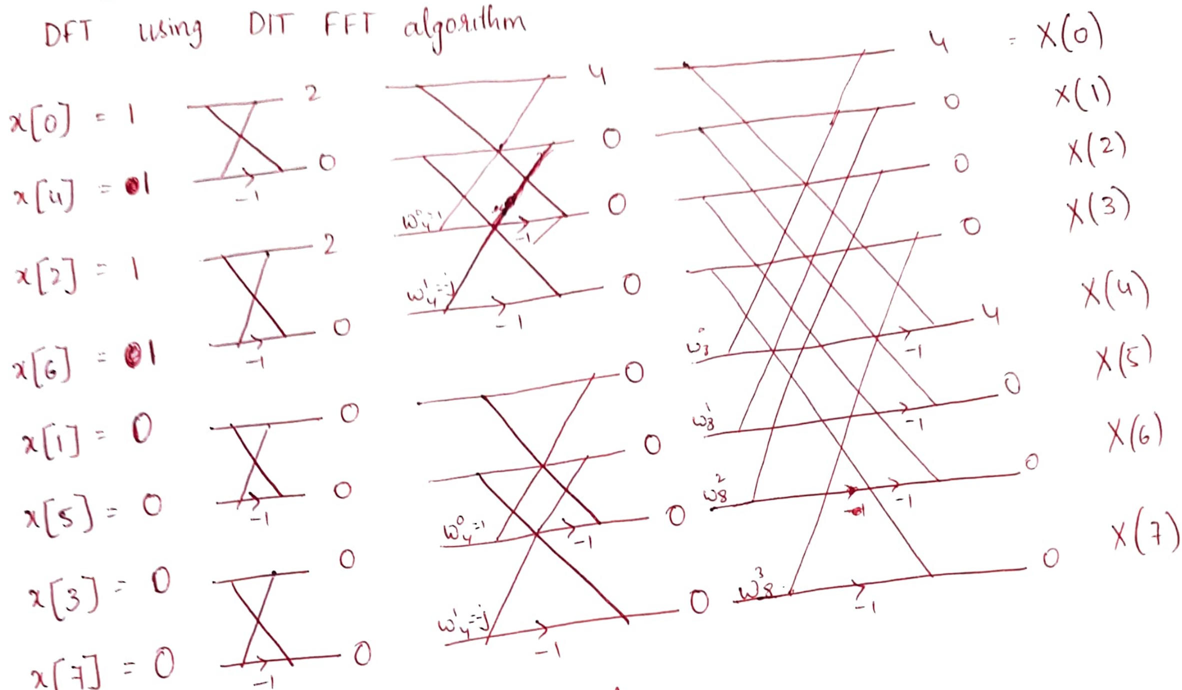
# DSA Endsem

1) $x[n] = \{1,0,1,0,1,0,1,0\}$

$N = 8$

DFT using DIT FFT algorithm




$\therefore$ DFT $= \{4, 0, 0, 0, 4, 0, 0, 0\}$

2 i) We take a small chunk of signal and view it as an LTI system

$$\hat{s}(n) = \sum_{k=1}^{p} a_k (s(n-k)) \quad \text{depending on previous inputs}$$

now, $e(n) = \hat{s}(n) - s(n)$, we will minimise $e^2(n)$ to get values of $a_k$.

now, let $H(z) = \dfrac{1}{1 + \sum_{k=1}^{\infty} a_k z^{-k}}$ $\Big\}$ all pole system

$\Rightarrow y(z) = x(z) - y(z)a_1 z^{-1} - y(z)a_2 z^{-2} - \dots$

$\Rightarrow y(n) = x(n) - a_1 y(n-1) - a_2 (y(n-2)) - \dots$

In this way we modelled the speech production using all pole-system.

exitation is an impulse on random noise model

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

Also, to seperate error and vocal track point, we apply fourier transform on log (spectrum).

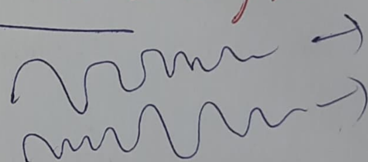
Take nearest power of 2 and apply FFT.

ii) JTFA is a technique that enables the analysis of signal in both the time and frequency domains simultaneously.

