Matlab 1.3.13

a) Convolution smoothens the signal removing high frequency components from the input signal.

b) Length of input x =600

Length of output y =610

Length of impulse response h =11

Length of output y = Length of input x + Length of impulse response h -1

c)

Input and output signals do not line up.

d) Length of y2 = 600

First 5 and last 5 samples of signal from output removed by using commands and lengths of input and out matches.

e)
```
h = ones(1,31)/31;
y3 = conv(x, h);
y3(1:15) = [];
y3(end-14:end) = [];
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f)
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h = ones(1,67)/67;
y4 = conv(x, h);
y4(1:33) = [];
y4(end-32:end) = [];
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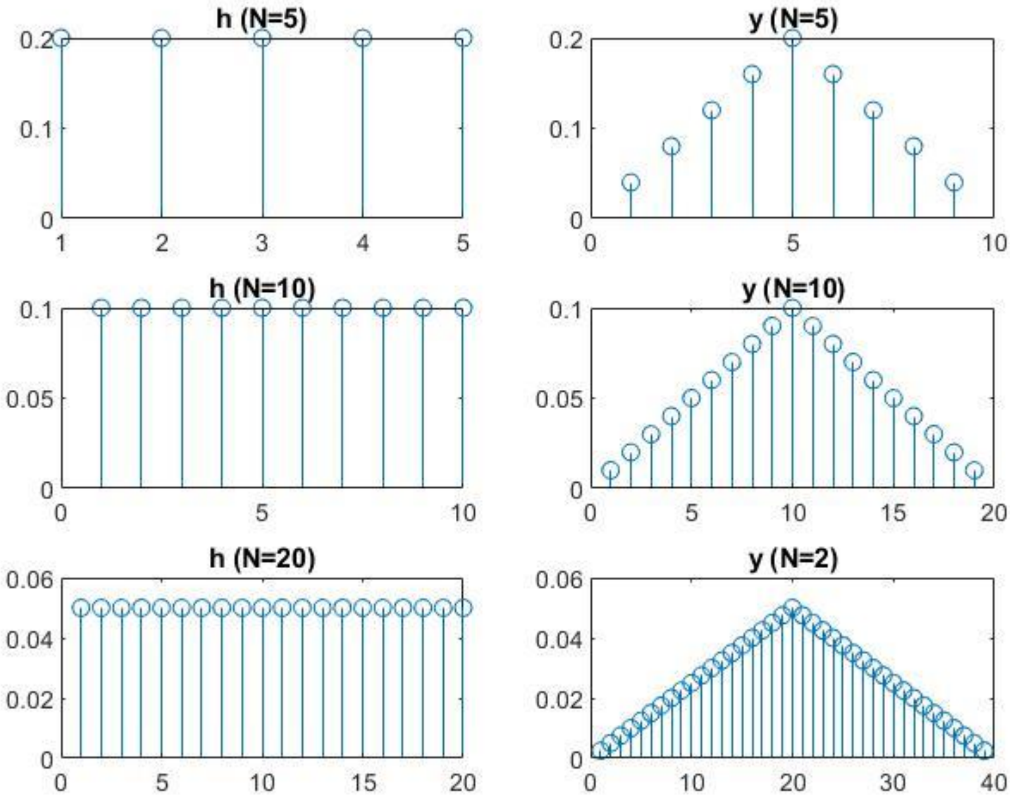
1.3.7

f(n) = a^(n)* u(n)

g(n) = f(−n) = a^(−n)* u(−n)

a =0.9

1.3.8



General Expression= (u[n]-u[n-N-1]).(1/N) * (u[n]-u[n-N-1]).(1/N)

1.3.10

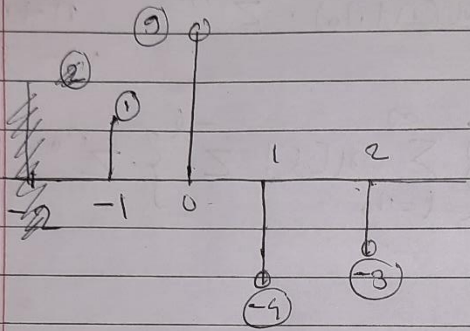
1.4.5. $X(z) = (1+2z)(1+3z^{-1})(1-z^{-1})$

$= (1+3z^{-1}+2z+6)(1-z^{-1})$

$= (7+3z^{-1}+2z)(1-z^{-1})$

$= 7 + 3z^{-1} + 2z - 7z^{-1} - 3z^{-2} + 2$

$= 9 + (-4)\cdot z^{-1} - 3z^{-2} + z^{+1}$



$x(n) = 9\delta(n) - 4\delta(n-1)$
$- 3\delta(n-2) + \delta(n+1)$

1.4.7. $x(n) = 4\left(\frac{1}{3}\right)^n u(n) - \left(\frac{2}{3}\right)^n u(n)$

$X(z) = \sum_{n=0}^{\infty} \left\{4\left(\frac{1}{3}\right)^n \cdot u(n) - \left(\frac{2}{3}\right)^n \cdot u(n)\right\} z^{-n}$

$= 4\sum_{n=0}^{\infty}\left(\frac{1}{3}\right)^n \cdot u(n) \cdot z^{-n} - \sum_{n=0}^{\infty}\left(\frac{2}{3}\right)^n u(n)\, z^{-n}$

$= 4 \cdot \frac{z}{z-(1/3)} - \frac{z}{z-(2/3)}$

$= \frac{4z\cdot(z-2/3) - z(z-1/3)}{(z-1/3)(z-2/3)} =$

$$= \frac{4z^2 - (8/3)z - z^2 + (1/3)z}{(z-1/3)(z-2/3)} = \frac{3z^2 - (7/3)z}{(z-1/3)(z-2/3)}$$

