BME 6310, Fall 2021 C. Meyer

Homework #5

Due: Wednesday, Oct. 27, 2021.

Reading

1. Read the HaykinVanVeen.pdf handout, especially Sections 1.4, 1.5, 1.8.5, and 1.8.6. This book is a good signals and systems reference.
2. Read Smith (http://www.dspguide.com/) Chapter 1 for background and Chapter 5 for help with the homework. (Note that we will maintain a distinction between linearity and linearity + shift invariance, which Smith does not.)
3. Review the section on complex numbers (pp. 18-24) in the Gaskill_Ch2.pdf handout. You might find reading the rest of the chapter to be helpful.

Problems

1. State whether the following continuous-time systems are linear or nonlinear; shift invariant or shift variant; and why.

   (a) $w(t) = v(t)\cos\omega t$

   (b) $w(t) = \sin[v(t)]$

   (c) $w(t) = \frac{d}{dt}v(t)$

   (d) $w(t) = \cos[\omega t + v(t)]$

2. Determine whether the discrete-time systems in the attached Matlab functions are linear or nonlinear; shift invariant or shift variant; and why. systemA.p is a content-obscured Matlab function that you execute in the same way as a normal Matlab function.

   See Section 1.11 in Haykin and Van Veen for examples of how to generate discrete-time signals. The following is a Matlab example of how to find the system response to a discrete-time (Kronecker) delta function in the center of the input waveform:

   ```
   v = [zeros(1,20) 1 zeros(1,20)];
   w = systemB(v);
   stem(w);
   ```

   For Python, download the systems_hw5.pyc file. Below is the equivalent example:

   ```
   from systems_hw5 import *
   v = np.zeros(41)
   v[20] = 1
   w = systemB(v)
   plt.stem(w)
   ```

(a) systemA.p

(b) systemB.p

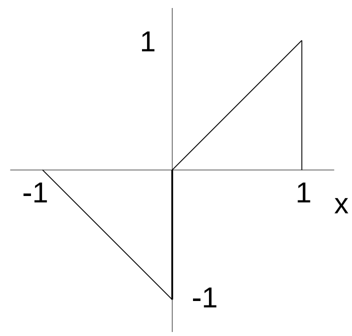
(c) systemC.p

(d) systemD.p

3. Find the even and odd parts (see Gaskill_Ch2, pp. 11-14) of

(a) $g(x) = (x^3 + x^2)\cos \pi x$

(b)



4. (Smith, Ch. 5) Two continuous waveforms, $b(t)$ and $x(t)$ are defined by:

$$b(t) = \begin{cases} 1 & 0 < t < 2 \\ 0 & \text{otherwise} \end{cases}$$

$$x(t) = \begin{cases} -1 & 1 < t < 2 \\ 1 & 2 < t < 3 \\ 4 & 3 < t < 4 \\ 2 & 4 < t < 5 \\ 0 & \text{otherwise} \end{cases}$$

(a) Sketch $b(t)$ and $x(t)$.

(b) Show that $x(t)$ can be decomposed into three scaled and shifted versions of $b(t)$. That is, find a_1, a_2, a_3, s_1, s_2, and s_3, such that

$$x(t) = a_1\, b(t - s_1) + a_2\, b(t - s_2) + a_3 b(t - s_3)$$

.

(c) Sketch these three component signals.