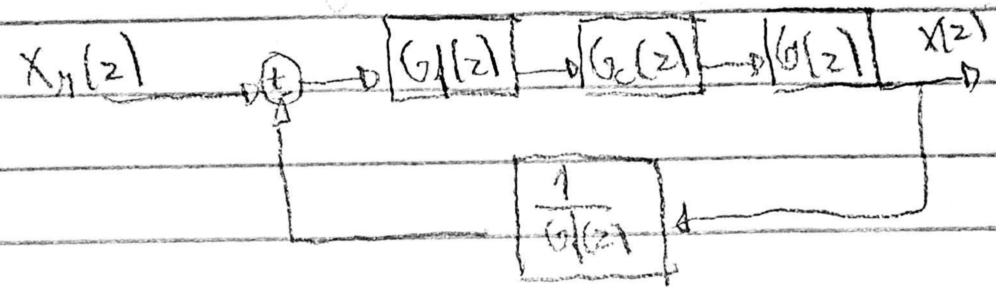
3) $G(s) = \frac{50}{40s-1} = \frac{1,25}{s-0,025}$ $\quad T = 10s$ $\quad e_{ss} = 0$

$M_p = 0,1$

$n = 15$

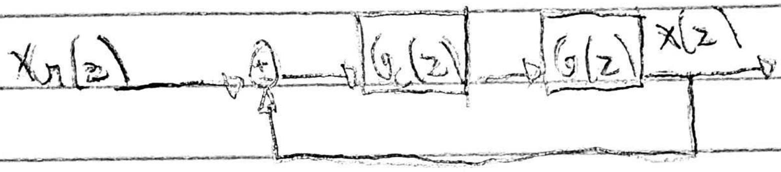
$G_f(z) = 1$

a)



Como $G_f(z) = 1$

$\Downarrow$



Sendo $G(z) = Z(G_{H0}(s) \cdot G(s)) = (1-z^{-1}) \cdot Z\left(\frac{G(s)}{s}\right) = (1-z^{-1}) \cdot Z\left(\frac{1,25}{s(s-0,025)}\right)$

$\frac{1,25}{s(s-0,025)} = \frac{A}{s} + \frac{B}{s-0,025} \Rightarrow A = -50 \quad B = 50$

$Z\left(\frac{1,25}{s(s-0,025)}\right) = \frac{-50z}{z-1} + \frac{50z}{z-1,284} \Rightarrow \frac{z-1}{z}\left(\frac{-50z}{z-1} + \frac{50z}{z-1,284}\right) \Rightarrow$

$G(z) = \frac{14,2}{z-1,284}$ e $G_c(z) = \frac{K_c(z-z_c)}{(z-1)}$ para $e_{ss} = 0$ em degrau

Como $n = 15 \Rightarrow n = \frac{2\pi}{\omega_d T} \Rightarrow 15 = \frac{2\pi}{\omega_d 10} \Rightarrow \omega_d = \frac{2\pi}{150}$ $\quad \omega_d = \omega_n\sqrt{1-\zeta^2} \Rightarrow \sqrt{1-\zeta^2} = \frac{2\pi}{150\omega_n}$

$M_p = e^{-\zeta\pi/\sqrt{1-\zeta^2}} \Rightarrow$ substituindo $\sqrt{1-\zeta^2} = \frac{2\pi}{150\omega_n} \Rightarrow M_p = e^{-\zeta\omega_n 75} = 0,1$, log nos dois lados

$2,3026 = 75\zeta\omega_n \Rightarrow \zeta\omega_n = 0,0307$

Logo $\zeta w_n = 0{,}0307$ e $w_d = \frac{2\pi}{150}$

Como $z = e^{sT} = e^{-\zeta w_n T} \cdot e^{j w T \sqrt{1-\zeta^2}} \Rightarrow e^{-0{,}307} \cdot e^{j\frac{2\pi}{15}}$

$\Downarrow$

$|z| = 0{,}7357$ $\Rightarrow z = 0{,}6721 + 0{,}2993j$

$\angle z = 0{,}4189 \text{ rad}$

Como $G_c(z) \cdot G(z) = \frac{14{,}2 K_c (z - z_c)}{(z-1)(z-1{,}284)}$

$\angle G_c(z) \cdot G(z) = \phi_{zc} - 180 + \operatorname{atan}\left(\frac{0{,}2993}{1 - 0{,}6721}\right) - 180 + \operatorname{atan}\left(\frac{0{,}2993}{1{,}284 - 0{,}6721}\right)$

$\angle G_c(z) G(z) = \phi_{zc} - 137{,}6108 - 153{,}9353$

$= \phi_{zc} - 291{,}5461 = -180$

$\phi_{zc} = 111{,}5461$

$\Downarrow$

$\phi_{zc} = 180 - \operatorname{atan}\left(\frac{0{,}2993}{z_c - 0{,}6721}\right) \Rightarrow 111{,}5461 - 180 = -\operatorname{atan}\left(\frac{0{,}2993}{z_c - 0{,}6721}\right)$

$68{,}4539 = \operatorname{atan}\left(\frac{0{,}2993}{z_c - 0{,}6721}\right)$, tan nos dois lados

$-2{,}5327 = \frac{0{,}2993}{z_c - 0{,}6721} \Rightarrow z_c = 0{,}7903$

Logo $G_c(z) G(z) = \frac{14{,}2 K_c (z - 0{,}7903)}{(z-1)(z-1{,}284)}$

$|G_c(z) G(z)| = 1 \Rightarrow \left|\frac{14{,}2 K_c (z - 0{,}7903)}{(z-1)(z-1{,}284)}\right|_{z = 0{,}6721 + 0{,}2993j} = 1$