JFT is particularly useful in analysing non-stationary signals, which cannot be analysed effectively using traditional technique.

[STFT, CWT, Gabor transform are some of the examples of JTFA.

need



7 first, we take fourier transform of $x(t)$ to get $x(jw)$; it is given by

$$x(jw) = \int_{-\infty}^{\infty} x(t) e^{-jwt} dt$$

$$= \int_{-1}^{1} e^{-jwt} dt$$

$$= \frac{e^{jw} - e^{-jw}}{jw}$$

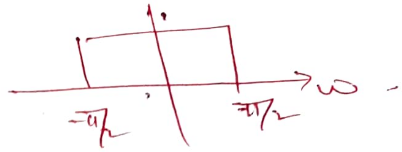
$$= \frac{2\sin W}{W}$$

$\Rightarrow$ magnitude spectrum $|x(jw)|$ is

$$\frac{2\sin w}{w}.$$

4) $N = 9$

w.k.t




$$h_d[n] = \frac{1}{2\pi}\int_{-\pi}^{\pi} H_d(e^{j\omega}) \cdot e^{j\omega n}\, d\omega$$

$$= \frac{1}{2\pi}\int_{-\pi/2}^{\pi/2} 1 \cdot e^{j\omega n}\, d\omega \quad 1M$$

$$= \frac{1}{2\pi \times jn}\left[e^{j\omega n}\right]_{-\pi/2}^{\pi/2} = \frac{\sin n\pi/2}{n\pi} \quad 1M$$

$$h[n] = \begin{cases} h_d[n] & 0 \le n \le 9 \\ 0 & \text{otherwise} \end{cases}$$

~~h[n] = { 1/2 ... }~~

2M

$$h(-4) \text{ to } h(4) = \left\{ \underset{-4}{0}, \underset{-3}{\frac{1}{-3\pi}}, \underset{-2}{0}, \underset{-1}{\frac{+1}{\pi}}, \underset{0}{\frac{1}{2}}, \underset{1}{\frac{1}{\pi}}, \underset{2}{0}, \underset{3}{\frac{-1}{3\pi}}, \underset{4}{0} \right\}$$

$\therefore$ answer is $\cancel{h(n)} = \left\{ \underset{0}{0}, \underset{1}{\frac{-1}{3\pi}}, \underset{2}{0}, \underset{3}{\frac{1}{\pi}}, \underset{4}{\frac{1}{2}}, \underset{5}{\frac{1}{\pi}}, \underset{6}{0}, \underset{7}{\frac{-1}{3\pi}}, \underset{8}{0} \right\}$ 1M.

3) $y(n) = -0.3y(n-1) + 0.4\, y(n-2) + 3x(n) + 3.6\, x(n-1) + 0.6\, x(n-2)$

applying z transform

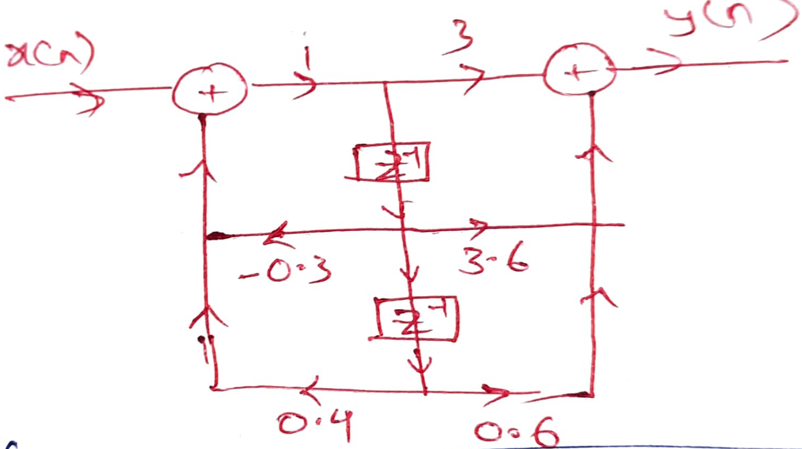
$$Y(z) = -0.3z^{-1}Y(z) + 0.4z^{-2}Y(z) + 3X(z) + 3.6z^{-1}X(z) + 0.6z^{-2}X(z)$$

