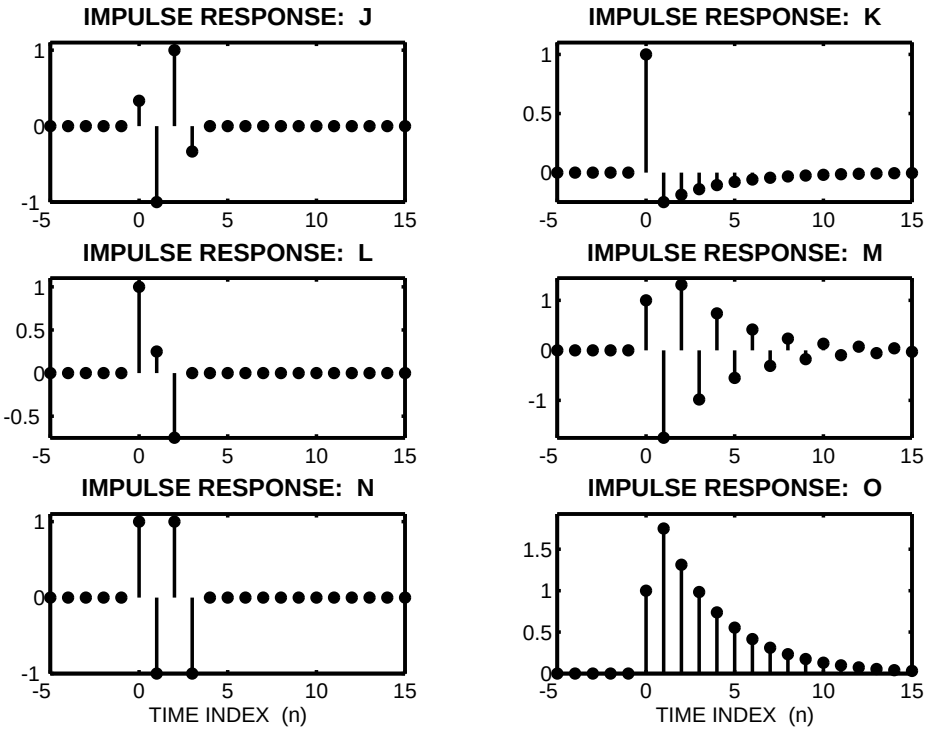
PROBLEM:



For each of the impulse-response plots (J, K, L, M, N, O), determine which one of the following systems (specified by either an $H(z)$ or a difference equation) matches the impulse response. In addition, derive a formula for the impulse response, $h[n]$, for $\mathcal{S}_1$ and $\mathcal{S}_4$.

