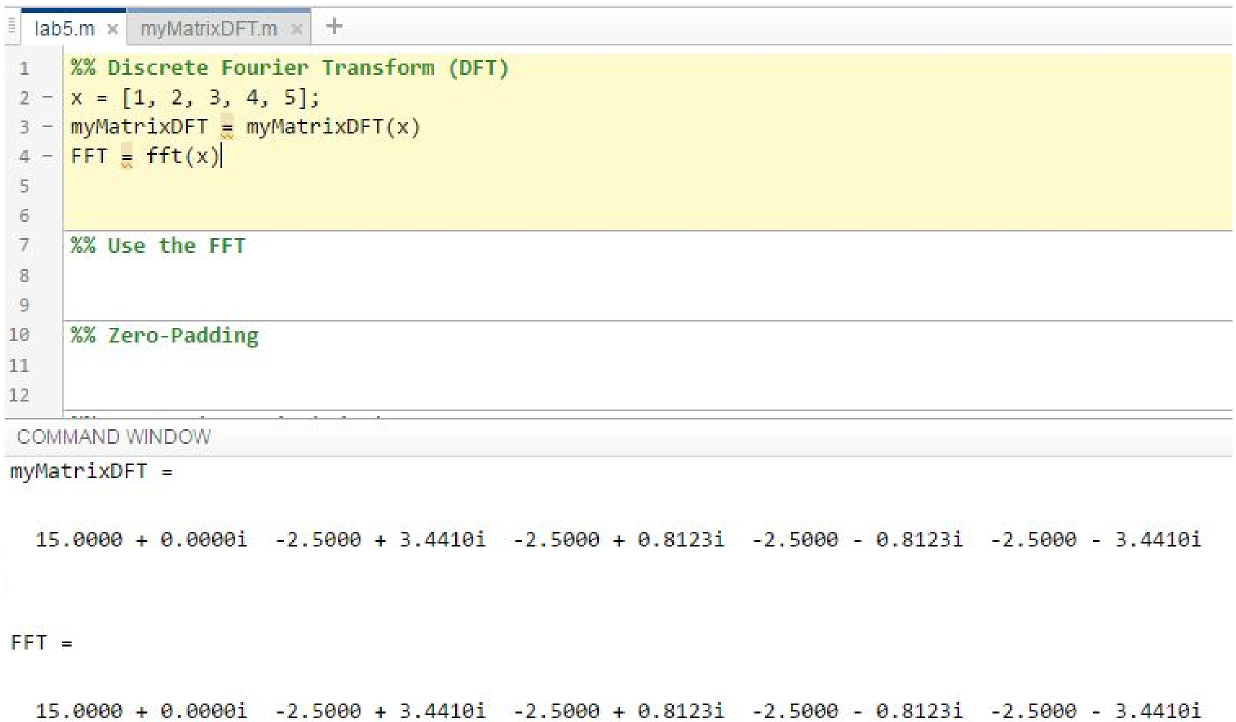
Lab 5
Name: Zhijie Jin
NetID: zhijiej2

1. Discrete Fourier Transform (DFT)

Report Item 1:

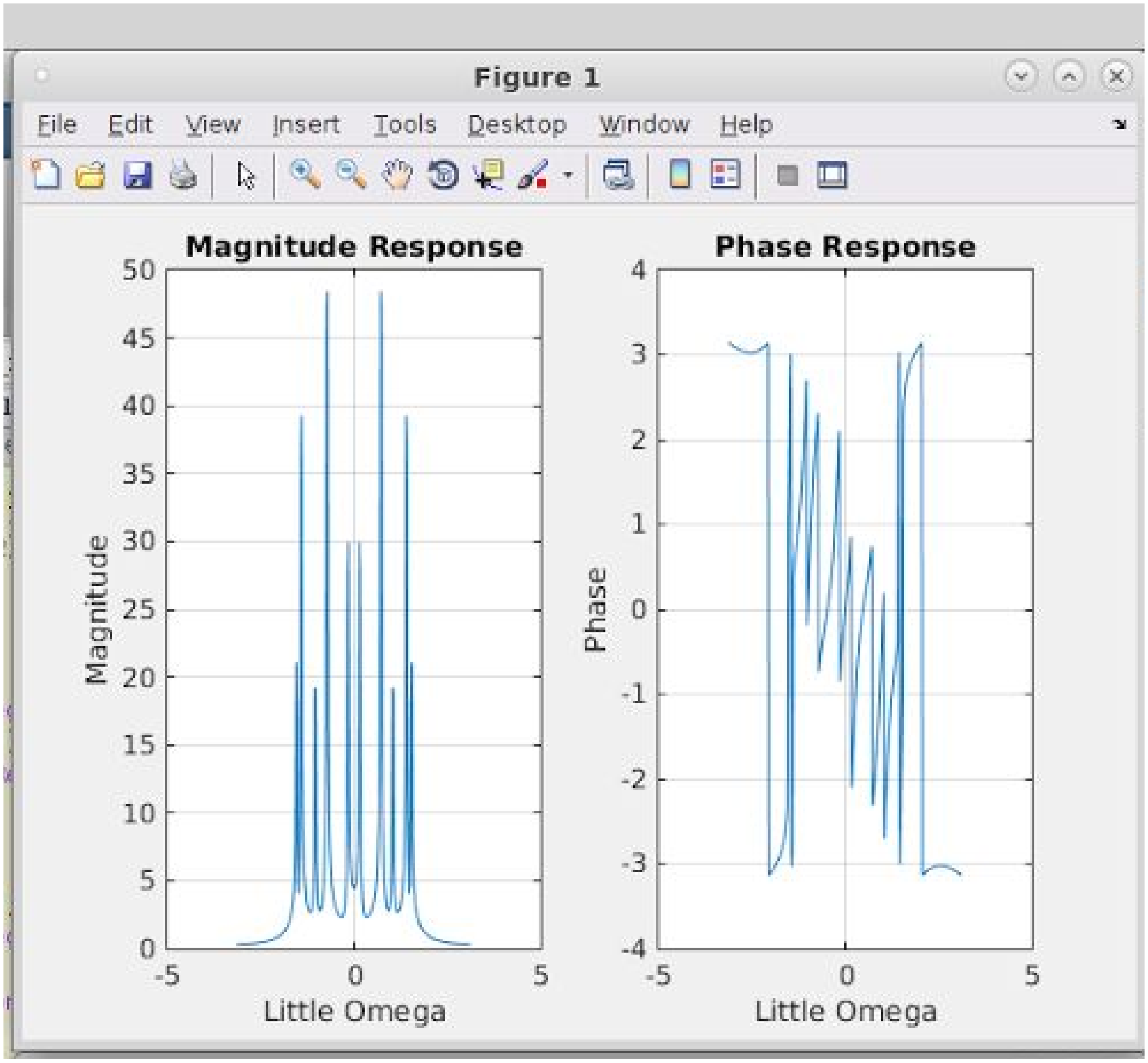


Calculated DFT using myMatrixDFT function is shown in the picture above. The value from fft is also in the picture. These two values matches each other. The DFT calculation has O(N^2) complexity because we have to go through x[n] to calculate one X[n], and we need to do this for N times to get all X[n]. This makes the calculation complexity N^2.

