EECS 360
Spring 2021

Use the FFT algorithm in Matlab to answer the given questions concerning the following discrete time signals:

$X_a[n] = 10 \sin Bn \qquad 0 \le n \le 255$, $B = 0.049087$

$x_b[n] = 10 \sin Bn \qquad 0 \le n \le 200$, $B = 0.049087$

$x_c[n] = 0 \qquad n=0$

$= 10 \left(1 - \frac{|n - 32|}{32}\right) \qquad n = 1, \ldots 64$

$= 0 \qquad n = 65, \ldots 127$

$x_d[n] = 0 \qquad n = 0$

$= 10 \left(1 - \frac{|n - 32|}{32}\right) \qquad n = 1, \ldots 64$

$= 0 \qquad n = 65, \ldots 255$

$x_e[n] = 0 \qquad n = 0$

$= 10 \left(1 - \frac{|n - 16|}{16}\right) \qquad n = 1, \ldots 33$

$= 0 \qquad n = 34, \ldots 127$

$x_f[n] = 0 \qquad n=0$

$= 10 \qquad n = 1, \ldots. 49$

$= 0 \qquad n = 50, \ldots 63$

1. Use the FFT program to calculate the FFT of $x_a[n]$, $x_b[n]$, $x_c[n]$, $x_d[n]$, $x_e[n]$, and $x_f[n]$ and plot the magnitude of the resulting FFTs.

2. Explain the difference between the FFT's of $x_a[n]$ and $x_b[n]$.

3. Explain the differences between the FFT's of $x_c[n]$ and $x_d[n]$.

4. Explain the differences between the FFT's of $x_c[n]$ and $x_e[n]$.

5. If the sampling rate is 10,000 samples/sec., how long is the time record of $x_c[n]$ in seconds, what is the frequency resolution of the FFT in Hz, what is the highest frequency present in the FFT in Hz? Re-lable your graph of the magnitude of the FFT for $x_c(n)$ in Hz in assuming a sampling rate of 10,000 samples/sec.

6. Let h[n] = {5, 4, 3, 2, 1} and x[n] = {1, 2, 3, 4, 3 ,2 ,1}, use the z-transform to find the linear convolution of h[n] and x[n]. Check your result by using FFT algorithm.

7. Use the Discrete Fourier Transform of a Two-Tone Signal at http://demonstrations.wolfram.com/DiscreteFourierTransformOfATwoToneSignal/ to answer the following questions. Set the noise amplitude to 0.1 for this problem. Note the frequency of the fix tone is 770 Hz and the sample rate is 8000 samples/sec. Use the dBV scale.

a) For N = 512 what is the record length and Δf.
b) Set the sine frequency = 1000 and the sine amplitude =0.5. Describe and explain the change as N changes from 512 to 1024 to 4096.
c) Set the sine frequency = 1000 and the sine amplitude =0.5 and N=512. Describe and explain the change as the window is changed from rect to Hanning to Blackman.