PROBLEM:

Suppose that $\mathcal{S}$ is a linear, time-invariant system whose exact form is unknown. It needs to be tested by running some inputs into the system, and then observing the output signals. Suppose that the following input/output pairs are the result of the tests:

$$x[n] = \delta[n] - \delta[n-1] \quad \longrightarrow \quad y[n] = \delta[n] - \delta[n-1] + 2\delta[n-3]$$
$$x[n] = \cos(\pi n/2) \quad \longrightarrow \quad y[n] = 2\cos(\pi n/2 - \pi/4)$$

(a) Make a plot of the signal: $y[n] = \delta[n] - \delta[n-1] + 2\delta[n-3]$.

(b) Use linearity and time-invariance to find the output of the system when the input is

$$x[n] = 7\delta[n] - 7\delta[n-2]$$

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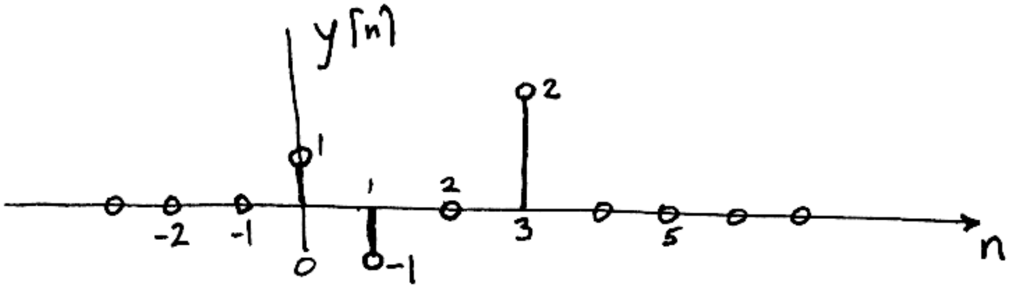
Prentice Hall, Upper Saddle River, NJ 07458.

SOLUTION

$$x[n] = \delta[n] - \delta[n-1] \longrightarrow y[n] = \delta[n] - \delta[n-1] + 2\delta[n-3]$$
$$x[n] = \cos(\pi n/2) \longrightarrow y[n] = 2\cos(\pi n/2 - \pi/4)$$

(a) Make a plot of the signal: $y[n] = \delta[n] - \delta[n-1] + 2\delta[n-3]$.



(b) Use linearity and time-invariance to find the output of the system when the input is

$$x[n] = 7\delta[n] - 7\delta[n-2]$$

In order to use Linearity & Time-Inv, we need to express $x[n]$ in terms of known signals

Let $x_1[n] = \delta[n] - \delta[n-1]$

Then $x[n] = 7\delta[n] - 7\delta[n-2] = 7x_1[n] + 7x_1[n-1]$

Because $x_1[n-1] = \delta[n-1] - \delta[n-2]$.

Now, LTI system $\Rightarrow$

$$7x_1[n] \longrightarrow 7\delta[n] - 7\delta[n-1] + 14\delta[n-3]$$
$$7x_1[n-1] \longrightarrow 7\delta[n-1] - 7\delta[n-2] + 14\delta[n-4]$$

Add them together:

$$x[n] \longrightarrow 7\delta[n] - 7\delta[n-2] + 14\delta[n-3] + 14\delta[n-4]$$

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