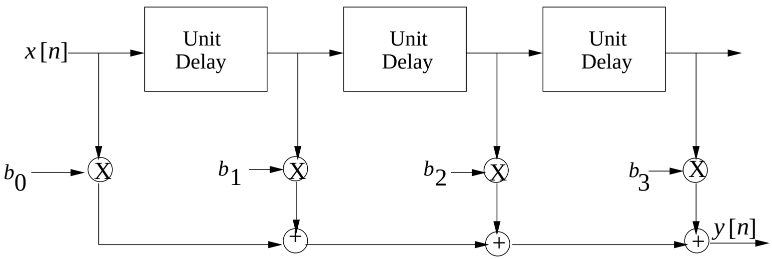
PROBLEM:

The following problem considers three different discrete-time systems. In each case, the input is $x[n]$ and the output is $y[n]$.

(a) If an LTI system has impulse response $h[n] = \frac{3}{4}\delta[n] - \frac{1}{2}\delta[n-1] + 2\delta[n-2]$, determine the difference equation that relates $x[n]$ and $y[n]$.

$y[n] =$

(b) If an LTI system is described by the block diagram below



where $b_0 = 1$, $b_1 = 0$, $b_2 = \frac{1}{2}$, $b_3 = \frac{1}{2}$, determine its impulse response $h[n]$.

$h[n] =$

(c) If a system is defined by the relation

$$y[n] = x[n^2] + (x[n-1])^2,$$

indicate which of the statements below is true or false by circling the appropriate T or F.

i. The system is linear. T or F

ii. The system is time-invariant. T or F

iii. The system is causal. T or F

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

SOLUTION

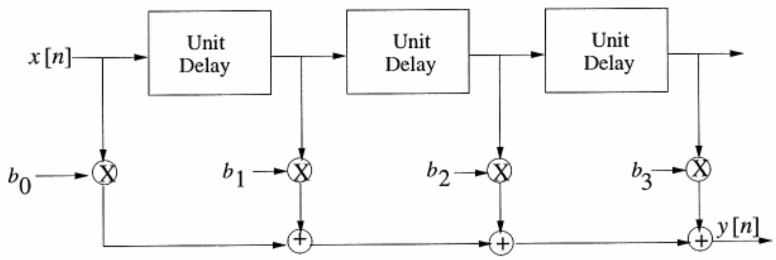
The following problem considers three different discrete-time systems. In each case, the input is $x[n]$ and the output is $y[n]$.

(a) If an LTI system has impulse response $h[n] = \frac{3}{4}\delta[n] - \frac{1}{2}\delta[n-1] + 2\delta[n-2]$, determine the difference equation that relates $x[n]$ and $y[n]$.

$$\boxed{y[n] = \frac{3}{4}x[n] - \frac{1}{2}x[n-1] + 2x[n-2]}$$

$b_k = \{\frac{3}{4}, -\frac{1}{2}, 2\}$ from $h[n]$

(b) If an LTI system is described by the block diagram below



where $b_0 = 1$, $b_1 = 0$, $b_2 = \frac{1}{2}$, $b_3 = \frac{1}{2}$, determine its impulse response $h[n]$. $= \sum_{k=0}^{M} b_k \delta[n-k]$

$$\boxed{h[n] = \delta[n] + \frac{1}{2}\delta[n-2] + \frac{1}{2}\delta[n-3]}$$

(c) If a system is defined by the relation

$$y[n] = x[n^2] + (x[n-1])^2,$$

indicate which of the statements below is true or false by circling the appropriate T or F.

i. The system is linear. T or F

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iii. The system is causal. T or F

If $x[n] = \delta[n]$, $y[n] = \delta[n] + \delta[n-1]$

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

$x[n] = \delta[n+1] \longrightarrow y[n] = 0 + \delta[n]$

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

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