IG 2407 June 2023

Ex: 1

1) 96 k samples = 1980 k bits

2) Yes because. Fe: 96 kHz >
$2F_{max.}$: 40 kHz.

3) $q : \frac{4}{2^{20}} =$

4) $P_s : \frac{q^2}{12}$.

5) SNR: $6,02 \times N + 4,77 - Fc$
$= 120,40 + 4,77 - 3$
$= 122,17$ dB

6) DFT requires N^2 multiplications and $N^2 - N$ additions
The computational load is
The DSP should cannic
N^2 MuL + $N^2 - N$ Add. / Te.
NA: $(1024^2$ MuL + 1024^2 ADD$)$ * Fe
$- 1024$

7) By moving from DFT to FFT

	Mul	ADD
DFT	N^2	$N^2 - N$
FFT	$\frac{N}{2}\log_2(N)$	$N\log_2(N)$

8) $f_e = \frac{F_e}{2} = 48\ kHz$.

Ex: 2

1) $H(z) = \frac{1^2}{(z-p_0)(z-p_0^*)}$

$= \frac{1}{(1-z^{-1}p_0)(1-z^{-1}p_0^*)}$

$= \frac{1}{1 - 2Re(p_0)z^{-1} + |p_0|^2 z^{-2}}$

$= \frac{1}{1 - \sqrt{2}z^{-1} + \frac{1}{2}z^{-2}}$

2) Filter with pole $\frac{1}{2}$ $\Rightarrow$ IIR.

3) $\frac{Y(z)}{X(z)} = \frac{1}{1 - \sqrt{2}z^{-1} + \frac{1}{2}z^{-2}}$

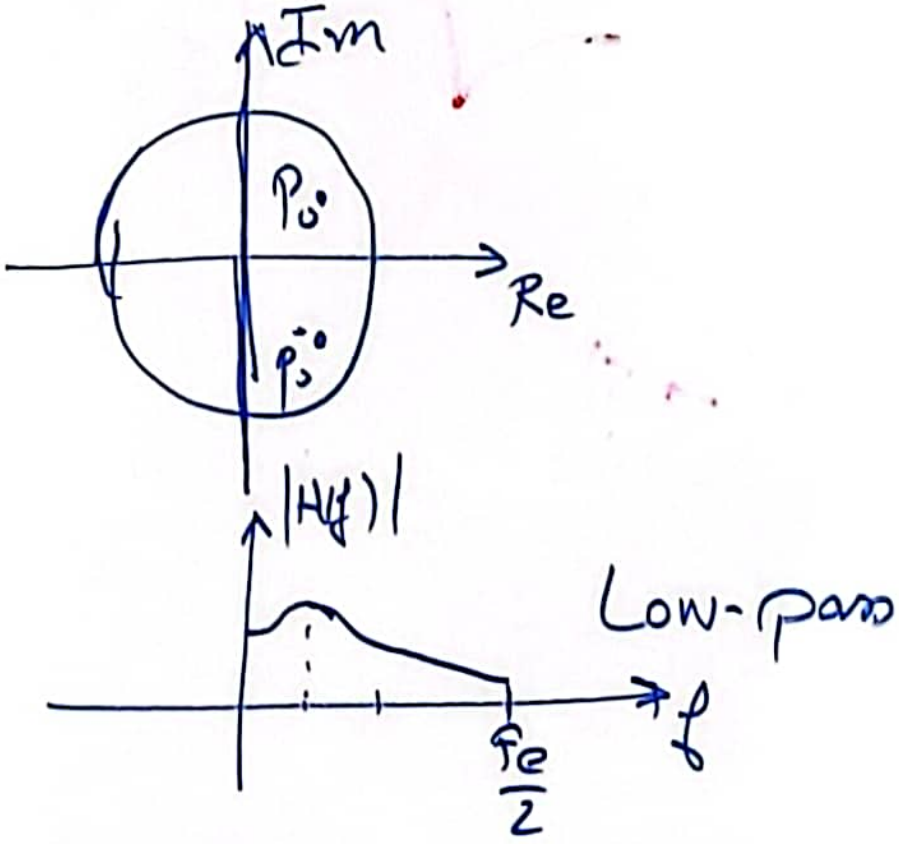
$\Rightarrow y(n) = x(n) + \sqrt{2}\,y(n-1) - \frac{1}{2}y(n-2)$

