ECE 220 Signals and Systems I

Problem Set 12 (Practice Problems)

Spring 2007

Issued: Wednesday, May 2, 2007 **Due:** For practice only. Not due.

FINAL EXAM:

The final exam is **Tuesday, May 15, 1:30pm-4:15pm**. The exam is comprehensive; it includes material from the entire semester. As discussed in class, the final exam will consist of two parts:

- Part 1 consists of multiple-choice questions. You will be given a maximum of one hour to complete the multiple-choice part of the exam. You may not use books or notes for Part 1. I will provide the scantron form required for this part. Use of calculators is not allowed.
- Part 2 consists of problems to be solved. This part is closed-book, but you will be allowed to use three 8.5 x 11 inch sheets of notes (both sides). Use of calculators is not allowed.

Office Hours prior to the Final Exam:

Professor Wage will have office hours during the week prior to the final. Please take advantage of them! If you cannot come during one of these times, send an email to make an appointment. Note that Prof. Wage will be out of town the week of 5/14, so if you need to see her, please do so before then.

Monday, 5/7	4:00-5:30pm
Tuesday, 5/8	3:00-4:15pm
Wednesday 5/9	4:00-5:30pm
Thursday, 5/10	3:00-4:15pm
Friday, 5/11	4:00-5:00pm

TA Omar Ghowrwal will have office hours on Tuesday, May 15 (just prior to the final exam) in Science & Tech II, Room 265:

Tuesday, 5/15	11:30am-1:00pm

Problem 7.3-6 in *Lathi*

Problem 7.3-7 in *Lathi*

Problem 7.4-3 in *Lathi*

ECE-220 Problem 28

Consider an LTI system whose response to the input

$$x(t) = \left[e^{-t} + e^{-3t}\right] u(t)$$

is

$$y(t) = \left[2e^{-t} - 2e^{-4t}\right] u(t).$$

(a) Find the frequency response of this system.

(b) Determine the system's impulse response.

(c) Find the differential equation relating the input and the output of this system.

ECE-220 Problem 29 Consider two LTI systems with impulse responses $h_1(t)$ and $h_2(t)$:

$$h_1(t) = \delta(t-5) \qquad\qquad h_2(t) = -\delta(t) + 2e^{-t}u(t).$$

(a) Determine the frequency response of each of the systems. Sketch the magnitude $|H(j\omega)|$ and phase $\angle H(j\omega)$ responses for each system. Are the magnitude responses identical? What about the phase responses? Could you have sketched the frequency response of system 2 by first sketching the pole-zero plot?

(b) Determine the output of each system when the input is $x(t) = \cos(\frac{t}{\sqrt{3}}) + \cos(\sqrt{3}t)$ for all time. Use Matlab to "sketch" the outputs over the interval 0 to 100 with 0.01 between samples. How do the outputs compare to the input?

ECE-220 Problem 30 (Old exam questions)
Consider the continuous-time LTI system that has the impulse response $h(t)$ shown in Figure 30.1 and the frequency response $H(j\omega)$ shown in Figure 30.2.

