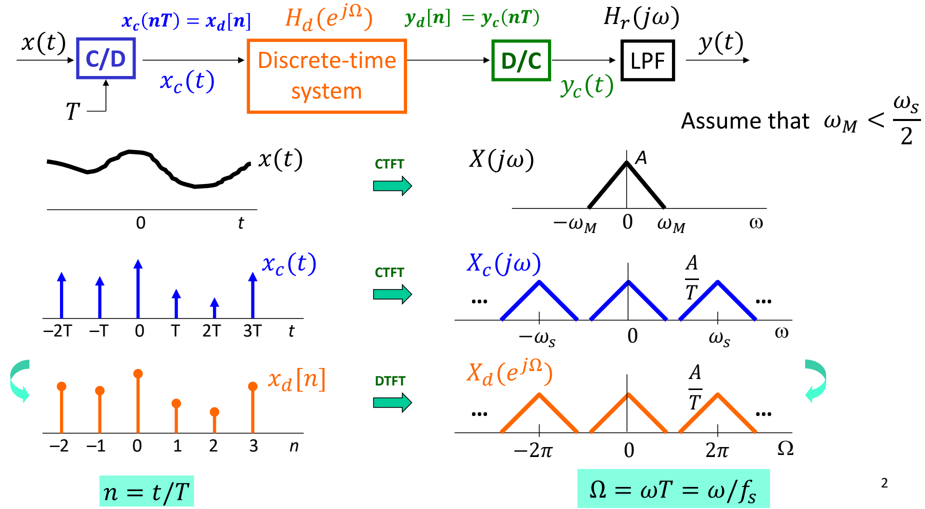
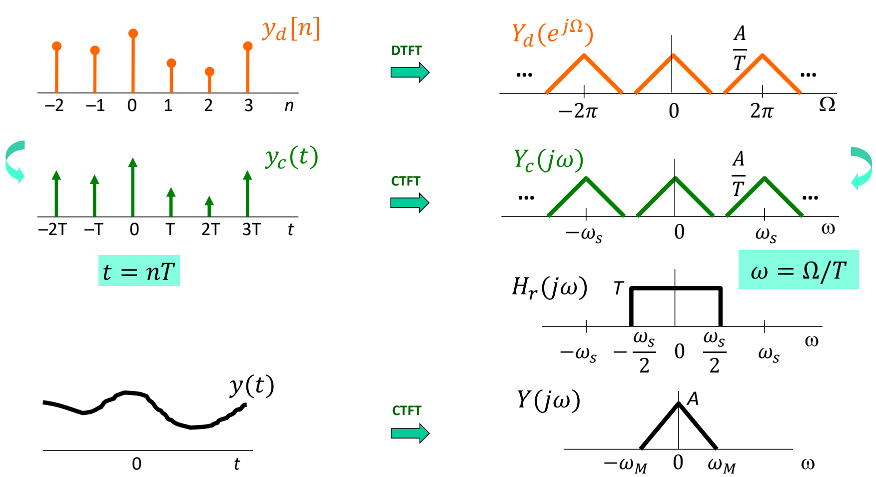
T10

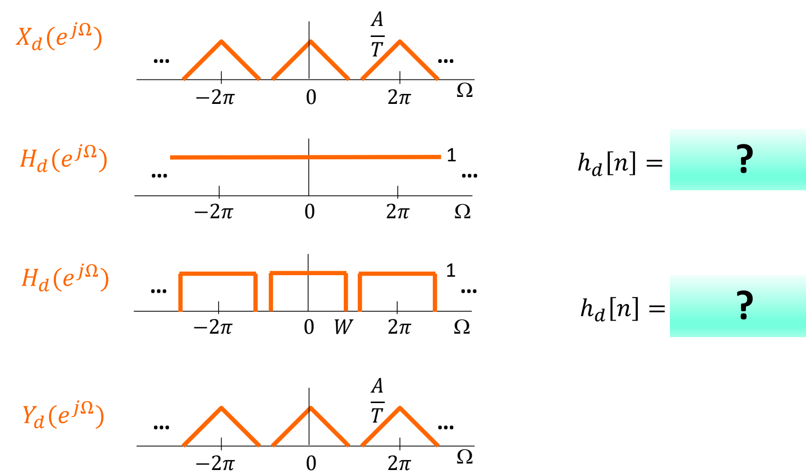
CT signal → DT system
The equivalent DT filter
Discrete approximation of filters
SAW filter

