EE 301 Signals and Systems I
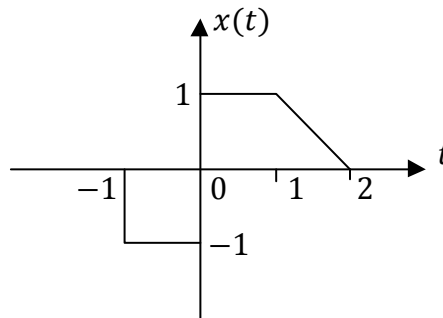
Homework 1

(due Oct. 20, 2019)

Problem 1

A signal $x(t)$ is given below. Sketch the following signals:

   i. $y(t) = x(t + 1)$
   ii. $y(t) = x(2t)$
   iii. $y(t) = x\left(\frac{t-2}{3}\right)$
   iv.   The even and odd parts of $x(t)$.

Problem 2

Determine whether or not each of the following signals is periodic. If the signal is periodic, determine its fundamental period.

   i. $x(t) = 3\cos(4t + \frac{\pi}{3})$

   ii. $x(t) = \left[\cos(2t - \frac{\pi}{3})\right]^2$

   iii. $x(t) = 2\cos(10t + 1) - \sin(4t - 1)$

   iv. $x(t) = Ev\{\cos(4\pi t)u(t)\}$, where Ev denotes the even part.

   v. $x[n] = j^n$

   vi. $x[n] = (1 + j)^n$

   vii. $x[n] = exp\left(j\frac{25}{4}\pi n\right)$

Problem 3

Determine whether or not the following systems are (1) memoryless, (2) causal, (3) stable, (4) time-invariant, (5) linear. Justify your answers.

   i. $y[n] = x[n-2] + x[2-n]$

ii. $y(t) = (\cos 3t)x(t)$

iii. $y[n] = \sum_{k=-\infty}^{2n} x[k]$

iv. $y(t) = \dfrac{dx(t)}{dt}$

Problem 4

Let $x_1(t) = u(t-3) - u(t-5)$ and $x_2(t) = \exp(-3t)u(t)$.

  i. Compute $x_1(t) * x_2(t)$.

  ii. Compute $\dfrac{dx_1(t)}{dt} * x_2(t)$.

  iii. How are the two results related?

Problem 5

The impulse response of a causal LTI system is $h[n] = \alpha^n u[n]$ where α is a complex constant. Find the output signals corresponding to the input signals $x_1[n] = 1$, $x_2[n] = u[n]$, and $x_3[n] = u[-n-1]$. Comment on your results.

Problem 6

  i. Let $x_1[n] = x_2[n] = \begin{cases} 1 & \text{for} \quad 1 \le n \le 5 \\ 0 & \text{elsewhere} \end{cases}$. Compute $x_1[n] * x_2[n]$. Use the MATLAB command 'conv' to verify your result.

  ii. Write a MATLAB code to compute the convolution of the signals $x_1[n]$ and $x_2[n]$ which satisfy the following conditions:

      a. Both signals are zero for $n \le 0$,

      b. $x_1[n] = 0$ for $n > N_1$,

      c. $x_2[n] = 0$ for $n > N_2$.

  iii. Use your code to compute the convolution of the signals $x_1[n]$ and $x_2[n]$ given below:

$$x_1[n] = \begin{cases} n & \text{for} \quad 1 \le n \le 20 \\ 0 & \text{elsewhere} \end{cases}, \quad x_1[n] = \begin{cases} 11-n & \text{for} \quad 1 \le n \le 10 \\ 0 & \text{elsewhere} \end{cases}$$

Use MATLAB to plot $x_1[n]$, $x_2[n]$, and $x_1[n] * x_2[n]$. Hint: Use the 'stem' command for your plots.

  iv. For the signals given in iii., calculate $x_1[n-4] * x_2[n+5]$, <u>without</u> modifying your code.