Homework #10: Chapter 5 (due Nov. 13, 2015)

Preliminary

- Textbook reading Ch. 5.2–5.9 (pp. 367–400)
- As a reminder, EE312 office hours are on Wed. from 9:00-10:00am and Thu. from 3:00-4:00pm.
- Please direct all email to pdeleon@nmsu.edu (do not send email via Canvas).
- In order to receive full credit for homework problems, you must provide a detailed solution. Simply writing a few, summarized steps toward the answer will result in minimal credit.
- All problems are worth +10 points unless otherwise noted.
- ~~Download the CompanionFiles10.zip file that contains Dow Jones Industrial Average (DJIA) data for the software problems.~~

  ~~http://www.ece.nmsu.edu/~pdeleon/Teaching/EE312/Homework/CompanionFiles10.zip~~.

Textbook Problems

5.19	5.22(a),(c),(f)	5.29 (a) only (i)
5.30 (a), (b) only (i)	5.33(a), (b) only (i), (c) only (i)	

Software Problems

Read the next section on using MATLAB to compute the frequency spectrum of a DT signal and refer to Homework #8 on using MATLAB to compute the frequency response of DT LTI system.

1. Consider the length-5 rectangular signal

$$x[n] = \begin{cases} 1, & 0 \leq n \leq 4 \\ 0, & \text{otherwise.} \end{cases}$$

   Use the code below to plot the magnitude spectrum and compare to Figure 5.6. Note that our $x[n]$ is a 2-sample advance version of the $x[n]$ in Example 5.3. Hence the magnitude spectrum will be the same but the phase spectrum will be different.

```
>> x = [1;1;1;1;1];
>> N = 1024;
>> X = fft(x,N);
>> w = [0:2*pi/N:2*pi-2*pi/N]'; % frequency vector from 0 to 2\pi in steps of 2\pi/N
>> figure(1);
>> plot(w,abs(X));
>> ylabel('|X(e^{j\omega})|');xlabel('\omega (radians/sample)');
```

2. Consider the system on p. 398 in Example 5.19. Use the code below to plot the frequency response.

```
>> b = [2];
>> a = [1 -3/4 1/8];
>> N = 1024;
>> [H,w] = freqz(b,a,N);
>> figure(1); % plot magnitude response in figure 1 window
```

```
>> plot(w,abs(H));
>> ylabel('|H(e^{j\omega})|');xlabel('\omega (radians/sample)');
>> figure(2)
>> plot(w,angle(H)); % plot phase response in figure 2 window
```

3. Consider the ideal delay system in Example 5.11. From previous work the LCCDE is given by

$$y[n] = x[n - n_0]$$

and the impulse response and frequency response are

$$h[n] = \delta[n - n_0] \leftrightarrow H(e^{j\omega}) = e^{-j\omega n_0}.$$

Let $n_0 = 10$ and plot the magnitude and phase response from $0 \leq \omega \leq \pi$. Since the system is a simple delay there is no magnitude impact on frequencies (hence a flat magnitude response) but the phase response is $-\omega n_0$. From your plot, verify the phase response slope is $-n_0$.

Frequency Spectrum of a DT Signal

The frequency spectrum of a DT signal, $x[n]$ may be computed using the MATLAB command

```
>> X = fft(x,N);
```

which returns $X(e^{j\omega})$ at N evenly spaced frequencies between 0 and 2π,

$$\mathbf{X} \;=\; \left[X(e^{j\omega_0}),\; X(e^{j\omega_1}),\; \ldots,\; X(e^{j\omega_{N-1}})\right]^T$$

where $\omega_k = 2\pi k/N$. We visualize the frequency spectrum by plotting the magnitude spectrum and phase spectrum of the signal using the MATLAB commands

```
>> w = [0:2*pi/N:2*pi-2*pi/N]'; % frequency vector from 0 to 2\pi in steps of 2\pi/N
>> figure(1)
>> plot(w,abs(X)); % plot magnitude spectrum in figure 1 window
>> ylabel('|X(e^{j\omega})|');xlabel('\omega (rads/sample)');
>> figure(2)
>> plot(w,angle(X)); % plot phase spectrum in figure 2 window
>> ylabel('\angle X(e^{j\omega})');xlabel('\omega (radians/sample)');
```