Homework #11, EECS 206, W03. Due **Fri. Mar. 28**, by 11:30AM

Notes

- Review the HW policies on HW1!
- Continuing to write *anything* on your homework after the 11:30AM due date, or attempting to put your solution into the box any time after 11:30AM is an honor code violation.
- The **final exam** is Wed. 4/23/03 from 4-6PM.
  - Section 1 will be in 1013 Dow as usual.
  - Section 2 will be in 1610 IOE.
- The time and place for the **alternate final exam** is Tues. 4/22 10:30-12:30 in 1303 EECS. Students in Section 2 who need to take this alternate final must use the sign up form on the web by **April 1**. Section 1 students or students with additional scheduling problems must see Prof. Fessler *in person* by April 1.
- Reading: Text Ch. 6.
- Relevant practice problems on the DSP CDROM: 6.2, 6.9-6.26, 6.29, 6.30, 6.34

Skill Problems

1. [0] Text 6.1. Concept(s): ***response of FIR filter to complex exponential***
   The answer is $y[n] = 1.176 \mathrm{e}^{-\jmath 0.63} \mathrm{e}^{\jmath 0.4 \pi n}$.

2. [0] Text 6.2. Concept(s): ***response of squaring system to complex exponential***
   The answer is $y[n] = A^2 \mathrm{e}^{\jmath 2\phi} \mathrm{e}^{\jmath 2\hat{\omega} n}$. This is *not* of the form $\mathcal{H}(\hat{\omega}) A \mathrm{e}^{\jmath \phi} \mathrm{e}^{\jmath \hat{\omega} n}$.
   (The nonlinearity changed the frequency.)

3. [25] Text 6.4. Concept(s): ***frequency response of FIR filter***

4. [20] Text 6.6. Concept(s): ***frequency response and steady-state response of FIR filter***

5. [15] Text 6.8. Concept(s): ***difference equation from frequency response***

6. [10] Text 6.12b. Concept(s): ***frequency response of cascade of LTI systems***

7. [10] By factoring, find the coefficients of two first-order FIR filters so that, when cascaded, they yield the following overall frequency response:
   $$\mathcal{H}(\hat{\omega}) = 2 - 5\mathrm{e}^{-\jmath \hat{\omega}} + 3\mathrm{e}^{-\jmath 2\hat{\omega}}.$$

8. [20] Consider the cascade system
   $$x[n] \rightarrow \boxed{h_1[n]} \rightarrow \boxed{\mathcal{H}_2(\hat{\omega})} \rightarrow y[n] \,,$$
   where $h_1[n] = \delta[n] - \delta[n-1] + \delta[n-3]$ and $\mathcal{H}_2(\hat{\omega}) = 1 + 2\mathrm{e}^{-\jmath \hat{\omega}} + \mathrm{e}^{-\jmath 2\hat{\omega}}$.
   (a) [5] Determine the overall frequency response $\mathcal{H}(\hat{\omega})$ of this system. Simplify your answer as much as possible.
   (b) [5] Determine and plot the overall impulse response $h[n]$ of this system.
   (c) [5] Determine the difference equation for this system.
   (d) [5] Determine the steady-state response of this system to a unit step function input.

9. [5] Text 6.20a. Concept(s): ***(sinusoidal response from frequency response)***

10. [10] The 6-periodic signal $x[n]$ having 6-point DFT given by $X[k] = [2,\ 0,\ \jmath,\ 3,\ -\jmath,\ 0]$ for $k = 0, 1, \ldots, 5$ is the input to a FIR filter with frequency response $\mathcal{H}(\hat{\omega}) = 2 - \mathrm{e}^{-\jmath \hat{\omega}}$. Determine the output signal $y[n]$.

Mastery Problems

11. [0] What room is the final exam in?