Sistemas de controle II
Controle digital

$(RCs+1)(R_2C_2s+1)$

$(s+2) \rightarrow z\left(\frac{z}{2}+1\right)$

$RC = \frac{1}{2}$

$C = 1\mu$

$R = \frac{1}{2\mu} = \frac{10^6}{2}$

Equivalentes por mapeamento
Equivalentes por segurador
Especificações no plano Z
Controle PID digital
Diagramas de blocos de sistemas digitais

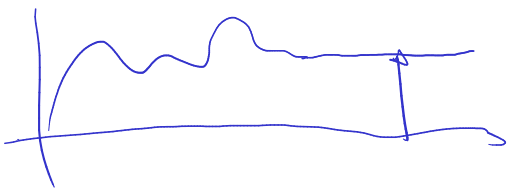
Teorema do valor final ($\mathcal{Z}$)

No domínio s

$Y(s) \rightarrow$ todos os polos no SPE

$$y(\infty) = \lim_{s \to 0} sY(s)$$

$z = e^{sT}$



$\frac{1}{Ys}$ $a^k u(k)$

$\frac{z}{z-1}$

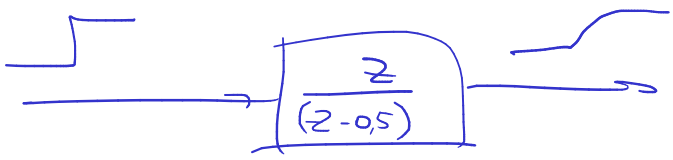
No discreto.

$$y[\infty] = \lim_{z \to 1} \frac{1}{z/z-1} Y(z)$$

$$= \lim_{z \to 1} \frac{z-1}{z} Y(z)$$

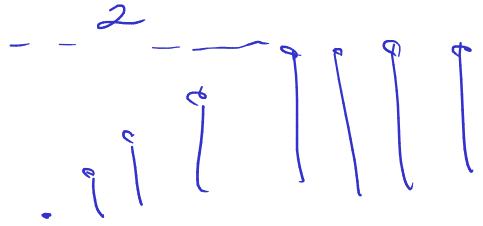
Para: $y = u[k]$

$$u[\infty] = \lim_{z \to 1} \frac{z+1}{z} \cdot \frac{z}{z+1} = 1$$



$\frac{z}{z-1}$ $\qquad Y(z) = \frac{z}{z-0,5} \cdot \frac{z}{z-1}$

$$y[\infty] = \lim_{z \to 1} \frac{z^{\cancel{2}}}{\cancel{(z-1)}(z-0,5)} \cdot \frac{\cancel{z-1}}{\cancel{z}} = \frac{1}{1-0,5} = 2$$



Ganho DC de um sistema:

G(s) sem integrados.

Ganho DC = G(0)

Ganho DC discreto → G(z)

→ G(1)

Analógico → Discreto.

$G(s)$ —Tustin→ $G(z)$

T período de amostragem

Equivalente discretos:

- Tustin
- Mapeamento
- ZOH

Para cada polo/zero calcule um polo ou zero correspondente z usando $z = e^{sT}$

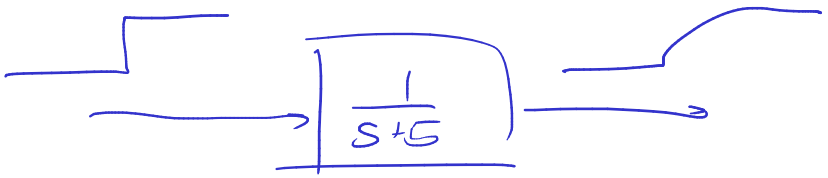
EX:

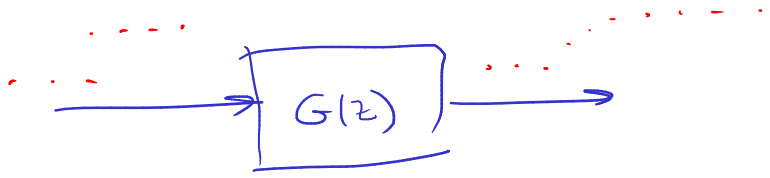
$$G(s) = \frac{1}{s+5} \Rightarrow \hat{G}(z) = ?$$

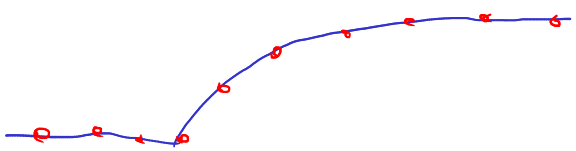
$T = 0,2$

$s = -5 \longrightarrow z = e^{-5 \cdot 0,2} = e^{-0,5} \approx 0,6065$

$$\tilde{G}(z) = \frac{k}{z - 0,6065}$$







Igualar os ganhos DC.

Ganho DC Analógico =

" " discreto.

$$G(0) = \hat{G}(1)$$

$$\frac{1}{0+5} = \frac{k}{1-0,6065}$$

$$k = \frac{1-0,6065}{5} \simeq 0,0787$$

$$\hat{G}(z) = \frac{0,0787}{z-0,6065}$$

Ex: $G(s) = \frac{10(s+1)}{s(s+3)}$ $\quad T = 0,1$

$$\hat{G}(z) = \frac{k(z-a)}{(z-b)(z-c)} \qquad (z+1)$$

$$z = e^{sT}$$

$$a = e^{-1 \cdot 0,1} = e^{-0,1} = 0,905$$

$$b = e^{-0,1 \cdot 0} = 1$$

$$c = e^{-0,1 \cdot 3} = e^{-0,3} = 0,741$$

$$\hat{G}(z) = \frac{k(z-0,905)}{(z-1)(z-0,741)}$$

Ganho sist. tipo 1: $\lim_{s \to 0} sG(s)$

$$= \cancel{s} \cdot \frac{s+1}{\cancel{s}(s+3)}\bigg|_{s=0} = \frac{1}{3}$$

Ganho DC do discreto:

$$\lim_{z \to 1} (z-1)\hat{G}(z) = \cancel{(z-1)} \frac{k(z-0,905)}{\cancel{(z-1)}(z-0,741)}$$

$$= \frac{k(1-0,905)}{1-0,741}$$

$$\frac{k(1-0,905)}{1-0,741} = \frac{1}{3} \Rightarrow k \approx 0,909$$

$$\hat{G}(z) = \frac{0,909(z-0,905)}{(z-1)(z-0,741)}$$