$$= \frac{3z\,(z-(7/9))}{(z-1/3)(z-2/3)} \qquad \text{ROC } |z| > 2/3$$

1.4.9

$$X(z) = \frac{2z+1}{z^2 - \left(\frac{5}{6}\right)z + \left(\frac{1}{6}\right)} = \frac{2z+1}{\left(z-\frac{1}{3}\right)\left(z-\frac{1}{2}\right)}$$

$$\frac{A}{(z-1/3)} + \frac{B}{(z-1/2)} = \frac{A(z-1/2) + B(z-1/3)}{(z-1/3)(z-1/2)}$$

$$= \frac{z(A+B) + (-1/2A - 1/3B)}{(z-1/3)(z-1/2)}$$

$$A+B=2 \qquad -1/2A - 1/3B = 1$$

$$-A - (2/3)B = 2$$

$$\cancel{A} + B = 2$$

$$-\cancel{A} - (2/3)B = 2$$

$$\frac{1}{3}B = 4 \qquad B = 12 \quad A = (-10)$$

$$X(z) = \frac{(-10)}{(z-1/3)} + \frac{12}{(z-1/2)} \qquad \text{ROC } |z| > 1/2$$

$$X(z) = \frac{1}{z}\,\frac{(-10)}{(1-1/3z^{-1})} + \frac{1}{z}\left(\frac{12}{1-1/2z^{-1}}\right)$$

1.4.9.

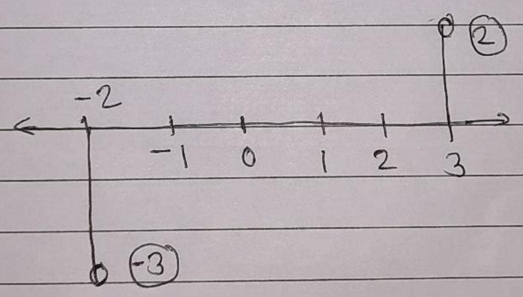
$$X(z) = (-10)\frac{z^{-1}}{1-\left(\frac{1}{3}\right)z^{-1}} + (12)\frac{z^{-1}}{1-\left(\frac{1}{2}\right)z^{-1}}$$

$$x(n) = (-10)\left(\frac{1}{3}\right)^{(n-1)} u[n-1] + (12)\cdot\left(\frac{1}{2}\right)^{(n-1)} u[n-1]$$

1.4.1

$$X(z) = -3z^{2} + 2z^{-3}$$

$$x(n) = -3\,\delta(n+2) + 2\,\delta(n-3)$$



1.4.10 $h(n) = 3\left(\frac{2}{3}\right)^n \cdot u(n)$

$x(n) = \left(\frac{1}{2}\right)^n \cdot u(n)$

$y(n) = (h * x)(n)$

$\downarrow$ Z.T.

$Y(z) = H(z) \cdot X(z)$

$$H(z) = \sum_{n=0}^{\infty} 3\left(2/3\right)^n \cdot u(n) \cdot z^{-n} = \frac{3 \cdot z}{z - (2/3)}$$

$$X(z) = \sum_{n=0}^{\infty} (1/2)^n z^{-n} u(n) = \frac{z}{z - (1/2)}$$

$$Y(z) = \frac{3z \cdot z}{(z - 2/3)(z - 1/2)} \qquad \frac{Y(z)}{z} = \frac{z}{(z-2/3)(z-1/2)}$$

$$\frac{A}{(z - 2/3)} + \frac{B}{(z - 1/2)} = \frac{(A+B)z + (-1/2A - 2/3B)}{(z-2/3)(z-1/2)}$$

$A + B = 1 \qquad -1/2A - 2/3B = 0$

$-A - 4/3\,B = 0$

$\cancel{A} + B = 1$

$\cancel{-A} + (4/3)B = 0$

