Mid-Term Project

Note: You should treat this project as a take-home exam. Thus, you should neither give nor receive assistance on completing the project. Include in an appendix your Matlab code.

I. Create the software which will be able to access a file of complex numbers of length $N \leq 8192$. Window that data, and perform a forward or inverse FFT on that data. Then output the resulting N complex numbers to a file. Window functions which should be available are: (1) rectangular, (2) triangular, (3) Hanning, (4) Hamming, and (5) Kaiser-Bessel.

II. Demonstrate that the program is operating correctly by computing the DFT of the following window sequences: (1) rectangular, (2) triangular, (3) Hanning, (4) Hamming, and (5) Kaiser-Bessel ($\alpha = 2.5$ or $\beta = \pi\alpha = 7.85$). Plot the original window sequence, the linear magnitude of its DFT and the dB magnitude of its DFT (window sequence length = 32; zero pad to N = 256 prior to FFT). Use the same dynamic range for each normalized plot (e.g. 0 to1 for linear magnitude plots and 0 to –80 dB for dB magnitude plots).

III. Illustrate the spectral resolution capabilities of the windows in (II) for two sinusoidal sequences 40 dB apart in magnitude and separated in frequency by : (1) 6 bins and (2) 5.5 bins. The weaker sinusoid's frequency should be at a bin center in both cases.

$$x(n) = A_1 cos(\omega_1 n + \phi_1) + A_2 cos(\omega_2 n + \phi_2); \quad 20 \log \frac{A_1}{A_2} = 40 \text{ dB}$$

"bin centered sinusoid" : $\omega = \left[2\frac{\pi}{N}\right]k,\ k = 0, \ldots, \frac{N}{2} - 1$

Let sequence length = window length = FFT length = 256.

Do not select $\{k_1, k_2\}$ too close to 0 (e.g. select $k_2 = 32$).

Your plots for Part III should be in dB and normalized so the peaks are at 0 dB.

Reference

[1] F. Harris, "On the Use of Windows for Harmonic Analysis with the Discrete Fourier Transform", Proc. IEEE 66: 51-83 (1978).