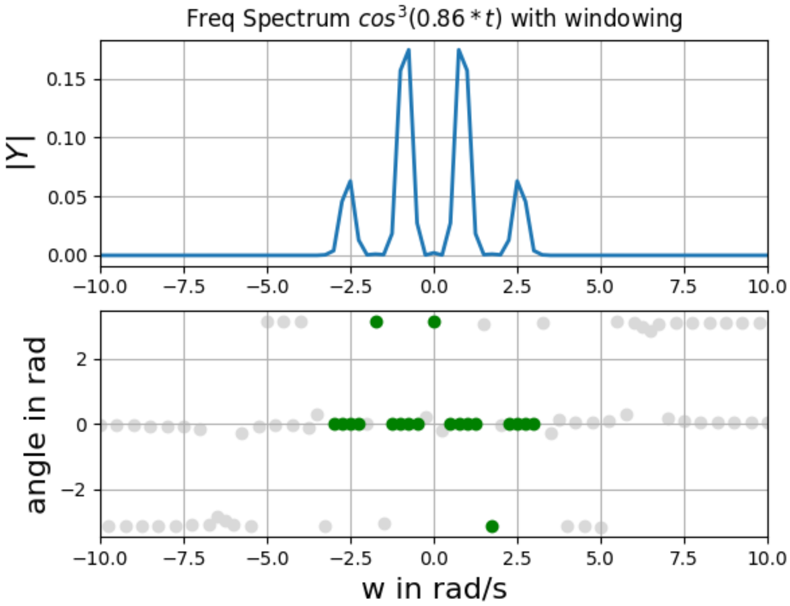
.

We can expect peaks at ± w and $\pm 3w$. Let us plot and check this.

Without windowing:



With Windowing:

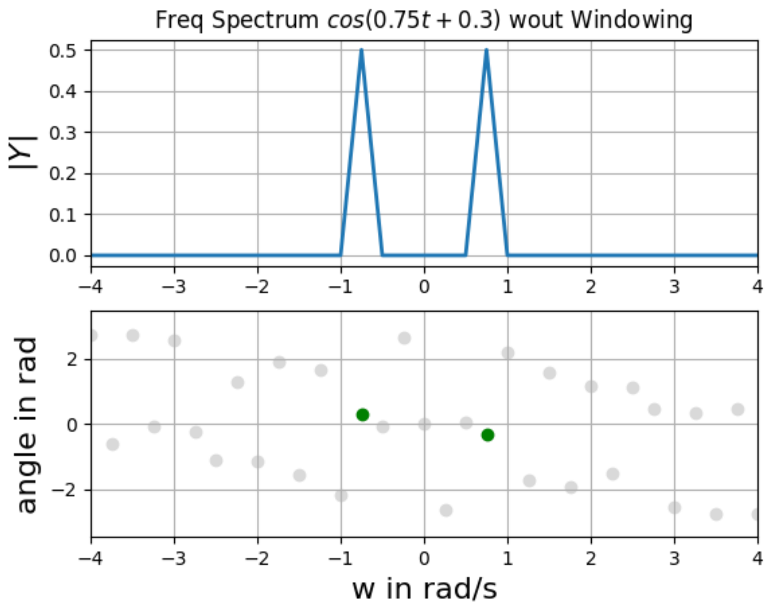


The result is as expected in both cases.

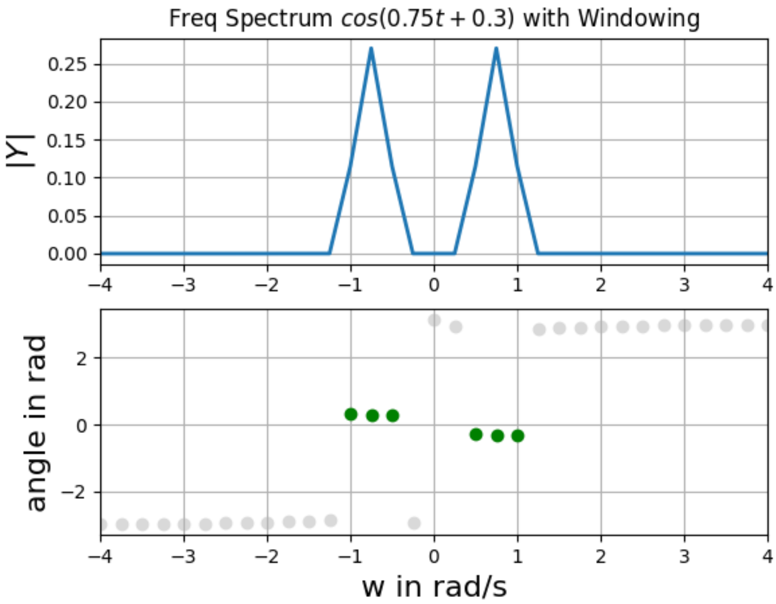
Section 3

let y = $cos(wt + \delta)$ with w = 0.75 and $\delta = 0.3$.

Without windowing:



With Windowing:



.