$\left(-\frac{1}{3}\right)B = 1 \qquad B = -3 \quad A = 4$

$$\frac{Y(z)}{z} = \frac{(4)}{(z - 2/3)} + \frac{(-3)}{(z - 1/2)}$$

$$\frac{Y(z)}{z} = \frac{4}{z(1 - \frac{2}{3}z^{-1})} - \frac{3}{z(1 - \frac{1}{2}z^{-1})}$$

1.4.10

$$Y(z) = \frac{4 \cdot \cancel{z}}{\cancel{z}\left(1 - \frac{2}{3} z^{-1}\right)} - \frac{3\cancel{z}}{\cancel{z}\left(1 - \frac{1}{2} z^{-1}\right)}$$

I.Z.T.

$$y(n) = 4\left(\frac{2}{3}\right)^n u(n) - (3)\left(\frac{1}{2}\right)^n u(n)$$

1.4.12

(a) $x(n) \longrightarrow \boxed{H_1(z)} \rightarrow \boxed{H_2(z)} \longrightarrow y(n)$

$x(n) \longrightarrow \boxed{H_1(z) \cdot H_2(z)} \longrightarrow y(n)$

$$H_1(z) \cdot H_2(z) = (1 + 2z^{-1} + z^{-2})(1 + z^{-1} + z^{-2})$$

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

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

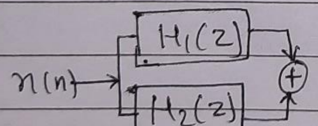
$$H(z) \xrightarrow{\text{I.Z.T.}} h(n)$$

$$h(n) = \delta(n) + 3 \cdot x(n-1) + 3 \cdot x(n-2)$$
$$+ 3 \cdot x(n-3) + x(n-4)$$

but $x(n) = \delta(n)$

$$h(n) = \delta(n) + 3\,\delta(n-1) + 3\,\delta(n-2) + 3\,\delta(n-3)$$
$$+ \delta(n-4)$$

(b)



$x(n) \rightarrow \boxed{H_1(z) + H_2(z)} \rightarrow y(n)$

$$H_1(z) + H_2(z) = (1 + 2z^{-1} + z^{-2}) + (1 + z^{-1} + z^{-2})$$
$$H(z) = 2 + 3z^{-1} + 2z^{-2}$$

$$h(n) = 2 \cdot \delta(n) + 3 \cdot \delta(n-1) + 2 \cdot \delta(n-2)$$

(1.5.1)

(a) $h(n) = -\delta(n) + 2\left(\frac{1}{2}\right)^n . u(n)$

$$H(z) = -1 + \frac{(2) \cdot z}{z-(1/2)}$$

$$= \frac{(1/2) - z + 2z}{(z - 1/2)}$$

$$= \frac{(z + 1/2)}{(z - 1/2)}$$

$$G(z) = \frac{1}{H(z)} = \frac{(z-1/2)}{(z+1/2)}$$

$$\frac{G(z)}{z} = \frac{(z-1/2)}{(z)(z+1/2)} = \frac{A}{z} + \frac{B}{z+(1/2)}$$

$$= \frac{z(A+B) + (A/2)}{(z)(z+1/2)}$$

$A+B = 1$

$A/2 = -1/2 \Rightarrow A = -1$

$\Rightarrow B = 2$

