Due Wednesday 25 January 2023 at 11:59 PM via GradeScope

ECE 438 Assignment No. 1 Spring 2023

1. For the signals $x[n]$ shown below, do the following:
   i. Sketch x[n] by hand, i.e. don't use Matlab or Python
   ii. Calculate the metrics E_x, P_x, x_{rms}, M_x, A_x, and x_{avg} by hand.
   iii. Sketch $y_1[n]$ and $y_2[n]$ by hand, where $y_1[n]$ and $y_2[n]$ are, respectively, the result of downsampling with D = 3, and upsampling with D = 3.

   a. $x[n] = \cos(\pi n / 4)$

   b. $x[n] = 2^{-n} u[n]$

2. For the CT signal

$$x(t) = \begin{cases} 1, & -1 \le t \le 0 \\ 1-t, & 0 \le t \le 1 \\ 0, & \text{else} \end{cases},$$

   do the following:
   a. Sketch $x(t)$ by hand, i.e. don't use Matlab or Python
   b. Sketch $x(-t/3+3)$ by hand, i.e. don't use Matlab or Python

3. For each signal x[n] below, do the following:
   i. Use MATLAB or Python to compute the result of the following two filtering operations:

$$y_1[n] = \frac{1}{4}\left(x[n] - 2x[n-1] + x[n-2]\right)$$
$$y_2[n] = x[n] + x[n-1] + y_2[n-1], \quad y_2[n] = 0, n < 0$$

   ii. Use MATLAB or Python to generate stem plots for $x[n]$, $y_1[n]$, and $y_2[n]$ for $-5 \le n \le 20$. Plot all three signals on the same page, using the subplot command.

   iii. Describe in detail the effect that each filter has on the signal.

   Note: Be sure to turn in printouts of all MATLAB or Python code.

   a. $x[n] = u[n] - u[n-6]$

   b. $x[n] = \cos(\pi n / 5) u[n]$

4. For each system below, determine whether or not it is:
   i. linear,
   ii. time-invariant,
   iii. memoryless

For the properties i) and ii), if you think it holds, prove it. Otherwise, find a counter-example. In addition, find the response to an impulse (unit sample).

a. $y[n] = x[n] - x[n-1] - \frac{1}{3} y[n-1]$

b. $y[n] = \left(x[n] \right)^{-2}$

c. $y[n] = e^{j\pi n/2} x[n]$