ENEE 425

Section 0101 Fall 2004

Homework #11

For any problem that you use Matlab you must attach a printed version of Matlab code (a Matlab file is preferable to copying and pasting a session, if possible). You may put several problems into a single printout, if the start of each problem is made obvious. Don't forget to answer the verbal questions too.

If you use Matlab remember that it uses "1" for the first index, whereas the book, the lectures, and these questions use "0" for the first index, so you must be ***very*** *careful with your indices. In fact for most of these problems it is easier to get the correct answers without Matlab than with it.*

1) For each of the following finite length discrete series:

   a) $x[n] = \{2, 4, 2, 0\}$

      i) What is its length N?

      ii) Evaluate $X[0], X[N/2], X[1], X[N-1]$ (hint: what restrictions must these obey?)

      iii) Graph the magnitude of its Discrete Fourier Transform, $|X[k]|$.

   b) Repeat (a) but with $x[n] = \{2, 4, 2, 0, 0, 0, 0, 0\}$. How and why are the answers to (ii) and (iii) related to the answers to (a)?

   c) Repeat (a) but with $x[n] = \{2, 4, 2, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0\}$. How and why are the answers to (ii) and (iii) related to the answers to (a)?

   d) Repeat (a) but with $x[n] = \{0, 2, 4, 2, 0, 0, 0, 0\}$. How and why are the answers to (ii) and (iii) related to the answers to (b)?

   e) Repeat (a) but with $x[n] = \{1, 3, 1, -1, -1, -1, -1, -1\}$. How and why are the answers to (ii) and (iii) related to the answers to (b)?

2) Let $X_0[k] = \{8, -4j, 0, 4j\}$.

   a) Calculate its inverse Discrete Fourier Transform (DFT) $x_0[n]$.

   b) Let $X_1[k] = e^{-j\frac{2\pi}{4}k} X_0[k]$. Calculate its inverse DFT $x_1[n]$. How is related to $x_0[n]$?

   c) Let $X_2[k] = e^{-j2\frac{2\pi}{4}k} X_0[k]$. Calculate its inverse DFT $x_2[n]$. How is related to $x_0[n]$?

3) Let $X[k] = \{1, \frac{e^{j\pi/4}}{3}, \frac{e^{-j\pi/4}}{2}, \frac{1}{4}, \_\_\_, \_\_\_\}$ for real $x[n]$. Fill in the blanks.

4) Let $x[n] = e^{-j\frac{4\pi}{10}n} \dfrac{\sin(n\pi/2)}{\sin(n\pi/10)}$ for $0 \le n < 10$. Compute $X[k]$.

5) Let $x[n] = \{0,\ a,\ b,\ c\}$ and $h[n] = \{1,\ -1\}$ be finite length sequences, with x representing a (delayed) measurement and h representing a (high pass) filter.

a) Padding each with an infinite number of zeros on both sides (to obtain a sequence defined for all n) compute the linear convolution $y_l[n] = x[n] * h[n]$. What does causality say that $y_l[0]$ must be and why?

b) Padding only $h[n]$ on the right with as many zeros as necessary to let its length equal that of $x[n]$, compute the circular convolution $y_c[n] = x[n] *_N h[n]$. What is the value of $y_c[0]$? What about causality?