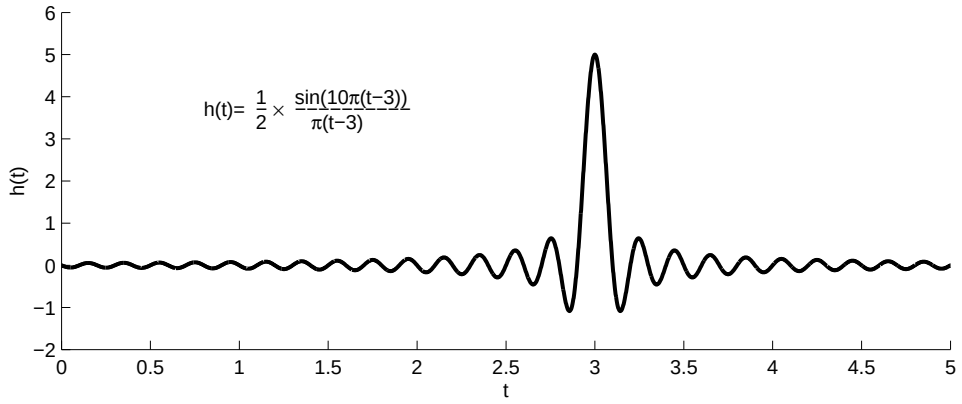

Figure 30.1: Impulse response $h(t)$ of the CT LTI system in Problem 3

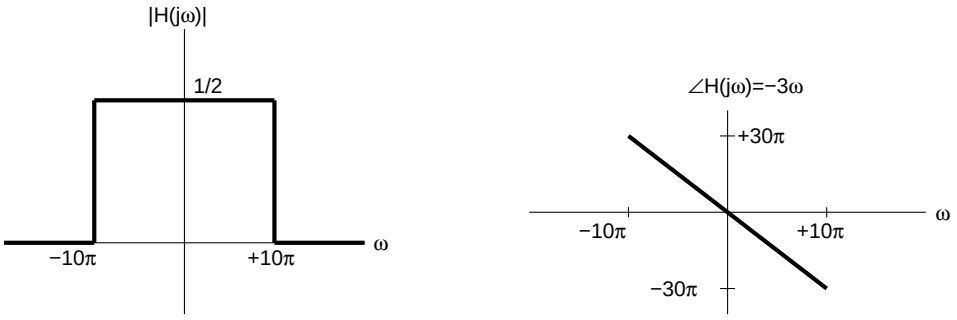

Figure 30.2: Frequency response (magnitude and phase plots) of the CT LTI system in Problem 3

In parts a-d below, you are given 4 signals that are inputs to the LTI system defined above: Determine and sketch the output of the system corresponding to each input. *Make sure to label your sketches!*

(a) Input to system: $x_a(t) = \delta(t)$. Determine the output $y_a(t)$. Provide a sketch of $y_a(t)$ and justification of your answer.

(b) Input to system: $x_b(t) = \cos(2\pi t)$. Determine the output $y_b(t)$. Provide a sketch of $y_b(t)$ and justification of your answer.

(c) Input to system: $x_c(t) = p(t)\cos(100\pi t)$, where $p(t)$ and its Fourier transform $P(j\omega)$ are shown in Figure 30.3. Determine the output $y_c(t)$. Provide a sketch of $y_c(t)$ and justification of your answer.

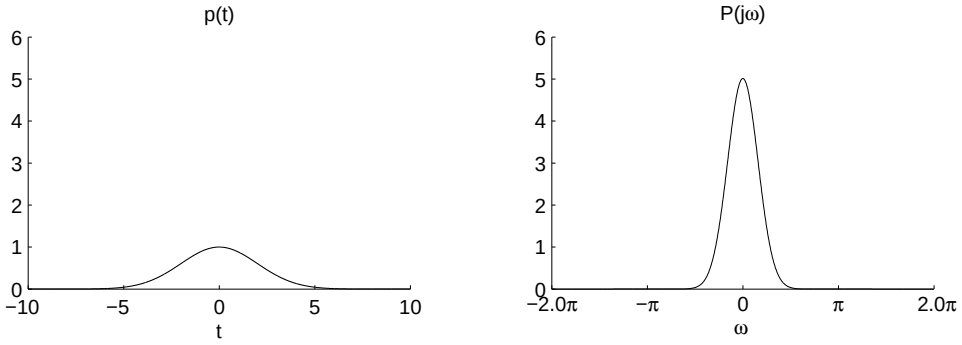

Figure 30.3: Signal $p(t)$ and its Fourier transform $P(j\omega)$.

(d) Input to system: $x_d(t)$ shown in Figure 30.4. Determine the output $y_d(t)$. Provide a sketch of $y_d(t)$ and justification of your answer.

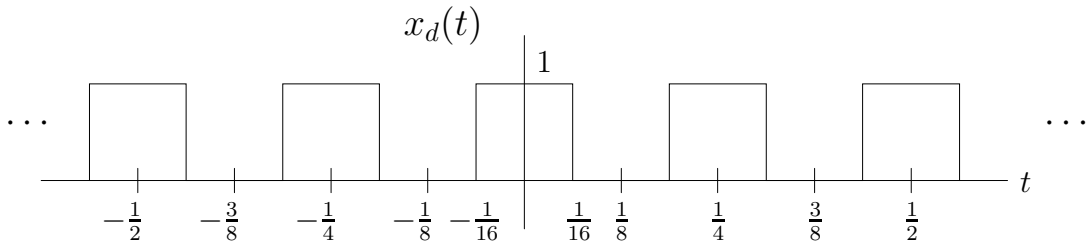

Figure 30.4: Input signal $x_d(t)$ for Problem 3d

ECE-220 Problem 31 (Old Exam Problem)
Consider a continuous-time LTI system with input $x(t)$ and output $y(t)$, as shown in Figure 31.1:

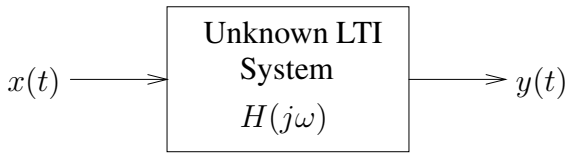

Figure 31.1: System for Problem 31.