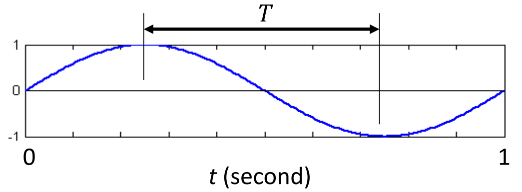
CT Signal → DT System

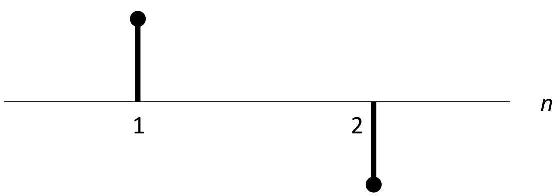


Question : Frequency response of the DT system ?









$f_o = 1$ Hz

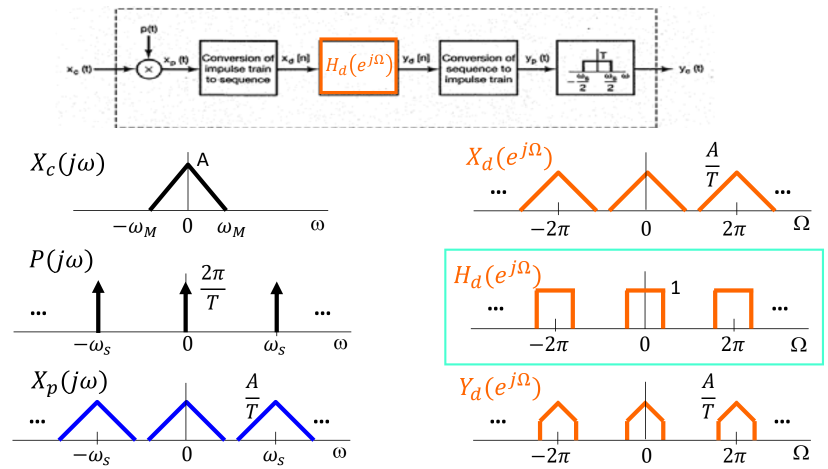
$\omega_o = 2\pi f_o = 2\pi$ rad/s

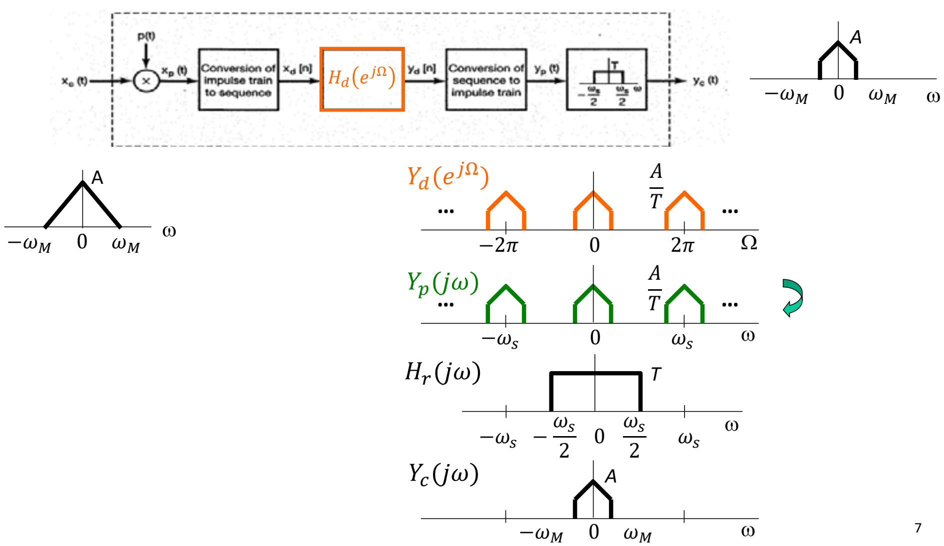
$f_s = 2$ Hz $\quad T = \frac{1}{2}$ seconds

