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September 17th, 2016

Report Item 1:
 $f_s \geq 2 \cdot f_{\max}$
 $1000\text{Hz} \geq 2 \cdot f_{\max}$
 $f_{\max} \leq 500\text{Hz}$

$N = 8000/8 = 1000\text{samples}$
 $1000/f_s \geq 1/f_{\min}$
 $f_{\min} > 1\text{Hz}$

Thus the maximum frequency it can capture is 500Hz; minimum is 1Hz

In order to prevent aliasing, one needs to sample above the Nyquist rate and sample long enough to get enough samples. Both criteria indicate a large number of samples to be stored in the memory. Therefore it's memory intensive

Report Item 2:

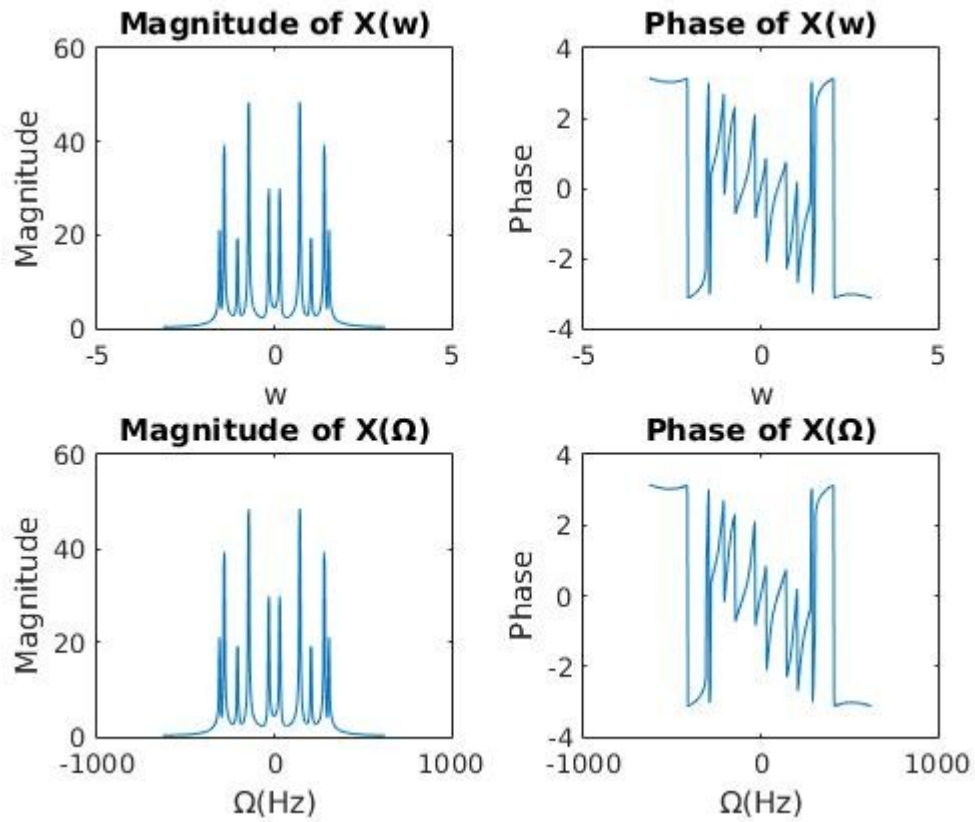
The spectral copies in $X_d(w)$ come from sampling in the time domain. Sampling in the time domain equals the multiplication of the signal with the impulse train, which means the convolution of the CTFT of $x(t)$ with the Dirac delta functions in the frequency domain. Therefore, $X_d(w)$ has spectral copies. These copies are merely the mathematical by-products, which have no physical significance. Only $X_d(w)$ in the range of $[-\pi, \pi]$ has physical significance

Report Item 3:

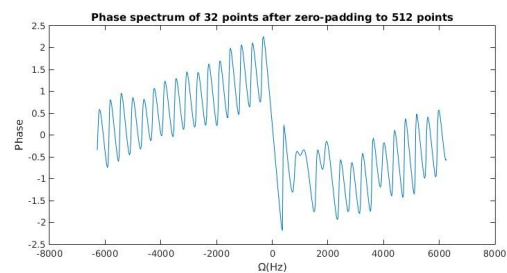
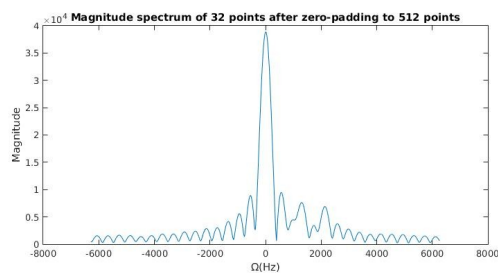
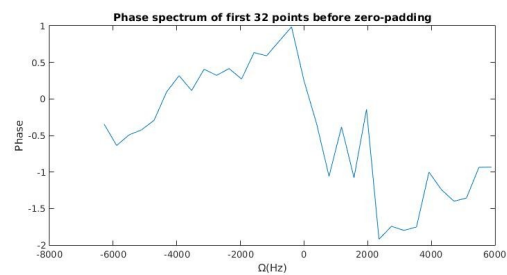
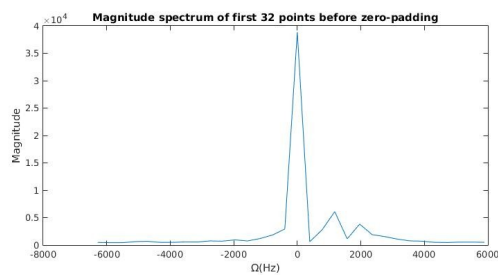
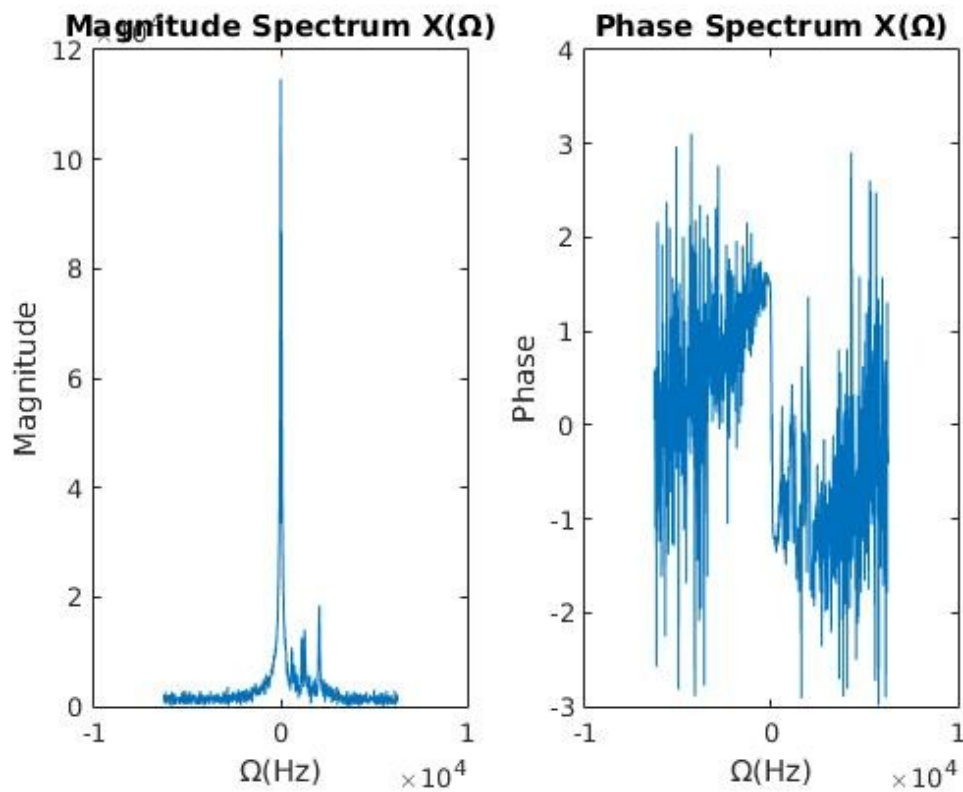
To calculate one sample of DFT of length N , one needs to do N complex multiplications, and $(N-1)$ complex additions. Thus N samples need N^2 complex operations to complete the DFT.

