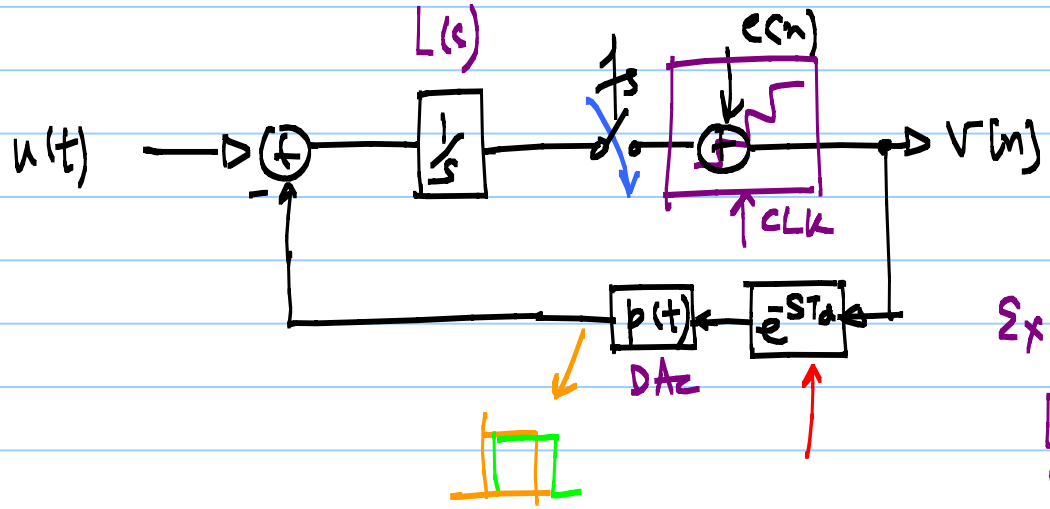
ECE 615 - Lecture 22

Note Title 11/19/2013

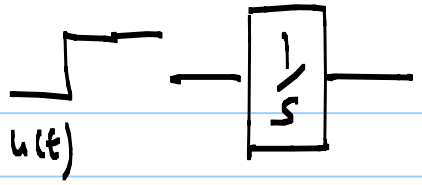
CT DΣ → non-idealities → Quantizer delay (⇒ELD)

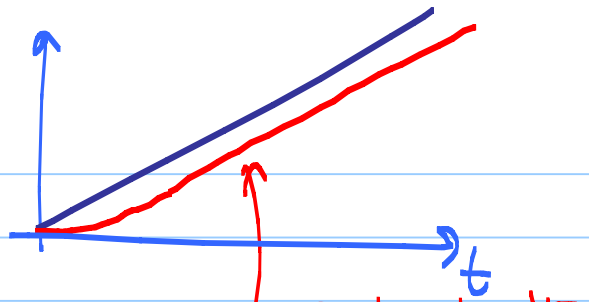


$f_s = 1$ Hz

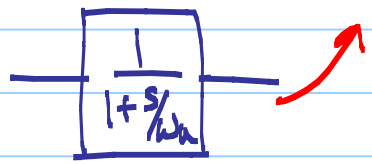
Excess loop delay
- ↳ Quantizer delay (T_d)
- ↳ DAC delay
- ↳ Finite BW of opamps in the loop-filter

