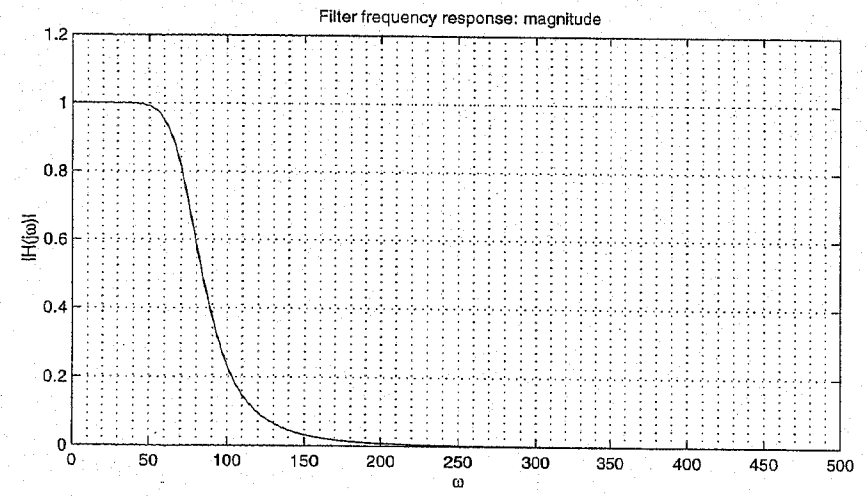
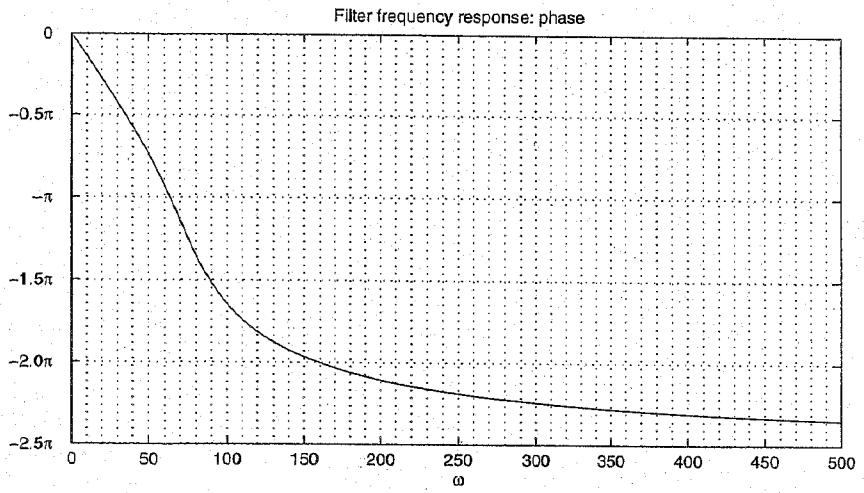
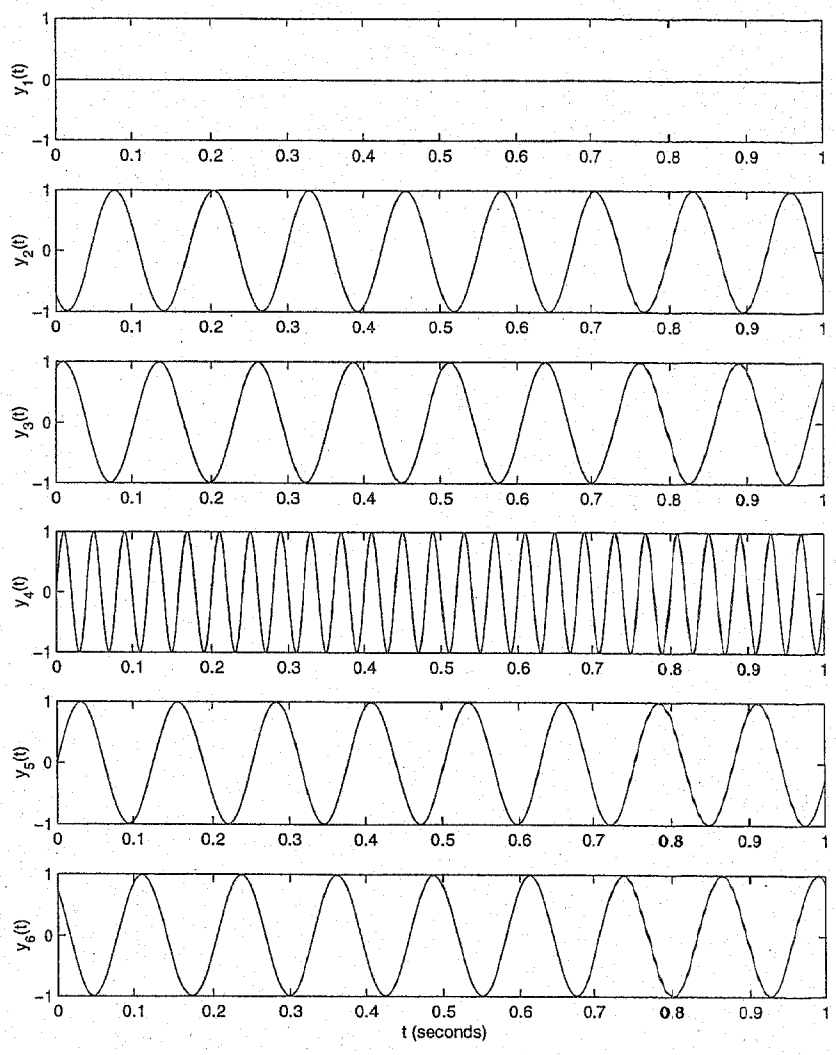
Problem 1: Frequency response of a real CT LTI filter





Problem 1: What is the output of this filter when x(t)=sin(50t)?