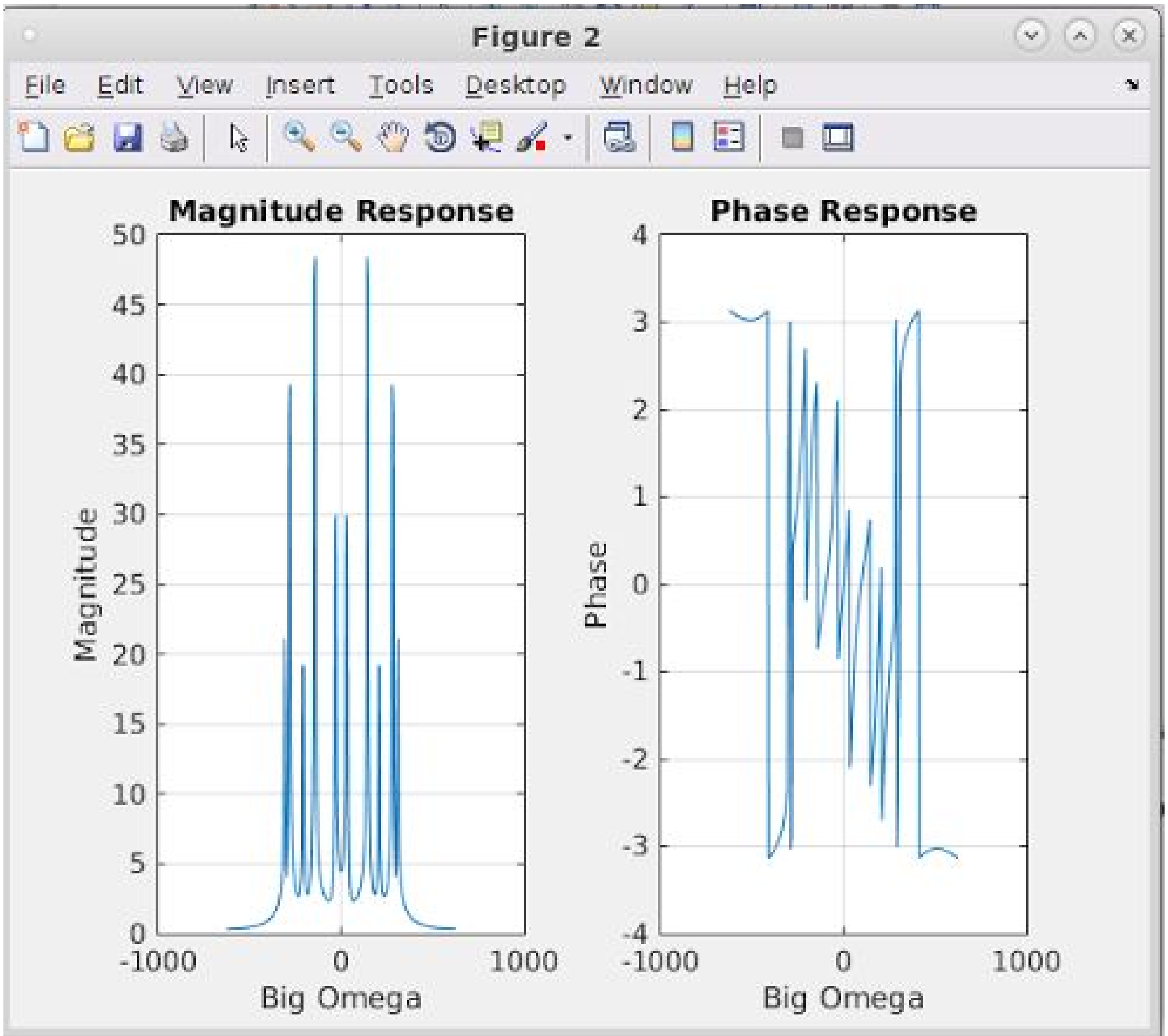
2. Use the FFT

Report Item 2:

The magnitude and phase response of $X_d(w)$ is shown below.



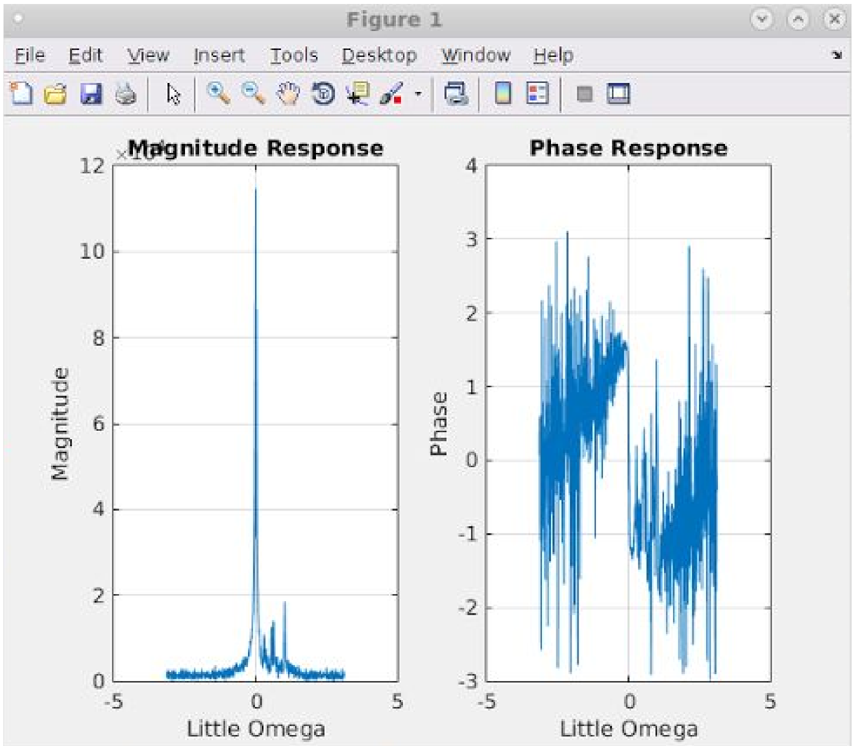
The magnitude and phase response of $X_d(\Omega)$ with $f_s = 200$ is shown below.



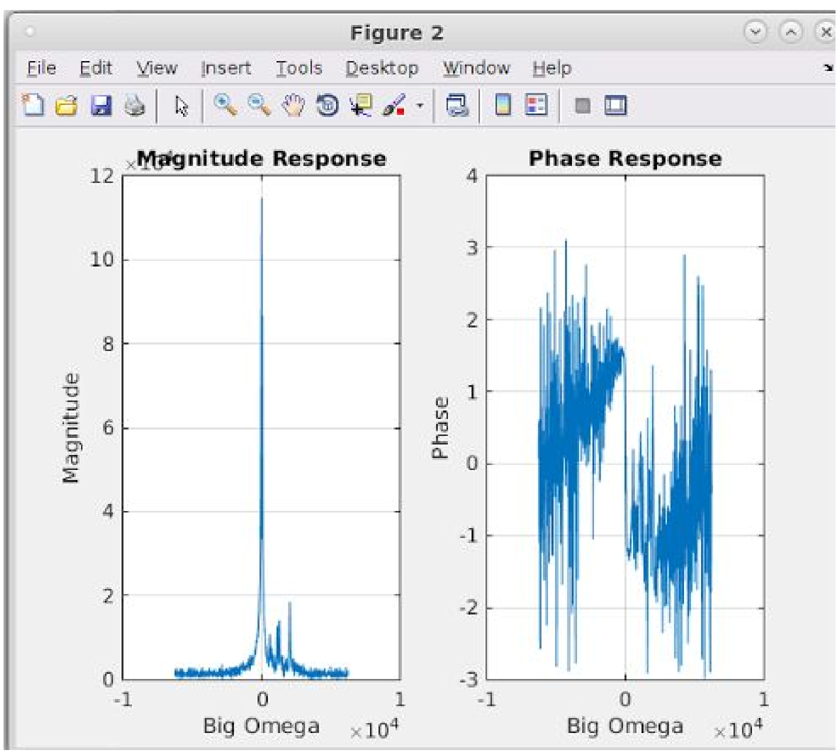
3. Zero-Padding

Report Item 3:

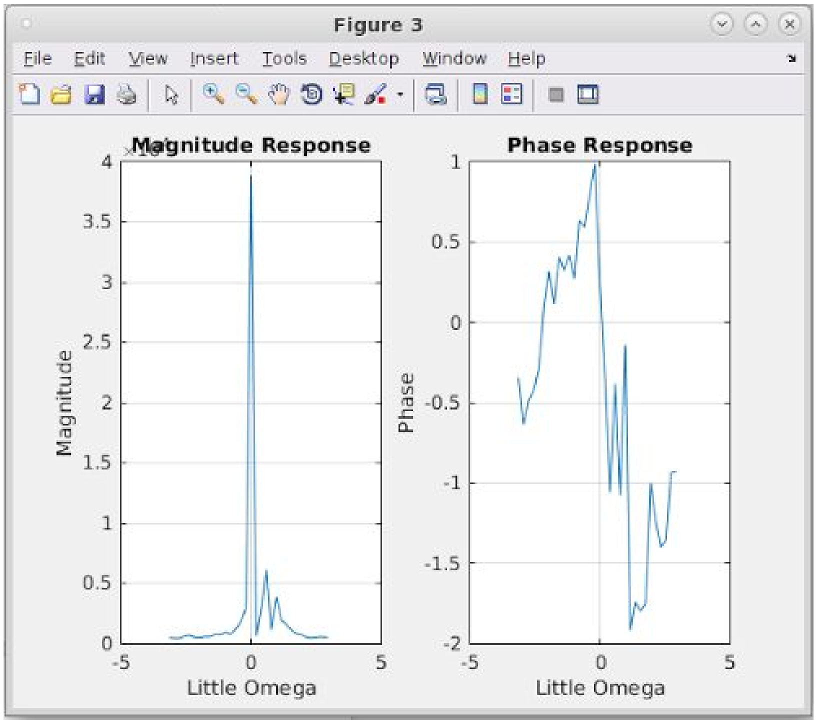
The magnitude and phase spectrum are shown below.