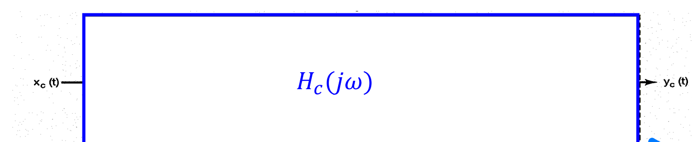
$N = 2$

$$\Omega_o = \frac{2\pi}{N} = \pi = \frac{\omega_o}{f_s} = \omega_o T$$

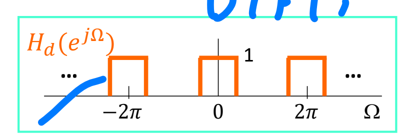
The Equivalent DT Filter

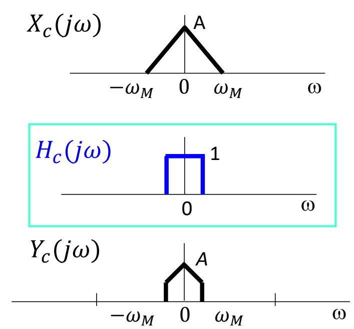






DTFT,

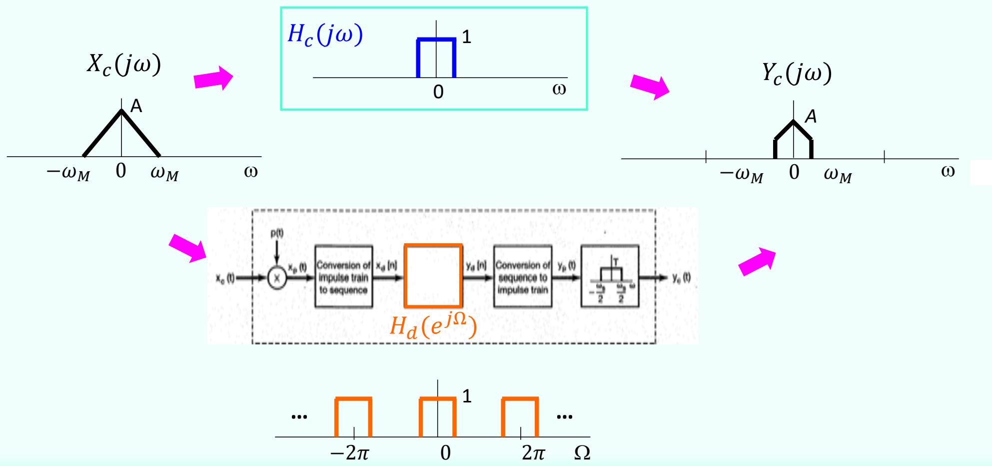




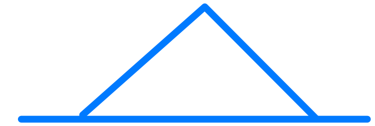
even symmetry

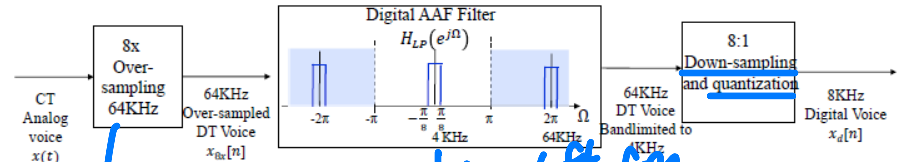
$$H_d(e^{j\Omega}) = \begin{cases} H_c\left(\frac{j\Omega}{T}\right) & |\Omega| < \pi \\ 0 & otherwise \end{cases}$$

Cannot exceed π,
중첩 되니! Aliasing!



Question : Why to oversample the signal ?

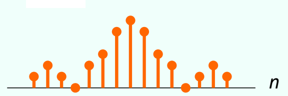




small cutoff freq.

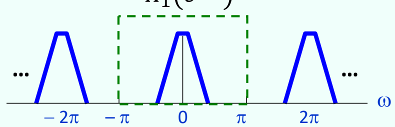
make spectrum very narrow!

$x_1[n]$ Slow-varying signal



F.T.

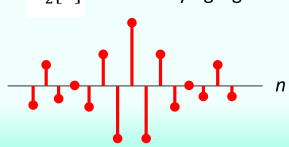
$X_1(e^{j\omega})$



Low-frequency components

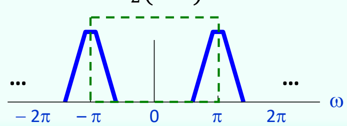
high frequency!

$x_2[n]$ Fast-varying signal



F.T.

$X_2(e^{j\omega})$



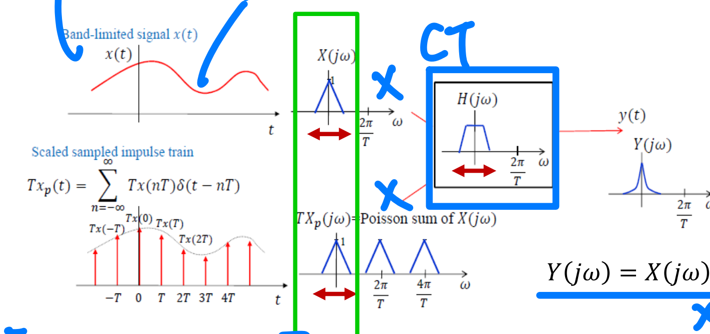
High-frequency components

magnetic tape (slow!!!)

