**Problem 6.1**

(a)

Linear

(b)

Time invariant

(c)

Non causal

(d)

Linear

(e)

Linear

(f)

Non-causal

**Problem 6.2**

(a) Write an equation for x[n]. Make sure to express x[n] as a real-valued signal.

(b) Determine the formula for the input signal y[n].

**Problem 6.3**

(a) Determine whether or not the system defined by (1) is (i) linear, (ii) time-invariant, (iii) causal.

Not linear

(b) For the system of Equation (1), determine the output y1[n] when the input is:

**Problem 6.4**

(a) Make a plot of u[n] for -5 <= n <= 10. Describe the plot of u[n] outside this range.

(b) We can use the unit step sequence as a convenient representation for sequences that are given by formulas over a range of values. Make a plot of the sequence

(c) Now make a plot of the sequence:

|  |  |
| --- | --- |
| **n** | **x[n]** |
| 0 | 1 |
| 1 | 0.9 |
| 2 | 0.81 |
| 3 | 0.729 |
| 4 | 0.65 |

(d) Suppose that x[n] in part (e) is the input to a 4-point running average system. Compute and plot y[n], the output of the system for -5 <= n <= 10.

**Problem 6.5**

(a) Determine the filter coefficients {bk} of this FIR filter

(b) Find the impulse response, h[n], for this FIR filter. The impulse response is a discrete-time signal, so make a (stem) plot of h[n] versus n.

(c) Use the above difference equation to compute the output y[n] when the input is

Make a plot of both x[n] and y[n] vs. n.

**Problem 6.6**

DO NOT UNDERSTAND, WILL ASK QUESTIONS ABOUT THIS PROBLEM IN CLASS

(a) Suppose the LTI system #1 is described by the difference equation:

Determine the impulse response h1[n] of the system.

(b) The LTI system #2 is described by the impulse response

For the special case of L = 10, use convolution to show that the impulse response sequence of the overall cascade system is

(c) Generalize your results in part (b) for the general case of L any integer value

(d) Obtain a single difference equation that relates y[n] to x[n]

(e) How would you choose L so that y[n] = x[n] in Figure 1; i.e. how would you choose L so that the second equation system “undoes” the effect of the first system?

**Problem 6.7**

A linear time-invariant discrete-time system is described by the difference equation

(a) Draw a block diagram that represents this system in terms of unit-delay elements, coefficient multipliers, and adders

(b) Determine the impulse response h[n] for this system. Express your answer as a sum of scaled and shifted unit impulse sequences.

(c) Use convolution to determine the output due to the input:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **1** | **-2** | **1** | **0** | **3** |
| **1** | 1 | -2 | 1 | 0 | 3 |
| **-2** | -2 | 4 | -2 | 0 | -6 |
| **-1** | -1 | 2 | -1 | 0 | -3 |

Use convolution again to determine yd[n]=xd[n] \* hd[n], the output of this system when the input is:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **1** | **-2** | **1** | **0** | **3** |
| **1** | 1 | -2 | 1 | 0 | 3 |
| **0** | 0 | 0 | 0 | 0 | 0 |
| **4** | 4 | -8 | 4 | 0 | 12 |
| **0** | 0 | 0 | 0 | 0 | 0 |
| **2** | 2 | -4 | 2 | 0 | 6 |
| **-6** | -6 | 12 | -6 | 0 | -18 |
| **-3** | -3 | 6 | -3 | 0 | -9 |

How does your answer compare to the answer in part (c)?