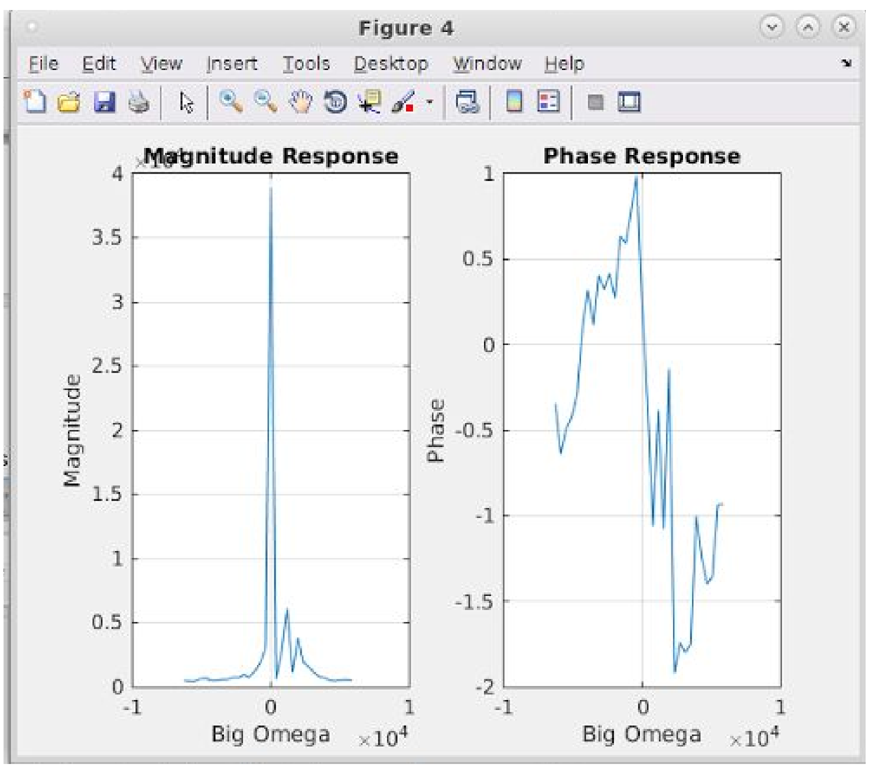
In Ω domain, the magnitude and phase spectrum are:



The magnitude and phase spectrum of first 32 points:

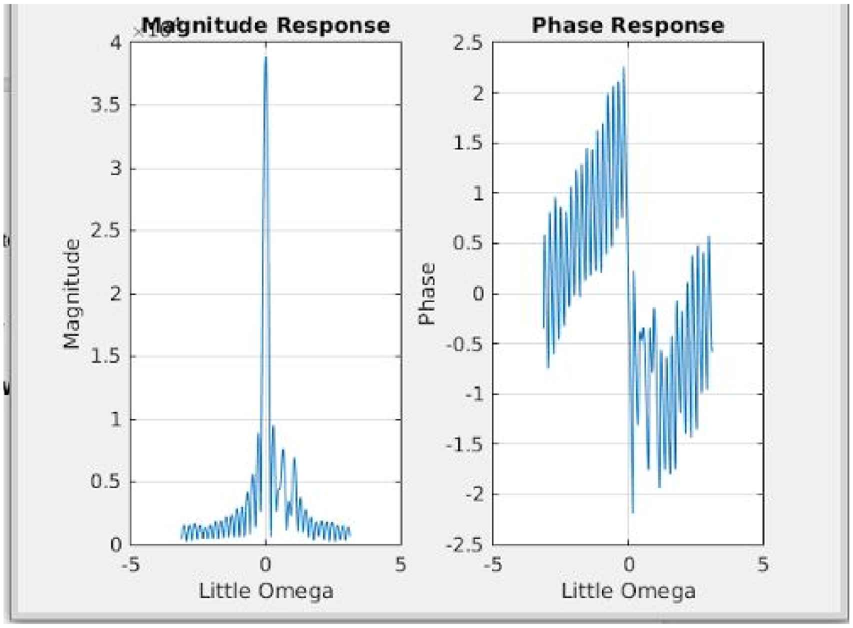


In Ω domain, the magnitude and phase spectrum are:

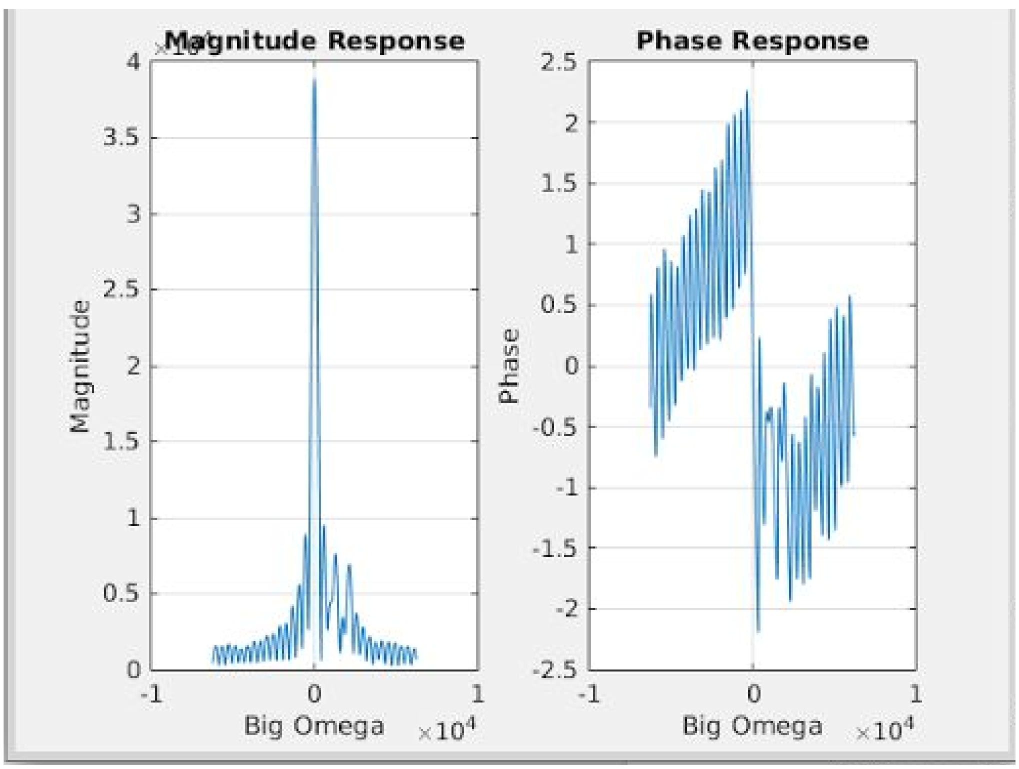


Peaks corresponding to creatine and chlorine can be seen from the plot.

The magnitude and phase spectrum after zero-padding the first 32 points to 512 points.



In Ω domain, the magnitude and phase spectrum are:



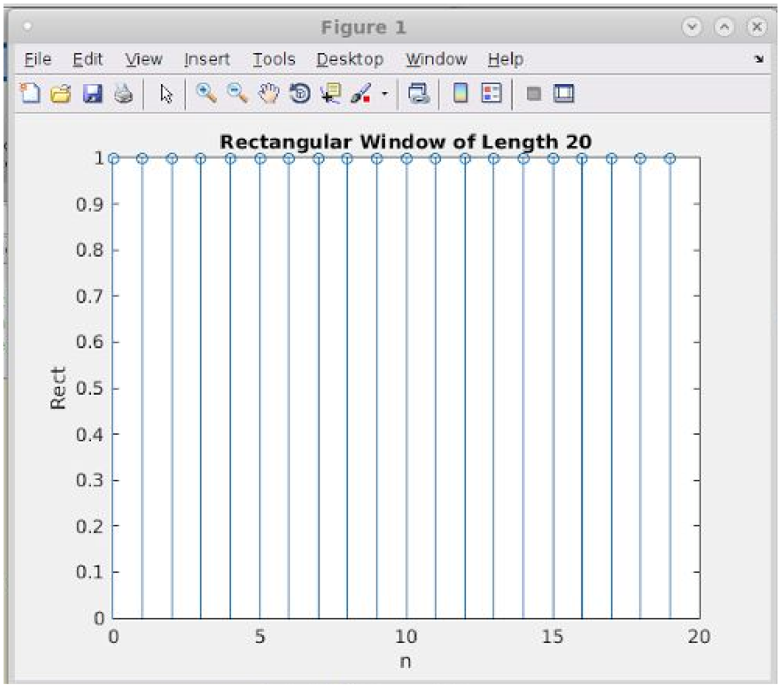
Peaks of creatine and chlorine can also be seen. Zero-padding shows more peaks on the plot (increases the resolution of the spectrum). It doesn't help a lot because original one is clear enough. But the padding indeed shows more details of the spectrum.