Lets try to estimate the values ourselves. We can take a weighted mean of the value with the mag square being the respective weights for all freqs under the peak. Using this process, I got the following values.

Expected w0: 0.75

Expected delta: 0.30000000000000004

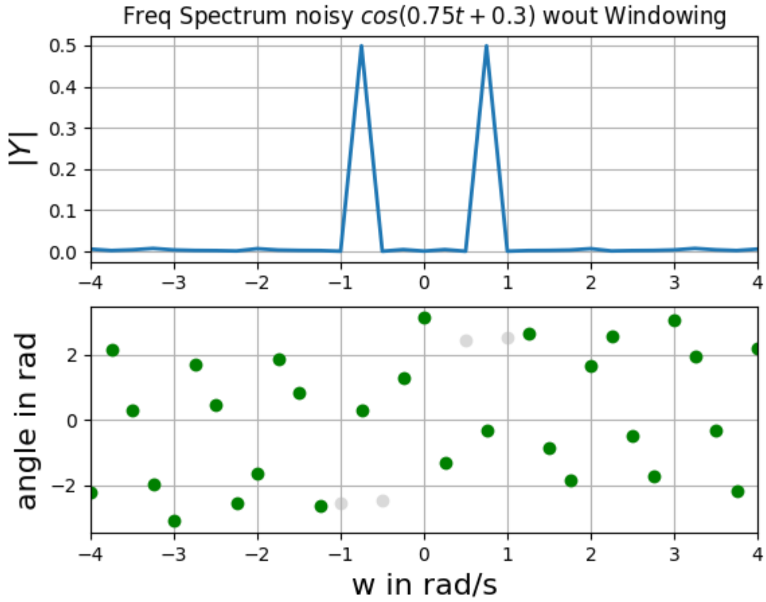
It is quite accurate.

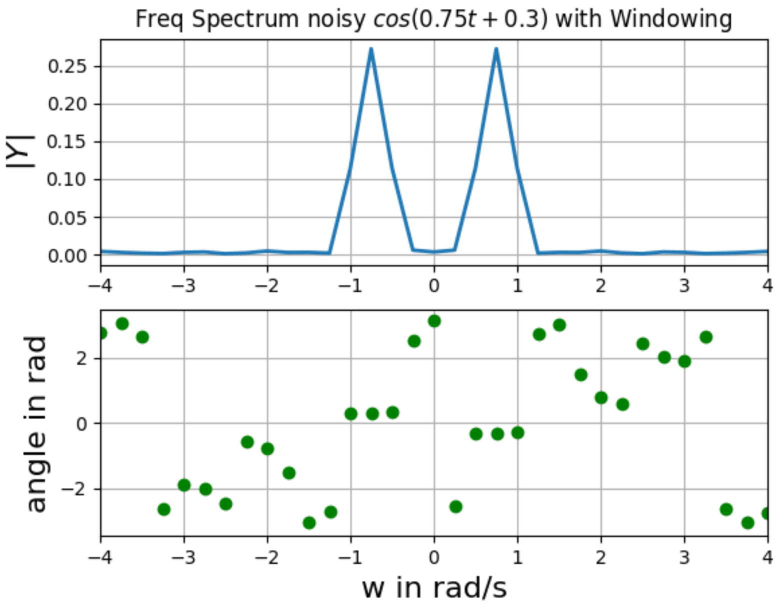
Section 4

We will be adding white gaussian noise to the system. We do this by adding the term 0.1 * randn(len(x)) to y.

y=$cos(wt + \delta)$+0.1 * randn(len(x))

We get the following plots.





Let us again estimate the same and find w and δ

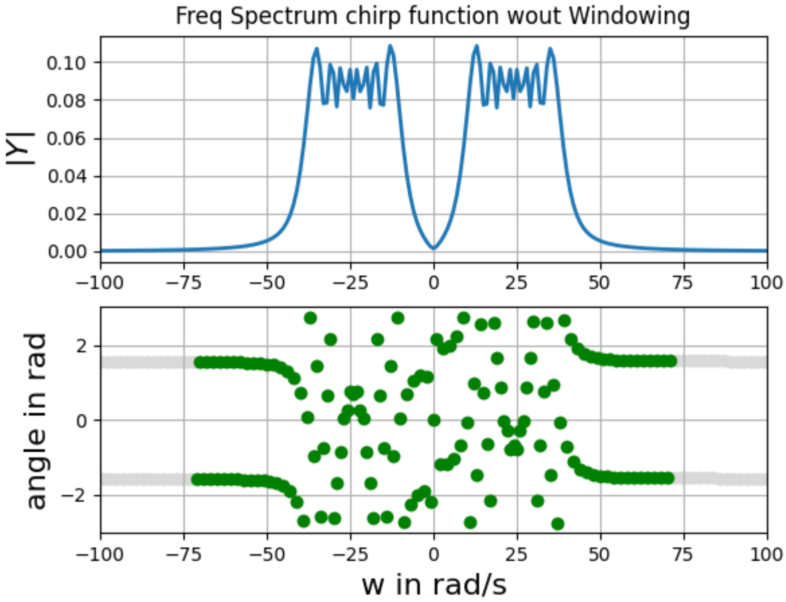
Expected w0: 0.75 Expected delta: 0.2954307476518013

