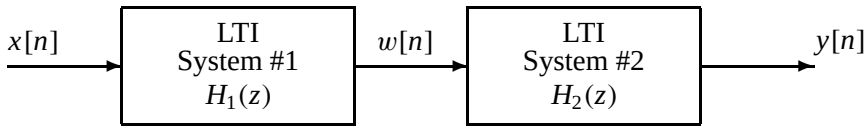
PROBLEM:

A cascade of two FIR discrete-time systems is depicted by the following block diagram:



The systems are defined by the following:

$$H_1(z) = (1 + z^{-2}) \quad \text{and} \quad h_2[n] = (-0.5)^{n-1}u[n-1].$$

(a) If the input to the first system is

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

determine the output, $w[n]$, of the **first** system.

$w[n] =$

(b) Determine the system function $H(z)$ of the overall system.

$H(z) =$

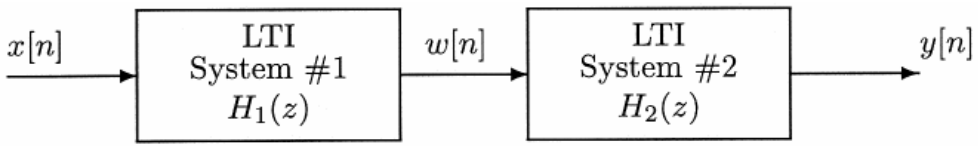
(c) Determine the impulse response of the the overall system.

$h[n] =$

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

SOLUTION

A cascade of two FIR discrete-time systems is depicted by the following block diagram:



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(a) If the input to the first system is

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

determine the output, $w[n]$, of the **first** system.

$$W(z) = (-1 + 2z^{-1} + z^{-2})(1 + z^{-2}) = -1 + 2z^{-1} + 2z^{-3} + z^{-4}$$

$$w[n] = -\delta[n] + 2\delta[n-1] + 2\delta[n-3] + \delta[n-4]$$

(b) Determine the system function $H(z)$ of the overall system.

$$H(z) = H_1(z)H_2(z) = (1 + z^{-2})\left(\frac{z^{-1}}{1 + 0.5z^{-1}}\right) = \frac{z^{-1} + z^{-3}}{1 + 0.5z^{-1}}$$

$$H(z) = (z^{-1} + z^{-3})/(1 + 0.5z^{-1})$$

(c) Determine the impulse response of the the overall system.

$$h[n] = \left(-\frac{1}{2}\right)^{n-1}u[n-1] + \left(-\frac{1}{2}\right)^{n-3}u[n-3]$$