10/22/18

# Nyquist Pulses

Recall: Linearly modulated signals

$$s(t) = \sum_n b_n \cdot p(t - nT)$$

PSD:

$$S(f) = \frac{\sigma_b^2}{T} \cdot |P(f)|^2$$

Full response signaling: $p(t) = 0$ for $t < 0$ and $t > T$

Partial-response signaling: duration of $p(t) > T$

- ~~BAD~~ potential for intersymbol interference
- GOOD Prospect for finite bandwidth

Nyquist criterion for no ISI:

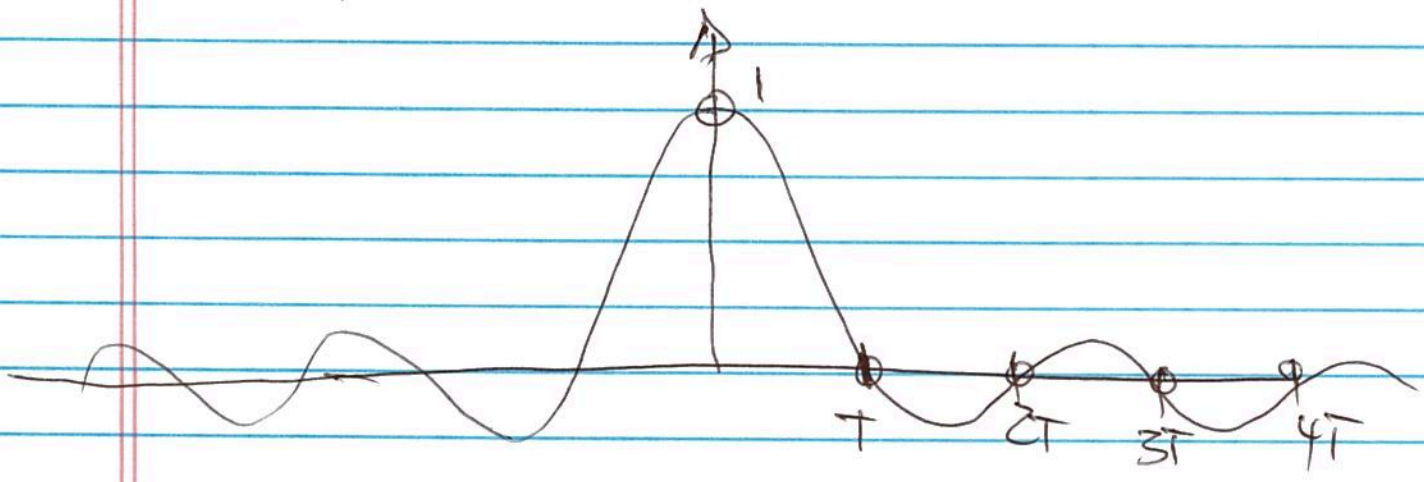
Time domain: $p(mT) = \begin{cases} 1 & m = 0 \\ 0 & \text{else} \end{cases}$