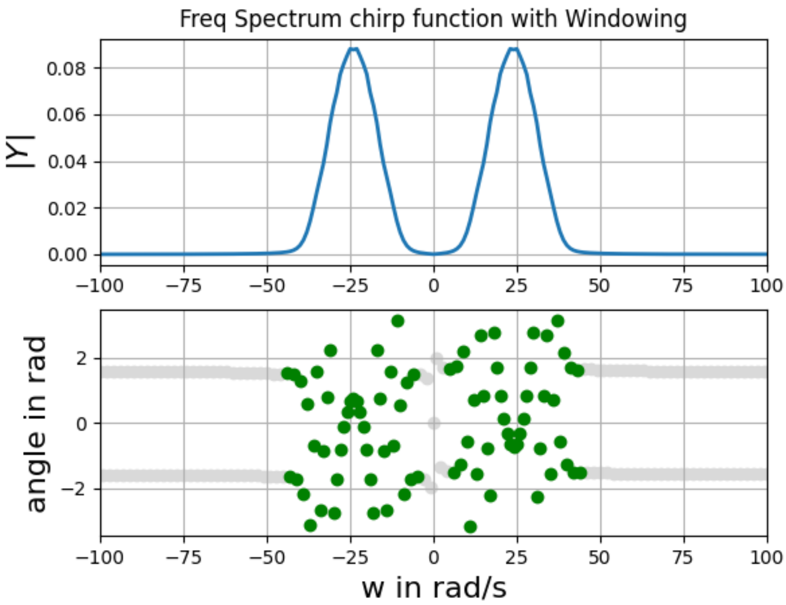
It's delta is close, but not as accurate.

Section 5

This is a chirped signal. Let us find it's DFT. $y = cos(16(1.5 + \frac{t}{2\pi})t)$

We get the following graphs.

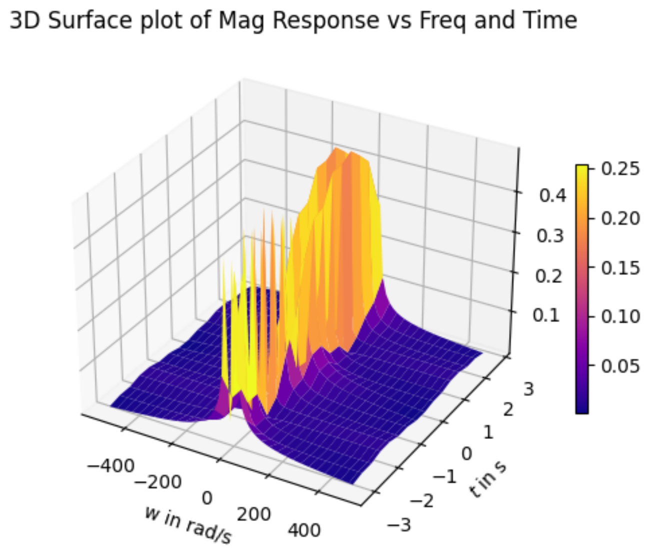


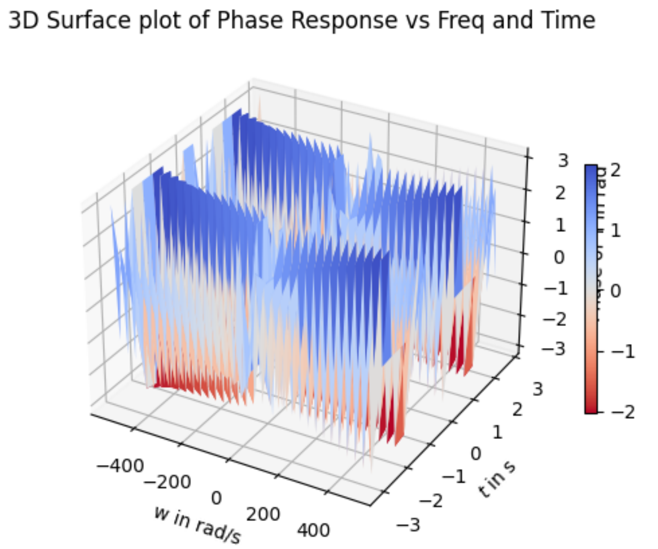


The hamming window greatly smoothens the function. We have thus identified the main frequencies around ± 25.

Section 6

Now, we break the signal obtained in the previous question using reshape function into a 16 samples, each 64 wide. The following plots are obtained.





It is a bit confusing to understand what is happening in the graph. As we move along the time axis, the gaps between the 2 consecutive peaks increase. They are also more well defined.

Conclusion

We analysed non periodic signals using FFT and used the hamming window approach for the betterment of the result. By taking a weighted mean method, we got a pretty accurate approximation of the frequency and phase shift. We analysed the the chirped signal, and found that the hamming window improves the result and allows us to identify the main signal. Lastly, we used a 3D plot of t,w and magnitudes/phases and analysed how the spectrum varied with time.