Name : Haris khan

ID : 13169

Subject : DSP.

Paper : Mid term

Teacher : Dr. Razia Mansoor ~~Sir, Mansoor.~~

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(1)

Q#1 following analog signal.

$$x_a(t) = 3\cos 100\pi t + 4\sin 200\pi t.$$

Soln:

(i) According to Sampling theorem.

$F_1 = 100\ Hz$ $\quad F_2 = 200\ Hz$.

$f_s \geq f_{max}$.

$\because \quad f = \omega / 2\pi$.

So, $f_2$ is maximum then $f_1$!

$f_s > 2 \times 100$.

$$\boxed{f_s = 200\ Hz}$$

ii, Suppose s.rate $F_s = 900\ Hz$. . . . .

discrete - time signal. . . . .

effect of sampling rate on

newly generated d. time signal.

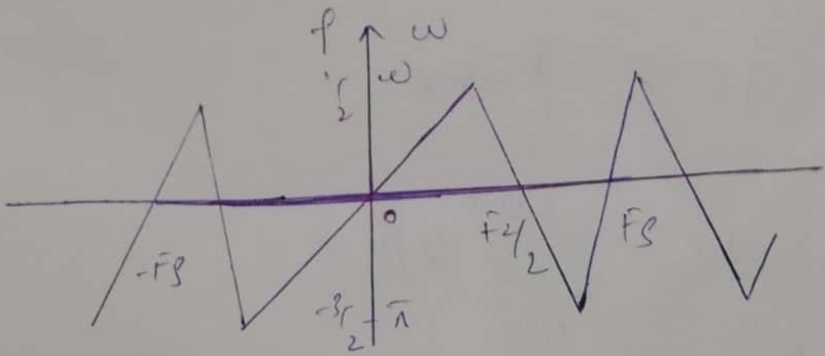
Soln:

$f_s = 100\ Hz.$

$f = 100/2 \Rightarrow 50\ Hz.$

$$x_a[n] = 3\cos\pi\left(\frac{50}{100}\right)n + 4\sin 2\pi\left(\frac{100}{100}\right)n.$$

$$= 3\cos\pi\left(5/10\right)n + 4\sin 2\pi n.$$




∴ The new generated discrete time signal is that. There will be no display phenomena mean, There will be not present unwanted component in Reconstruct of the signal.

(iii) what is analog signal $y_a(t)$ we can construct from sample if we use Ideal Interpolation. (3)

Ans.

folding frequency $= f_1/2 = \frac{100}{2} = 50Hz$.

$f_1 = 50Hz$, $f_2 = 100Hz$

original signal $x_a(t) = 3\cos 100\pi t + 4\sin 200\pi t$.

Since only the frequency components at 100 Hz are present on the sampled signal The analog signal we can remove or reconstant

is

$$\boxed{y_a(t) = 3\cos 100\pi t}$$ Ans.

Q1 (D) Consider discrete t. signal. (4)

$$x(n) = \begin{cases} 0.5^n , & n \geq 0 \\ 0 , & n < 0 \end{cases}$$

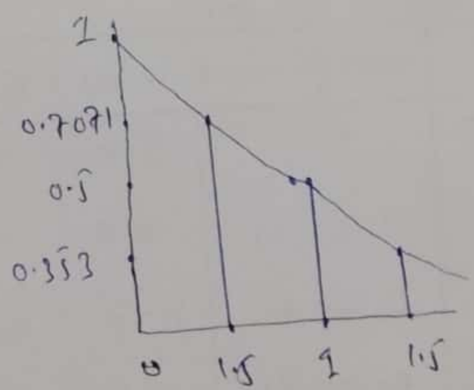
Signal sampled rate is $F_s = 2$ Hz.

