

ECE 220 Signals and Systems I
Problem Set 12(Practice Problems)
Spring 2008

Issued: Monday, May 5, 2008

Due: For practice only. Not due.

FINAL EXAM:

The final exam is **Monday, May 12, 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.

Monday, 5/5	1:30pm-2:30pm
Tuesday, 5/6	5:00pm-6:00pm
Wednesday 5/7	5:00pm-6:00pm
Thursday, 5/8	5:00pm-6:00pm
Friday, 5/9	4:00pm-5:00pm
Sunday, 5/11	3:00pm-5:00pm
Monday, 5/12	10:00am-11:00am

ECE-220 Problem 12-1

Consider an LTI system whose response to the input

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

is

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

- Find the frequency response of this system.
- Determine the system's impulse response.
- Find the differential equation relating the input and the output of this system.

ECE-220 Problem 12-2 (Old ECE 220 exam question)

Consider the causal LTI system with transfer function $H(s)$ given below:

$$H(s) = \frac{2s}{(s+1-j100)(s+1+j100)}.$$

- Determine a differential equation for this system.
- Determine the output $y(t)$ of this system when the input is $x(t) = u(t) - e^{3t}u(t)$.
- Sketch the pole-zero plot for this system.
- Sketch the frequency response magnitude of this system. Do not use a log scale, *i.e.*, do not sketch the Bode plot.
- What type of filter is this system?

ECE-220 Problem 12-3 (Old ECE 220 exam question)

A linear time-invariant system has the impulse response $h(t)$ given below:

$$h(t) = u(t + 1) - u(t - 3).$$

- (a) Make a fully-labeled sketch of the impulse response $h(t)$:
- (b) Is this system stable? Why or why not? (Justify your answer! Answers without justification will receive zero credit.)
- (c) Determine the output $y(t)$ of this system when the input is $x(t) = e^{-2t}u(t)$. *Suggestion: implement via convolution and Laplace.*

ECE-220 Problem 12-4 (Old Exam Problem)

Consider a continuous-time LTI system with input $x(t)$ and output $y(t)$, as shown in Figure 4.1:

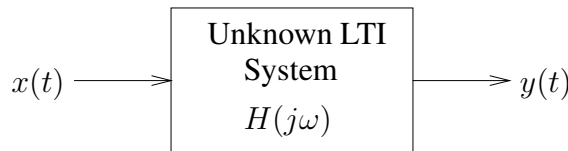


Figure 4.1: System for Problem 4.

The frequency response $H(j\omega)$ of this system is not known. We do know that when the input is the signal $x_1(t)$ shown in Figure 4.2, the output is $y_1(t)$ shown in the same figure. Note that $x_1(t)$ and $y_1(t)$ are periodic (they repeat outside the interval shown).

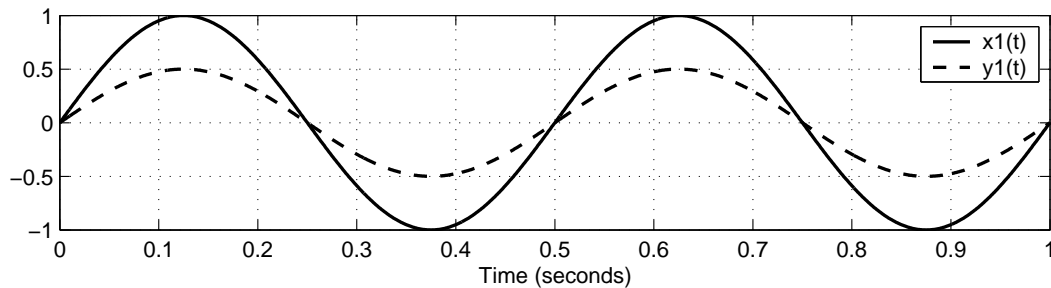


Figure 4.2: Input/output pair for the system in Problem 4.

Figure 4.3 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 4.3 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 4.3. If you could run a second test signal $x_2(t)$ through the system and measure the output $y_2(t)$, 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.