Freq domain: $\frac{1}{T} \sum_K P\left(f + \frac{K}{T}\right) = 1$ for all $f$

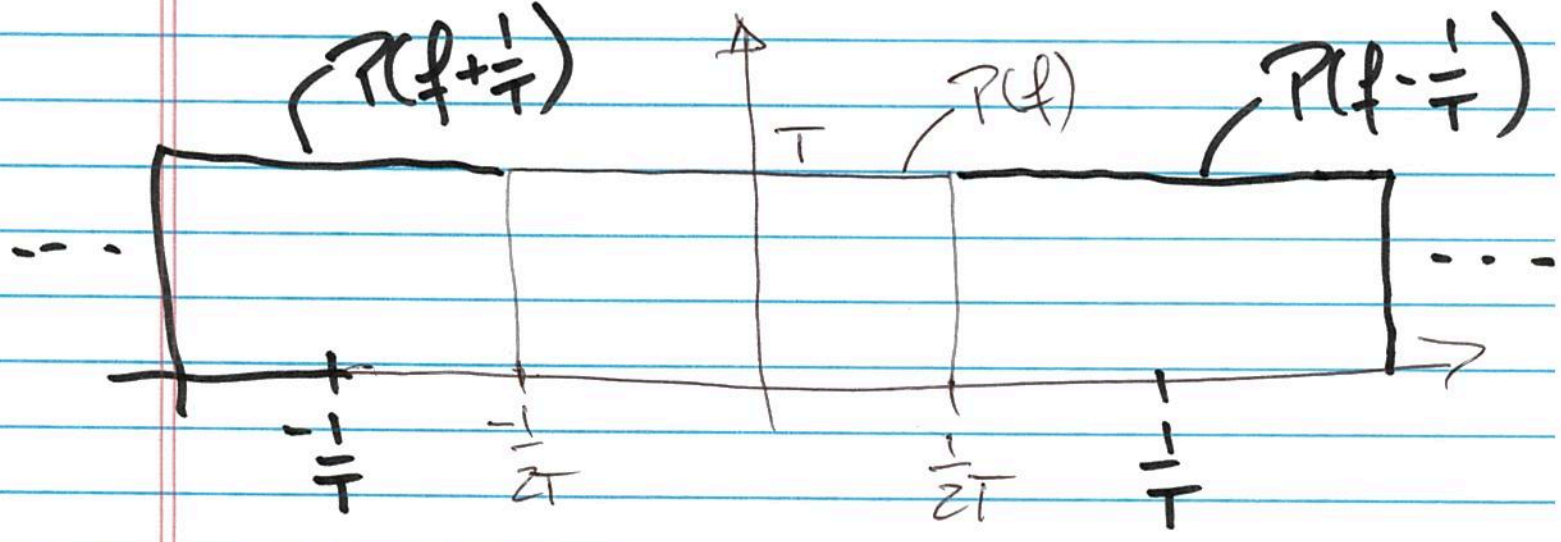
Example: minimum BW Nyquist pulse

"Sinc"

$$p(t) = \text{sinc}(t/T)$$



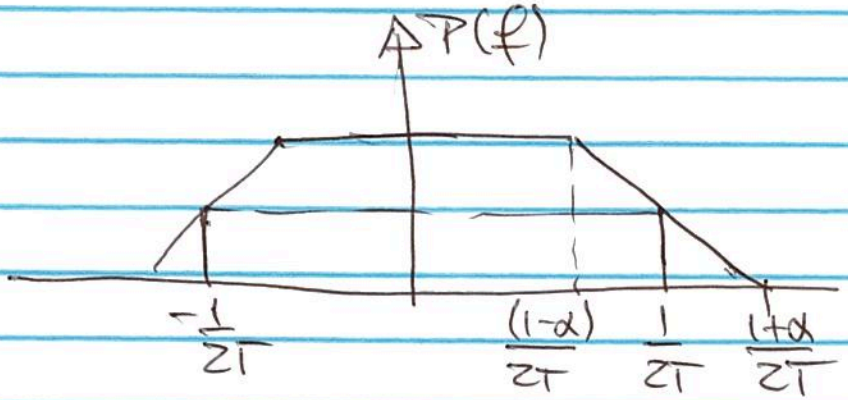

$$P(f) = T \cdot \Pi_{[-1/2T,\, 1/2T]}(f)$$




not robust to timing errors

sample

Example: Trapezoidal Pulse




$BW = \frac{1+\alpha}{T}$

Excess BW

$\frac{\alpha}{T}$

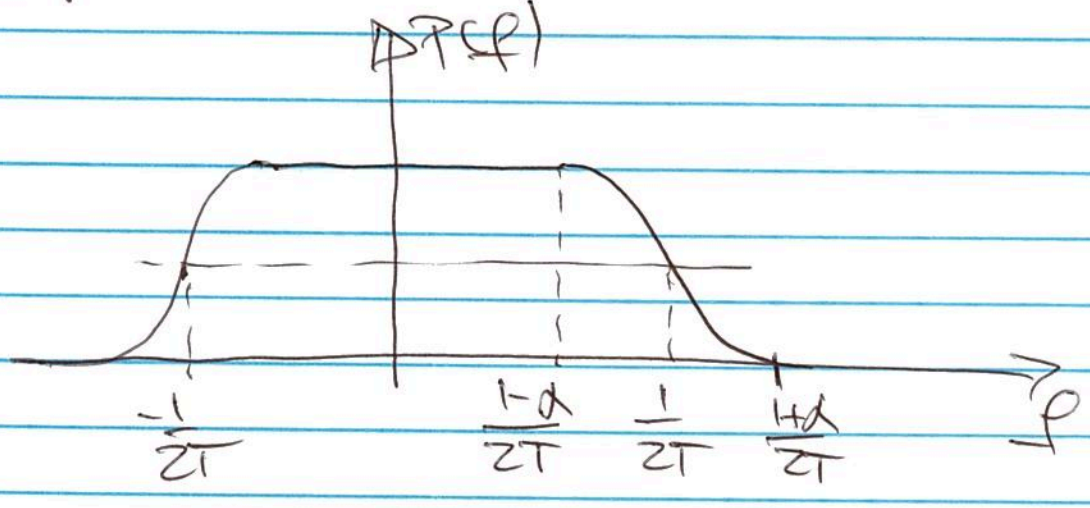
Time domain:

$$p(t) = \text{sinc}\left(\frac{t}{T}\right) \cdot \text{sinc}\left(\frac{\alpha t}{T}\right)$$

decays like $1/t^2$

$\Rightarrow$ more robust to sample timing errors

## Example: Raise Cosine Pulse




$$P(f) = \begin{cases} T & |f| \le \frac{1-\alpha}{2T} \\ \frac{T}{2}\cdot\left(1+\cos\left(|f|-\frac{1-\alpha}{2T}\cdot\frac{\pi}{\alpha}\right)\right) & \frac{1-\alpha}{2T} \le |f| \le \frac{1+\alpha}{2T} \\ 0 & \text{else} \end{cases}$$

Time domain:

$$p(t) = \mathrm{sinc}(\pi t/T)\cdot\frac{\cos(\pi\alpha t/T)}{1-(2\alpha t/T)^2}$$

decays like $1/t^3$