(1) Draw sampled signal.

$$f_s = 1/T = T = 1/f_s.$$

$$T = 0.5 \text{ sec.}$$

| $x_n$ | $0.5^n$ |
|---|---|
| 0 | 1 |
| 0.5 | 0.7071 |
| 1 | 0.5 |
| 1.5 | 0.353 |



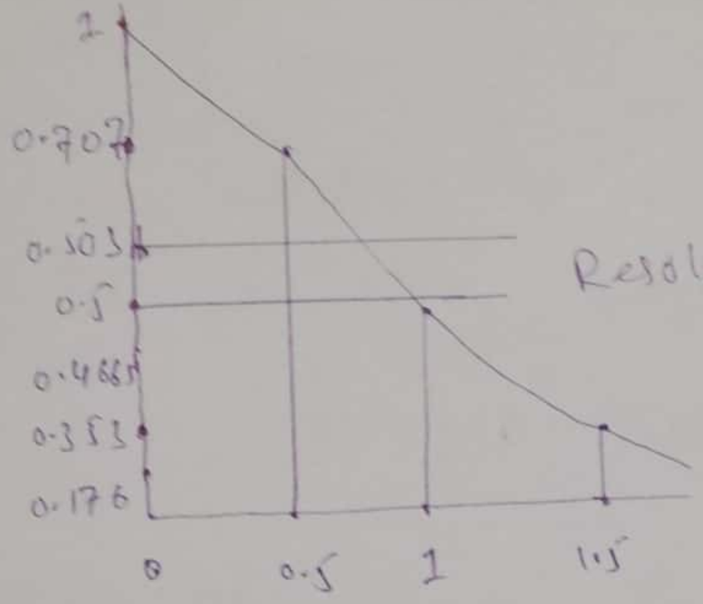

(ii) Ans $L = 2^n$, $n$ = bits = 3.

$$L = 2^3 = 8 \text{ levels.}$$

$$\text{Resolution} = \frac{X_{max} - X_{min}}{L}$$

$$= \frac{1-0}{8} \Rightarrow 0.125$$

5




(iii)

| | Discrete signal | Truncation | Rounding | Error |
|---|---|---|---|---|
| 0 | 1 | 1.0 | 1.0 | 0.0 |
| 1 | 0.8535 | 0.8 | 0.9 | −0.1 |
| 2 | 0.707 | 0.7 | 0.7 | 0.0 |
| 3 | 0.6035 | 0.6 | 0.6 | 0.0 |
| 4 | 0.5 | 0.5 | 0.5 | 0.0 |
| 5 | 0.4265 | 0.4 | 0.4 | 0.0 |
| 6 | 0.353 | 0.3 | 0.4 | −0.1 |
| 7 | 0.1765 | 0.1 | 0.1 | −0.1 |

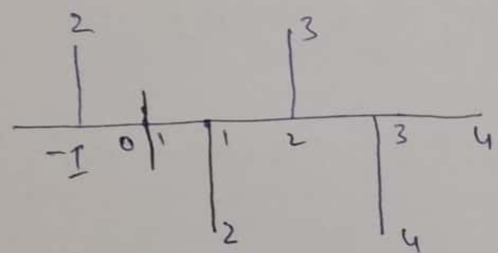
Q#2 Determine response of the signal. (6)

(a) $x[n] = \{2, \underset{\uparrow}{1}, -2, 3, -4\}$.

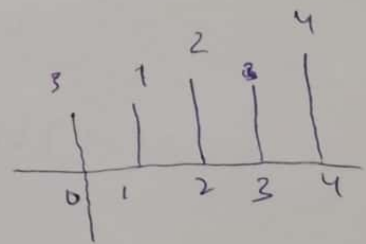
$h[n] = \{\underset{\uparrow}{3}, 1, 2, 1, 4\}$.

Soln:

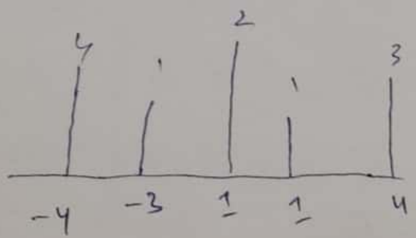
$$y[n] = \sum_{k=-\infty}^{\infty} x[k]\, h[n-k].$$



h(k)



$h(-k)$ = folded signal



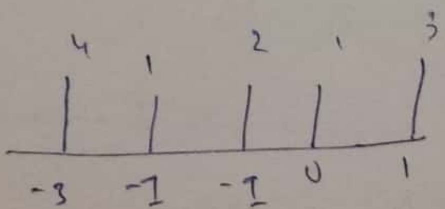
$h(-k)$

$$y[0] = \sum_{k=0}^{0} x(-1)\, h(-1) + x(0)\,(h(0))$$

$$= 2 + 3 \Rightarrow 5.$$

for $n = 1$.