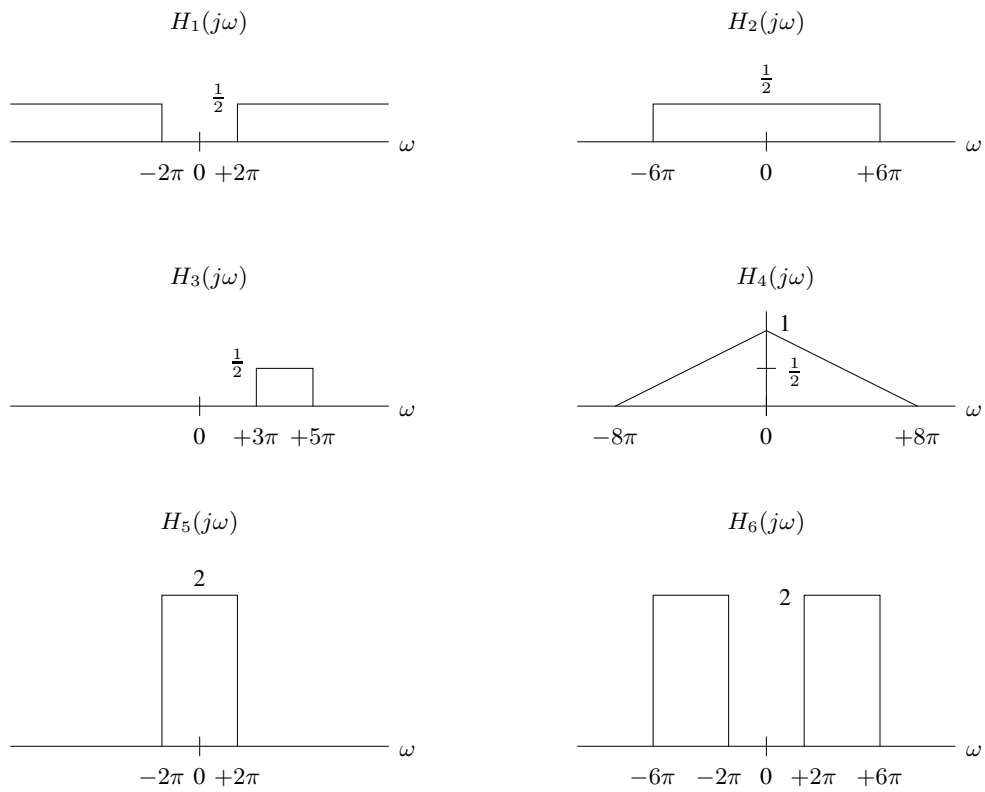


Figure 4.3: Frequency response choices for Problem 4.

ECE-220 Problem 12-5 (Old ECE 220 exam question)

The following is known about a causal LTI system:

- The system has real poles and zeros.
- The system has the frequency response magnitude shown in the Bode plot in Figure 5.1. (The plot shows relative amplitudes only.)
- When the input is $x(t) = \cos(10t)u(t)$ the output $y(t)$ is shown in Figure 5.2.

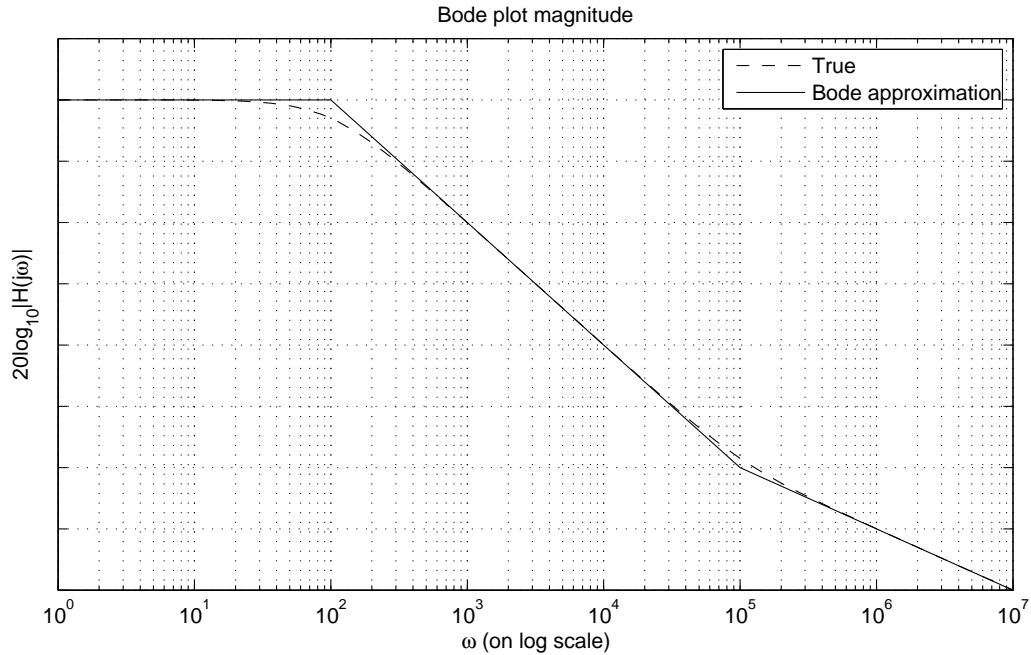


Figure 5.1: Bode plot magnitude for Problem 5.

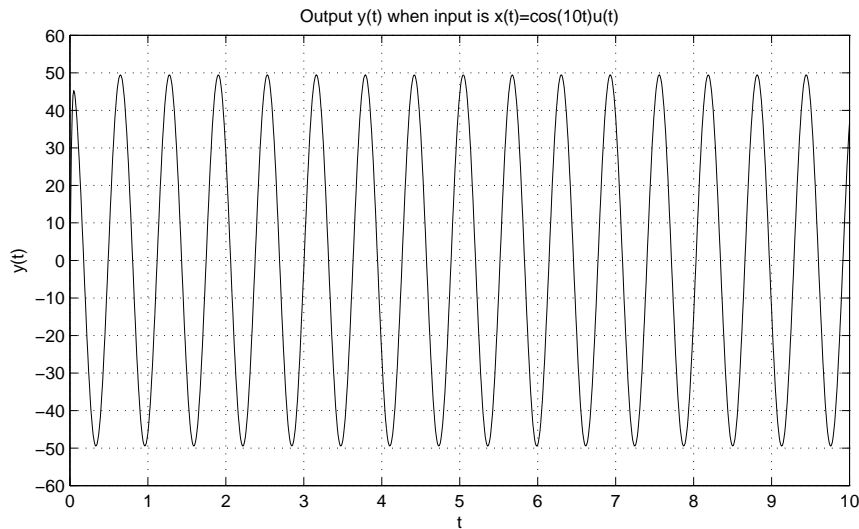


Figure 5.2: Output of system for Problem 5 when input is $x(t) = \cos(10t)u(t)$.

Based on the clues given above, determine as much as you can about the system function $H(s)$ for this system.