Signals and Systems February 12, 2013
Sharif University of Technology CE 40-242
Ali Soltani Farani

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Homework 2 (Chapters 1 & 2)

Problems

1. Determine and sketch the following signal and its even and odd parts. Label your sketches carefully.
   $x(t) = u(t-2) - u(t-1) + (u(t+1) - u(t-1)) * (u(t+1) - u(t)) * \delta(t+2)$

2. Are the following signals periodic? If so determine their fundamental period.

   a. $x(t) = 3\sin(6t) + \cos^2(15t)$

   b. $y(t) = 2\cos(2\pi t) + 4\sin(3t)$

   c. $w(t) = \sin(\frac{\pi}{5}t) - 2\cos^2(3\pi t)$

3. A system may or may not be linear, time-invariant, memoryless, causal, or stable. Determine whether or not each of the following systems has these properties.

   a. $y(t) = (t+1)x(t)$

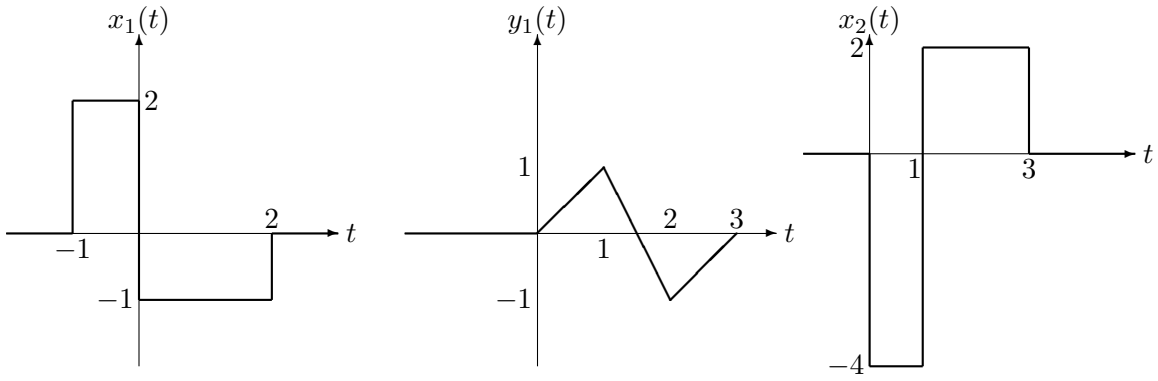
   b. $y(t) = \cos(t)\int_{-\infty}^{t} x^2(\tau)\,d\tau$

   c. $y[n] = e^n \cos(2\pi x[n])$

   d. $y[n] = x[n-2] - x[3-n]$

4. For a discrete-time system G, the following input-output relations hold:
   $x[n] = \delta[n] \longrightarrow y[n] = 2\delta[n-1] + 3\delta[n-4]$
   $x[n] = 2\delta[n] \longrightarrow y[n] = 4\delta[n-1] + 6\delta[n-4]$
   $x[n] = \delta[n] - \delta[n-1] \longrightarrow y[n] = 2\delta[n-1] - 2\delta[n-2] + 3\delta[n-4] - 3\delta[n-5]$
   Based on this information, is G (i) linear and (ii) time-invariant? Explain your answer clearly.

5. Consider an LTI system whose response to the signal $x_1(t)$ is the signal $y_1(t)$ where these signals are depicted below. Determine and provide a labeled sketch of the response to the input $x_2(t)$, which is also depicted below.



6. A discrete-time, causal system F has an input-output signal pair x and y described below:

$$x[n] = \delta[n-2] \longrightarrow y[n] = \delta[n-1] + 2\delta[n-2] - \delta[n-3]$$

Which one of the following is true? Explain your choice clearly.

a. F must be a linear system.

b. F can be a linear system.

c. F cannot be a linear system.

7. Compute the convolution sum $y[n] = x[n] * h[n]$ for each of the following pairs of signals.

a. $x[n] = h[n] = \alpha^n u[n]$

b. $x[n] = u[n+4]$, $h[n] = 2^n u[2-n]$

8. Compute the convolution $y(t) = x(t) * h(t)$ for each of the following pairs of signals.

a. $x(t) = u(t) - 2u(t-2) + u(t-5), h(t) = e^{2t}u(1-t)$

b. $x(t) = 2u(t-10), h(t) = \sin(2t)u(t)$

9. The following are the impulse responses of LTI systems. Determine whether each system is causal and/or stable. Justify your answers.

a. $h[n] = \frac{1}{4}^n u[10-n]$

b. $h[n] = \cos(2\pi n)u[n+1]$

d. $h(t) = u(t+4) - 5e^{-3t}u(t)$

e. $h(t) = e^{5t}[u(t-1) - u(t-100)]$

10. Determine whether each of the following statements concerning LTI systems is true or false. Justify your answers.

a. The inverse of a causal LTI system is always causal.

b. If an LTI system is causal, it is stable.

11. Suppose two following signals:

$$x(t) = u(t+2) - u(t-2)$$
$$h(t) = e^{j\omega t}$$

Determine a value of ω which ensures that y(0)=0 where y(t)= x(t)*h(t).