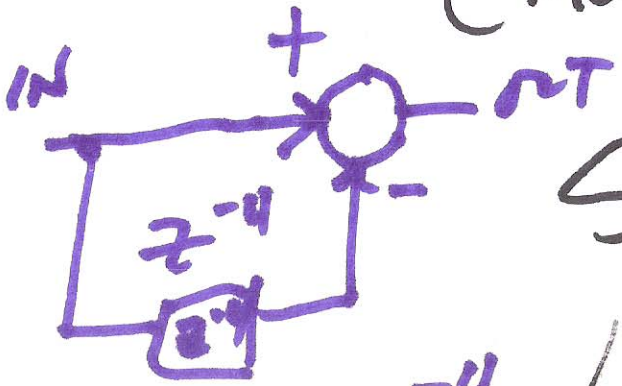
ECE 722

CMOS Mixed-Signal Circuit Design

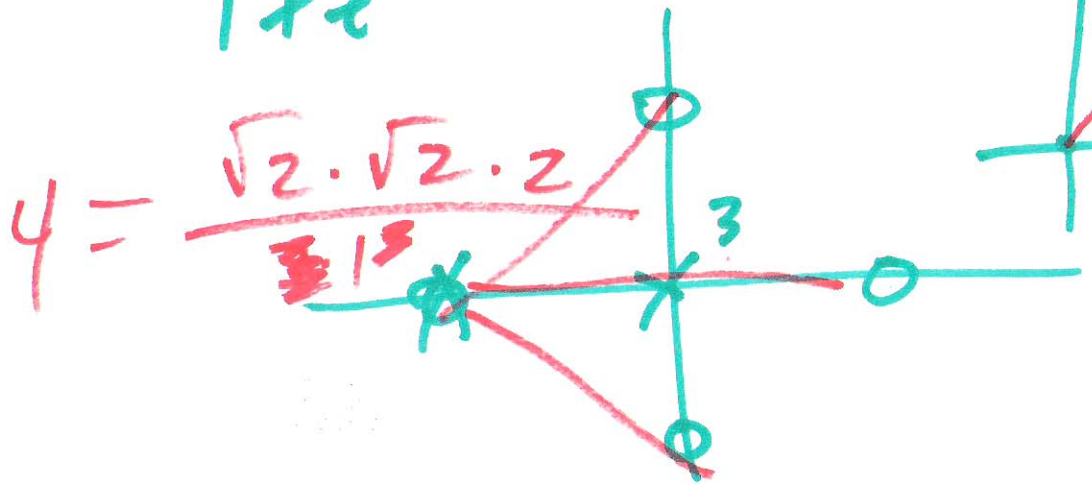


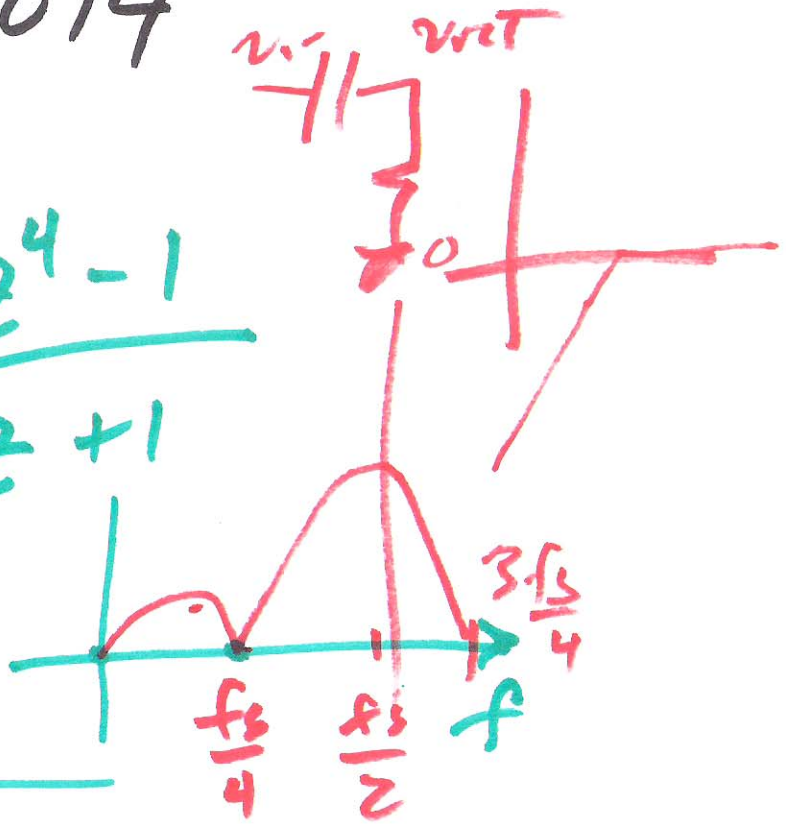
Sept. 3, 2014