$\frac{14{,}2 K_c \cdot 0{,}3218}{0{,}444 \cdot 0{,}6812} = 1 \Rightarrow K_c = 0{,}0662$

Logo $G_c(z) = 0{,}0662 \cdot \left(\frac{z - 0{,}7903}{z - 1}\right)$

Controle Digital - Questao 3 - P1

João Viktor de Carvalho Mota - 160127823

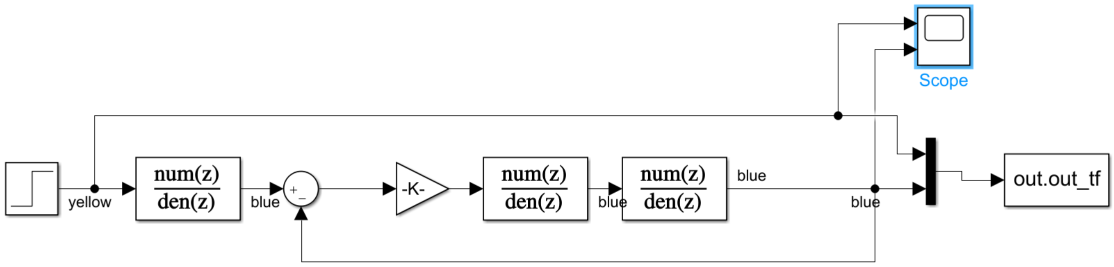
1

1.

$$G = \frac{14.2}{(z - 1.1284)} \tag{1}$$

$$Gc = \frac{0.0662 * (z - 0.7903)}{(z - 1)} \tag{2}$$

$$Gf = \frac{1}{1} \tag{3}$$



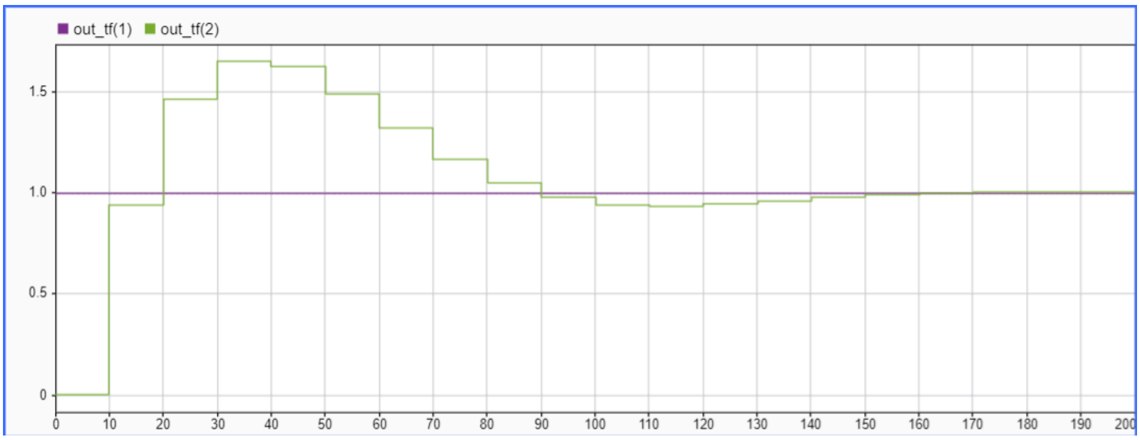
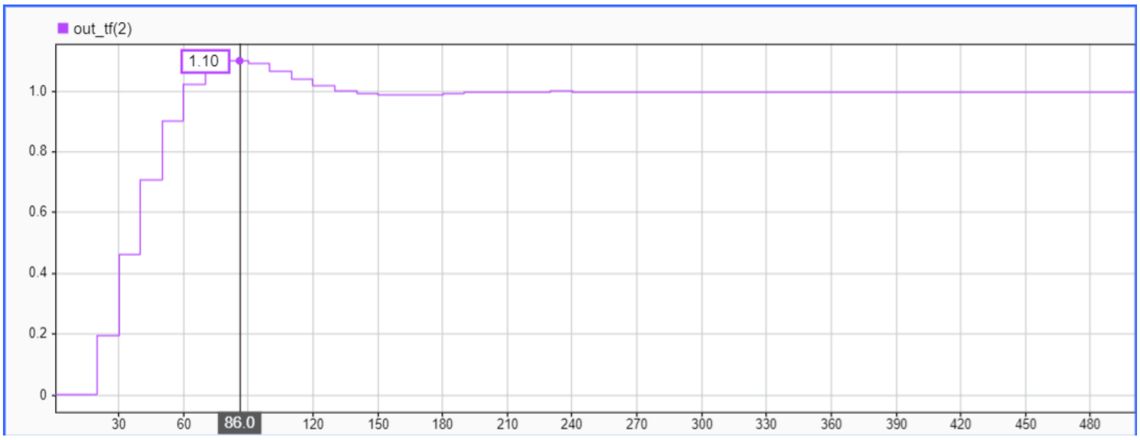


Figure 1. gf=1

Colocando

$$Gf = \frac{1}{4.78 * (z - 0.7903)} \tag{4}$$

,isso é,um polo com mesmo valor do meu zero calculado para cortar e um ganho para ter valor estacionário igual a 1.



out_tf(2)
1.10
1.0
0.8
0.6
0.4
0.2
0
30
60
86.0
120
150
180
210
240
270
300
330
360
390
420
450
480