$h(1-k)$



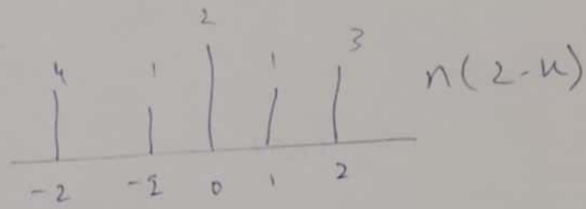
$$y[1] = \sum_{k=1}^{0} x[k](h[1-k)]$$

$$= x[-1](h)(-1) + x(0)h(0) + x(1)h(1)$$

$$= 4+1-6 \Rightarrow -1.$$

$\therefore$ $n = 2$

$h[2-k]$.




$$y(2) = \sum_{k=2}^{2} x(k)\, h(2-k)$$

$$= x(-2)h(-2) + 2(0) + h(0) + x(1)h(1) \ldots$$

$$= 2+2-2+9.$$

$$= 11.$$

As $n = 3$

$y[3] = -8$

$n = 4$

$y[4] = 4.$

$n = 5$

$y[5] = 13$

$n = 6$

$y[6] = 8$

(b) Compute the convolution (8)
$y[n]$ of the following signal.

$$x[n] = \begin{cases} a^{n-2} & , -3 \le n \le 5 \\ 0 & , \text{else where.} \end{cases}$$

$$h[n] = \begin{cases} 2^n & 0 \le n \le 4 \\ 0 & \text{elsewhere.} \end{cases}$$

Soln:

we have.

$$x[n] = x(k) = \{\alpha-2, \alpha-1, 1, \alpha, \alpha^2, \alpha^3 \cdots \alpha^6, 0, a \cdots\}$$

$$h[n] = h(k) = \{\cdots\cdots 0, 1, 2, 4, 8, 16, 0 \cdots\}.$$

To find $y[n]$;

$$y[n] = \sum_{k=\infty} x(k)\, h(n-k)$$

for $n=0$ first to find $h(n-k) = h(0-k)$
by inverting $h(k)$ we get $h(-k)$.

$$\Rightarrow h(-k) = \{16, 8, 4, 2, \underset{\uparrow}{1}\} \text{ — } (4)$$

so
$$y(0) = \sum_{k=-\infty}^{\infty} x(k) * h(-k)$$

$$y(0) = (\infty^{-2} + 4\alpha^{-3} + \alpha + 2$$

$$= a \cdot -2 + 4\alpha^{-2} + 4\alpha^{-2}$$

for = 1. (9)

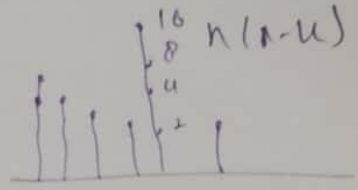
$h(1-k) = \{16, 8, 4, 2, 3\}$.

so

$y(1)\ (\alpha^{-2} \times 16) + (\alpha^{-2} \times 8) + (1 \times 4) + (\alpha \times 2) + (\alpha^{2} \times 1)$

$y(1) = (16\alpha^{-2} + 8\alpha^{-1} + 4 + 2\alpha + \alpha^{2}$

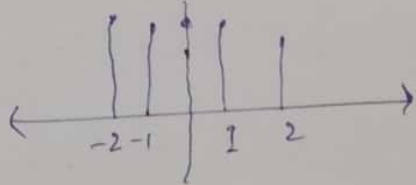
$= \alpha^{2} + 2a + 4 + 4 + 8\alpha^{-1} + 16\alpha^{-2}$




Now

for $n = 2$.