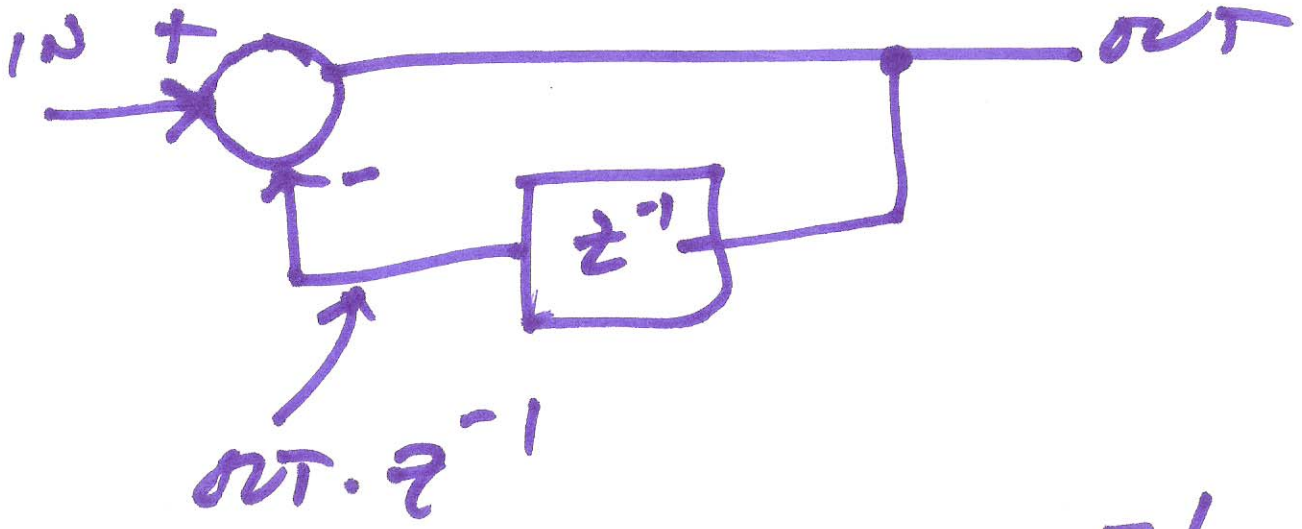
Lecture 3

$$\frac{OUT}{IN} = 1 - z^{-4}$$

$$\frac{1 - z^{-4}}{1 + z^{-1}} = \frac{1}{z^3}\,\frac{z^4 - 1}{z + 1}$$



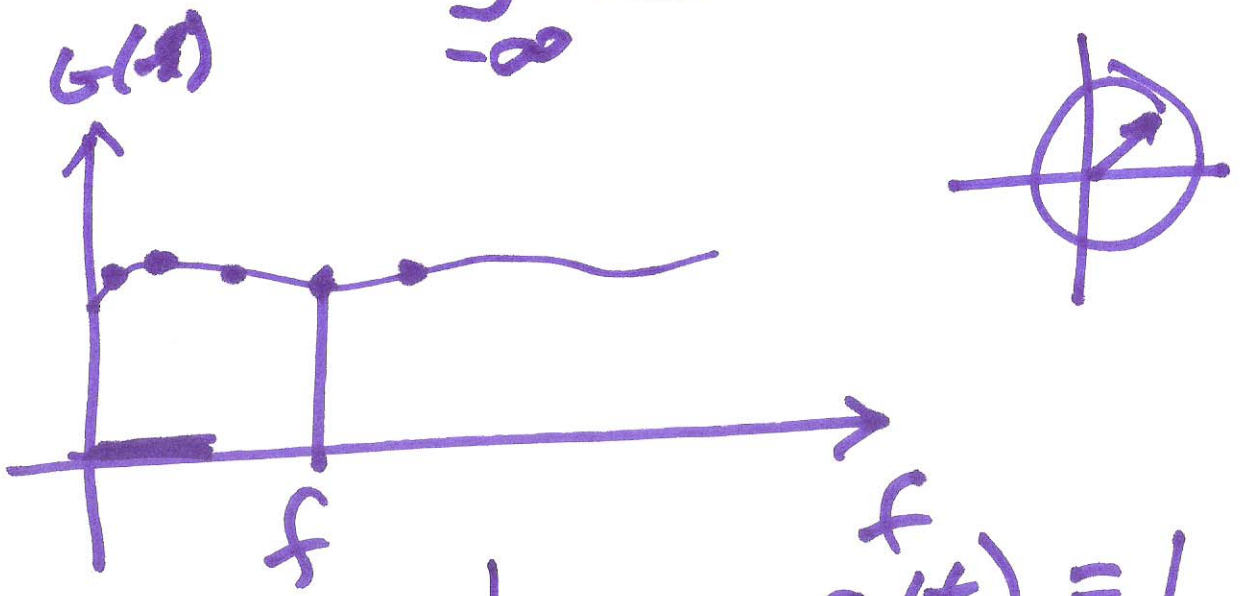