4. Truncation and Windowing

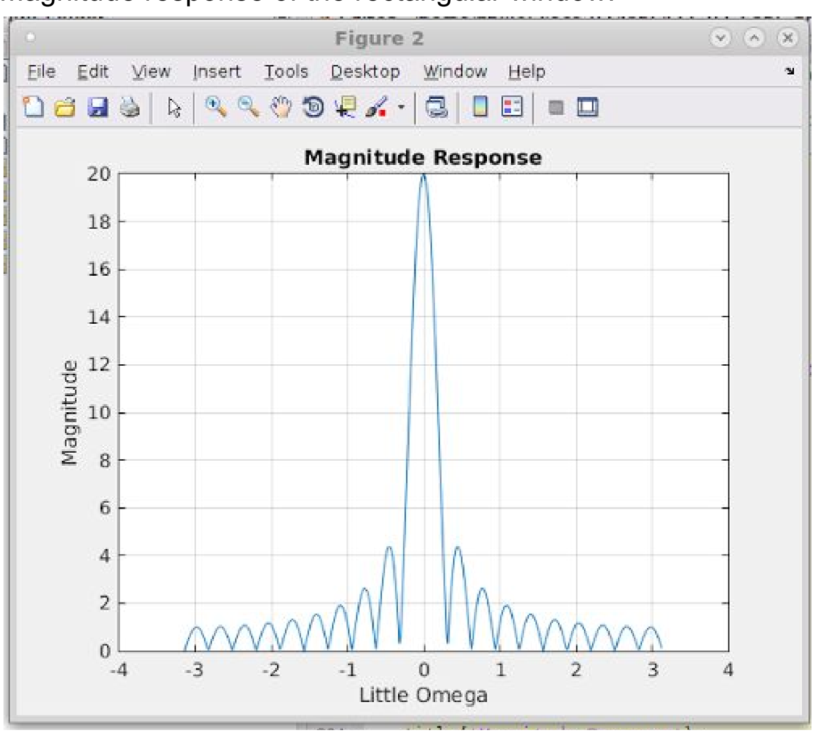
Report Item 4:

Rectangular Window:

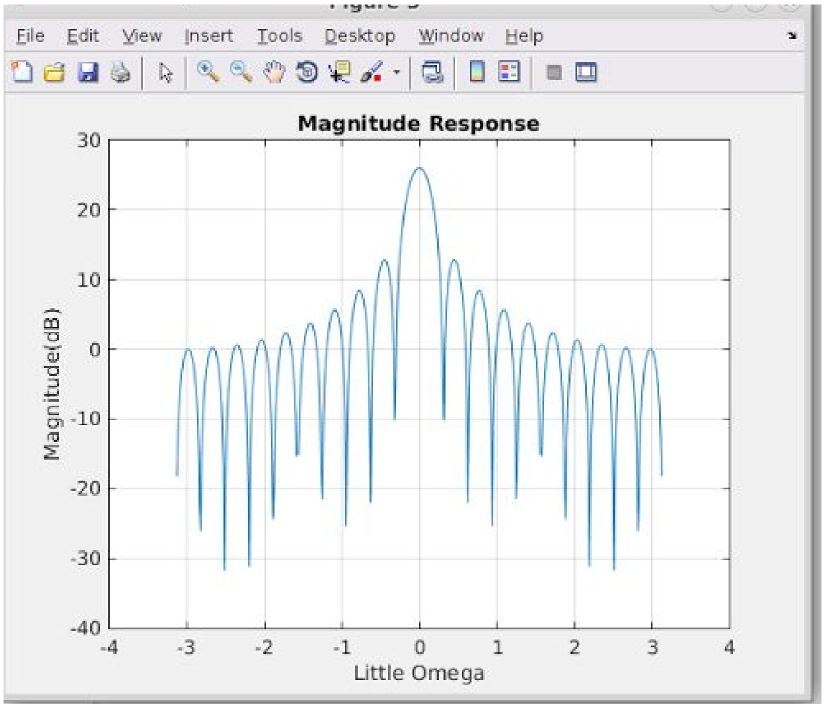
The window:



Magnitude response of the rectangular window:

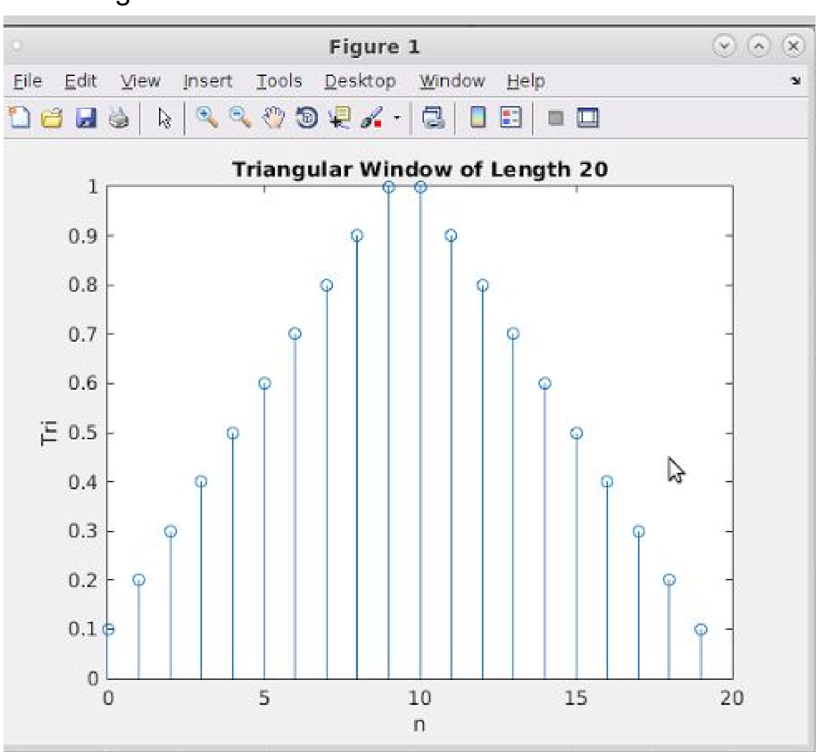


mag2dB of the rectangular window:

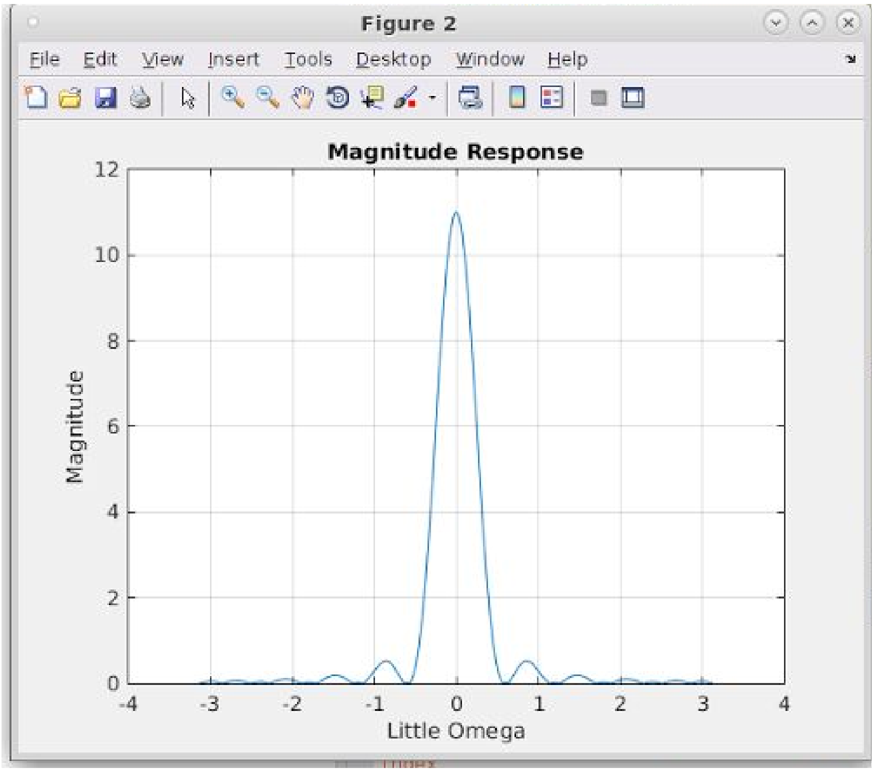


Triangular Window:

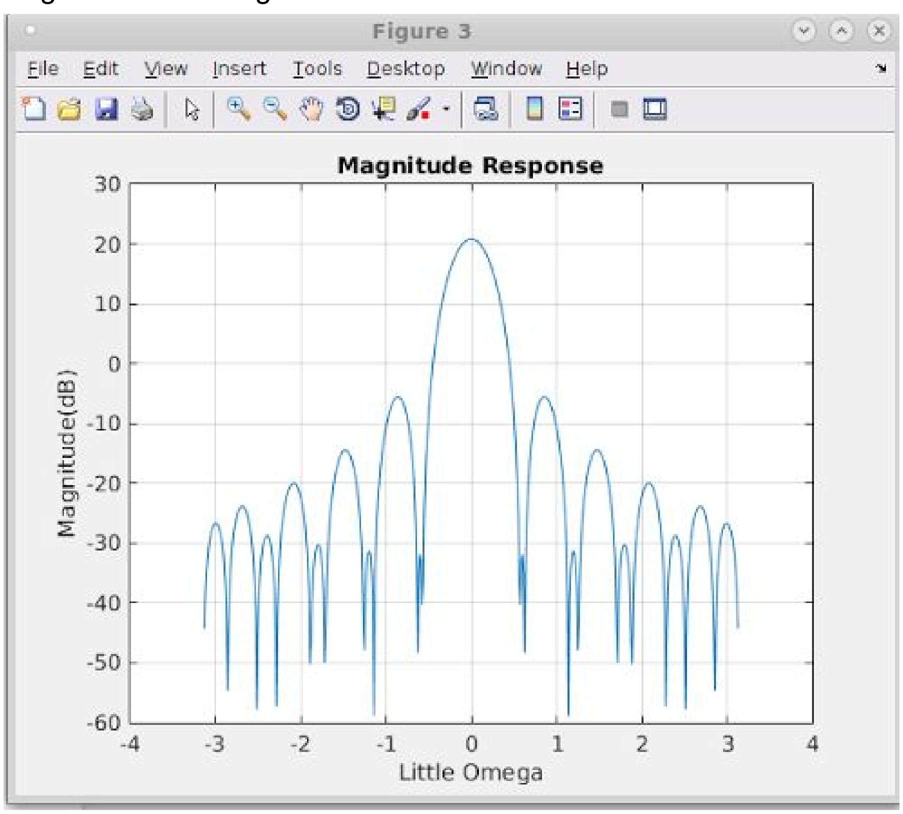
The triangular window:



Magnitude response of the triangular window:

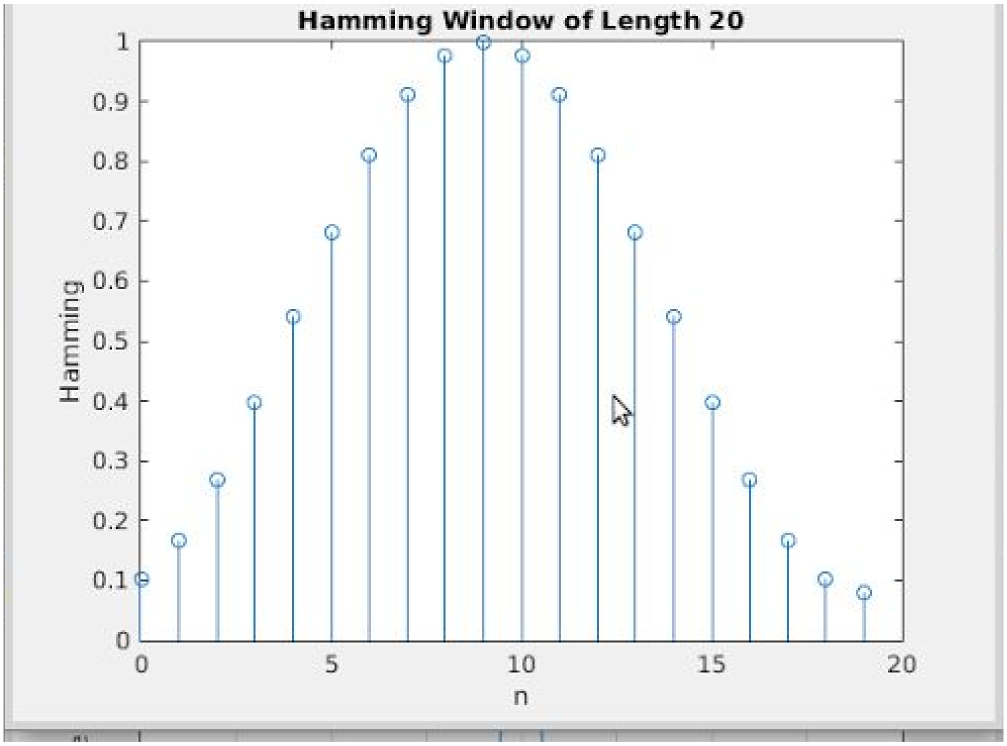


mag2dB of the triangular window:

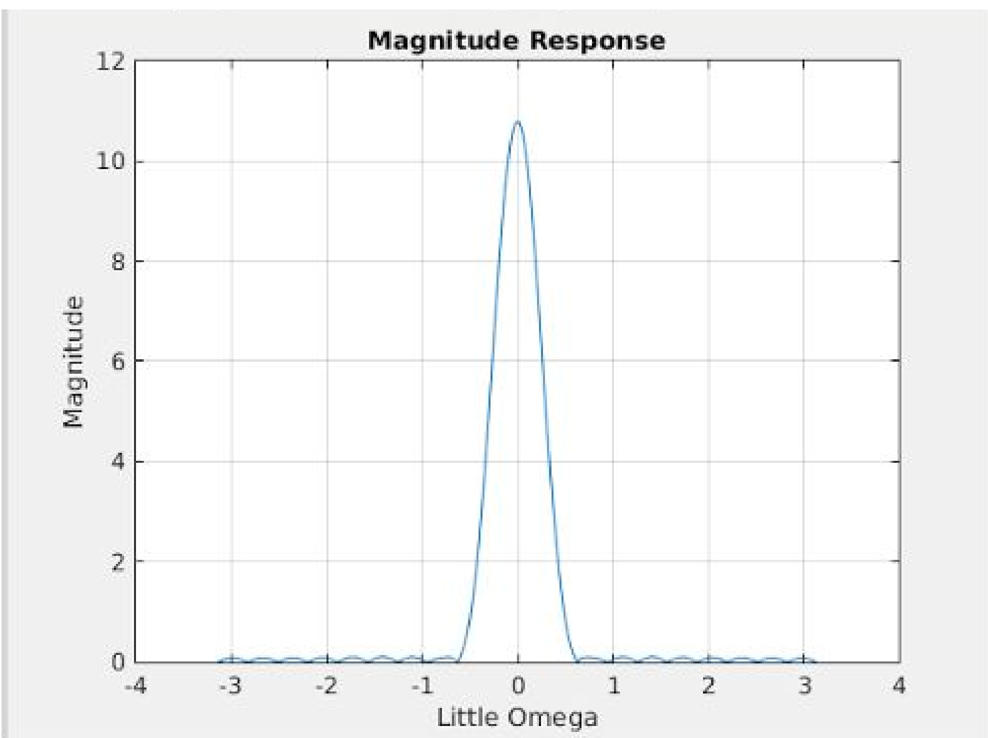


Hamming Window:

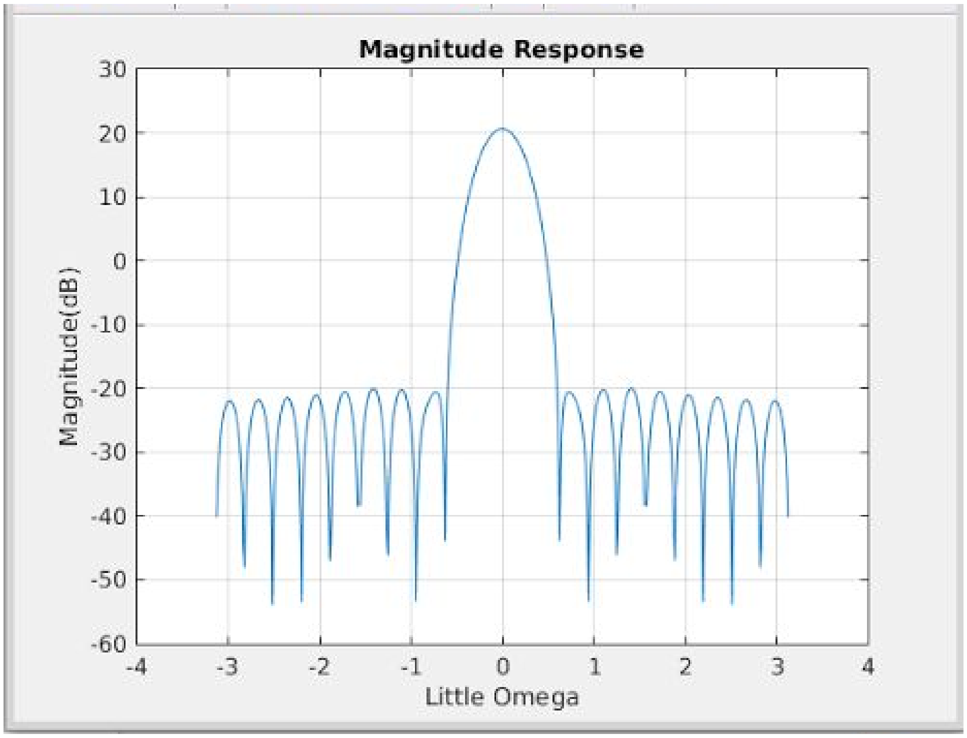
The Hamming window:



Magnitude response of the Hamming window:

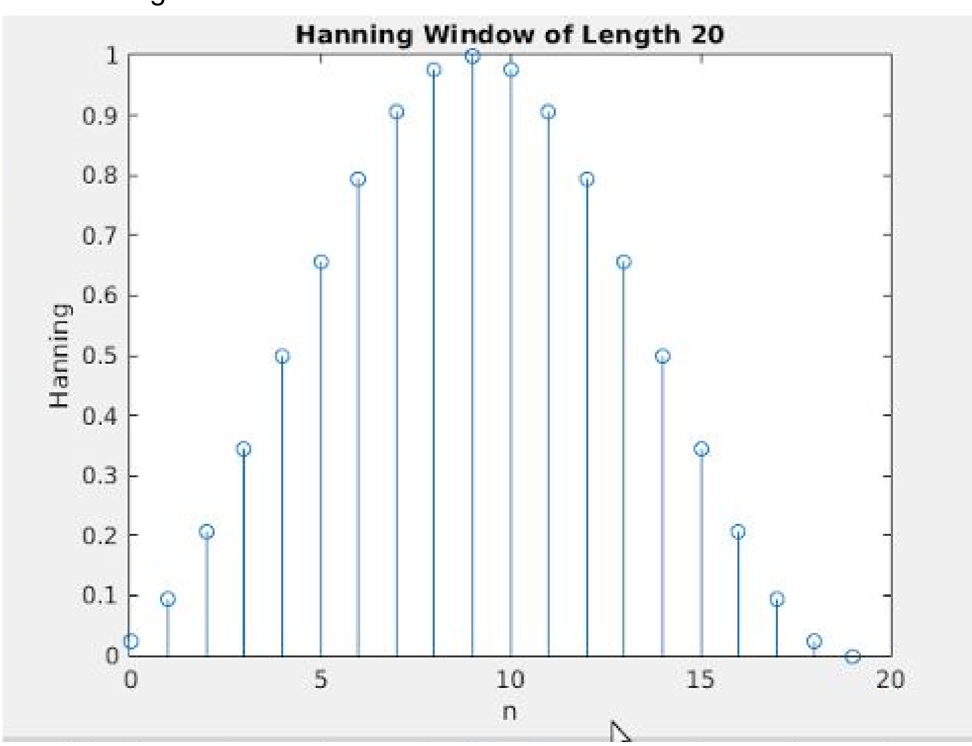


mag2dB of the Hamming window:

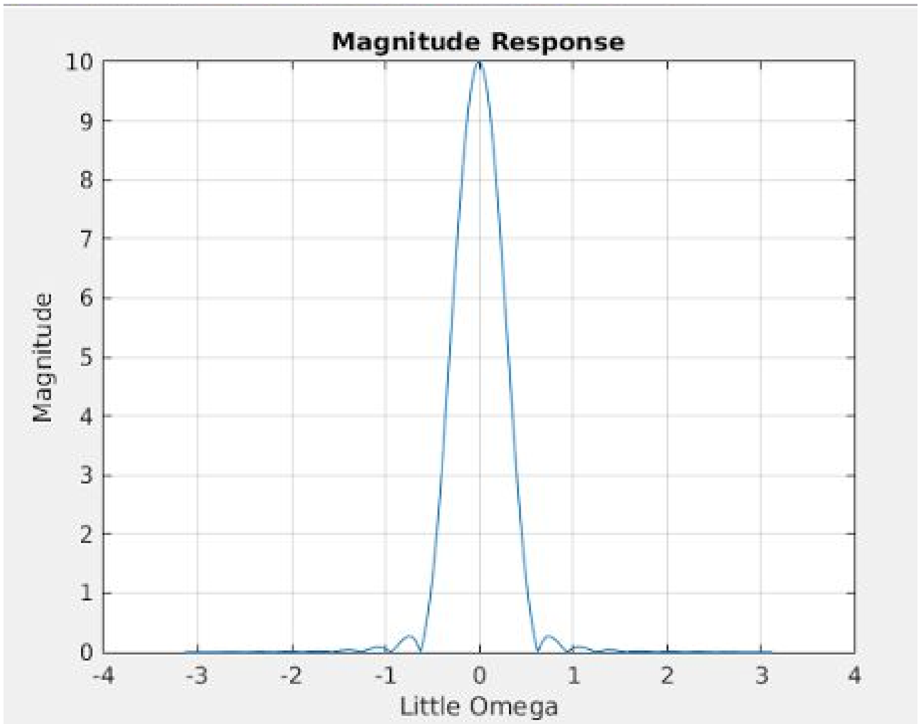


Hanning Window:

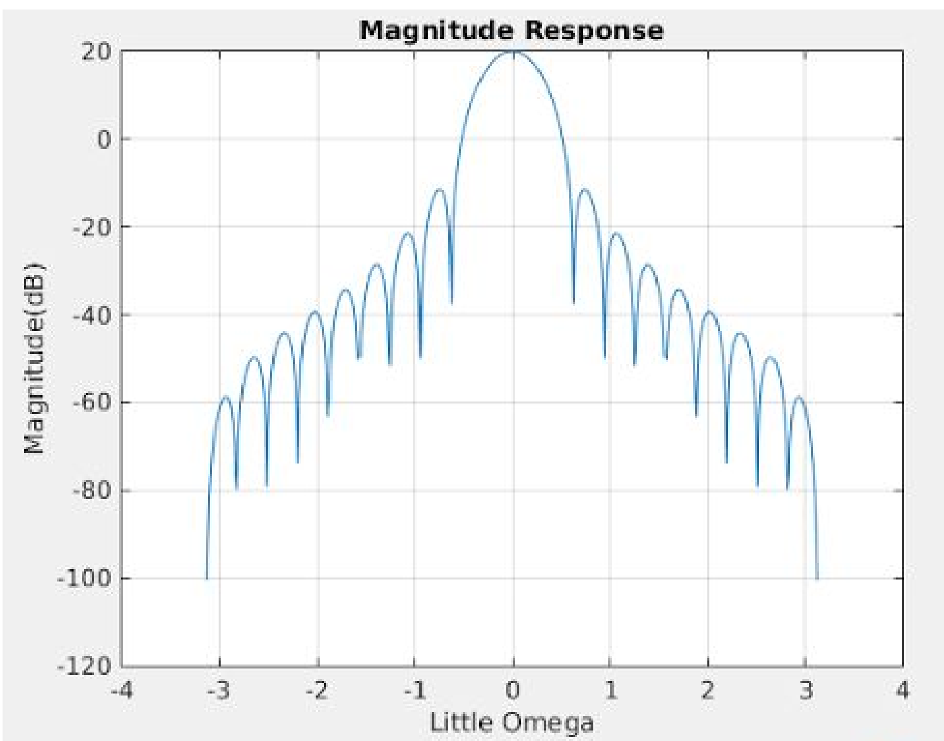
The Hanning window:



Magnitude response of the Hanning window:

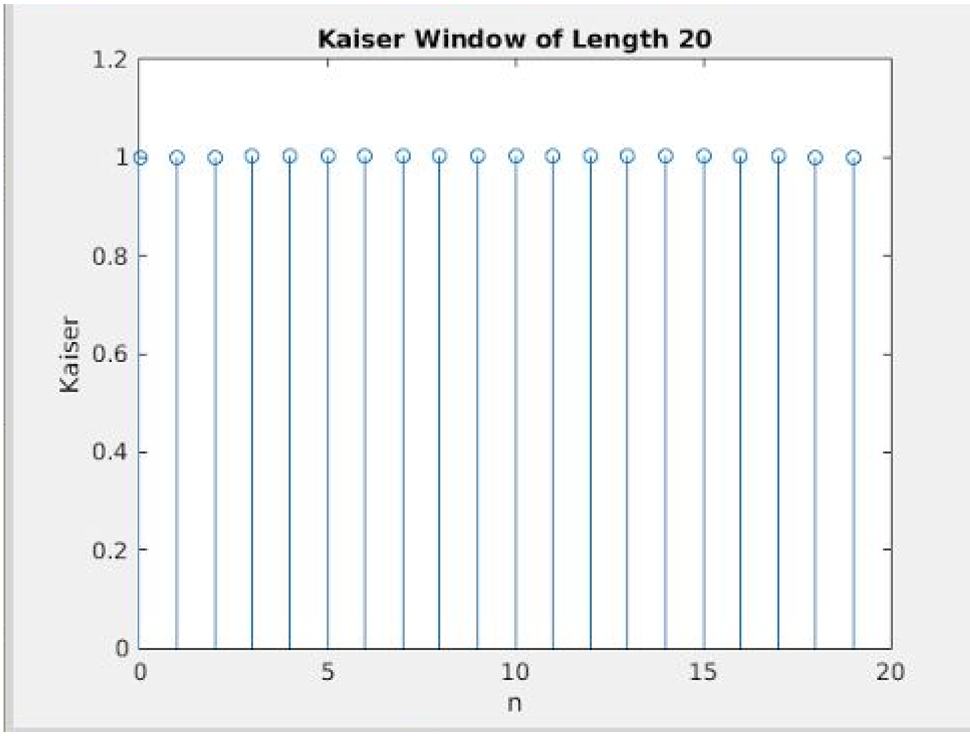


mag2dB of the Hanning window:

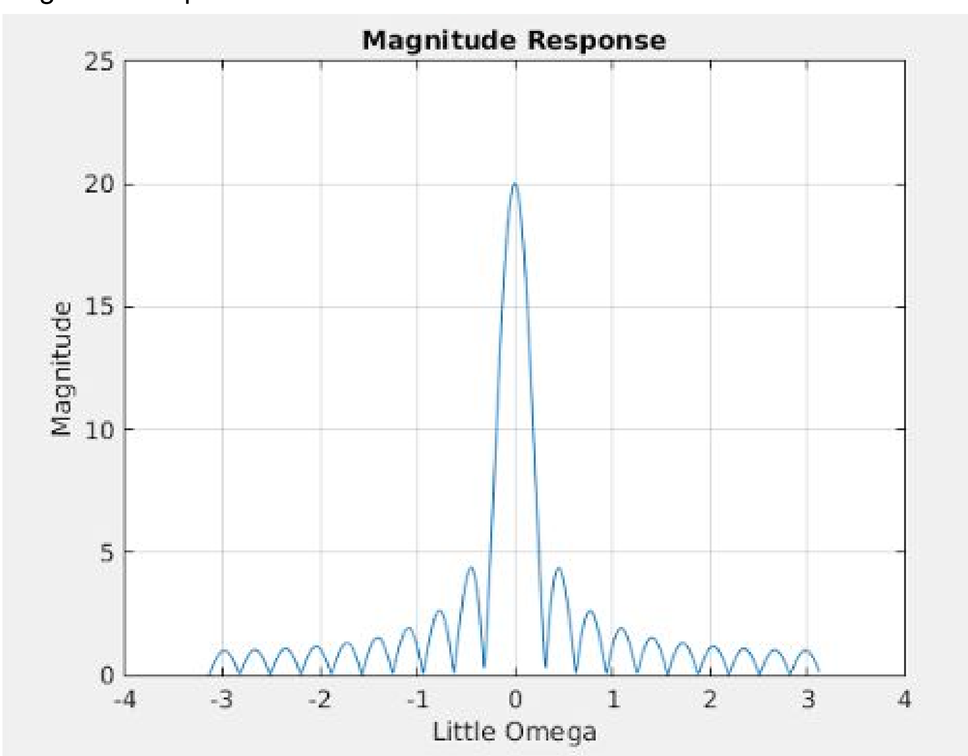


Kaiser Window:

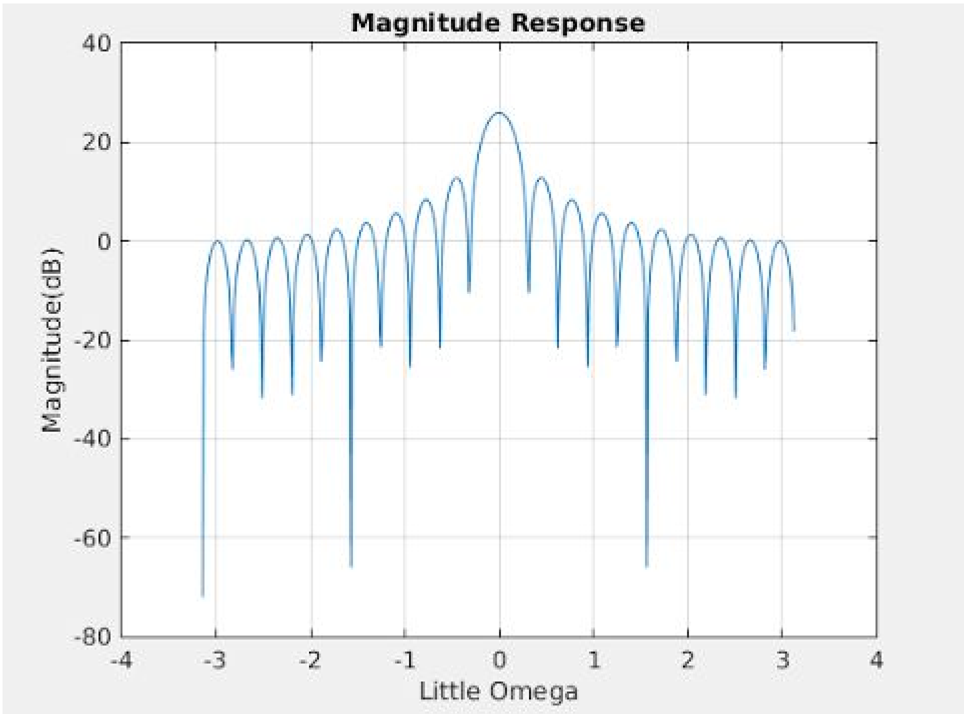
The Kaiser window:



Magnitude response of the Kaiser window:



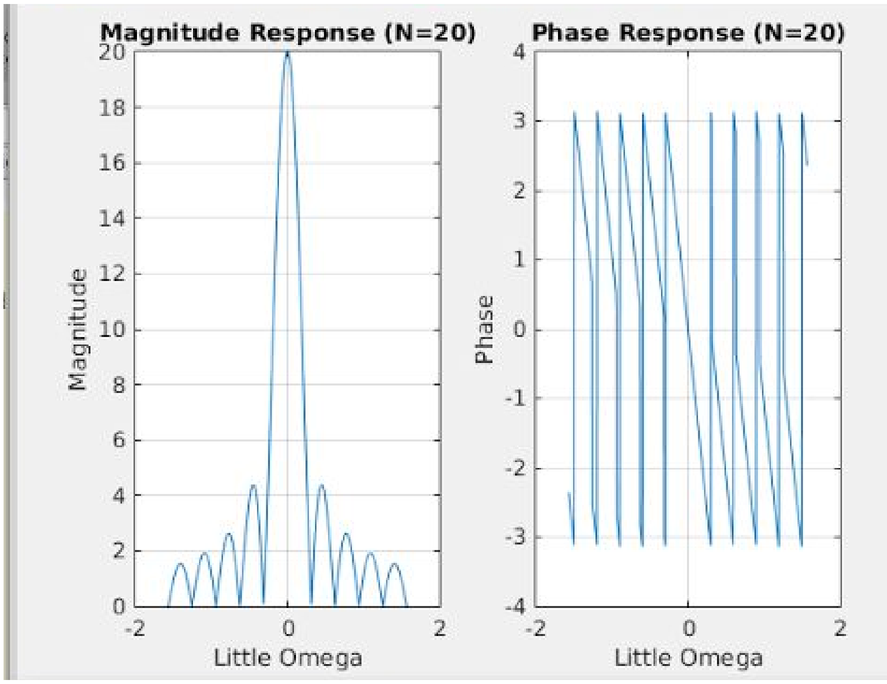
mag2dB of the Kaiser window:



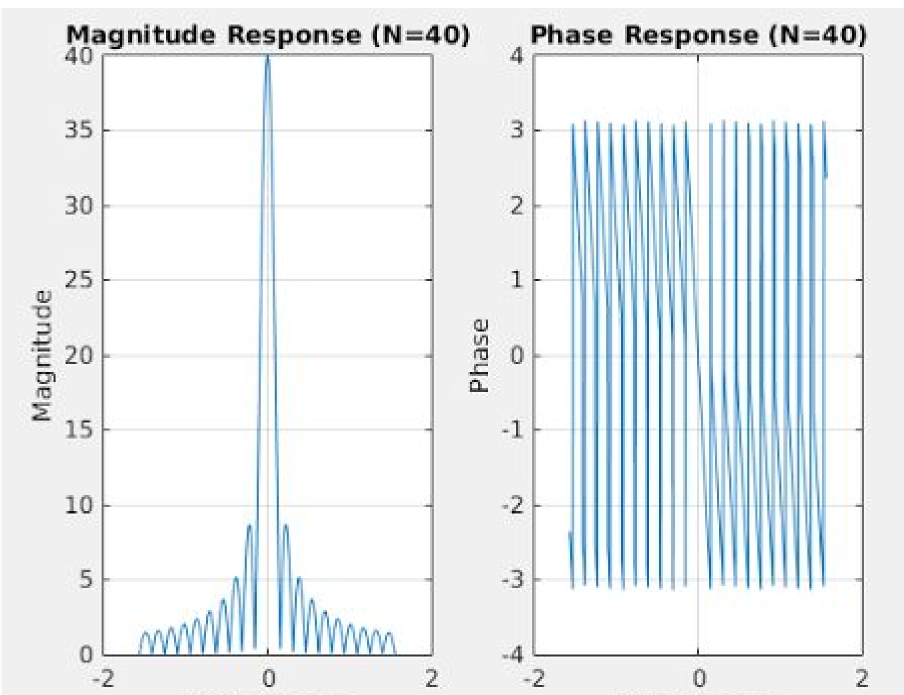
The mainlobe width of the triangular window is bigger than the mainlobe width of the rectangular window.
The sidelobe height of triangular window's sidelobe lower than the sidelobe height of the rectangular window.
Comparing the sidelobe height of a rectangular window and a hamming window, the hamming window has lower sidelobe height.

