EE 438 **Assignment No. 1** **Spring 1997**

1. For each signal below, do the following:

   i. Sketch x(t) by hand, i.e. don't use Matlab
   ii. State whether it is right-sided, left-sided, or two-sided.
   iii. State whether it is causal, anti-causal, or neither.
   iv. Calculate the metrics E_x, P_x, x_{rms}, M_x, A_x, and x_{avg} by hand.

   a. $x(t) = e^t u(-t-1)$

   b. $x[n] = \sum_{k=-\infty}^{\infty} \cos(\pi(n-6k)/6)\{\mathrm{u}[n-6k] - \mathrm{u}[n-6k-3]\}$

   c. $x[n] = e^{(-j-1)\pi n/6}\{\mathrm{u[n] - u[n-12]}\}$

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

$$y_1[n] = \{x[n] + x[n-1] + x[n-2]\}/3$$

$$y_2[n] = \{x[n] - x[n-1]\}$$

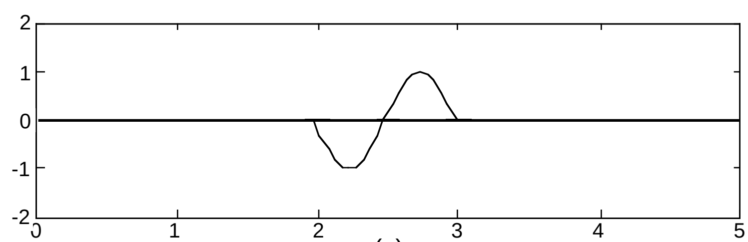
   ii. Use MATLAB to generate stem plots for x[n], y_1[n], and y_2[n] for $-20 \le n \le 20$. Plot all three signals on the same page, using the subplot command.

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

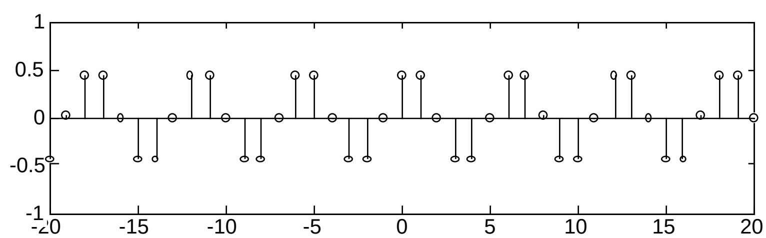
   a. $x[n] = \sin(\pi n)/\sin(\pi n/10)$

   b. $x[n] = (1.2)^{-n}\sin(\pi n/4)u[n]$

3. Express each signal shown below in terms of standard functions. Note that the signal for part (b) is a sinusoid, and should be expressed as such.



(a)



(b)

4. For each system below, determine whether or not it is:

   i. linear,
   ii. time-invariant,
   iii. causal,
   iv. stable,
   v. memoryless

   For each of the above properties, if you think it holds, prove it. Otherwise, find a counter-example. In addition, find the response to an impulse.

   a. $y[n] = \begin{cases} x[n], & n \text{ even} \\ -x[n], & \text{else} \end{cases}$

   b. $y[n] = \sum_{k=-1}^{1} x[n-k]$

   c. $y(t) = x(2t)$

5. For the LTI systems below,

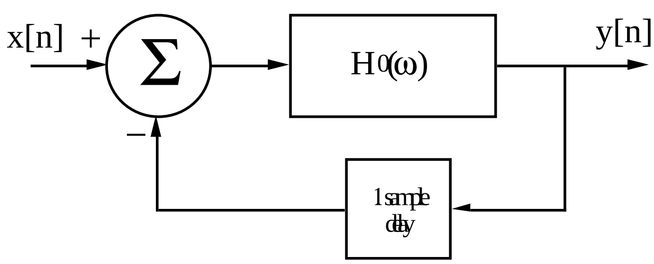
   i. find the impulse response,
   ii. find an expression for the frequency response (simplify as much as possible),
   iii. sketch the magnitude and phase of the frequency response,
   iv. describe in general terms the effect that the filter has on a signal.

   a. $y[n] = \left(x[n] + x[n-1]\right) / 2$

   b. $y[n] = \left(x[n] - y[n-3]\right) / 2$

   c. $y[n] = \left(x[n] - 2x[n-1] + x[n-2]\right) / 4$

6. Consider the system shown below where the filter is described by the difference equation $y[n] = \left(x[n] + y[n-1]\right) / 2$:



   a. Find a difference equation that describes the overall system.

   b. Find an expression for the frequency response $H(\omega)$ of the overall system in terms of $H_0(\omega)$, the frequency response of the filter.

   c. Find the actual frequency response $H(\omega)$ from your answer to part a. and also using your answer to part b. Verify that the two approaches lead to the same answer.