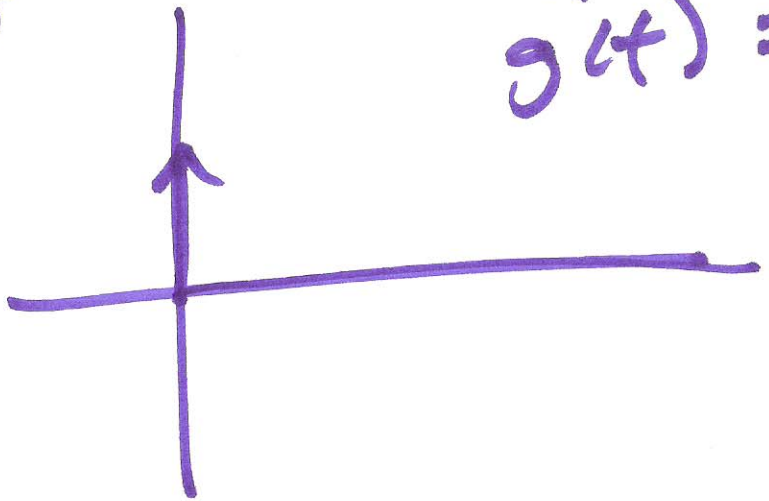
$$OUT = IN - OUT\,z^{-1}$$

$$OUT = \frac{1}{1 + z^{-1}}$$

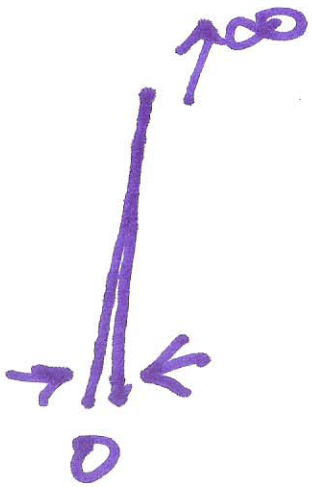
$$G(f) = \int_{-\infty}^{\infty} g(t) \cdot e^{-j2\pi ft} \cdot dt$$