Discrete Approximation (i.e. Sampling)

continous data → 不可 store

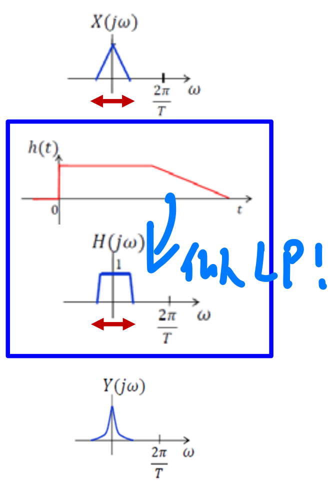
Signals

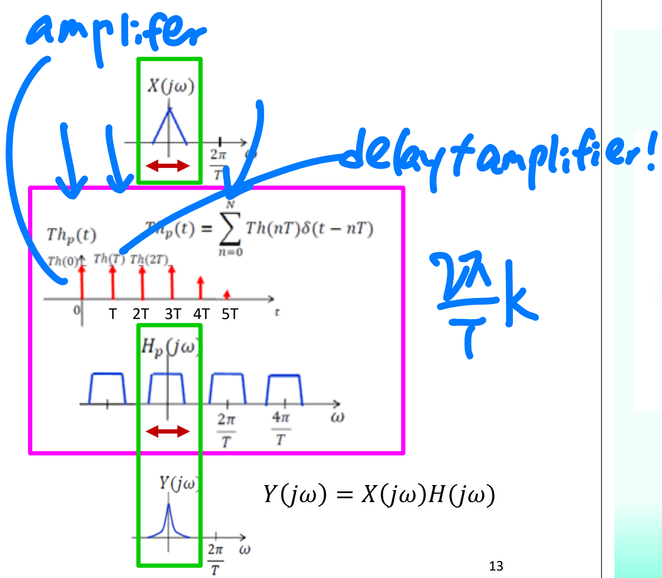


$$Y(j\omega) = X(j\omega)H(j\omega)$$

[. . . .]

Systems





$$Y(j\omega) = X(j\omega)H(j\omega)$$

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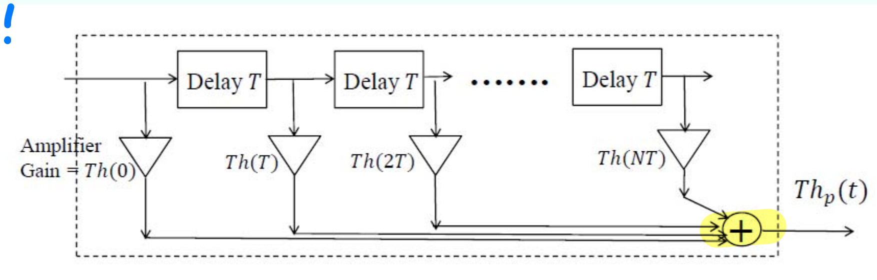

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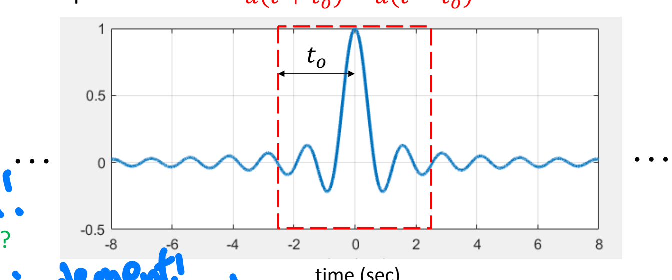
first $*\delta(t-t_0)$

e.g. Implementation of Lowpass Filter

$$h(t) = \frac{\sin(\omega_c t)}{\pi t}$$

non causal!

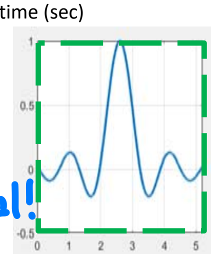


Question : Is it causal ?

不可implement!

$$h_t(t-t_o) = \frac{\sin(\omega_c(t-t_o))}{\pi(t-t_o)}[u(t) - u(t-2t_o)]$$

避免 non-causal!



