Due Friday, 16 July 2004 at 4:00 PM

ECE 438 **Assignment No. 7** **Summer 2004**

1. Compute the N-point DFT of each of the following signals *without using any transform properties or pairs* (unless you derive the properties). Specify $X_N(k)$ for $0 \le k \le N-1$. Show all your work.

   a. $x(n) = \delta(n - n_o) \quad \textit{where} \;\; 0 \le n_o \le N-1$

   b. $x(n) = \cos(2\pi k_o n / N) \quad \textit{where} \;\; 0 \le k_o \le N-1$

2. Show that if the signal x(n) is real-valued then its DFT $X_N(k)$ is *conjugate symmetric*:

$$x(n) = x^*(n) \quad \Rightarrow \quad X_N(k) = X_N^*(N-k)$$

3. Consider the signals x(n) and h(n) defined below.

n	0	1	2	3
x(n)	3	2	1	3
h(n)	1	1	1	0

   a. Perform the periodic convolution, with N=4, between x(n) and h(n).

   b. Suppose we wanted to compute the regular convolution $x(n) * h(n)$ by performing a periodic convolution. For these signals, how should we choose N so that the periodic convolution is equal to the regular convolution for $0 \le n \le N-1$. Justify your answer.

4. The *radix-3 decimation-in-time FFT* algorithm differs from radix-2 in that it computes DFTs after decimating the input sequence by 3.

   a. Derive the first stage of a radix-3 decimation-in-time FFT for an input sequence of length N. Assume N/3 is an integer.
   b. Use a tree to determine the number of complex multiplications required for the full implementation of this algorithm for an input sequence of length N, where $N=3^p$ for some integer p.
   c. Compare the number of multiplications required for this FFT with the multiplications required for a direct evaluation of the DFT sum when N=2187.