Report Item 5:

N = 20



N = 40



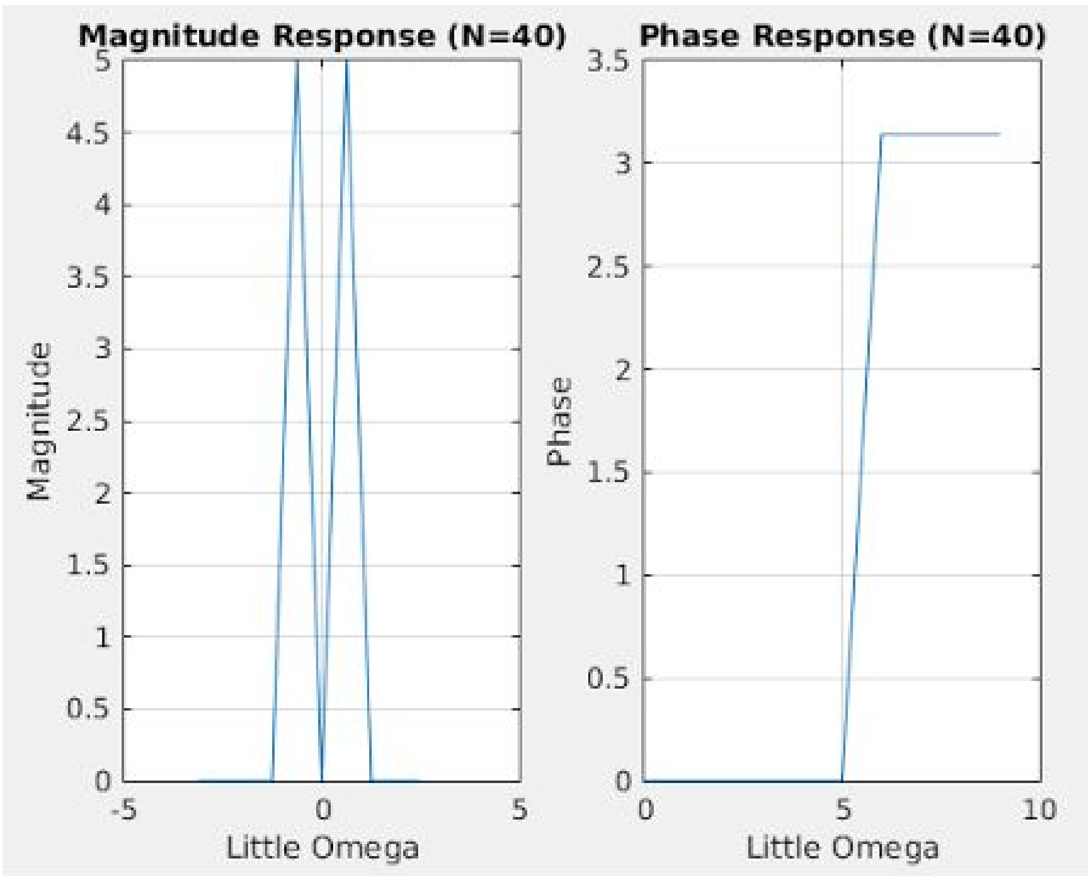
The zero crossing frequency of the diric function is w = 2pi*l/N

Therefore, for N = 20, mainlobe width is pi/10.

For N = 40, mainlobe width is pi/20.

Report Item 6:

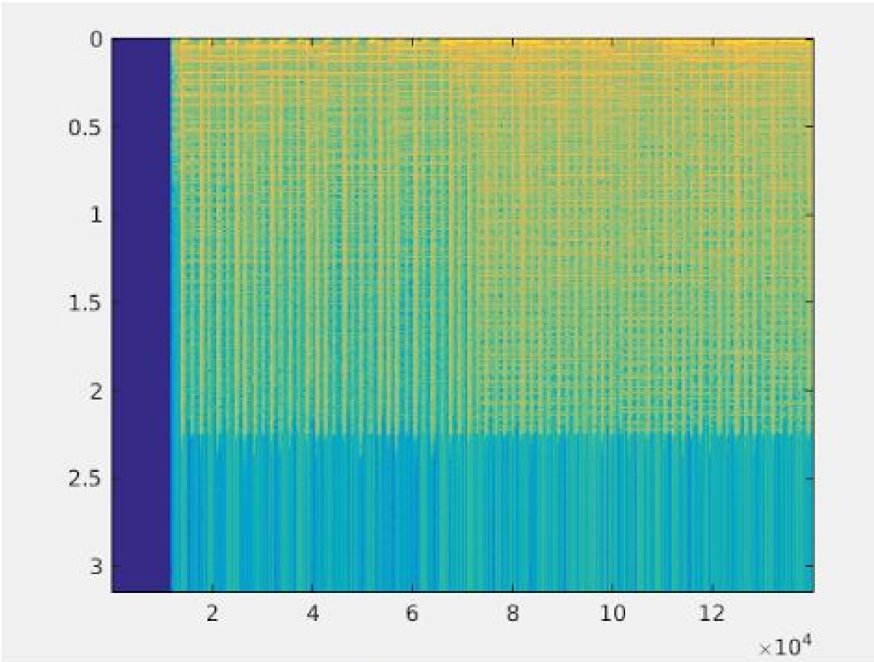
x(n) = sin(2pi*5*n*0.02) = sin(0.2pi*n)
0.2pi*N = 2pi*l => N = 2pi*l/0.2pi = 10l
minimum N = 10 (l=1)



5. Spectrogram

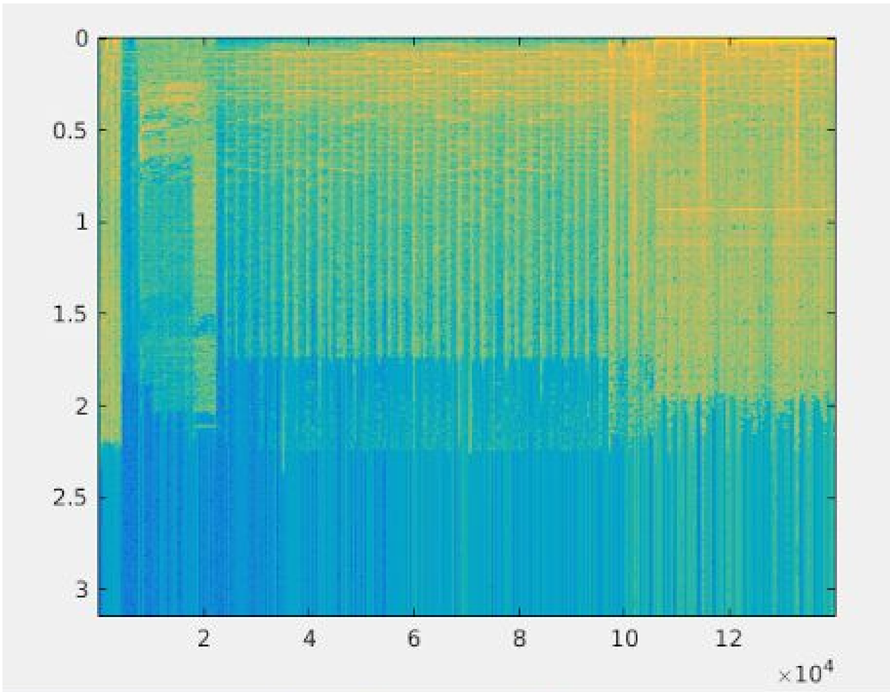
Report Item 7:

Song1 spectrum:



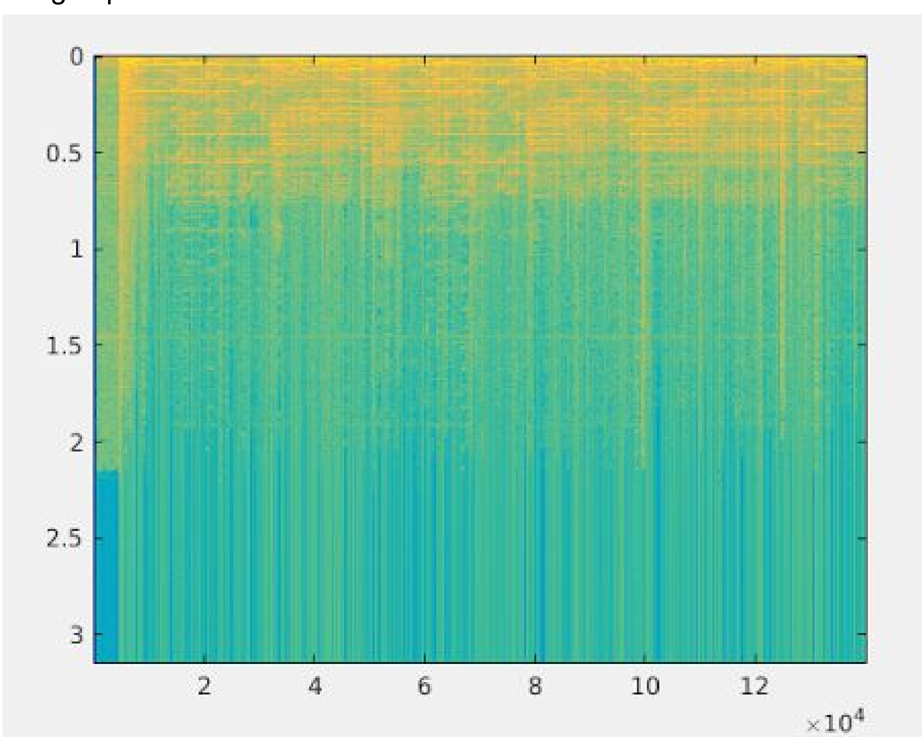
There is no sound at first and then the song has two melody. We can see that from the spectrum. At approximately block 7*10^4, we saw a change in its spectrum. That represents the change of melody. The horizontal lines represent the duration of the sound. And the yellow vertical lines represents the drum.

Song2 spectrum:



The spectrum is divided into several parts, starting with a horse sound. It is also distinguishable between different sections when listening to the sound.

Song3 spectrum:



For this song, it is just the guitar playing. Therefore, we saw a lot of durations from the spectrum.