$$\Rightarrow H(z) = \frac{Y(z)}{X(z)} = \frac{3 + 3.6z^{-1} + 0.6z^{-2}}{1 + 0.3z^{-1} - 0.4z^{-2}} \quad 1.5$$

$$\Rightarrow h(z) = 3\left[\frac{-1}{2}\delta - \frac{15}{4}\left(\frac{-1.4}{3.25}(0.5)^n u(n)\right) - \frac{15^3}{4 \times 26 \times 1.25}(-1.25)^n u(n)\right]$$

1.5

D-II realisation



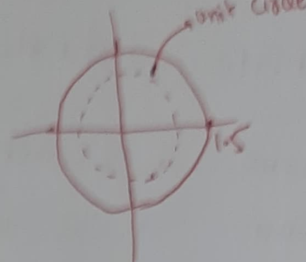

2M.

(i) $H(z) = \dfrac{(z-0.9)(z-0.8)}{(z-0.4)(z-0.95)(z-1.15)}$ 2

For a system to be stable, all the poles should lie within the unit circle.

Poles = 0.4, 0.95, 1.15

Zeroes = 0.9, 0.8




The circle for ROC will have the radius 1.5.

∴ ROC doesn't contain a unit circle.

Thus, the system is <u>NOT STABLE</u>.

(ii) FIR (pros) more order 3

a) Easy to design
b) Always stable
c) Linear phase filter

Cons

a) No information about poles
b) Previous output are not taken into consideration

IIR (pros) less order

a) Information about both zeroes & poles
b) Consideration of previous outputs

Cons

a) Difficult to construct
b) Not always stable
c) Linear phase not possible.

(i) When N is even and Symmetric

$h(n) = h(L-n)$ 2

Taking z transform $\mathcal{Z}\{h(n)\} = \mathcal{Z}\{h(L-n)\}$

$H(z) = z^{L} H(z^{-1})$

N is even $\Rightarrow$ $L = N-1$ is odd. $\boxed{H(-1) = 0.}$

After a certain point, the signal is 1. We get zero at $\pi$.

Hence <u>(not Possible)</u>.

Asymmetric Case

May ~~may not~~ be possible.

Question 6 (a)

(i) Bitrate = 8000 × 16 = 128 Kbps ✓ — 1

(ii) 20 ms → 40 values

1000 ms → $\frac{40}{20} \times 1000$ — 1.5

Bit rate = 2000 × 16 = 32 Kbps ✓

(iii) 30 ms → 13 values

1000 ms → $\frac{13}{30} \times 1000 = 433.3$ × 16 — 1.5

Bit rate = 6.933 Kbps

(b) $\text{Power} = \lim_{N\to\infty} \frac{1}{2N+1} \sum_{n=-N}^{N} |x[n]|^2$

i, $x[n] = \begin{cases} 1 & n \geq 0 \\ 0 & \text{otherwise} \end{cases}$

$P = \lim_{N\to\infty} \frac{1}{2N+1} \sum_{n=0}^{N} 1^2$

$= \lim_{N\to\infty} \frac{N+1}{2N+1} = \frac{1}{2}$ (non zero)

Power signal ✓

ii, $x[n] = \begin{cases} 2^n & n < 0 \\ (1/3)^n & n \geq 0 \end{cases}$

$P = \lim_{N\to\infty} \frac{1}{2N+1} \left\{ \sum_{n=-\infty}^{-1} (2^n)^2 + \sum_{n=0}^{N} (3^{-n})^2 \right\}$

$= \lim_{N\to\infty} \frac{1}{2N+1} \left\{ \sum_{n=1}^{\infty} (2^{-n})^2 + \sum_{n=0}^{\infty} (3^{-n})^2 \right\}$

$= \lim_{N\to\infty} \frac{1}{2N+1} \left[ \frac{2^{-1}}{1-2^{-2}} + \frac{1}{1-3^{-2}} \right]$

$= 0$

✓ Energy signal