Report Item 4:

There are 10 frequency tones
29.32Hz and -29.32Hz
142.4Hz and -142.4Hz
205.3Hz and -205.3Hz
280.6Hz and -280.6Hz
310Hz and -310Hz



Report Item 5:
Original Spectrum

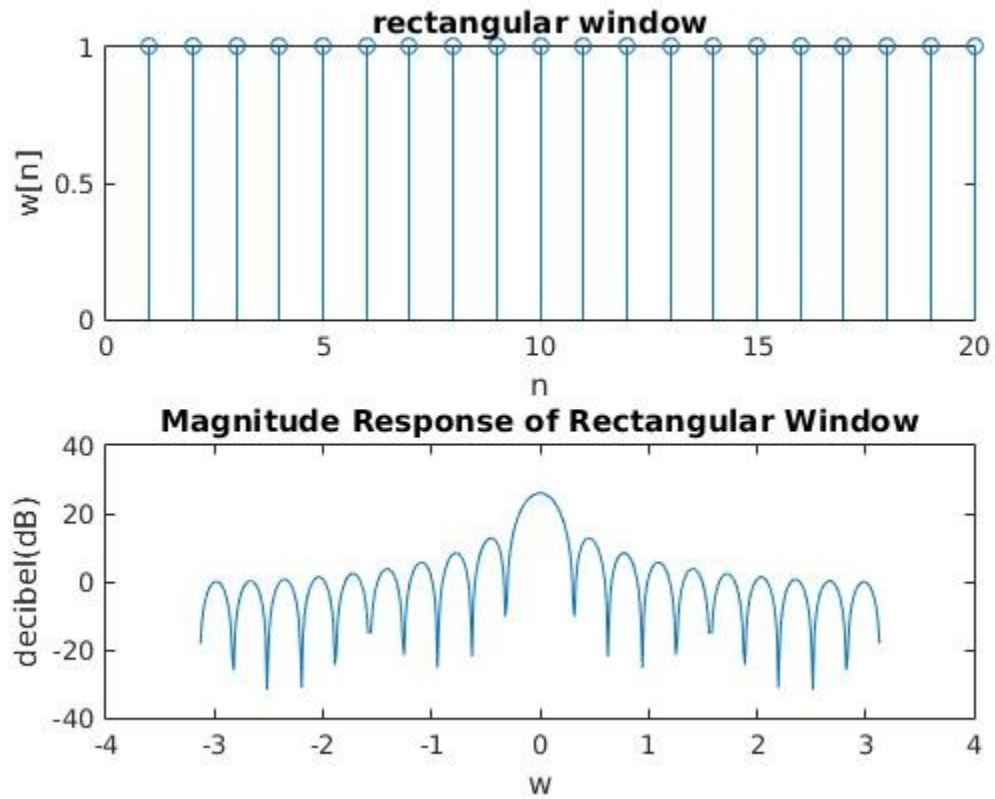


Before zero-padding, we cannot distinguish creating and chlorine. Zero-padding does help in terms of increasing the resolution of the spectrum, as there are more peaks present, but still not enough to distinguish 209Hz and 185Hz

