Homework #9: Chapters 4 and 5 (due Nov. 18, 2016)

Preliminary

- Textbook reading Ch. 4.0-5.9 (pp. 284-400)
- Reminder: EE312 office hours are Wed. from 9:00-10:00am and Thu. from 3:30-4:30pm, in GA 160F.
  http://www.ece.nmsu.edu/~pdeleon/Teaching/EE312/Homework/HomeworkFormat.pdf
- Please direct all email to spsandov@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.

Textbook Problems

5.19
5.33 (a), (b)
5.35 (a), (d)
5.36 (a), (b): (i), (ii); (c)

Software Problems

Refer to Homework #7 for information on using MATLAB for frequency analysis systems. Listed below is example MATLAB code for Problems #1 and #2.

Frequency Response in Continuous-time

1. For the following system

\[
\frac{d^2 y(t)}{dt^2} + 4 \frac{dy(t)}{dt} + 3 y(t) = \frac{dx(t)}{dt} + 2 x(t)
\]
compute and plot the frequency response using 'freqs' command.

2. Plot the magnitude and phase response of the system in Prob. 4.19.

3. Plot the magnitude and phase response of the system in Prob. 4.33(a).

4. Plot the magnitude and phase response of the system in Prob. 4.34.

```matlab
% Prob. 1
a = [1 4 3]; % feedback coefs see Example (4.25) and 'help freqs'
b = [1 2]; % feedforward coefs see Example (4.25)
[H,w] = freqs(b,a);

figure(1);plot(w,abs(H));
ylabel('|H(j\omega)|');xlabel('
\omega (rads/s)');grid;title('Magnitude response')

figure(2);plot(w,angle(H));
ylabel('
\angle H(j\omega) (rads)');xlabel('
\omega (rads/s)');axis([min(w) max(w) -pi pi]);grid;title('Phase response')
```
% Prob. 2
w = [0 1000]; % pick a range of freqs
H = 1./(j.*w + 3);
figure(1);plot(w,abs(H)); ylabel('|H(j\omega)|');xlabel('\omega (rads/s)');grid;title('Magnitude response (4.19)')
figure(2);plot(w,angle(H)); ylabel('\angle H(j\omega) (rads)');xlabel('\omega (rads/s)'); axis([min(w) max(w) -pi pi]);grid;title('Phase response (4.19)')

Frequency Response in Discrete-time

5. 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.

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

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

\[ >> b = [2]; \]
\[ >> a = [1 -3/4 1/8]; \]
\[ >> N = 1024; \]
\[ >> [H,w] = \text{freqz}(b,a,N); \]
\[ >> \text{figure}(1); % plot magnitude response in figure 1 window \]
\[ >> \text{plot}(w,abs(H)); \]
\[ >> \text{ylabel}('|H(e^{j\omega})|');\text{xlabel}('\omega (radians/sample)'); \]
\[ >> \text{figure}(2) \]
\[ >> \text{plot}(w,angle(H)); % plot phase response in figure 2 window \]

7. 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 \( -n_0 \).