The frequency response $H(j\omega)$ of this system is not known. We do know that when the input is the signal $x1(t)$ shown in Figure 31.2, the output is $y1(t)$ shown in the same figure. Note that $x1(t)$ and $y1(t)$ are periodic (they repeat outside the interval shown).

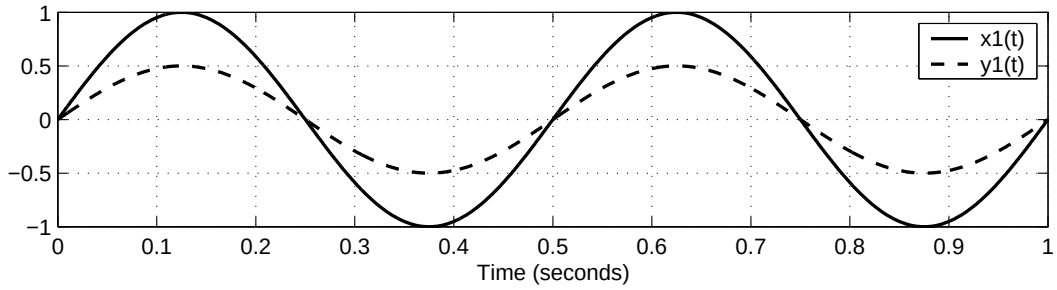

Figure 31.2: Input/output pair for the system in Problem 31.

Figure 31.3 on the next page shows the frequency responses of six systems, $H_1(j\omega)$ through $H_6(j\omega)$. These frequency responses are purely real.

(a) Which of the frequency responses shown in Figure 31.3 could be the frequency response of the unknown LTI system? *Hint:* There are **at least two** possibilities. Please provide a brief justification (**Answers without justification will receive zero credit.**)

(b) Suppose that you are told that the frequency response of the unknown system is definitely one of the choices in Figure 31.3. If you could run a second test signal $x2(t)$ through the system and measure the output $y2(t)$, could you determine which of your answers from part (a) is frequency response of the unknown system? If your answer is yes, explain what type of test signal you would use. If your answer is no, explain why you cannot determine which of the choices is the correct one.

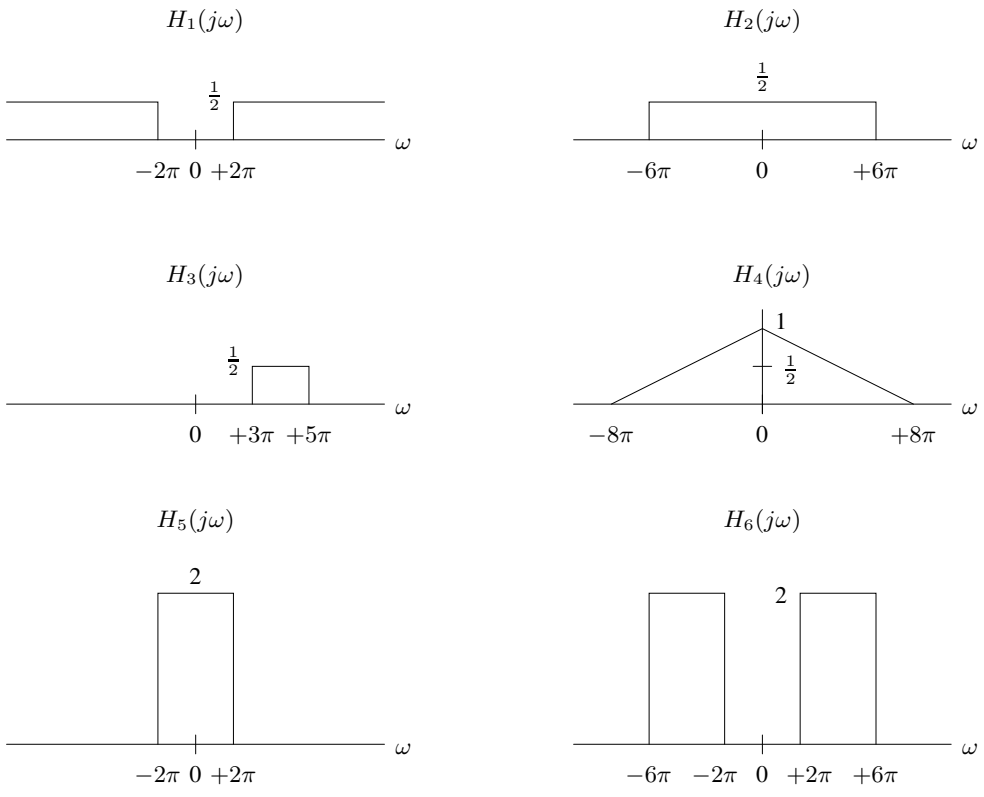

Figure 31.3: Frequency response choices for Problem 31.