(11) $G_1(s) = \dfrac{0,2}{s^2+0,2s}$ (Polos = 0 e −0,2)

$M_s = 0,16$ $t_s = 11s$ $T_s = 1s$

degrau → $e_\infty = 0$

rampa → $e_\infty = 0,02$ rad

$$G(s) = \frac{Y(s)}{U(s)} = \frac{0,2}{s(s+0,2)}$$

$$0,16 = e^{\frac{-\xi\pi}{\sqrt{1+\xi^2}}} \rightarrow \ln(0,16) = \frac{-\xi\pi}{\sqrt{1+\xi^2}} \rightarrow \xi = 0,7182$$

$$t_s = \frac{4}{\sigma} \rightarrow 11 = \frac{4}{\sigma} \rightarrow \sigma = 2,75 \rightarrow \xi\omega_n = 2,75 \rightarrow \omega_n = 3,829 \text{ ra}$$

$$G_1(z) = (1-z^{-1})\mathcal{Z}\left\{\frac{G_1(s)}{s}\right\} = (1-z^{-1})\mathcal{Z}\left\{\frac{0,2}{s^2(s+0,2)}\right\}$$

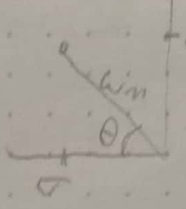
$$G_1(z) = \frac{\cancel{(1-z^{-1})}}{0,2} \cdot \frac{[(0,2-1+e^{-0,2}) + (1-e^{-0,2}-0,2e^{-0,2})z^{-1}]z^{-1}}{(1-z^{-1})^2(1-e^{-0,2}z^{-1})}$$

$$G_1(z) = 5\,\frac{[0,01873 + 0,01752\cdot z^{-1}]\,z^{-1}}{(1-z^{-1})(1-0,8187\cdot z^{-1})}$$

$$G_1(z) = \frac{0,09365\,z^{-1} + 0,0876\,z^{-2}}{(1-z^{-1})\cdot(1-0,8187\,z^{-1})}$$

polos de G(s) compensado é:

Polos $= -2,75 \pm j2,6584$



$\sigma = \xi\omega_n = 2,75$

$\omega_n = 3,829$

$\omega_n \cos\theta = \sigma \rightarrow \theta = \cos^{-1}\left(\frac{\sigma}{\omega_n}\right) = 44,1°$

$\omega_d = \omega_n \operatorname{sen}(\theta) = 2,6584$

Utilizando a ferramenta rltools chegamos na seguinte função transferencia

$$G_c(s) = \frac{s+1,4}{s+8} \rightarrow G_c(z) = \frac{0,03292\,z^2 + 0,0009556\,z - 0,002\ldots}{z^3 - 1,819z^2 + 0,8193z - 0,0002747}$$

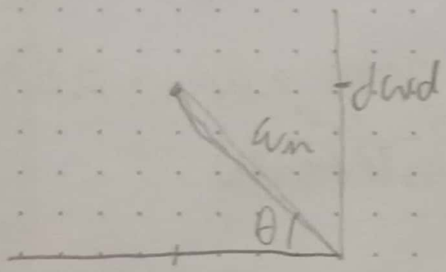
5) a) $\frac{5}{s(s+0,3)}$, $T = 1s$

$s^2+0,3s+0 \to 0, -0,3$, $\xi = 1$

Definindo

$T_s = 3s$ e $\xi = 0,5$

$T_s = \frac{4}{\xi w_n} \to \frac{3}{4} = \frac{1}{0,5 w_n} \to w_n = \frac{4}{3} \cdot \frac{1}{0,5} = 2,667$ rad/s



$\sigma = \xi w_n$

- $\sigma = 1,335$
- $\theta = \cos^{-1}\left(\frac{\sigma}{w_n}\right) = 60°$
- $w_d = w_n \cdot \operatorname{sen}(\theta) = 2,3097$

$: -1,335 \pm j2,3097$

Com a ferramenta RLTool conseguimos o $G_c(s)$

$G_c(s) = K \cdot \frac{(s-3)}{(s+4,25)}$, $K = -0,37$

$G_f(s) = G_2(s) \cdot G_c(s) = \frac{5K(s-3)}{s(s+0,3)(s+4,25)}$

$= \frac{A}{s} + \frac{B}{s+0,3} + \frac{C}{s+4,25}$

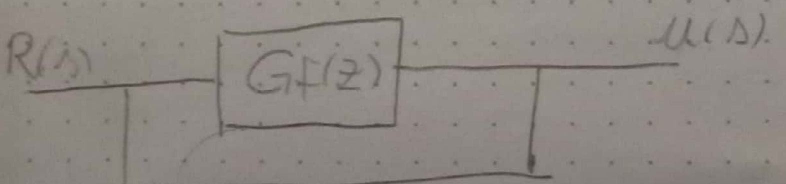
$A = -\frac{15K}{1,275} = -11,765K = 4,35305$

$B = \frac{6,105}{-1,185} = -5,1519$

$C = \frac{13,4125}{16,7875} = 0,79896$

$G_1(s) = \frac{4,35305}{s} - \frac{5,1519}{s+0,3} + \frac{0,7984}{s+4,25}$

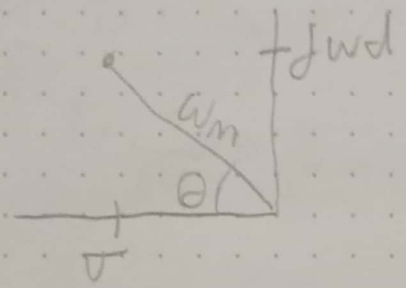
$$G_f(z) = \frac{0,08732 z^2 + 0,905 z + 0,1198}{z^3 - 1,755 z^2 + 0,7656 z - 0,01057}$$



b) $\frac{10}{s(s+1)(s+3)} = \frac{10}{s(s^2+4s+3)} = \frac{10}{s^3+4s^2+3s}$

definindo $\xi = 0{,}5$ $t_s = 3s$

$3 = \frac{4}{\xi w_n} \rightarrow w_n = \frac{4}{3}\frac{1}{\xi} = \frac{4}{6} = 0{,}667$ rad/s



- $\sigma = \xi w_n = 0{,}33\overline{3}$
- $\theta = \cos^{-1}\left(\frac{\sigma}{w_n}\right) = 60°$
- $w_d = w_n \cdot \operatorname{sen}(\theta) = 0{,}577$

Polos $= -\frac{1}{3} \pm j\,0{,}577$

Pelo rltool chegamos em

$G_c(s) = k\frac{(s+3{,}7)}{(s+2{,}29)}$, $k = 0{,}0912$

c) $\frac{1}{s^4+15{,}4s^3+56s^2+20s}$

def $\Rightarrow \xi = 0{,}5$ $t_s = 3s$

polos $\rightarrow -1{,}335 \pm j2{,}3097$

$G_c(s) = k\frac{s}{s+7{,}72}$, $k = 644{,}8428$

$G_c(z) = \frac{644{,}8z - 644{,}8}{z - 0{,}0004439}$