

Homework #8: Chapter 4 (due Friday Oct. 23, 2015)

Preliminary

- Textbook reading Ch. 3.10 - 4.4 (pp. 239 - 322)
- As a reminder, EE312 office hours are on Wed. from 9:00-10:00am and Thu. from 3:30-4:30pm.
- Please direct all email to pdeleon@nmsu.edu (do not send email via Canvas). All requests for bonus points will receive a confirmation email within 48 hours.
- Download the CompanionFiles8.zip file that contains financial data software problem 3.
<http://www.ece.nmsu.edu/~pdeleon/Teaching/EE312/Homework/CompanionFiles8.zip>.
- As a reminder, Exam #2 is on Wednesday, October 28 from 6.30-8.30pm in Hardeman Jacobs Learning Center Room 210. The exam will cover Ch. 2.4 – 4.4.
- There is no class on Monday, October 26.

Textbook Problems

| | | | | |
|---------|---------|------------|------------|--------|
| 3.36(a) | 4.1(a) | 4.2(a) | 4.3(a) | 4.4(a) |
| 4.19 | 4.22(d) | 4.26(a)(i) | 4.28(b)(i) | |

Software Problems

Read the next section on using MATLAB to compute the Frequency Response of CT and DT LTI systems.

1. Consider the following DT system

$$y[n] + a_1 y[n - 1] = x[n].$$

Recreate the frequency response plots in Figure 3.34(a) by letting $a_1 = -0.6$ and in Figure 3.34(b) by letting $a_1 = 0.6$. Use the 'freqz' command.

2. Consider the following CT system

$$RC \frac{dy(t)}{dt} + y(t) = x(t).$$

Recreate the frequency response plots in Figure 3.30 by letting $RC = 0.01$. Use the 'freqs' command.

3. Consider the M -point moving average (MA) filter from Section 3.11.2

$$y[n] = \frac{1}{M} \sum_{k=0}^{M-1} x[n - k].$$

Using the DJIA data in the companion file, plot the original and 30-MA data on a single plot.

```
M = 30; % number of points for averaging
x = csvread('DJIA.csv',1,1);
N = length(x);
n = [0:N-1];
```

```
b = (1/M).*ones(M,1); % build filter coefficients
y = filter(b,1,x);
plot(n,x,'r',n,y,'b');
xlabel('day');ylabel('DJIA Close');
title('DJIA data and moving average (1 Jan 2013 - 13 Oct 2015)');
axis([0 N-1 13000 18500]);grid;
```

4. Plot the magnitude response of the 30-point MA filter from above and compare to Figure 3.36.

Frequency Response of DT LTI systems

For causal DT LTI systems described by a difference equation, the MATLAB command

```
>> [H, w] = freqz(b,a,N);
```

computes the frequency response $H(e^{j\omega})$ at N evenly spaced frequencies between 0 and π , where

$$\mathbf{H} = [H(e^{j\omega_0}), H(e^{j\omega_1}), \dots, H(e^{j\omega_{N-1}})]^T, \quad (1)$$

where

$$\mathbf{w} = [\omega_0, \omega_1, \dots, \omega_{N-1}]^T, \quad (2)$$

and $\omega_k = k\pi/N$. The coefficient vectors $\mathbf{a} = [a_0, a_1, \dots, a_N]$, $\mathbf{b} = [b_0, b_1, \dots, b_M]$ specify the parameters (coefficients) of the difference equation on p. 121 equation (2.113). We visualize the frequency response by plotting the magnitude and phase responses of the system using the MATLAB commands

```
>> figure(1)
>> plot(w,abs(H)); % plots mag response in fig 1 window
>> figure(2)
>> plot(w,angle(H)); % plots phase response in fig 2 window
```

Alternately, we can plot the magnitude and phase responses of the system in a single window using the MATLAB command

```
>> freqz(b,a,N);
```

Computing the DTFT of the impulse response will also give the frequency response (Chapter 5).

Frequency Response of CT LTI systems

For causal CT LTI systems described by a differential equation, the MATLAB command

```
>> [H, w] = freqs(b,a);
```

computes the frequency response $H(j\omega)$ at 200 frequencies, where

$$\mathbf{H} = [H(j\omega_0), H(j\omega_1), \dots, H(j\omega_{199})]^T, \quad (3)$$

where

$$\mathbf{w} = [\omega_0, \omega_1, \dots, \omega_{N-1}]^T. \quad (4)$$

The MATLAB command ‘freqs’ automatically selects the range of frequencies over which $H(j\omega)$ is computed. The coefficient vectors $\mathbf{a} = [a_N, \dots, a_1, a_0]$, $\mathbf{b} = [b_M, \dots, b_1, b_0]$ specify the parameters of the differential equation on p. 120 equation (2.109). We visualize the frequency response by plotting the magnitude and phase responses of the system using the MATLAB commands

```
>> figure(1)
>> plot(w,abs(H)); % plots mag response in fig 1 window
>> figure(2)
>> plot(w,angle(H)); % plots phase response in fig 2 window
```

Alternately, we can plot the magnitude and phase responses of the system in a single window using the MATLAB command

```
>> freqs(b,a);
```

Computing the FT of the impulse response will also give the frequency response (Chapter 4).