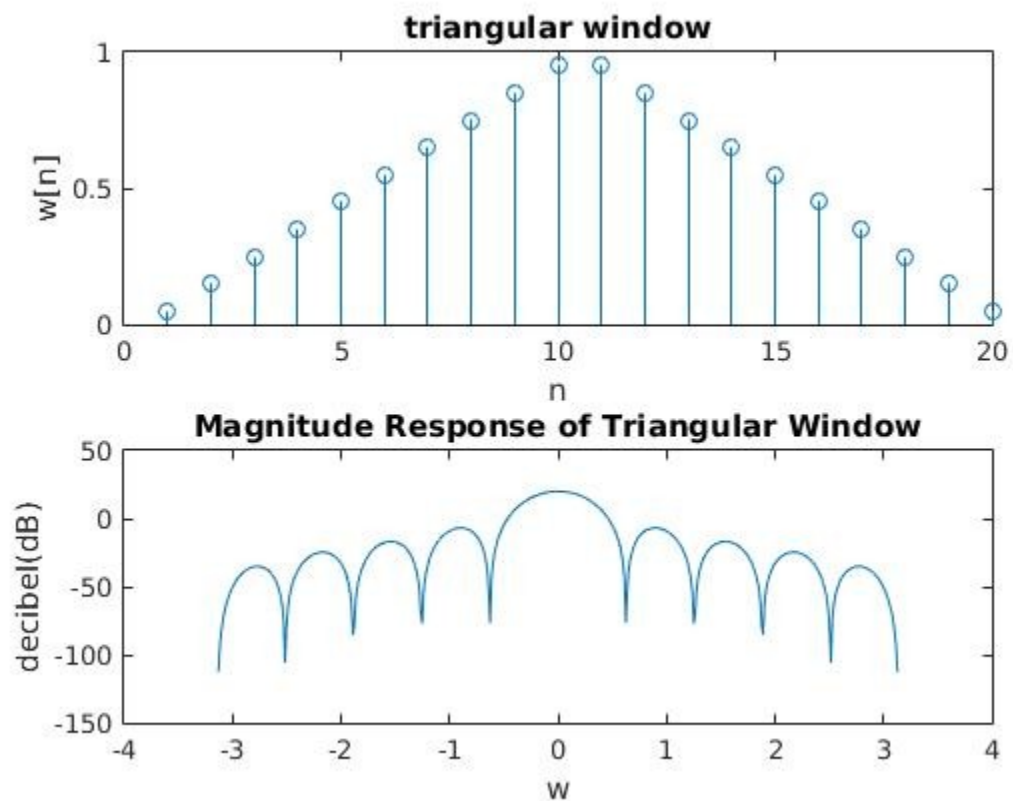
Report Item 6:

Window functions and there spectra:

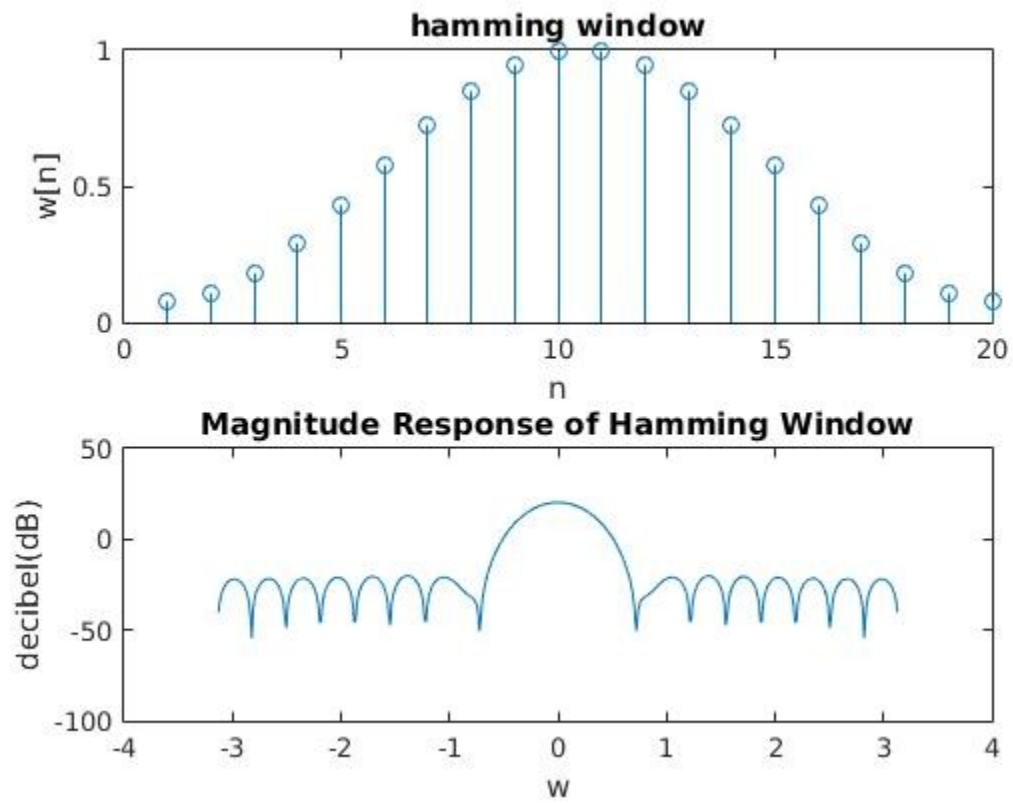
Rectangular:



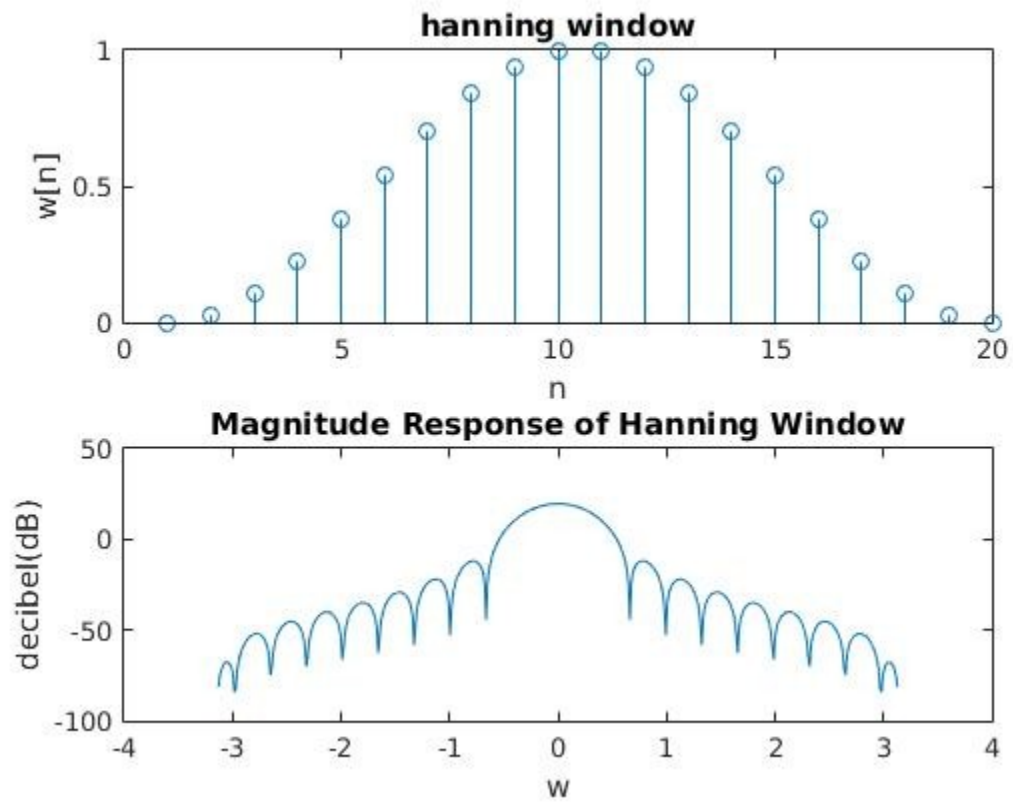
Triangular:



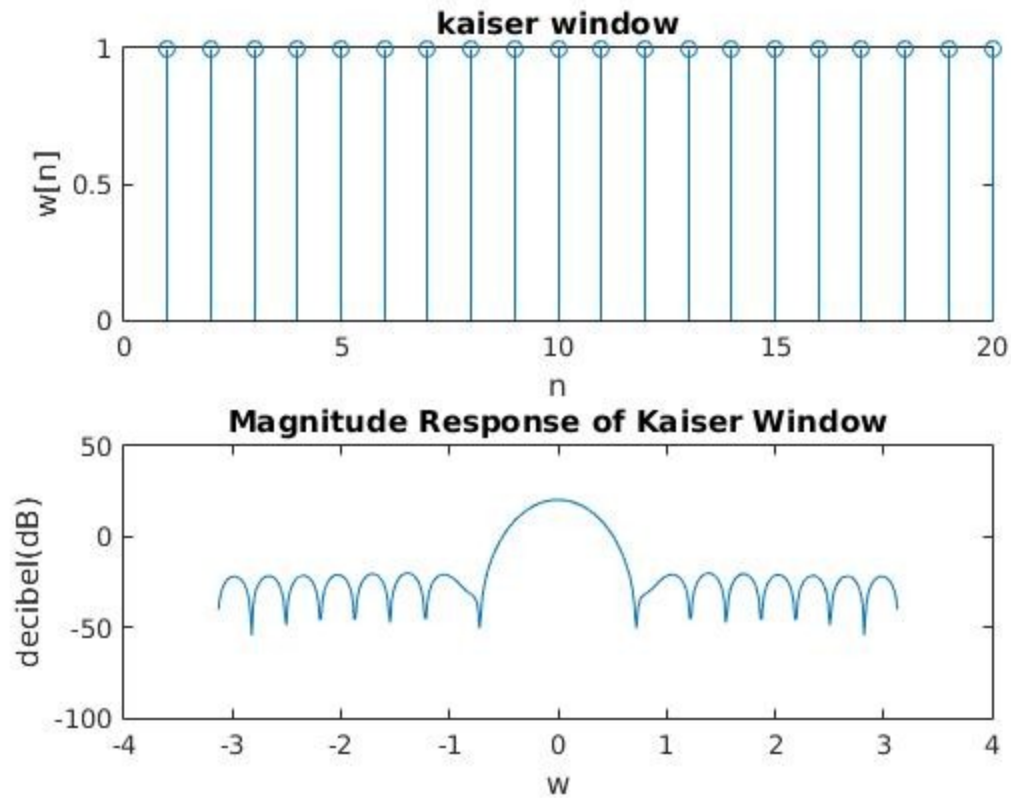
Hamming:



Hanning:



Kaiser



Rectangular window:

The side lobe height is 13dB lower than that of the main lobe

\The width of the main lobe is about 0.64 rad

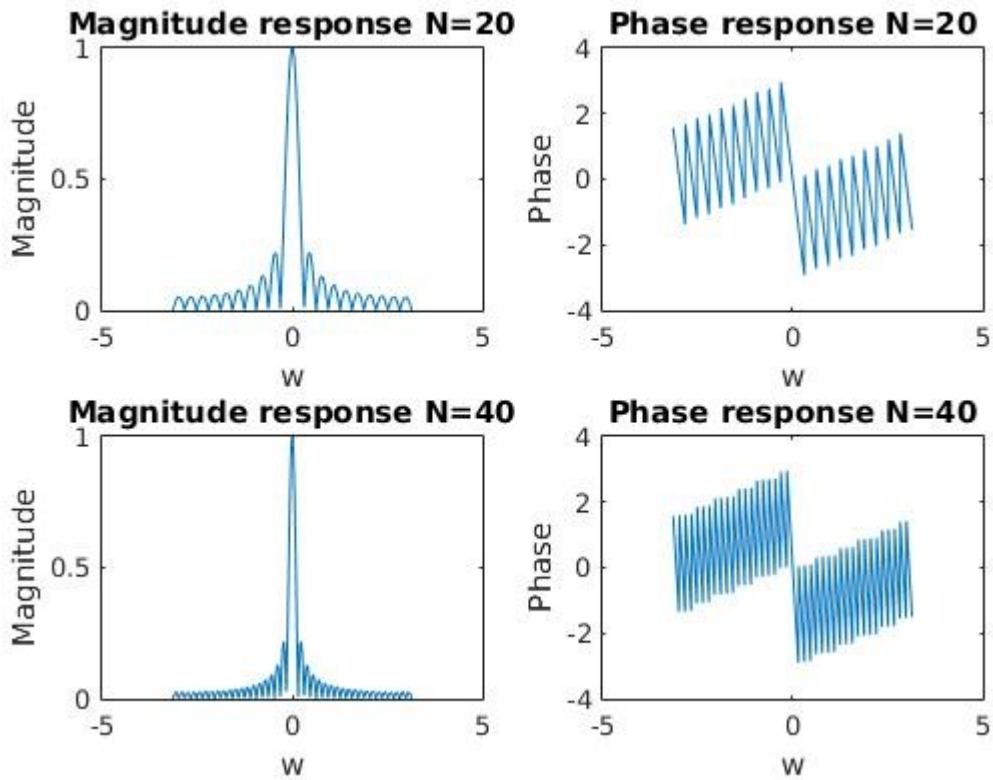
Triangular window:

The side lobe is about 25 dB lower than that of the main lobe

The width of the main lobe is about 1.24 rad

Between the rectangular window and the hamming window, hamming window has lower side lobes.

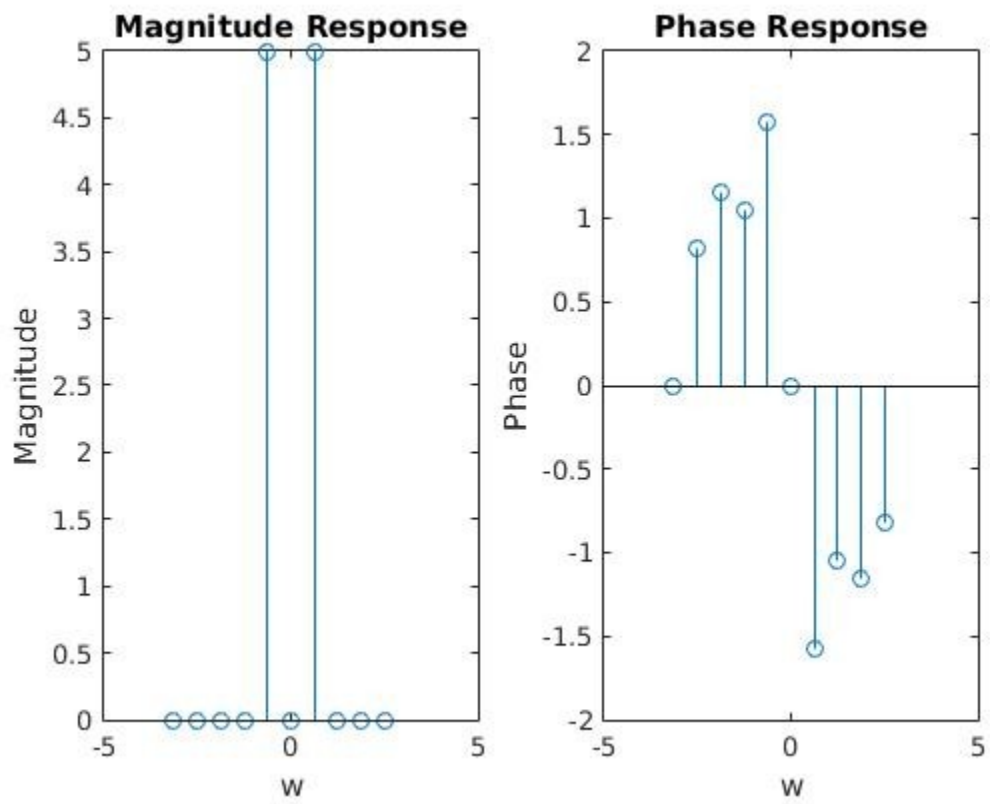
Report Item 7:



When $N = 20$, the main lobe has a width about 0.63 rad.

When $N = 40$
the main lobe has a width about 0.32 rad.

Report Item 8:



Nmin =
 $T/\Delta t = 1/5/0.02 = 10$