ELEG 305 SIGNALS AND SYSTEMS
SPRING 2019

- **All Homeworks and Homework Quizzes are worth 25 points.**
- **Homeworks and Solutions from Spring 2018 have been posted on Canvas.**

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HOMEWORK #2 → *Hand-in on Thursday February 28 (Collected in Lecture)*

Problem #1

Evaluate the following sums and integrals of impulse functions:

a.) $x_1(t) = \int_{-3}^{-1} t^4 \, \delta(t+2)dt$

b.) $x_2(t) = \int_{-2}^{2} (1+t)^2 \, \delta(t-1)dt$

c.) $x_3(t) = \int_{-2}^{2} (1-t) \, \delta(t+3)dt$

d.) $x_4[n] = \sum_{n=-3}^{\infty} \left(\frac{1}{2}\right)^n \delta[n-1]$

e.) $x_5[n] = \sum_{n=0}^{\infty} \left(e^{j2\pi/3}\right)^n \delta[n-k]\,, \; k \in [0, \infty)$

f.) $x_6[n] = \sum_{n=-3}^{3} (-3)^n \delta[n+4]$

Problem #2

In class, we introduced several properties of systems. In particular, a system may or may not be **(a) memoryless, (b) time invariant, (c) linear, (d) causal, and (e) stable**. Determine which of these properties hold and which do not hold for each of the following systems. **Justify your answer.** For the continuous-time systems, $y(t)$ denotes the system output and $x(t)$ is the input. For discrete-time systems, $y[n]$ denotes the system output and $x[n]$ is the input.

a.) $y(t) = x(2-t)$

b.) $y(t) = [sin(2t)]x(t-2)$

c.) $y[n] = |x[n-3]|$

d.) $y[n] = \left(\frac{1}{3}\right)(x[n+1] + x[n] + x[n-1])$

Note: This operation is called a *moving average* and will result in a smoother output.

Problem #3

The impulse response is the response of the system to an input that is an impulse function. Determine the impulse response for a continuous-time, LTI system with input-output related as:

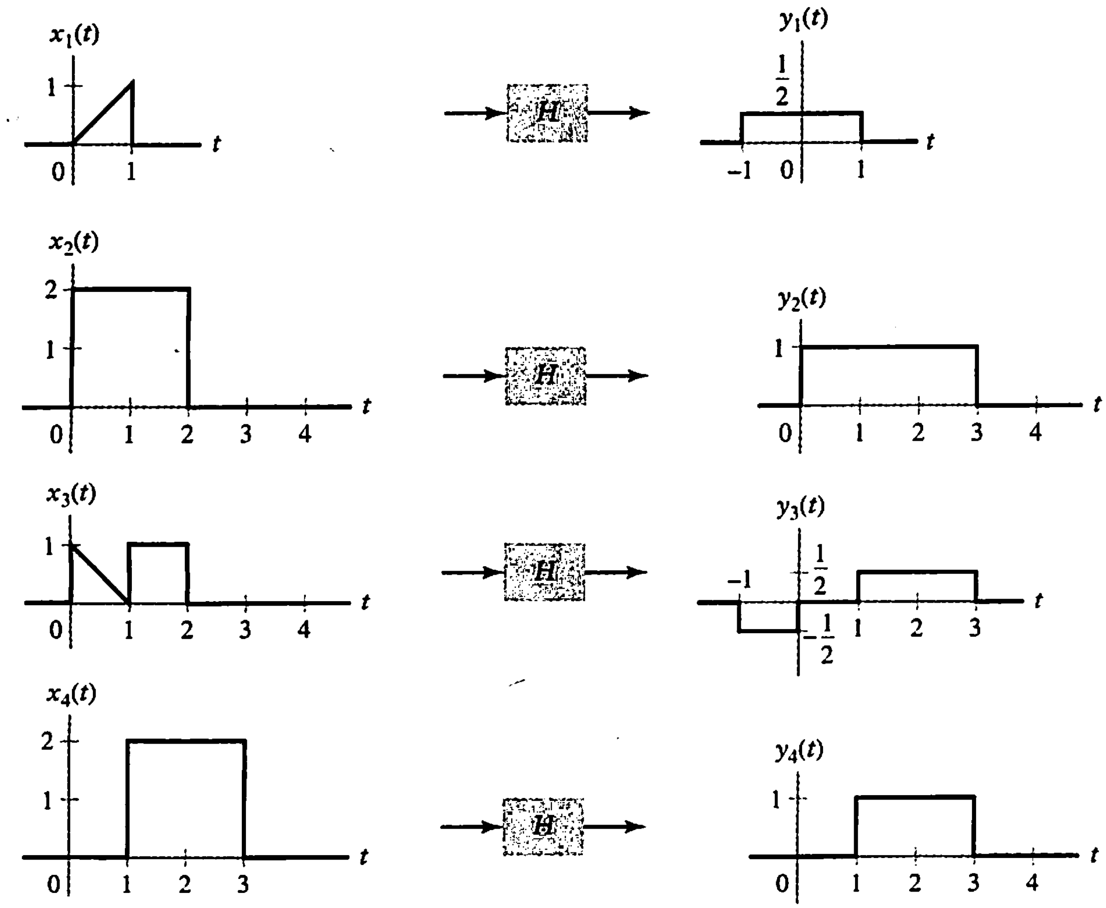
a.) $y[n] = 2x[n] + x[n-\alpha] + x[n+\beta]$

Note: A wireless communication system (like cellular or WiFi) can be modeled in this way. The signal that you get from the cell site or wireless router arrives by many paths because it bounces off of everything. Assume there are only two paths: a direct one, and another that bounces off the ground first. The second received signal is a replica of the transmitted signal, but it arrives delayed and attenuated relative to the first. So, the received signal can be written as $y[n] = x[n] + ax[n-n_0]$, where a is the attenuation and n_0 is the delay.

b.) $y(t) = \int_{0}^{\infty} e^{-\tau} x(t-\tau)d\tau$

Problem #4

In practice, we use test signals as inputs to get information about how the system behaves (by observing the output for these specific inputs). Consider a system, *H*, that has the following input-output pairs (i.e., $y(t)$ is the response of the system when $x(t)$ is the input):



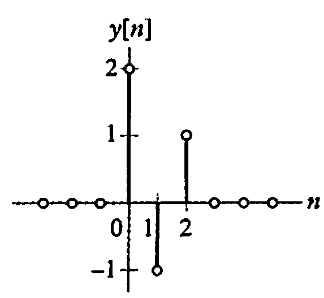
Answer the following questions, and please explain your answers (again, a simple "yes' or "no" will get you no points even if it is the correct answer).

a.) Could this system be causal?

b.) Could this system be time-invariant?

Problem #5

Consider a discrete-time LTI system. Suppose the output due to an impulse input, $\delta[n]$, is as shown below. What is the output due to the input $x[n] = 2\delta[n] - \delta[n-2]$?



Problem #6

a.) Compute the convolution $y[n] = x[n] * h[n]$ where $x[n] = u[n-1]$ and $h[n] = \left(\frac{3}{4}\right)^n u[n]$.

b.) Compute the convolution $y[n] = x[n] * h[n]$ for

$$x[n] = u[n+1]$$

and

$$h[n] = -u[n] + 2u[n-3] - u[n-6].$$

(Note: It helps if you draw the functions first.)

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EXAM # 1 Tuesday March 12

- Closed everything: no calculators, cellphones, laptops, …
- Chapters 1 and 2
- Review on Monday March 11