$$\frac{G(z)}{z} = \frac{-1}{z} + \frac{(2)}{z+(1/2)}$$

$$G(z) = \frac{-z}{z} + \frac{2z}{z+(1/2)}$$

$$g(n) = -\delta(n) + (2)\left(\frac{-1}{2}\right)^n u(n)$$

(1.5.3)

(a)

g(n)

$\hookrightarrow -(a^n)\cdot u[-n-1]$

1.5.2

(a) $$h(n) = \delta(n) + 3.5\cdot\delta(n-1) + 1.5\,\delta(n-2)$$

$$H(z) = 1 + 3.5\cdot z^{-1} + 1.5\cdot z^{-2}$$

$$G(z) = \frac{1}{H(z)} = \frac{1}{1+3.5\cdot z^{-1}+1.5\cdot z^{-2}}$$

$$G(z) = \frac{z^2}{z^2+3.5\cdot z^1+1.5} = \frac{z^2}{(z+3)(z+0.5)}$$

$$\frac{G(z)}{z} = \frac{z}{(z+3)(z+0.5)} = \frac{A}{(z+3)} + \frac{B}{(z+0.5)}$$

$$= \frac{(A+B)z + (0.5A+3B)}{(z+3)(z+0.5)}$$

$A+B=1 \qquad 0.5A+3B=0$

$\qquad\qquad\quad A+6B=0$

$\cancel{A}+B=1$

$-\ \cancel{A}+6B=0 \qquad B=-1/5 \quad A=6/5$

$-5B=1$

$$G(z) = \left(\frac{6}{5}\right)\frac{z}{z+3} + \left(\frac{-1}{5}\right)\frac{z}{(z+0.5)}$$

$$g(n) = \left(\frac{6}{5}\right)(-1)(-3)^n\,u[-n-1] - \left(\frac{1}{5}\right)(-0.5)^n\,u[n]$$

(1.5.3)

(a) $h(n) = \cancel{\delta(n)} + \delta(n+1) - \left(\frac{10}{3}\right)\delta(n) + \delta(n-1)$

$H(z) = z^{+1} + \left(\frac{-10}{3}\right) \cdot 1 + z^{-1}$

$G(z) = \frac{1}{H(z)} = \frac{1}{z - (10/3) + z^{-1}} = \frac{z}{z^2 - \left(\frac{10}{3}\right)z + 1}$

$= \frac{z}{(z-3)(z-1/3)} = \frac{A}{(z-3)} + \frac{B}{(z-1/3)}$

$= \frac{(A+B)z + (-A/3 - 3B)}{(z-3)(z-1/3)}$

$A + B = 1 \qquad -A/3 - 3B = 0$

$\cancel{A} + B = 1 \qquad -A - 9B = 0$

$-\cancel{A} - 9B = 0$

$-8B = 1 \qquad B = -1/8 \quad A = 9/8$

$G(z) = \frac{(9/8)}{(z-3)} + \frac{(-1/8)}{(z-1/3)}$

$G(z) = \left(\frac{9}{8}\right) z^{-1}\left(\frac{1}{1-3z^{-1}}\right) - \left(\frac{1}{8}\right) z^{-1}\left(\frac{1}{1-\frac{1}{3}z^{-1}}\right)$

$g(n) = \left(\frac{9}{8}\right)(-1)(3)^{(n-1)} u[n-2] - \left(\frac{1}{8}\right)\left(\frac{1}{3}\right)^{n} \cdot u[n-1]$