Aside

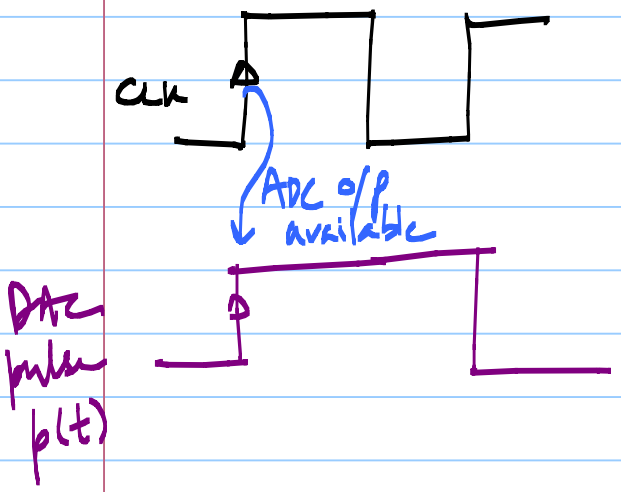




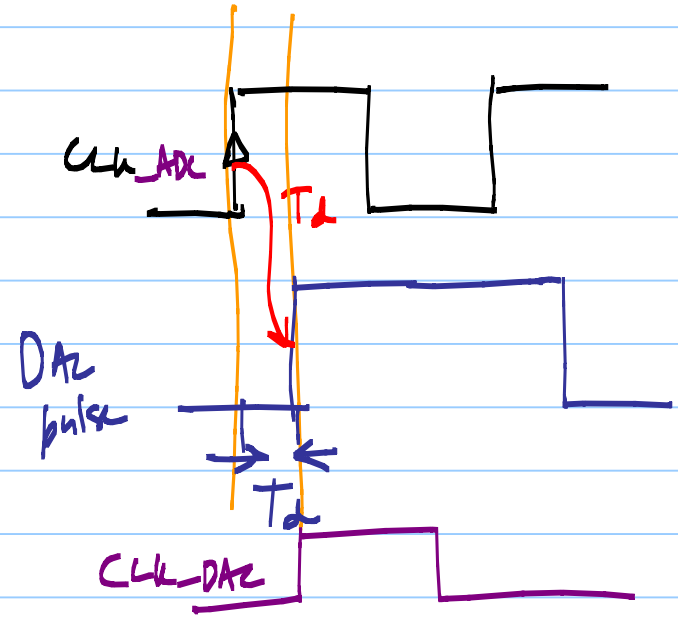
ELD due to the loop jitter.



Ideal Case
(No delay)



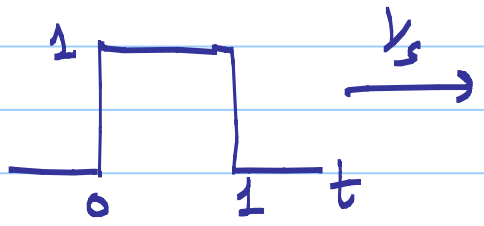
Real Case



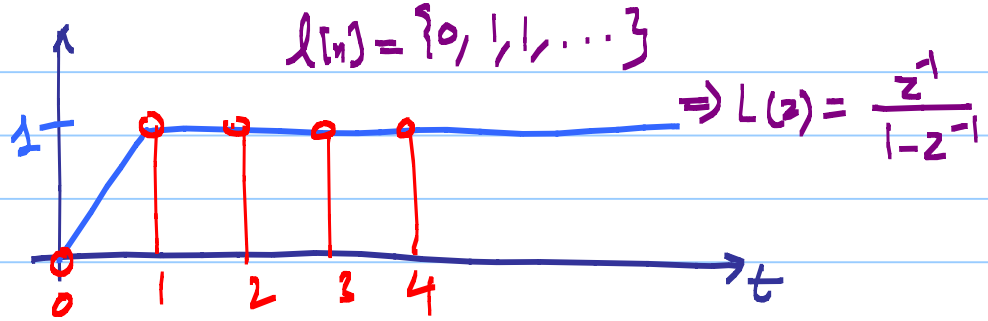
⇒ More delay in the loop ⇒ NTF will be changed as L(z) changes