Extra Credit Worth a 25% bonus on this homework!

ECE-220 Problem 18 (Old Exam Problem)
Consider a continuous-time LTI system with input $x(t)$ and output $y(t)$, as shown in Figure 18.1:

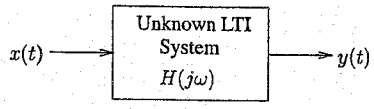


Figure 18.1: System for Problem 18.

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 18.2, 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).

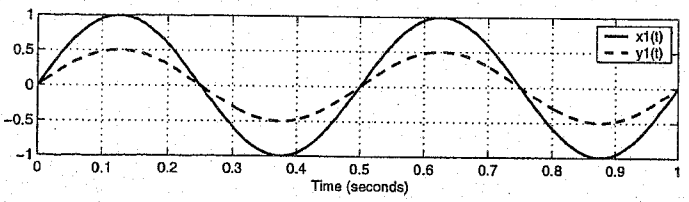


Figure 18.2: Input/output pair for the system in Problem 18.

Figure 18.3 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 18.3 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 18.3. 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.

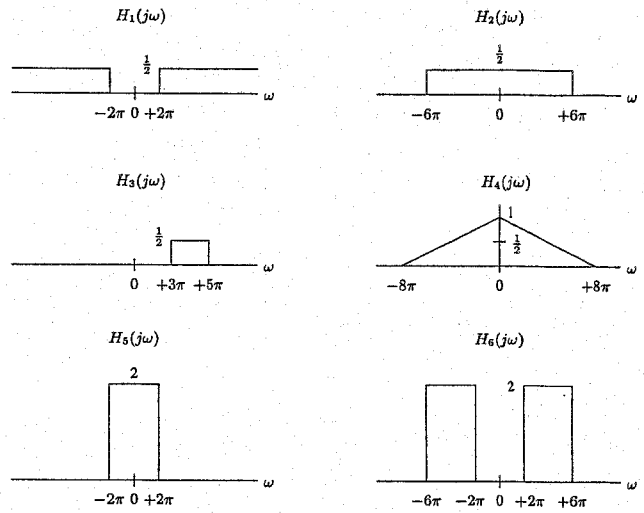


Figure 18.3: Frequency response choices for Problem 18.

ECE-220 Problem 21 (Old exam questions)

Consider the continuous-time LTI system that has the impulse response $h(t)$ shown in Figure 21.1 and the frequency response $H(j\omega)$ shown in Figure 21.2.

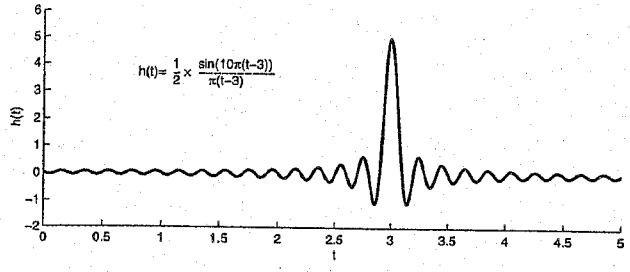


Figure 21.1: Impulse response $h(t)$ of the CT LTI system in Problem 3

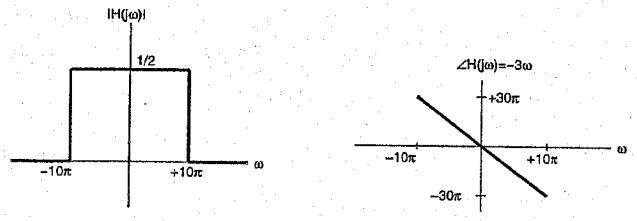


Figure 21.2: Frequency response (magnitude and phase plots) of the CT LTI system in Problem 3

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 21.3. Determine the output $y_c(t)$. Provide a sketch of $y_c(t)$ and justification of your answer.

(d) Input to system: $x_d(t)$ shown in Figure 21.4. Determine the output $y_d(t)$. Provide a sketch of $y_d(t)$ and justification of your answer.

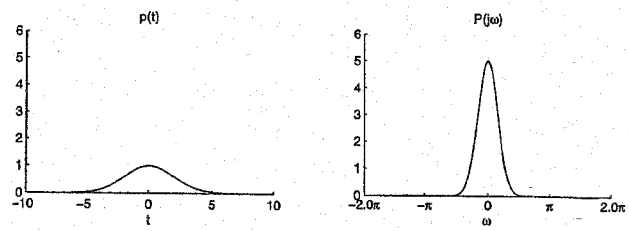


Figure 21.3: Signal $p(t)$ and its Fourier transform $P(j\omega)$.

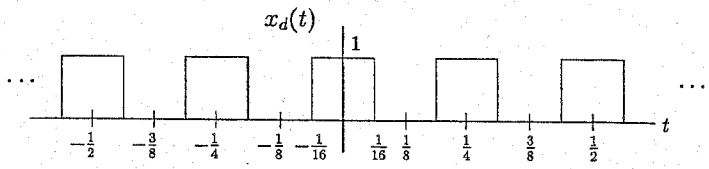


Figure 21.4: Input signal $x_d(t)$ for Problem 3d