

# Spring 2019 - Problem Set 1

## ECE 301: Signals and Systems

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**Due Date : February 15, 2019**

### Instructions

1. Please write clearly and legibly.
2. Your solutions must include detailed steps and/or explanations. Do not simply state the answer.
3. Write your full name (first,last), PUID on your homework submission.
4. All problems carry equal weight.

### Problem 1

For each of the below systems with input  $x$  and output  $y$ , determine if they are :

1. Linear or Non linear, 2. Causal or Non causal , 3. Time Variant or Time Invariant, 4. Stable or Unstable

a  $y[n] = 2x[n] + 3$

b  $y[n] = n^2x[n]$

c  $y[n] = (n + 4)x[n - 4]$

d  $y(t) = e^{-t}x(t)$

e  $y(t) = e^{jt}x(t)$

### Problem 2

Consider a Discrete-Time LTI system, where the output at each time  $n$  is obtained by accumulating the values of the input from  $n + 1$  to  $n + 2$ .

- a What is the impulse response?
- b What is  $y[n]$  when  $x[n] = u[n + 3] - u[n + 4]$ , where  $u[n]$  indicates the unit step signal?
- c Is this system
  - i Causal?
  - ii Memoryless?
  - iii Stable?
  - iv Invertible? If so, what is the impulse response of the inverse system.
- d Repeat all the above when the output at time  $n$  is obtained by accumulating the values of the input from  $n + 1$  to  $\infty$ .

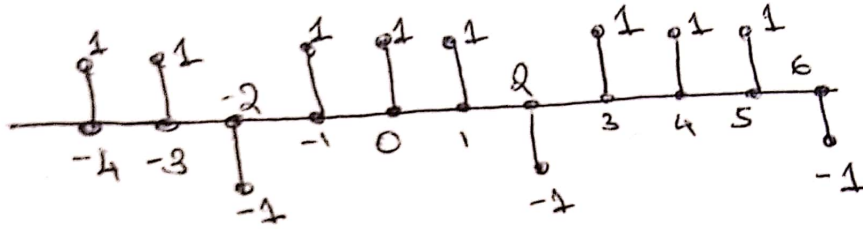


Figure 1:  $x[n]$

### Problem 3

Consider a linear system, where the response to an input signal  $x[n] = \delta[n - k]$  is given by

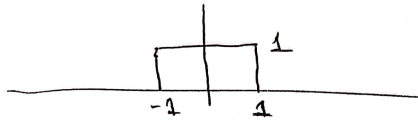
$$y[n] = \begin{cases} \delta[n], & \text{if } k \text{ is even,} \\ \delta[n - 1], & \text{if } k \text{ is odd.} \end{cases}$$

Is this system time invariant? What is the output to  $x[n]$  in Figure 1 (all values that are not shown in the figure equal zero)?

### Problem 4

- a  $x[n] = \delta[n - 4] + \delta[n + 3] - \delta[n]$   
 $h[n] = u[n]$   
 Find  $x[n] * h[n]$ . Note:  $u[n]$  is the unit step signal
- b Calculate  $x_1[n] * x_2[n] * x_3[n]$ .  
 $x_1[n] = \frac{1}{4^n} u[n]$   
 $x_2[n] = u[n]$   
 $x_3[n] = \delta[n - 5]$
- c For  $x(t)$  and  $y(t)$  in Figure 2, find  $x(t) * y(t)$ .

$x(t)$



$h(t)$

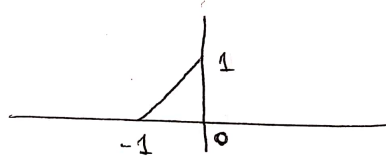


Figure 2

## Problem 5

For each of the following signals, comment if the signal is: Causal? Stable? Invertible? Memoryless? Justify your answer.

- a  $h[n] = u[n]$
- b  $h[n] = \delta[n]$
- c  $h(t) = t$
- d  $h(t) = e^{-t}u(t)$
- e  $h(t) = e^t u(-t)$