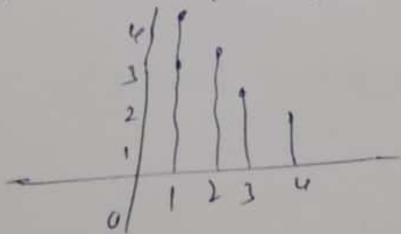
$y(2) = 16\alpha^{-2} + 8 + 4\alpha + 2\alpha^{2} + \alpha^{3}$




Similarly

for $n = 3$

$y(3) = 16 + 8\alpha + 4\alpha^{2} + 2\alpha^{3} + \alpha^{4}$

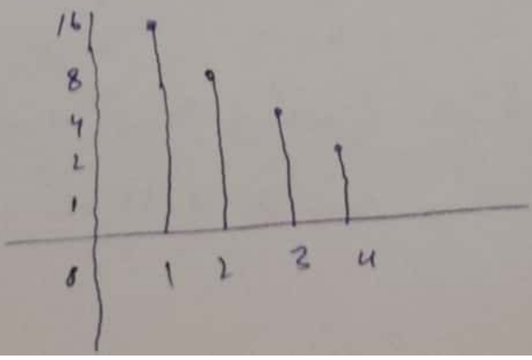



Now

$h(4-k) = \{16, 8, 4, 2, 1)$.

$y(4) = (\alpha^{n} \times 16 + (\alpha^{2} \times 8) + (\alpha^{3} + 4) + (\alpha^{4} + 1) + (\alpha^{5} + 1)$

$= 16\alpha + 8\alpha^{2} + 4\alpha^{3} + 2\alpha^{4} + \alpha^{5}$



(10)

Similarly $x(5-k) = y(5)$ ~~$= 16\alpha^3 + 8\alpha^3$~~

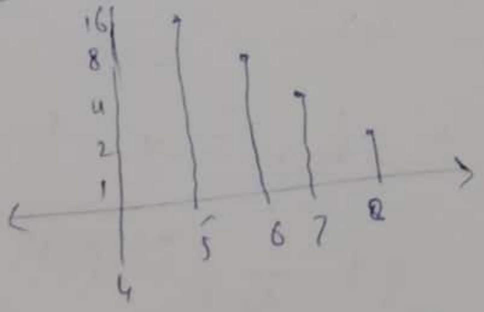
$\therefore\ y[5] = 16\alpha^2 + 8\alpha^3 + 4\alpha^4 + 2\alpha^5 + \alpha^6$

$\therefore\ y[6] = 16\alpha^3 + 8\alpha^4 + 4\alpha^5 + 2\alpha^6$

$\therefore\ y[7] = 16\alpha^4 + 8\alpha^5 + 4\alpha^6.$

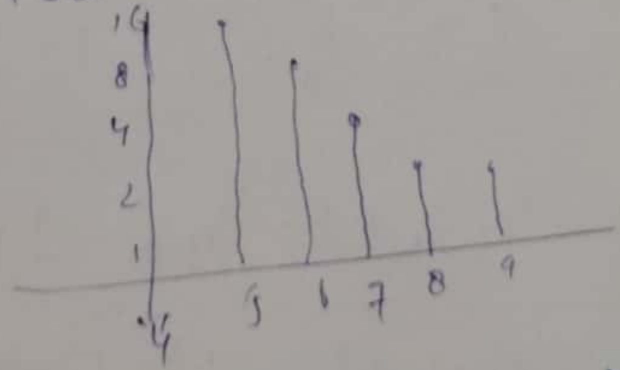
and there discrete time signal sam fune $y[4]$..

$y[8] = 16\alpha^5 + 8\alpha^6.$




$y[9] = 0 + 0 + 0 + 0 + 0 + 16\alpha^6$

$= 16\alpha^6$




X ——— X ——— X

Q#3 Determine Z-transform. (11)

(1) $x[n] = \begin{cases} (1/4)^n, & n \geq 0 \\ (1/3)^{-n}, & n < 0 \end{cases}$

Soln:

As we know that
Z-transform.

$$X(z) = \sum_{n=0}^{\infty} (1/4)^n z + \sum_{n=-\infty}^{0} (1/3)^n z^{n} - 1.$$

using geometric series.