$f_s = 1\,Hz$

IDEAL CASE



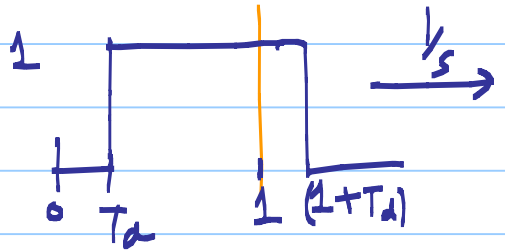
$1/s$



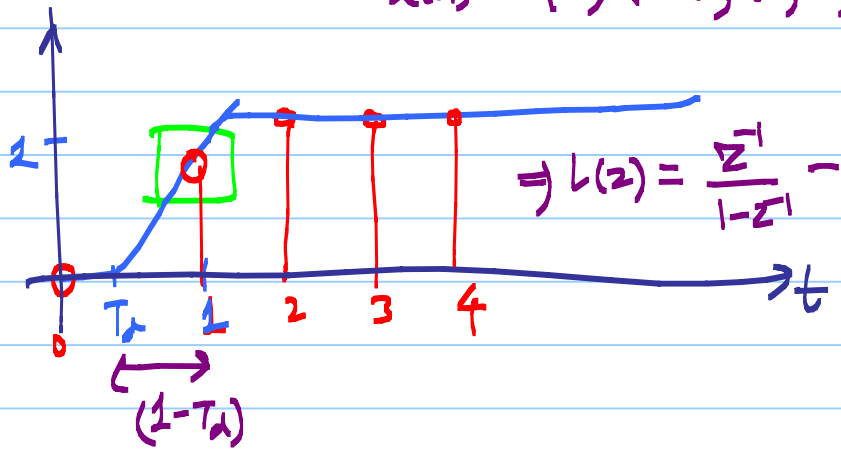
$l[n] = \{0, 1, 1, \dots\}$

$\Rightarrow L(z) = \frac{z^{-1}}{1-z^{-1}}$

with ELD

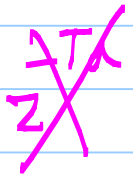


$1/s$



$l[n] = \{0, (1-T_d), 1, 1, \dots\}$

$\Rightarrow L(z) = \frac{z^{-1}}{1-z^{-1}} - T_d z^{-1}$



With ELD

$$NTF(z) = \frac{1}{1+L(z)} = \frac{1}{1+\frac{z^{-1}}{1-z^{-1}} - T_d z^{-1}}$$

$$= \frac{(1-z^{-1})}{1-T_d z^{-1}(1-z^{-1})} = \frac{(1-z^{-1})}{1-T_d z^{-1}+T_d z^{-2}}$$

← without ELD

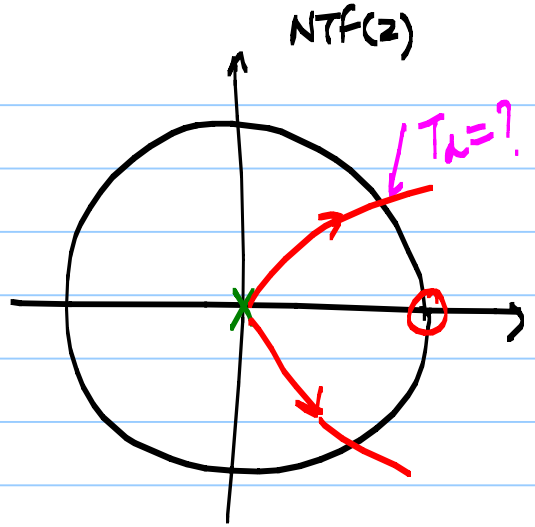
* for low frequency, $\omega \approx 0 \Rightarrow z \approx 1$

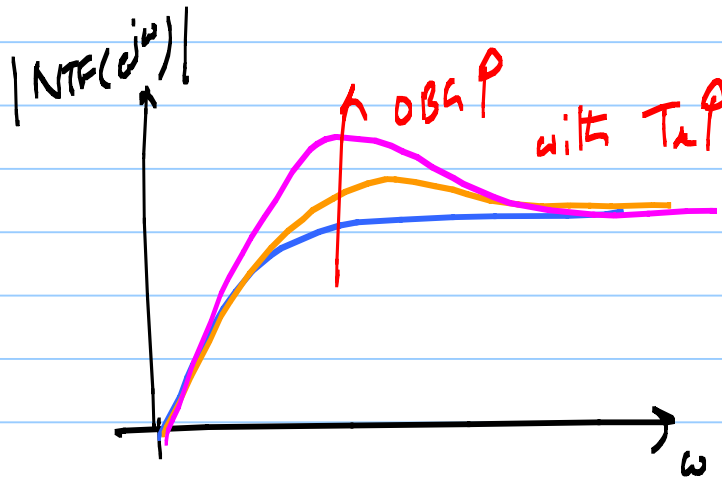
$$NTF(z)\Big|_{z=1} \approx (1-z^{-1})$$