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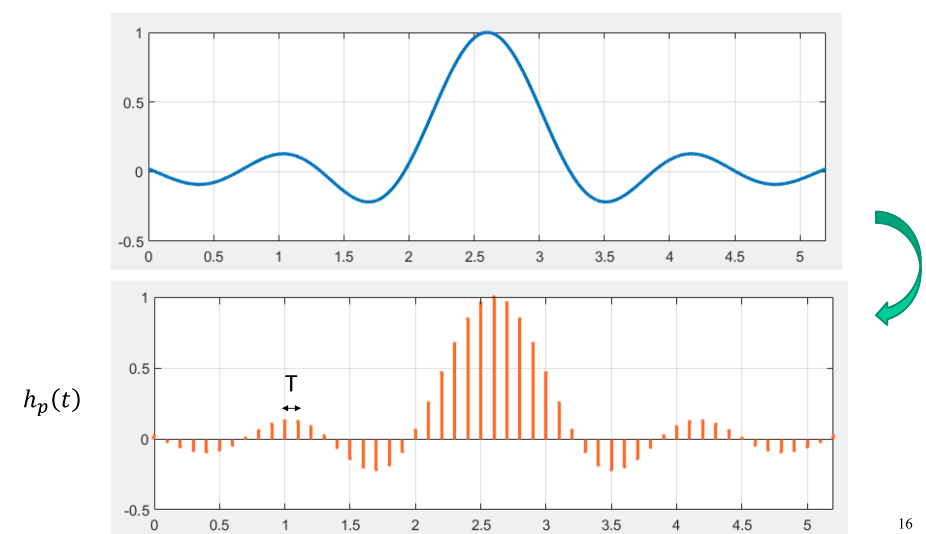

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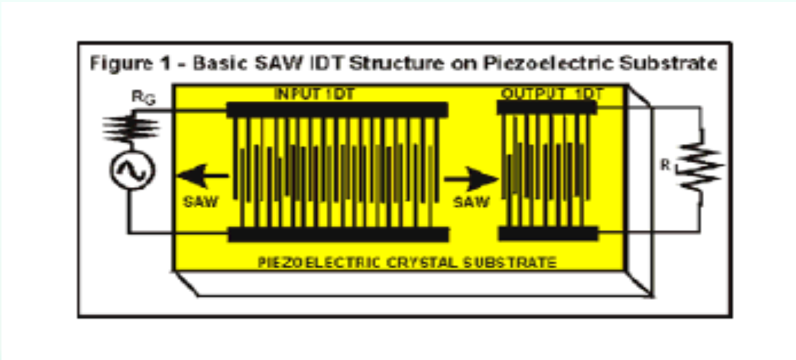
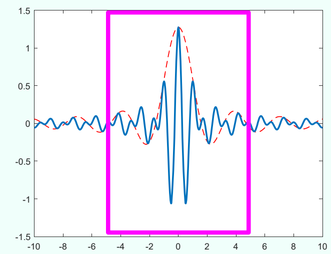
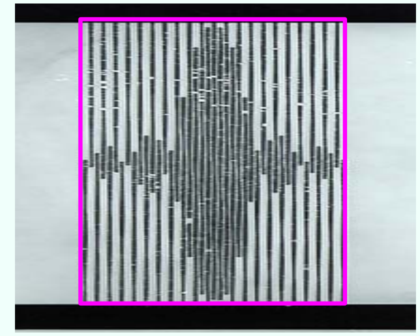
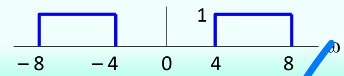
Application (e.g. SAW filter)



$$h(t) = \frac{2\sin(2t)}{\pi t}\cos(6t)$$







$f_s > 2GHz$

Assume that the maximum frequency in $x(t)$ and $h(t)$ is $\boxed{1\text{ GHz}}$ and v is 4000 meters/sec (13x of velocity of sound in air). To avoid aliasing, we need:

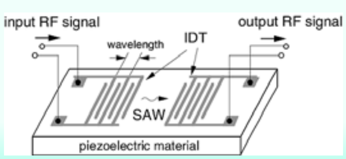
$$T < \frac{1}{\boxed{2 \times 1GHz}} = 0.5ns$$

$d = T \times v$

Hence spacing between fingers should be <0.5ns × 4000 m/s = 2μm

f_s

$$c = f\lambda$$



Speed (in m/s) = Frequency (in Hz) × Wavelength (in m)

Spacing = Speed / Frequency

= Speed × time