PROBLEM:

A linear time-invariant system is described by the difference equation

$$y[n] = 2x[n] + 4x[n-1] + 2x[n-2]$$

(a) When the input to this system is

$$x[n] = \begin{cases} 0 & n < 0 \\ 3 & n = 0, 1, 2 \\ 6 - n & n = 3, 4 \\ 1 & n \geq 5 \end{cases}$$

Compute the values of $y[n]$, over the range $0 \leq n \leq 10$.

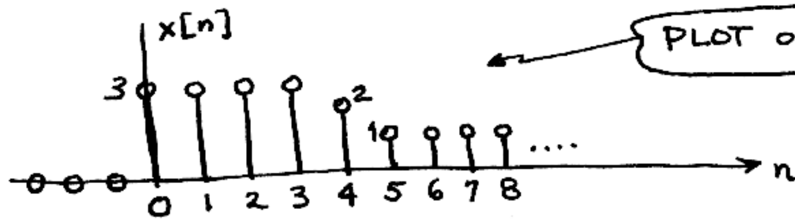
(b) For the previous part, plot both $x[n]$ and $y[n]$.

(c) *Impulse Response:* Determine the response of this system to a unit impulse input; i.e., find the output $y[n] = h[n]$ when the input is $x[n] = \delta[n]$. Plot $h[n]$ as a function of n.

McClellan, Schafer and Yoder, *Signal Processing First*, ISBN 0-13-065562-7.
Prentice Hall, Upper Saddle River, NJ 07458.

SOLUTION

(a)



PLOT of x[n] vs. n

Make a table when computing y[n] from x[n].

n	n<0	0	1	2	3	4	5	6	7	8	n≥9
x[n]	0	3	3	3	3	2	1	1	1	1	1
y[n]	0	6	18	24	24	22	16	10	8	8	8

$$y[0] = 2x[0] + 4x[-1] + 2x[-2]$$
$$= 2(3) + 4(0) + 2(0)$$
$$= 6$$

$$y[5] = 2x[5] + 4x[4] + 2x[3]$$
$$= 2(1) + 4(2) + 2(3)$$
$$= 2 + 8 + 6 = 16$$

(b)

(c) When $x[n] = \delta[n]$, the output is denoted $h[n]$

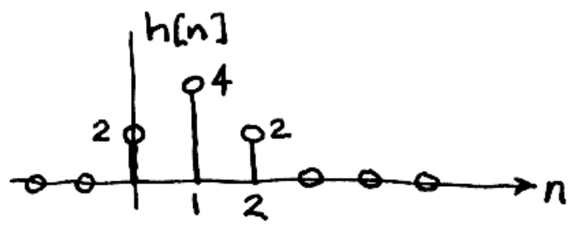
$$y[n] = 2x[n] + 4x[n-1] + 2x[n-2]$$
$$h[n] = 2\delta[n] + 4\delta[n-1] + 2\delta[n-2]$$

NON-ZERO WHEN n=0

NON-ZERO FOR n=1

NON-ZERO WHEN n=2

$$\therefore h[n] = \begin{cases} 2, & \text{for } n=0 \\ 4, & n=1 \\ 2, & n=2 \\ 0, & \text{elsewhere} \end{cases}$$



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