$g(t) = 1$ DC



Dirac delta



$$\delta(t-t_0) = \infty \quad \text{for } t = t_0$$

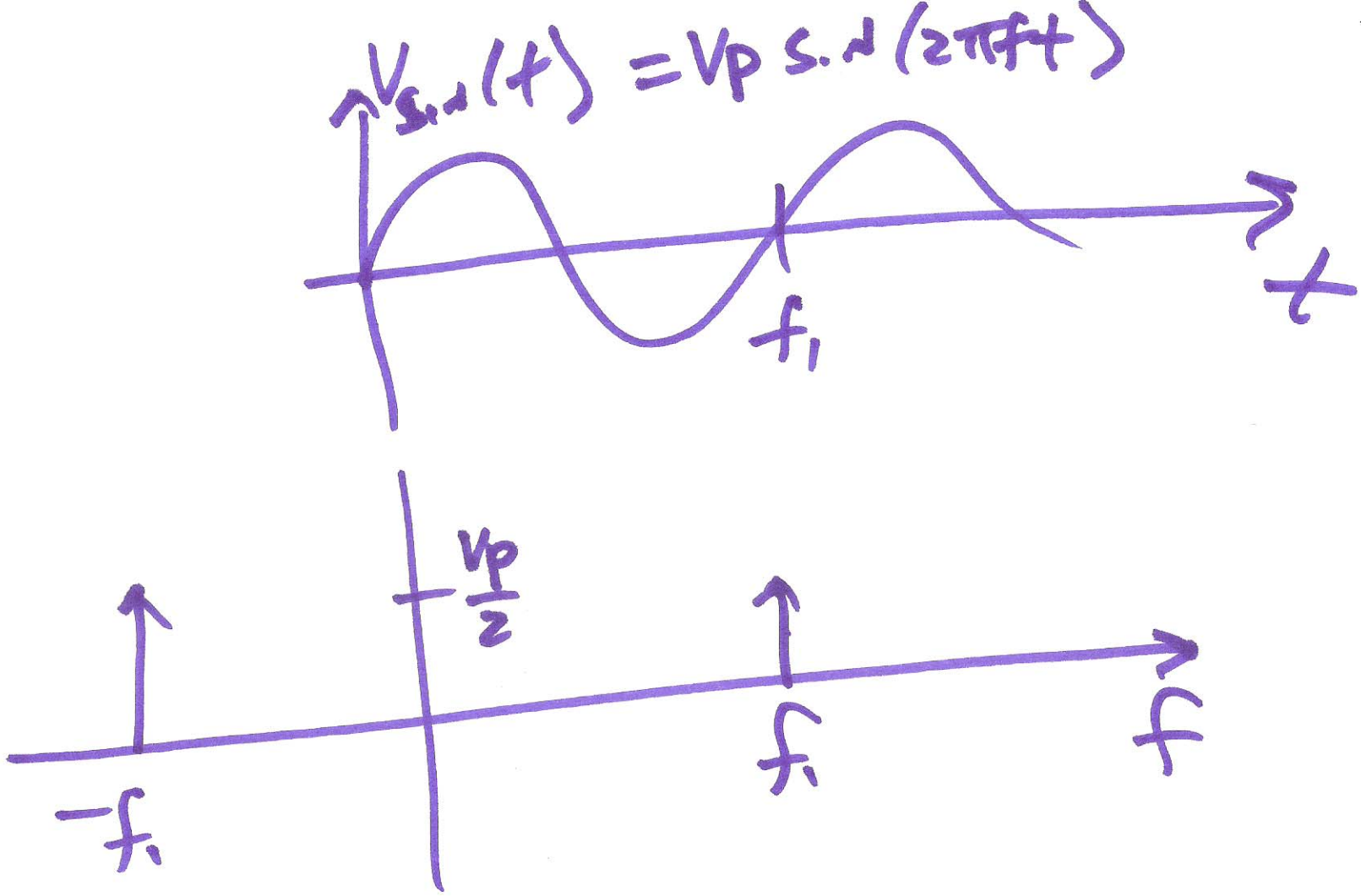
$$\int_{-\infty}^{\infty} \delta(t-t_0)\,dt = 1$$

Kronecker delta function

$$\delta(t-NT_s) = 1 \quad t = NT_s$$

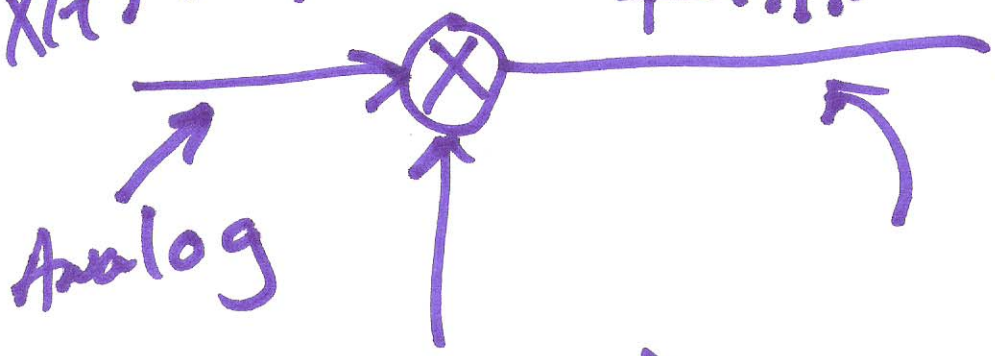
$$= 0 \quad t \neq NT_s$$

$$\int_{-\infty}^{\infty} f(t)\,\delta(t-NT_s)\,dt = f(NT_s)$$



5)

