Homework #4: Chapter 4 (due Fri. Oct. 12, 2012)

Preliminary

- All problems are worth +10 points unless otherwise noted.
- Code the following tools from *DSP Software Toolkit* Chapter 6: **dtft.m** and **dft.m**.
- Please attach at the *end* of your assignment printouts of **main1.m** (code to solve software problem 1), **main2.m** (code to solve software problem 2), etc... as well as any new tools developed in this assignment.

Software Problems

Use your software tools to solve the following problems.

1. Consider the complex exponential sequence with frequency ω_0 and its DTFT (spectrum)

$$x(n) = e^{j\omega_0 n},\ -\infty < n < \infty \quad \leftrightarrow \quad X(\omega) = 2\pi\delta(\omega - \omega_0),\ -\pi < \omega < \pi. \tag{1}$$

   For the length-101 sequence, numerically compute the spectrum at the frequencies defined below:

```
L = 101; % signal length
w0 = 4*pi/10; % frequency
x = cexpgen(1, w0, 0, 2*pi, L/(2*pi)); % signal synthesis
w = [-10*pi/10  -9*pi/10   -8*pi/10   -7*pi/10   -6*pi/10  -5*pi/10 ...
     -w0-0.001  -w0  -w0+0.001   -3*pi/10  -2*pi/10  -1*pi/10  0*pi/10 ...
     1*pi/10  2*pi/10  3*pi/10  w0-0.001  w0  w0+0.001 5*pi/10 ...
     6*pi/10  7*pi/10  8*pi/10  9*pi/10  10*pi/10]'; % evaluation frequencies
X = dtft(x,w); % numerical evaluation of DTFT
[w  X  abs(X)]
```

   (a) Compare the magnitude values to the figure on p. 199 and comment.

   (b) Does $X(\omega)$ have the Hermitian property? Why or why not?

2. Consider the cosine sequence with frequency ω_0 and its DTFT (spectrum)

$$x(n) = \cos(\omega_0 n),\ -\infty < n < \infty \quad \leftrightarrow \quad X(\omega) = \pi\left[\delta(\omega - \omega_0) + \delta(\omega + \omega_0)\right],\ -\pi < \omega < \pi. \tag{2}$$

   Repeat Prob. 1 assuming a length-101 sequence and the same evaluation frequencies.

3. Compute the 20-point DFT (spectrum) of the complex exponential sequence in Problem 1:

```
L = 101; % signal length
w0 = 4*pi/10; % frequency
x = cexpgen(1, w0, 0, 2*pi, L/(2*pi)); % signal synthesis
N = 20; % DFT length
X = dft(x,N);
k = [0:N-1]'; % DFT indices
[k  X  abs(X)]
```

   (a) You should observe a peak in the magnitude spectrum at $k = 4$ corresponding to $\omega_k = 2\pi k/10$. Denote this peak in your DFT values.

4. Repeat Prob. 3 but with a cosine signal instead of a complex exponential signal.

Textbook Problems

5.3 b; 5.5; 5.8 b, d, f; 5.13; 5.19; 5.21