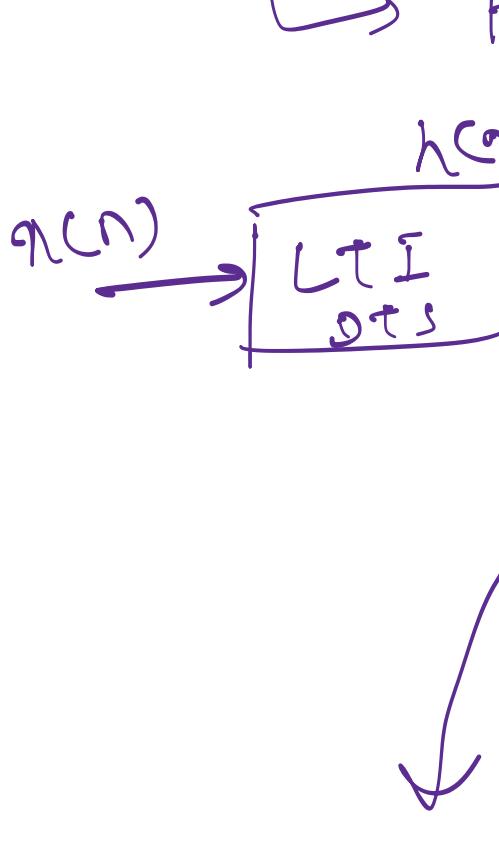


FIR and IIR systemsFinite Impulse response (FIR)

→ If $h(n) \neq 0$, $N_1 \leq n \leq N_2$
 $= 0$, otherwise.



→ If N_1 or N_2 or both $\rightarrow \infty$, then it will be infinite impulse response (IIR) system.

Ex $y(n) = \frac{1}{M} \sum_{k=0}^{M-1} x(n-k)$

$$h(n) = \left\{ \begin{array}{l} \frac{1}{M}, \frac{1}{M}, \dots, \frac{1}{M} \\ \uparrow \quad \quad \quad \downarrow \\ n=0 \quad \quad \quad n=M-1 \end{array} \right\}$$

↪ FIR system.

→ $x(n) \xrightarrow{\text{LTI}} y(n) = \sum_{k=0}^{\infty} x(k) h(n-k)$

This is a non-recursive computation.
This computation is independent to FIR or IIR systems.

→ Both FIR & IIR LTI systems can be computed non-iteratively.

→ $y(n) = x(n) + x(n-1) \rightarrow$ non-recursive
 \downarrow FIR system
 $h(n) \rightarrow \{1, 1\}$

→ $x(e^{j\omega}) = \sum_{n=-\infty}^{\infty} x(n) e^{-j\omega n}$

continuous fun of ω .

$$\rightarrow x(e^{j(\omega+2\pi)}) = \sum_{n=-\infty}^{\infty} x(n) e^{-j(\omega+2\pi)n}$$

$$= \sum_{n=-\infty}^{\infty} x(n) e^{-j\omega n}$$

$$= x(e^{j\omega}).$$

→ $x(e^{j\omega})$ is a periodic function of ω with a period 2π .

$$x(e^{j\omega}) = \sum_{k=-\infty}^{\infty} c_k (e^{j2\pi f_k t})$$

$c_k = \frac{1}{T} \int_{-\pi}^{\pi} x(t) e^{-j2\pi f_k t} dt$

$x(n) \xrightarrow{F} x(e^{j\omega})$.

$x(e^{j\omega}) \rightarrow$ periodic function of the real variable ω .

$x(e^{j\omega}) = x_{re}(e^{j\omega}) + j x_{im}(e^{j\omega})$.

$x_{re}(e^{j\omega}) = \frac{1}{2} \{ x(e^{j\omega}) + x^*(e^{j\omega}) \}$

$x_{im}(e^{j\omega}) = \frac{1}{2j} \{ x(e^{j\omega}) - x^*(e^{j\omega}) \}$

$x(e^{j\omega}) = |x(e^{j\omega})| e^{j\phi(\omega)}$.

$\phi(\omega) = \arg \{ x(e^{j\omega}) \}$.

$|x(e^{j\omega})| \rightarrow$ magnitude spectrum (even fun).

$\phi(\omega) \rightarrow$ phase spectrum.

$\tan(\phi(\omega)) = \frac{x_{im}(e^{j\omega})}{x_{re}(e^{j\omega})}$.

$\rightarrow \phi(\omega) \rightarrow \phi(\omega) + 2\pi k$.

$\rightarrow x(e^{j\omega}) = |x(e^{j\omega})| e^{j(\phi(\omega) + 2\pi k)}$.

$\rightarrow x(e^{j\omega}) = |x(e^{j\omega})| e^{j\phi(\omega)}$.

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$x(e^{j\omega}) = x_{re}(e^{j\omega}) + j x_{im}(e^{j$