$x(t) = V_p \sin(2\pi f_{in} \cdot t)$

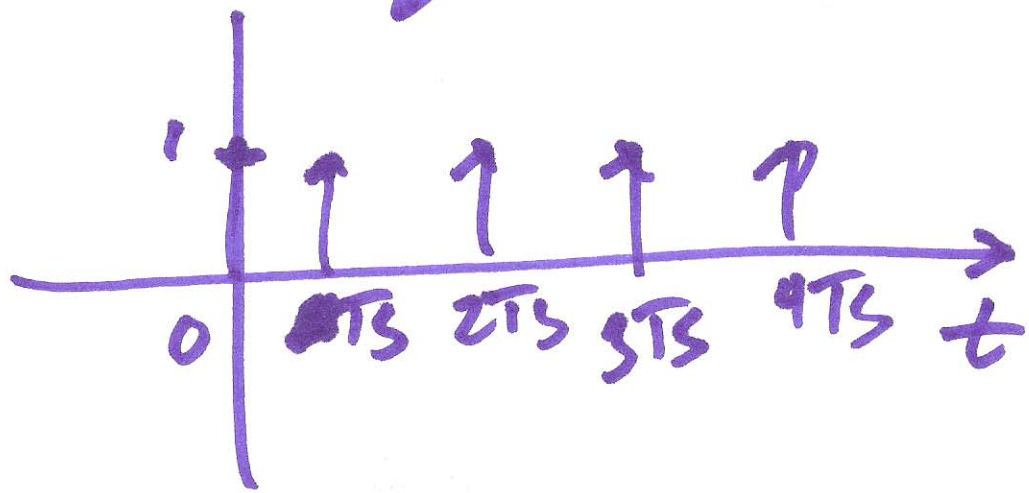


$y(t) = V_p \sin(2\pi f_{in} \cdot t) \cdot$

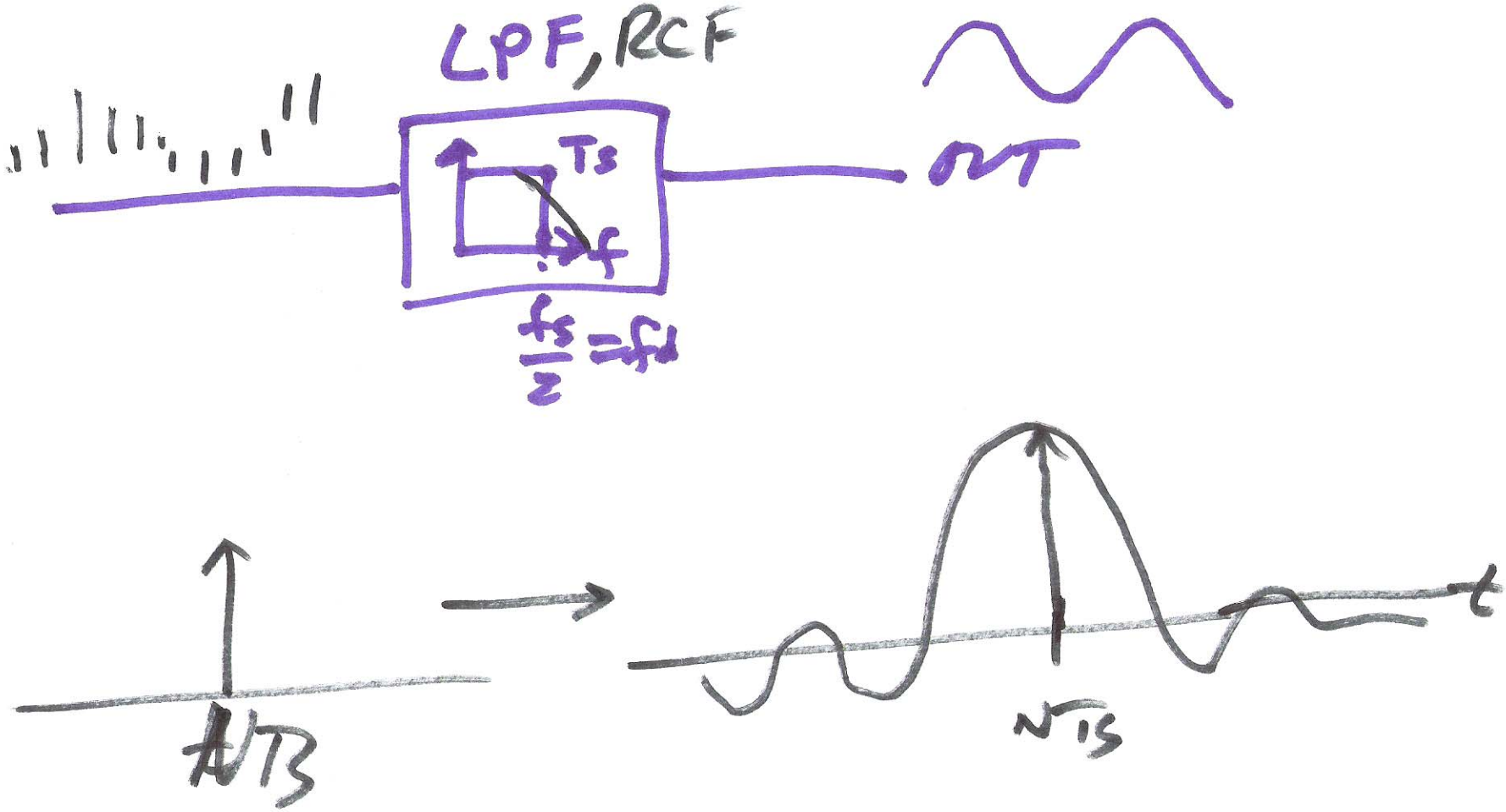
$\delta(t - NT_s)$

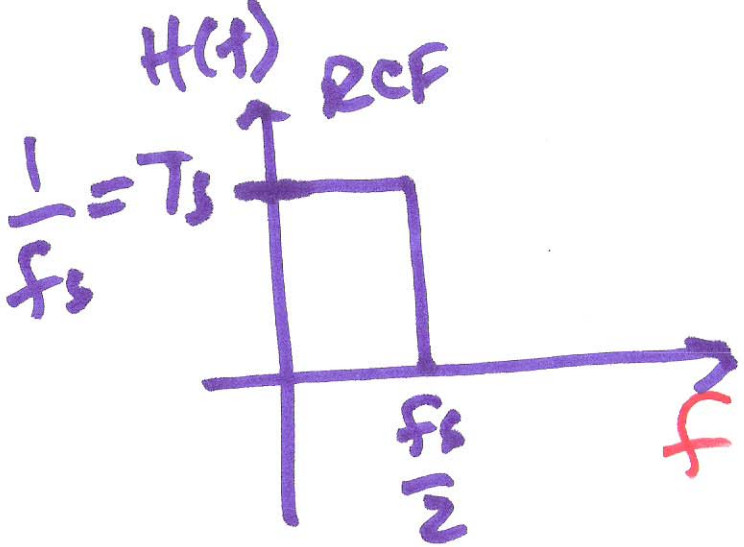
$\downarrow \mathcal{F}\{\ \}$

$\delta(t - NT_s)$



$$Y(f) = \frac{V_p}{2jT_s} \sum_{k=-\infty}^{\infty} \left(\delta(f - f_{in} - kf_s) - \delta(f + f_{in} - kf_s) \right)$$


LPF, RCF
Ts
OUT
$\frac{f_s}{2} = f_d$
t



$$H(f) = \frac{1}{f_s} \quad |f| < f_N$$

$$= 0 \quad |f| > f_N$$

