MAS160: Signals, Systems & Information for Media Technology

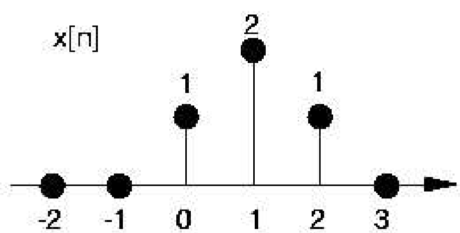
Problem Set 5

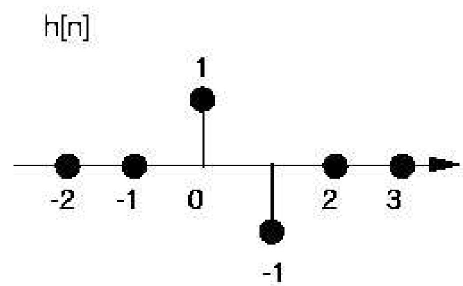
Instructor : V. Michael Bove, Jr.

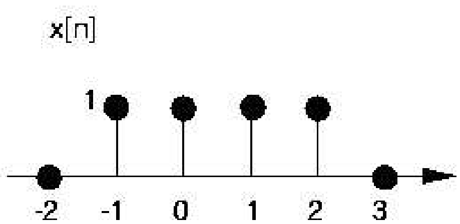
Problem 1: Unit-step and running average (*DSP First* 5.5)

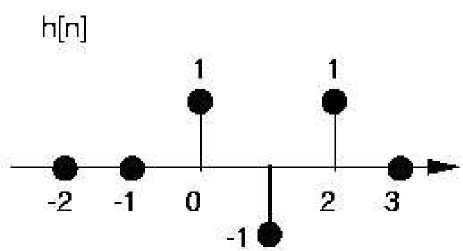
Problem 2: Convolution

For each of the following sets of signals, compute their convolution (1) graphically by hand, (2) with MATLAB (you may use the `conv` function), and (3) by expressing the signals in terms of $\delta[n]$ and computing the convolution sum. In MATLAB, plot your results with `stem`, but be sure to fix the n-axis appropriately (use `stem(n,y)` where `n` is a vector of the appropriate range).









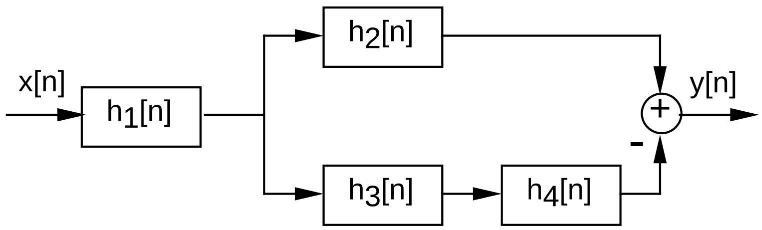
For each of the following of signals, compute their convolution with $x[n] = \cos(2\pi(\frac{1}{16})n)$ using MATLAB (you may use the `conv` function). Use `stem` to plot your result over the range [0:99], assuming the sinusoid exists for all time. Compare each convolution with $x[n]$.

(a) $h[n] = \frac{1}{2}\delta[n] + \frac{1}{2}\delta[n-1]$
(b) $h[n] = \delta[n] - \delta[n-1]$

Problem 3: Time-domain response of FIR filters (*DSP First* 5.6)

Problem 4: LTI Systems

Consider the interconnection of LTI systems as shown below.



(a) Express the overall impulse response, $h[n]$, in terms of $h_1[n]$, $h_2[n]$, $h_3[n]$ and $h_4[n]$.

(b) Determine $h[n]$ when

$$\begin{aligned} h_1[n] &= \{\tfrac{1}{2}, \tfrac{1}{4}, \tfrac{1}{2}\} \\ h_2[n] &= h_3[n] = (n+1)u[n] \\ h_4[n] &= \delta[n-2] \end{aligned}$$

Problem 5: Block Diagrams (*DSP First* 5.9)

Problem 6: MAS.510 Additional Problem

It is possible to determine the impulse response for a LTI system using a system of equations, given enough information about the system. For example, if we know that the system is FIR and has no delay and that $y[0] = 1$ if $x[n] = \delta[n]$, then

$$\begin{aligned} y[n] &= ax[n] \\ y[0] &= ax[0] \\ 1 &= a * 1 \\ a &= 1 \end{aligned}$$

Using systems of equations, compute the impulse response given the following system descriptions and input-output pairs

(a) FIR and single delay, $x[n] = \delta[n]$, $y[0] = 2$, $y[1] = -2$

(b) FIR and double delay, $x[n] = \delta[n]$, $y[0] = 3$, $y[1] = -4$, $y[2] = 3/2$

(c) FIR and double delay, $x[n] = 4\delta[n] + \delta[n-1]$, $y[0] = 2$, $y[1] = 2$, $y[2] = -1$

(d) Calculate $y[3]$ for each of the preceding systems.