2-31

$$y(n) - 3y(n-1) - 4y(n-2) = x(n) + 2x(n-1)$$

Since the particular solution $y_p = 0$ when the excitation is an impulse, we have the impulse response $h(n) = y_h(n)$ for $n \geq 0$.

By assuming $y_h(n) = \lambda^n$, we obtain the characteristic equation as follows:

$\lambda^2 - 3\lambda - 4 = 0$. Therefore, $\lambda = -1, 4$ and $y_h(n) = C_1(-1)^n + C_2(4)^n$ ①

Since the system must be relaxed, we have $y(-1) = 0$ and $y(-2) = 0$.

Thus for $n = 0, 1$, $x(n) = \delta(n)$, we have

$$\begin{cases} y(0) = 1 & ② \\ y(1) - 3y(0) = 2 \overset{②}{\Rightarrow} y(1) = 5 & ③ \end{cases}$$

By using Eqs. ① ② and ③ we have

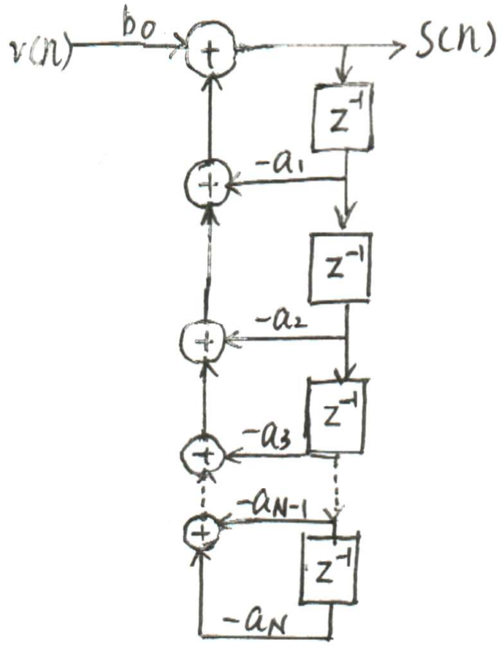
$$\begin{cases} C_1 + C_2 = 1 \\ 4C_2 - C_1 = 5 \end{cases} \Rightarrow \begin{cases} C_1 = -\frac{1}{5} \\ C_2 = \frac{6}{5} \end{cases}$$

Therefore $h(n) = [\frac{6}{5} 4^n - \frac{1}{5}(-1)^n] u(n)$.

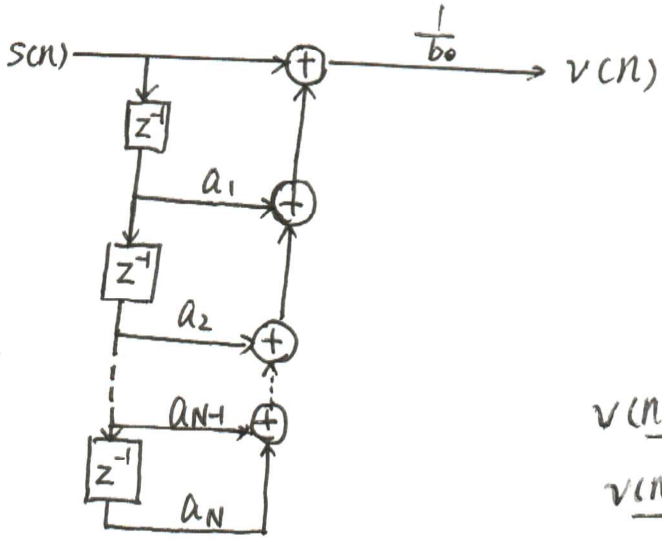
2.44

$$s(n) + a_1 s(n-1) + \cdots + a_N s(n-N) = b_0 v(n)$$

(a) $s(n) = -a_1 s(n-1) - a_2 s(n-2) - \cdots - a_N s(n-N) + b_0 v(n)$



(b) $v(n) = \frac{1}{b_0}[s(n) + a_1 s(n-1) + \cdots + a_N s(n-N)]$



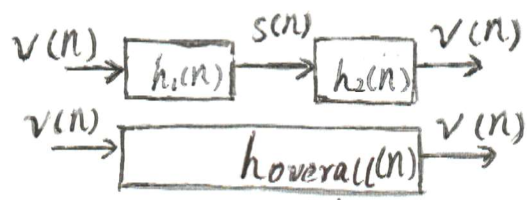


Fig. 1

(C) The system can be described as $v(n) = h(n) * v(n)$., this is an identity system

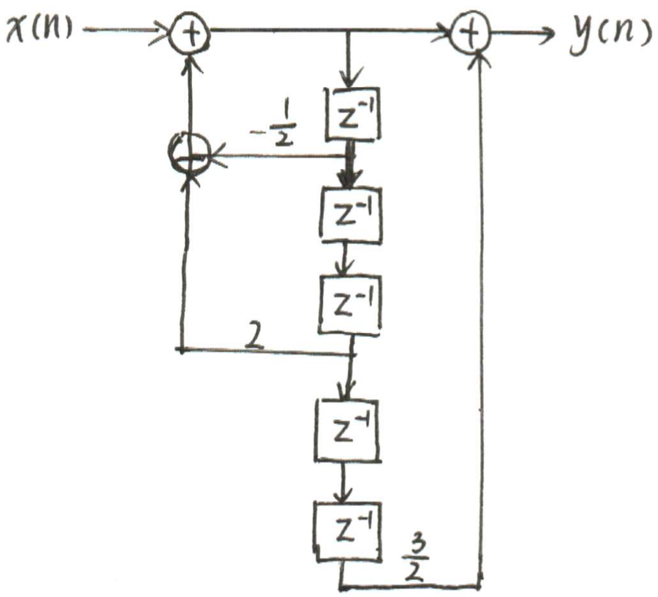
Therefore the impulse response is $h(n) = \delta(n)$

Note: this procedure can be illustrated in Fig. 1.

