



Curso de Engenharia Eletrônica

Unidade Curricular: Sistemas de controle II (SCT22108)

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Avaliação 01

Questão 01 – a)

RAYAN M. STEINBACH

Q01 a)

$$G(s) = \frac{1}{s+1} \rightarrow G(z) = \frac{0,1393z^{-1}}{1-0,8607z^{-1}} = \frac{0,1393}{z-0,8607} \quad \left| \quad G_c(z) = K_c \frac{z+\alpha}{z+\beta} \right.$$

$$G(s)H(s) = \frac{1}{s(s+1)} \rightarrow GH(z) = \frac{0,010708(z^{-1}+0,9512z^{-2})}{(1-z^{-1})(1-0,8607z^{-1})} = \frac{0,010708(z+0,9512)}{(z-1)(z-0,8607)}$$

$$s_1 = -\zeta\omega_n + j\omega_n\sqrt{1-\zeta^2} = -1,75 + j1,7853 \quad | \quad T_s = 0,15s$$

$$z_1 = e^{(s_1 T_s)} = 0,7417 + j0,2035$$

COMO $(z+\alpha)$ CANCELA O POLO DE $G(z)$, $\alpha = -0,8607$

CONSIDERANDO $FTMA = K_c C(z)G(z)H(z) = K_c \cdot G_1(z)G_2(z)$, ONDE

$$G_1(z) = \frac{1}{z+\beta} \quad \text{e} \quad G_2(z) = (z+\alpha)GH(z) = \frac{0,010708(z+0,9512)}{(z-1)}$$

$$G_2(z_1) = -0,0392 - j0,0393$$

$$\phi_2 = \angle G_2(z_1) = -134,94^\circ \rightarrow \phi_1 = -180 - \phi_2 = -45,09^\circ$$

$$\beta = \frac{\text{Imag}(z_1) - \text{Real}(z_1) \tan(\phi_1)}{\tan(\phi_1)} = \boxed{-0,5388}$$

$$|FTMA(z_1)| = 1 \rightarrow K_c |C(z_1)G(z_1)H(z_1)| = 1 \rightarrow K_c = \frac{1}{|C(z_1)G(z_1)H(z_1)|} \rightarrow \boxed{K_c = 5,1754}$$



Questão 01 – b)

Q01 | b)

BLOCO C | $\frac{U(z)}{E(z)} = \frac{5,175 - 4,455z^{-1}}{1 - 0,5388z^{-1}}$

$$[1 - 0,5388z^{-1}]U(z) = [5,175 - 4,455z^{-1}]E(z)$$

$$\boxed{\mu(k) = 5,175e(k) - 4,455e(k-1) + 0,5388\mu(k-1)}$$

BLOCO G | $\frac{C(z)}{U(z)} = \frac{0,1393z^{-1}}{1 - 0,8607z^{-1}} \rightarrow [1 - 0,8607z^{-1}]C(z) = 0,1393z^{-1}U(z)$

$$\boxed{c(k) = 0,1393\mu(k-1) + 0,8607c(k-1)}$$

BLOCO GH | $\frac{V(z)}{U(z)} = \frac{0,01071z^{-1} + 0,01019z^{-2}}{1 - 1,861z^{-1} + 0,8607z^{-2}}$

$$\boxed{v(k) = 0,01071\mu(k-1) + 0,01019\mu(k-2) + 1,861v(k-1) - 0,8607v(k-2)}$$

Questão 01 – c)

$$K_v = \lim_{z \rightarrow 1} \frac{z-1}{zT} FTMA = \lim_{z \rightarrow 1} \frac{z-1}{zT} \cdot \frac{0,055418(z+0,9512)}{(z-0,5388)(z-1)}$$

$$K_v = \lim_{z \rightarrow 1} \frac{0,055418(z+0,9512)}{0,15z(z-0,5388)} = \frac{0,055418(1,9512)}{0,15(0,4612)} = 1,563$$

$$\boxed{e_{ss} = \frac{1}{K_v} \cdot 100\% = \frac{1}{1,563} \cdot 100\% = 63,98\%}$$