- Sampling - cont
  - What is happening in the time domain?

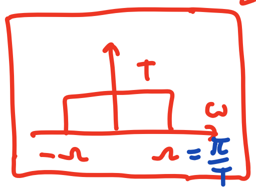
To satisfy Nyquist criterion: $\omega_s \geq 2\Omega \Rightarrow \Omega \leq \frac{\omega_s}{2}$, $\omega_s \rightarrow \frac{2\pi}{T} \Rightarrow \Omega \leq \frac{\pi}{T}$

$$y(t) = \left(\sum_{n=-\infty}^{\infty} f(nT)\delta(t-nT)\right) * sinc\left(\frac{\pi t}{T}\right) = ?$$

$= \mathcal{F}^{-1}\left\{T\,rect\left(\frac{\omega}{2\Omega}\right)\right\}$

LPF

$\sum_{n=-\infty}^{\infty} f(nT)\,\delta(t-nT) \rightarrow$



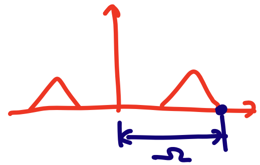
$\rightarrow y(t) = f(t)$

$H(\omega) = T\,rect\left(\frac{\omega}{2\Omega}\right)$, $\Omega = \pi/T$

$$y(t) = \sum_{n=-\infty}^{\infty} f(nT)\, sinc\left(\frac{\pi(t-nT)}{T}\right) = f(t)$$

- Sampling - cont
  - Reconstruction formula

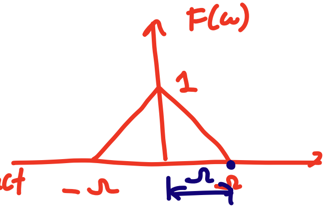
$$y(t) = \sum_{n=-\infty}^{\infty} f(nT) sinc\left(\frac{\pi(t-nT)}{T}\right)$$



Ω is the largest freq. such that $F(\omega) \neq 0$

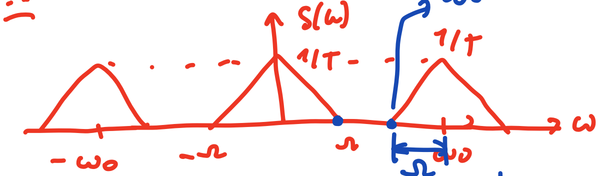
$\Omega = 2\pi B$

when does this work?



if $\omega_0 < 2\Omega \Rightarrow$ undersampling
↓
aliasing
↓
can't reconstruct :(

if $\omega_0 = 2\Omega \Rightarrow$ sampling at Nyquist sampl. freq
⇓
can reconstruct :)



$\omega_0 - \Omega > \Omega \Rightarrow \boxed{\omega_0 \geq 2\Omega}$

sampling freq.

Nyquist sampling frequency

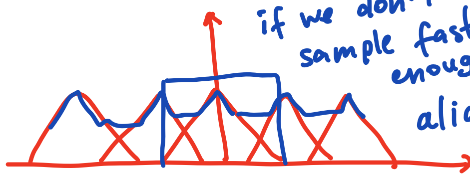
$T < \frac{1}{2B}$ ← bandwidth in Hz

↑ sampling period

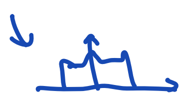
Nyquist criterion $\frac{1}{T} > 2B$

↑ sampling freq. in Hz

if $\omega_0 > 2\Omega \Rightarrow$ oversampling
↓
can reconstruct :)



if we don't sample fast enough aliasing



Chapter objectives

- Understand what convolution represents
- Understand how to convolve two signals
- Understand and be able to apply properties of convolution
- Understand what an impulse represents
- Understand and be able to apply properties of the impulse
- Understand what the impulse response of an LTI system represents
- Understand Fourier Transforms of power signals
- Understand sampling and reconstruction
- Understand Nyquist sampling frequency and aliasing
- Understand the difference between sampling bandwidth and energy bandwidth