4) Yes as $y(n)$ is function of previous samples

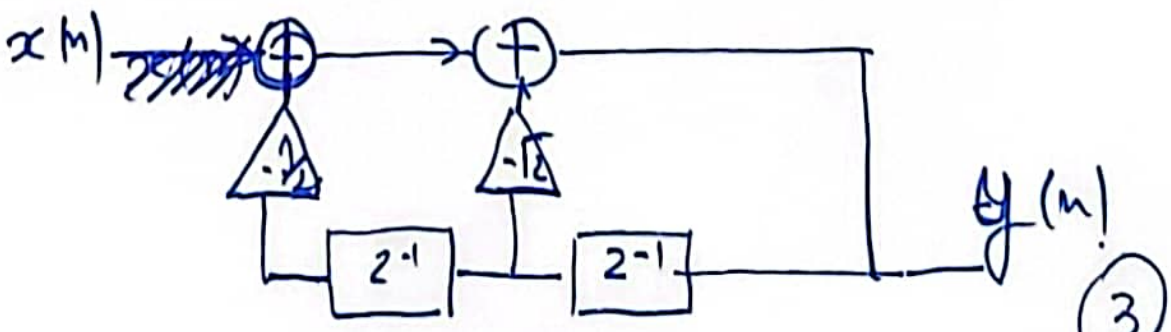
5)
$$H(f) = H(z)\Big|_{z = e^{j2\pi f T_e}}$$
$$= \frac{1}{1 - \sqrt{2}\, e^{-j2\pi f T_e} + \frac{1}{2} e^{-j4\pi f T_e}}$$

6) $|H(f)| = \ldots$

7)



8)



Ex : 3

$b(n) \longrightarrow \boxed{1 - \sqrt{2} z^{-1} + z^{-2}} \longrightarrow y(n)$

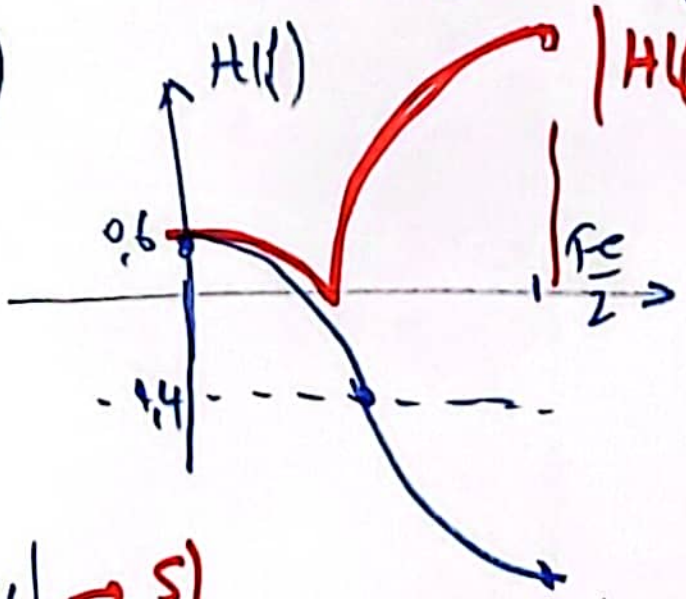
1) FIR because this is no pole.

2) $H(z) = 1 - \sqrt{2} z^{-1} + z^{-2}$.

$= 1 - \sqrt{2} e^{-j 2\pi f_c} + e^{-j 4\pi f_c}$.

$= e^{-j 2\pi f_c} \cdot \left(2 \cos(2\pi f_c) - \sqrt{2} \right)$

3)



4) → 5)

$r_{yy}(0) = (1+2+1)\sigma^2 = 4\sigma^2$

$r_{yy}(\pm 1) = E\{ (y(n) - \sqrt{2}\, y(n-1) + y(n-2)) (y(n-1) - \sqrt{2}\, y(n-2) + y(n-3)) \}$

$= 2\sqrt{2}\, \sigma^2$

$r_{yy}(\pm 2) = E\{ (y(n) - \sqrt{2}\, y(n-1) + y(n-2)) (y(n-2) \quad \cdots \quad 1) \}$

$= \sigma^2$

$r_{yy}(p)_{|p|>2} = 0$

4).

6) No because

$$r_{yy}(\tau) \neq k_0 \delta(\tau)$$

7) $S_y(f) = FT(r_{yy}(\tau))$

$$= 4\sigma^2 + 4\sqrt{2}\sigma^2 \cos(2\pi f T_c) + 2\sigma^2 \cos(4\pi f T_c)$$

8) $S_y(f=0) = 4\sigma^2 - 4\sqrt{2}\sigma^2 + 2\sigma^2$

$$= \sigma^2(6 - 4\sqrt{2})$$

$$S_y\left(\frac{3F_e}{8}\right) = 4\sigma^2 - 4\sqrt{2}\sigma^2 \underbrace{\cos\left(\frac{3\pi}{4}\right)}_{-\frac{\sqrt{2}}{2}} + 2\sigma^2 \underbrace{\cos\left(\frac{3\pi}{2}\right)}_{0} = 0.$$