EC401 HW03 Spring 2020

Due Date: Wednesday Feb 12, 2020

You must submit your homework on paper (all pages of your submission stapled together) during the first 10 minutes of lecture on the due date. Please be sure to write your name on the first page of the homework you submit. Additionally, if you have collaborated on the homework with other individuals enrolled in EC401 this semester, please identify them as your collaborators on the first page of the submitted homework.

HW03.1

Consider the discrete-time signal $x[n] = u[n+1] + u[n-2] - 2u[n-5]$, where $u[n]$ is the unit step. Answer the following questions.

a) Sketch $x[n]$

b) Sketch the *Even Part* of $x[n]$

c) Sketch the *Odd Part* of $x[n]$

d) Verify that the sum of the *Odd Part* and the *Even Part* gives back the original $x[n]$

e) Sketch the $Even\ Part$ of $x[n-2]$

f) Sketch the Odd Part of $x[n-2]$

HW03.2

Consider the discrete-time signal $x[n] = \sum_{k=5}^{\infty} (0.5)^{k-5}\, \delta[n-k]$, where $\delta[n]$ is the unit impulse or atom.

a) Sketch $x[n]$ from $n = -5$ to $n = 10$. *Justify your answer.*

b) Determine the integer values n_1 and n_2 such that we can write $x[n] = (0.5)^{n-n_1} u[n-n_2]$. *Justify your answer.*

HW03.3

In each part of this problem, show that the specified system S is *linear*. That is, show that for *any* $x_1[n]$ and any $x_2[n]$, **if** S: $x_1[n] \rightarrow y_1[n]$ and S: $x_2[n] \rightarrow y_2[n]$, **then** for all possible scalars α_1 and α_2 we can say that S: $\alpha_1 x_1[n] + \alpha_2 x_2[n] \rightarrow \alpha_1 y_1[n] + \alpha_2 y_2[n]$. In other words, each of these systems preserves *linear combination glue*.

a) S: $x[n] \rightarrow y[n] = 1.5x[n]$

b) S: $x[n] \rightarrow y[n] = x[n-3]$

c) S: $x[n] \rightarrow y[n] = nx[n]$

d) S: $x[n] \rightarrow y[n] = x[n+2] + x[n-3]$

HW03.4

In each part of this problem, construct a *counterexample* to show that the specified system S is *not* linear.

a) S: $x[n] \rightarrow y[n] = (x[n-3])^3$

b) S: $x[n] \rightarrow y[n] = sin(x[n])$

c) S: $x[n] \rightarrow y[n] = 2x[n-1] + x[n-3] + 2$

d) S: $x[n] \rightarrow y[n] = \begin{cases} x[n]/|x[n]| & \text{if } x[n] \neq 0 \\ 0 & \text{if } x[n] = 0 \end{cases}$

HW03.5

Use MATLAB to obtain the stem plots for the two discrete time signals specified as follows:

$$x[n] = \begin{cases} 0.125 & n = 0 \\ \left(\dfrac{\sin(0.125\pi n)}{\pi n}\right) & n \neq 0 \end{cases} \quad \text{and}$$

$$y[n] = \begin{cases} (0.125)^2 & n = 0 \\ \left(\dfrac{\sin(0.125\pi n)}{\pi n}\right)^2 & n \neq 0 \end{cases} .$$

In your plots, the range of values for n should be $-32 \leq n \leq 32$. Based on the two stem plots obtained using MATLAB, sketch *by hand* the plots of the following two *continuous-time* signals:

$$x(t) = \frac{\sin(0.125\pi t)}{\pi t} \quad \text{and}$$

$$y(t) = \left(\frac{\sin(0.125\pi t}{\pi t}\right)^2 .$$

Justify your answers.