* poles of the NTF are at

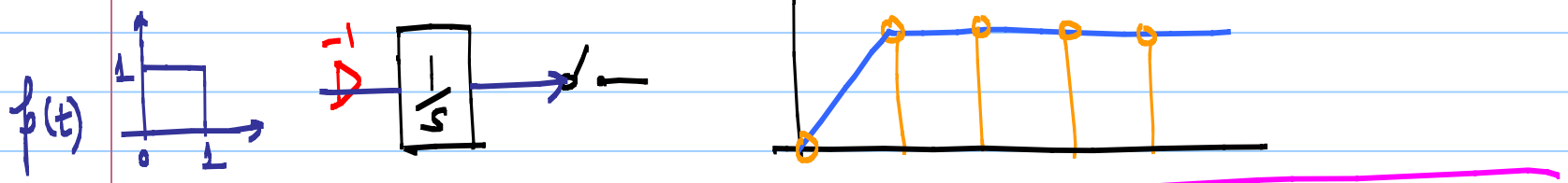
$$p_{1,2} = \frac{T_d \pm \sqrt{T_d^2 - 4T_d}}{2}$$

$= \frac{T_d}{2}\left[1 \pm \sqrt{1 - \frac{4}{T_d}}\right]$

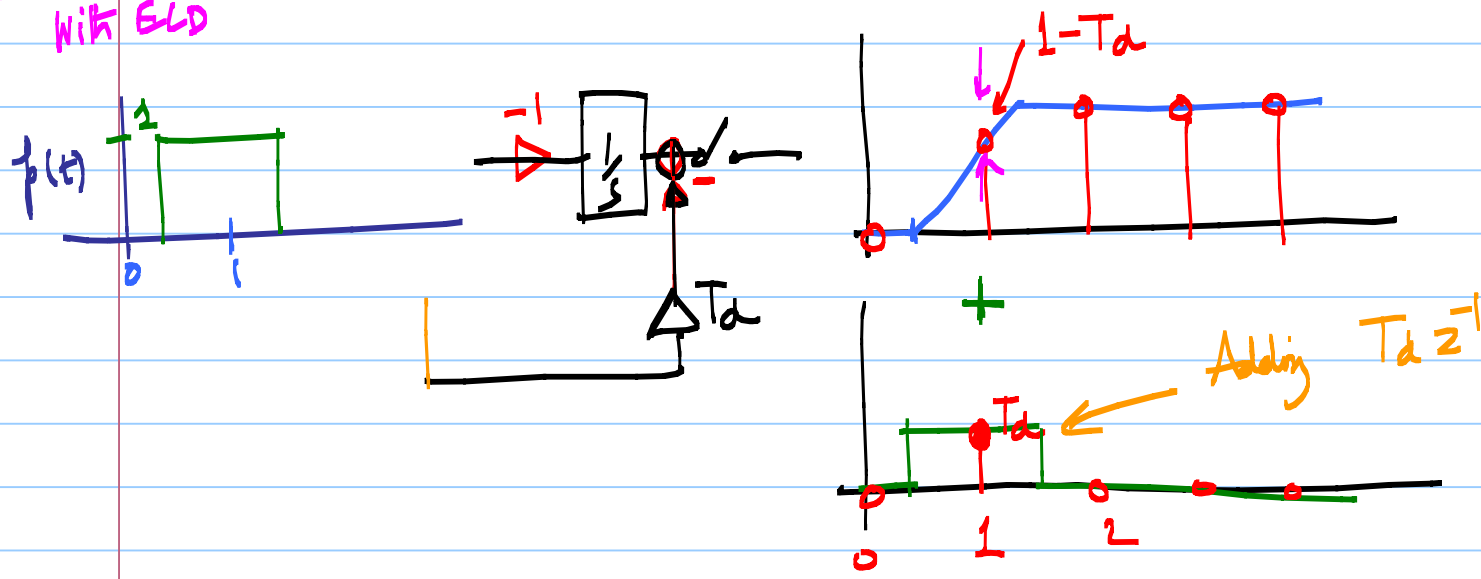




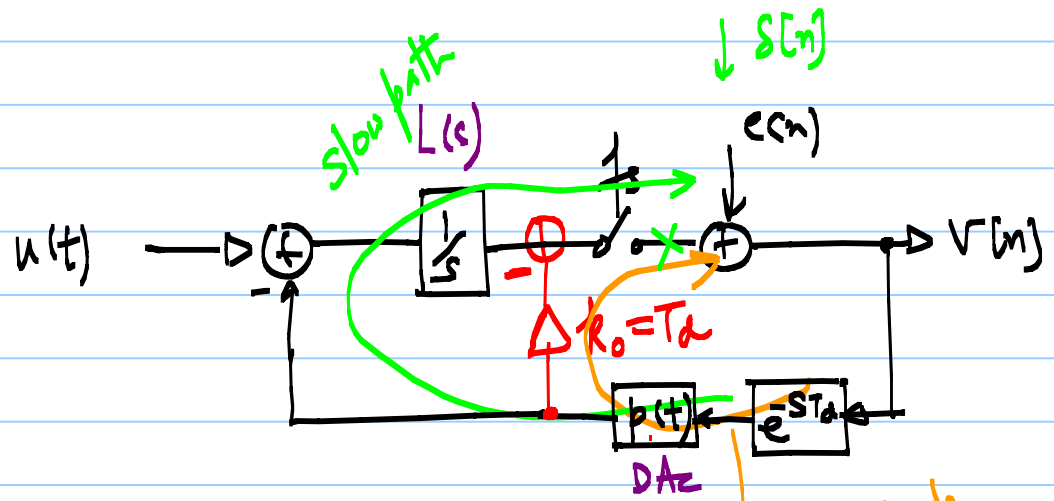
Ideal



With ELD



"ELD compensation scheme"

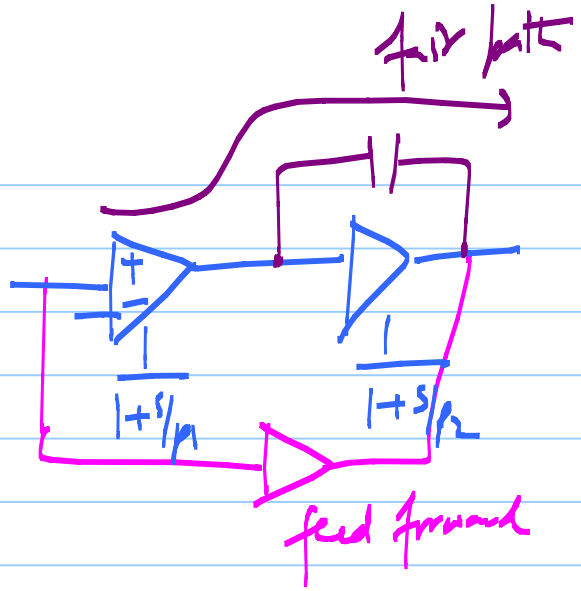


$$L(z) = \left(\frac{z^{-1}}{1-z^{-1}} - T_d z^{-1}\right) + T_d z^{-1} = \frac{z^{-1}}{1-z^{-1}} \Rightarrow$$

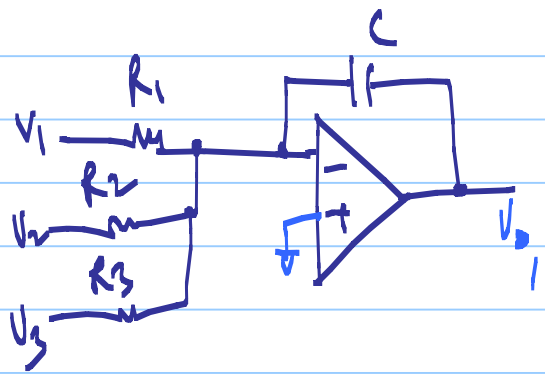
$L(z)$ is fixed

$\Rightarrow$ NTF is fixed

Aside



short loop ⇒ fast path



$$V_0 = \frac{1}{sC}\left[\frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3}\right]$$