$$h(t) = \int_{-\infty}^{\infty} \frac{1}{f_s} e^{j2\pi ft} \, df$$

$\frac{f_s}{2} = f_N$

$-\frac{f_s}{2} = -f_N$

$$\frac{1}{f_s} \frac{1}{j2\pi t} e^{j2\pi ft} \Big|_{-\frac{f_s}{2}}^{\frac{f_s}{2}} = \frac{1}{j2\pi f_s t} \left(e^{j\pi f_s T} - e^{-j\pi} \right)$$

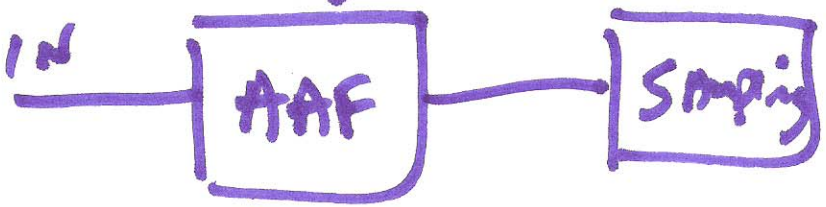
$$h(t) = \frac{1}{j2\pi f_s t}\left(e^{j\pi f_s t} - e^{-j\pi f_s t}\right)$$

$$= \frac{\sin \pi f_s t}{\pi f_s t} = \mathrm{sinc}\, \pi f_s \cdot t$$

$\frac{\sin x}{x}$

Remove spectral $> \frac{f_s}{2} = f_N$

Sampling



Decimation

sampling but for digital signals