$\mathcal{S}_1$: $y[n] = 0.4y[n-1] + x[n] + x[n-1]$

$\mathcal{S}_2$: $H(z) = \dfrac{1+z^{-1}}{1-0.75z^{-1}}$

$\mathcal{S}_3$: $y[n] = -0.75y[n-1] + x[n] - x[n-1]$

$\mathcal{S}_4$: $H(z) = \dfrac{1-z^{-1}}{1-0.75z^{-1}}$

$\mathcal{S}_5$: $y[n] = x[n] - x[n-1] + x[n-2]$

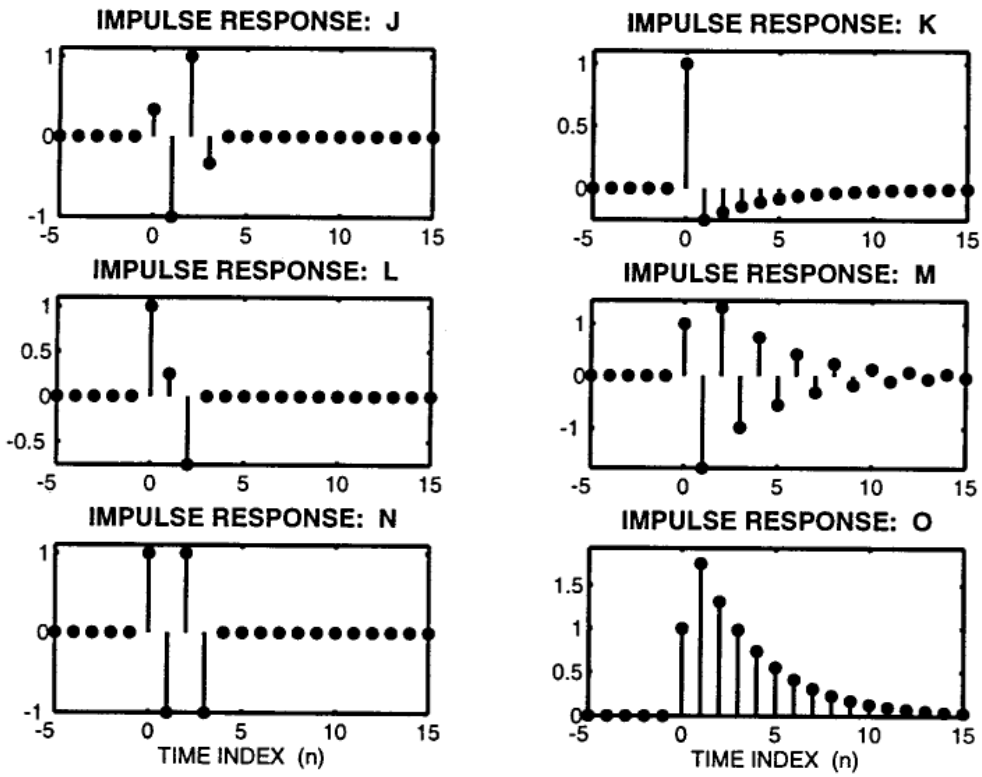
$\mathcal{S}_6$: $H(z) = 1 - z^{-1} + z^{-2} - z^{-3}$

$\mathcal{S}_7$: $y[n] = x[n] + \frac{1}{4}x[n-1] - \frac{3}{4}x[n-2]$

$\mathcal{S}_8$: $H(z) = \frac{1}{3}(1-z^{-1})^3$

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

SOLUTION



S_1: $y(n) = 0.4\,y(n-1) + x(n) + x(n-1) \rightsquigarrow H(z) = \dfrac{1+z^{-1}}{1-0.4z^{-1}}$

S_2: $H(z) = \dfrac{1+z^{-1}}{1-0.75z^{-1}}$

S_3: $y(n) = -0.75\,y(n-1) + x(n) - x(n-1) \rightsquigarrow H(z) = \dfrac{1-z^{-1}}{1+0.75z^{-1}}$

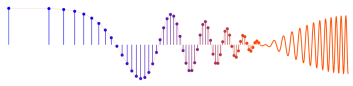
S_4: $H(z) = \dfrac{1-z^{-1}}{1-0.75z^{-1}}$

S_5: $y(n) = x(n) - x(n-1) + x(n-2)$

S_6: $H(z) = 1 - z^{-1} + z^{-2} - z^{-3}$

S_7: $y(n) = x(n) + \frac{1}{4}x(n-1) - \frac{3}{4}x(n-2)$

S_8: $H(z) = \frac{1}{3}(1-z^{-1})^3 = \frac{1}{3}\left[1 - 3z^{-1} + 3z^{-2} - z^{-3}\right]$



(a) J: FIR response 4 samples

possibilities S_6 and S_8. Since varies in magnitude

S_8 is the answer.

$$J \leftrightarrow S_8$$

(b) K: IIR one of the S_1, S_2, S_3 and S_4

S_1 : $h(n) = 0.4^n u(n) + (0.4)^{n-1} u(n-1) \rightsquigarrow h(1) = 1.4$

S_2 : $h(n) = 0.75^n u(n) + (0.75)^{n-1} u(n-1) \rightsquigarrow h(1) = 1.75$

S_3 : $h(n) = (-0.75)^n u(n) - (-0.75)^{n-1} u(n-1) \rightarrow h(1) = -1.75$

S_4 : $h(n) = 0.75^n u(n) - (0.75)^{n-1} u(n-1) \rightsquigarrow h(1) = -0.25$

The only one that matches K is S_4

$$K \leftrightarrow S_4$$

(c) L: FIR with 3 samples

one of the FIR systems S_5, S_6, S_7 (S_8 matches J)

The only one that matches L is S_7

$$L \leftrightarrow S_7$$

(d) M: IIR ~ one of S_1, S_2, S_3 (S_4 matches K)

S_1 and S_2 only positive ~

$$M \leftrightarrow S_3$$

(e) N: FIR ~ 3 samples ~ one of FIR ~ S_6 since all samples equal magnitude.

$$N \leftrightarrow S_6$$

(f) O: IIR one of S_1, S_2

Since ($h(1)$ of S_2) = 1.75 ~

$$O \leftrightarrow S_2$$

For S_1 $h(1) = 1.4$ < sample (1) of O