BME 790.01: Engineering Programming and Signal Processing
Fall 2013

Homework Assignment #1
Assigned Monday, September 16, 2013
Due: Monday, September 23, 2013, in class

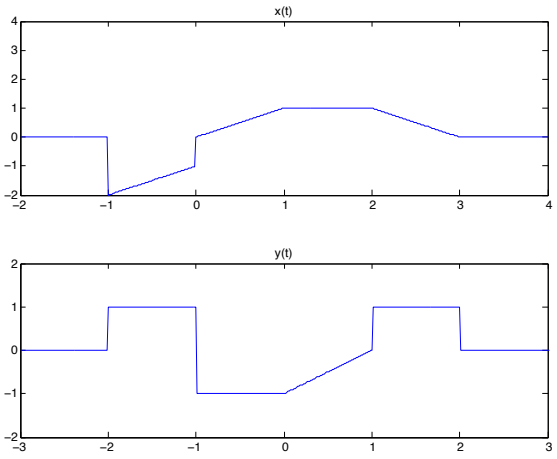
First, read Chapter 1, sections 1.1–1.8 of Hayken, 2nd ed. and then complete the following problems.

1. Let x(t) and y(t) be defined as the following piecewise functions. Carefully sketch the following signals (Problem 1.52 from Haykin Signals and Systems):

   (a) $x(t)y(t-1)$

   (b) $y(t-1)y(-t)$

   (c) $x(2t)y(\frac{1}{2}t+1)$



2. Using your flip shift function we programmed in/out of class, plot the result $y(\frac{1}{2}t+1)$ from the above problem in MATLAB for t=-10 to 10 seconds. At the same time plot the original $y(t)$ on top of the new function in a different color using the 'hold on' command.

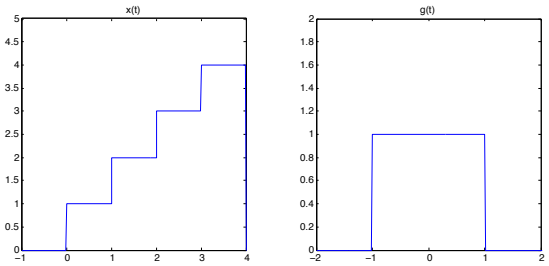
3. Using MATLAB again, calculate the derivative and integral of the function y(t) for every timepoint and plot the derivative, integral, and original function on the same graph.

4. Look at Problem 1 again. This time take $y(\frac{1}{2}t+1)$ and show how math works. Plot your function at the interim steps and arrive (hopefully) at the same conclusion:

   (a) shift, then scale

   (b) scale, then shift

5. The below figure shows a staircase like signal x(t) that may be viewed as the superposition of four rectangular pulses. Starting with a compressed version of the rectangular pulse g(t) shown in the below figure construct the waveform and express x9t) in terms of g(t). This is problem 1.53 from Haykin Signals and Systems, Second Edition.



6. If you have an LTI system with a known response to the input $g(t)$ from Problem 5 above that is equal to $y(t)$, can you determine the output to the system when you give the input $x(t)$ with no additional information? If not, how could you modify your calculation of your $x(t)$ such that your output could be determined?

7. Sketch the following signals:

   (a) x(t)=u(t)-u(t-4)

   (b) x[n]=u[n]-u[n-4]

   (c) x(t)=u(t+2)-2u(t)+u(t-2)

8. Problem 1.56 (a), (b), (e), and (k)

9. For each of the systems below, state whether it is memoryless, stable, causal, linear, and time invariant.

   (a) $y(t) = \frac{d^2x}{dt^2} + 5\frac{dx}{dt}$

   (b) $y(t) = ln(x(t))$

   (c) $y(t) = \int_{-\infty}^{t} x(\tau)d\tau$

   (d) $y(t) = x(t+1) - x(t-1)$

10. Problem 1.75 from Haykin Signals and Systems

11. Problem 1.76 from Haykin Signals and Systems

12. Explain how sampling of the signal $x(t) = r(t)$ will not always yield $x[n] = r[n]$. Give an example of how they could be different.

13. Extra credit: Give one hint to your classmates that helped you complete the MATLAB portion of this assignment. To receive credit, must be a unique hint (not given already by other students).