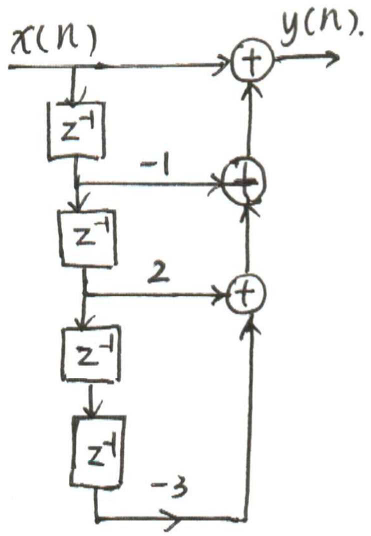
2.46.

(a) $2y(n) + y(n-1) - 4y(n-3) = x(n) + 3x(n-5)$

$$y(n) = -\frac{1}{2}y(n-1) + 2y(n-3) + \frac{1}{2}x(n) + \frac{3}{2}x(n-5)$$

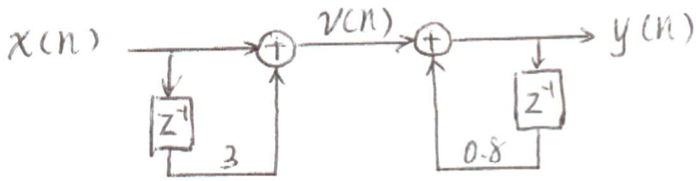


(b) $y(n) = x(n) - x(n-1) + 2x(n-2) - 3x(n-4)$



2.49 $y(n) = 0.8\,y(n-1) + 3x(n-1) + 2x(n)$, $\quad y(n) - 0.8\,y(n-1) = 2x(n) + 3x(n-1)$

(a)



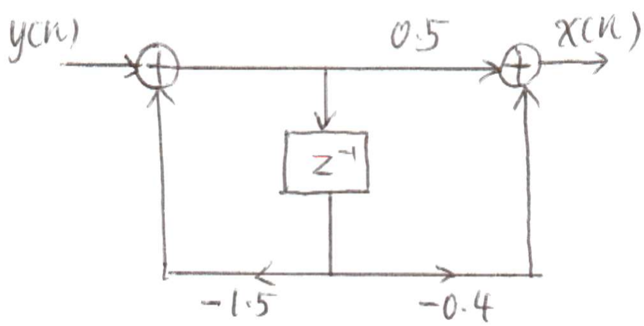
$$\begin{cases} v(n) = 2x(n) + 3x(n-1) \Rightarrow h_1(n) = 2\delta(n) + 3\delta(n-1) \\ y(n) = v(n) + 0.8\,y(n-1) \end{cases}$$

n	$v(n)=\delta(n)$	$y(n-1)$	$y(n)$
-2	0	0	0
-1	0	0	0
0	1	0	1
1	0	1	0.8
2	0	0.8	$(0.8)^2$
3	0	$(0.8)^2$	$(0.8)^3$
	$\vdots$	$\vdots$	$\vdots$

$$h_2(n) = (0.8)^n u(n)$$

$$h_{overall}(n) = h_1(n) * h_2(n) = 3(0.8)^{n-1}u(n-1) + 2(0.8)^n u(n).$$

(b) $x(n) = -1.5\,x(n-1) + 0.5\,y(n) - 0.4\,y(n-1)$



2.52

(a) $h_1(n) = C_0\delta(n) + C_1\delta(n-1) + C_2\delta(n-2)$

$h_2(n) = b_2\delta(n) + b_1\delta(n-1) + b_0\delta(n-2)$

$h_3(n) = a_0\delta(n) + (a_1 + a_0a_2)\delta(n-1) + a_1a_2\delta(n-2)$

(b) In order to ensure $h_1(n) = h_2(n)$, we need to assign

$$\begin{cases} b_2 = C_0 \\ b_1 = C_1 \\ b_0 = C_2 \end{cases}$$

, and this is easily to be realized.

In order to ensure $h_1(n) = h_3(n)$, we need to assign

$$\begin{cases} a_0 = C_0 \\ a_1 + a_0a_2 = C_1 \\ a_1a_2 = C_2 \end{cases}$$

Therefore $\begin{cases} a_1 + C_0a_2 = C_1 \\ a_1a_2 = C_2 \end{cases}$

We can further get $C_0a_2^2 - C_1a_2 + C_2 = 0$.

Thus if $C_0 \neq 0$, if and only if $\Delta = C_1^2 - 4C_0C_2 \geqslant 0$, it can be satisfied.