$$\Rightarrow \frac{1}{1 - \frac{1}{4} z^{-1}} + \sum_{n0}^{\infty} (1/3)^n z^n - 1.$$

$$\Rightarrow \frac{1}{1 - \frac{1}{4} z^{-1}} + \frac{1}{1 - \frac{1}{3}} - 1.$$

$$\Rightarrow \frac{1 - \frac{1}{4} z^{-1} + 1 - \frac{1}{3} - 1}{(1 - \frac{1}{4} z^{-1})(1 - \frac{1}{3} z^{-3})^{-1}}.$$

$$\Rightarrow \frac{1 - \frac{1}{3} z + 1 - \frac{1}{4} z^{1} - (1 - \frac{1}{4} z^{-1})(1 - \frac{1}{3} z)}{(1 - \frac{1}{4} z^{-1})(1 - 1/3 z)}$$

$$\Rightarrow \frac{1 - \cancel{1/3 z} + 1 - \cancel{1/4 z^{1}} - 1 + \cancel{1/3 z} + \cancel{1/4 z} + 1/1^{2}}{(1 - \frac{1}{4} z^{-1})(1 - 1/3 z)}$$

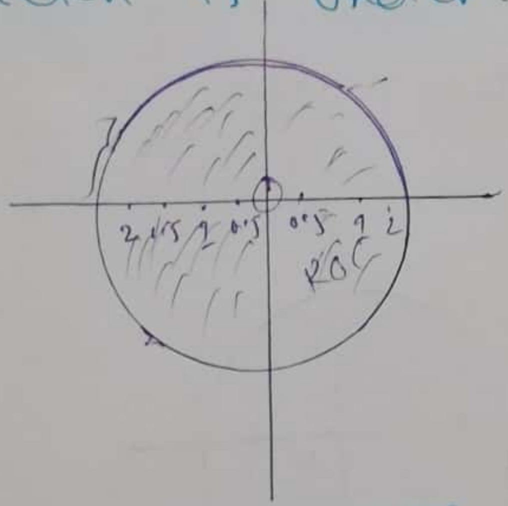
(12)

$$= \frac{1 - \frac{1}{12}}{(1 - \frac{1}{4} z^{-1})(1 - \frac{1}{3} z)}$$

$$= \frac{13/12}{(1 - \frac{1}{4} z^{-1})(1 - 1/3\, z)}$$

Hence The ROC is $\frac{1}{4} < |z| < 3$

The sketch is under.




(ii) $x(n) = \begin{cases} (1/2)^n - 3^n, & n \geq 0 \\ 0 & \text{elsewhere} \end{cases}$

Soln

z - transform.

$x(n) = \alpha^n u\{n\}$ — $x[z] = \frac{1}{1 - \alpha z^{-1}}$ — (B).

By putting values.

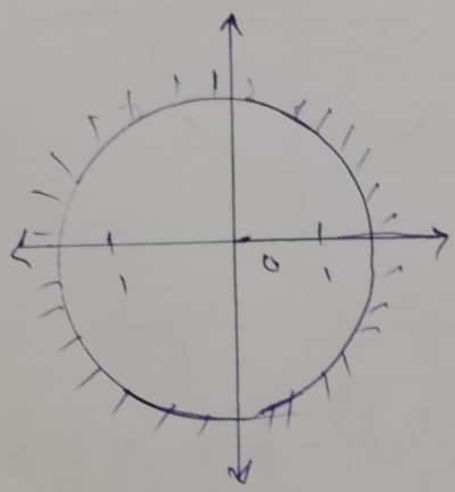
$$x_2(z) = \sum_{n=0}^{\infty} (1/2) z^{-n} - \sum_{n=0}^{\infty} 3^n z^{-n}$$

$$= \frac{1}{1 - \frac{1}{2} z^{-3}} - \frac{1}{1 - 2z^{-1}}.$$

$$= \frac{-5/2 \; z^{-1}}{(1 - \frac{1}{2} z^{3})(1 - 2z^{-1})}$$

∵ A seen ROC use $|z| > 2$.

⇒ The sketch are:




THE END.