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ECM303 - Sistemas de Controle

P1:

$G_p(s) = \frac{1}{s(s+3)}$; $G_c(s) = K_p$

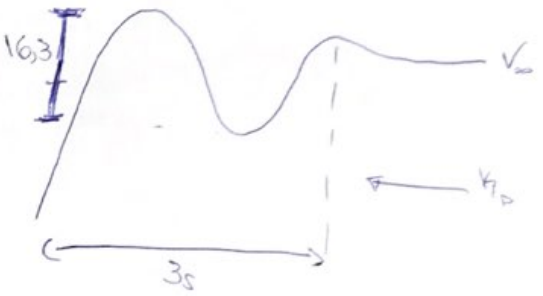
(Processo / Controlador)

↓

Desempenho: $M_p \leq 16{,}3\%$

$M_p = \left(e^{-\zeta\pi/\sqrt{1-\zeta^2}}\right)100$

$T_{s\,5\%} = 3s$



P2: $\ddot{y} - \dot{y} + \sqrt{y} = u$ ... não linear

y: saída

u: entrada

. Qual relação $\left.\frac{\Delta Y(s)}{\Delta U(s)}\right|_{Y_0=1}$

. Sistema é estável?

$e^{-\zeta\pi/\sqrt{1-\zeta^2}} = 0{,}163$

$-\frac{\zeta\pi}{\sqrt{1-\zeta^2}} = \ln(0{,}163)$

$+\frac{\zeta\pi}{\sqrt{1-\zeta^2}} = +1{,}814$

$\frac{(\zeta\pi)^2}{1-\zeta^2} = 3{,}291$

$\zeta^2\pi^2 = 3{,}291 - 3{,}291\zeta^2$

$(\pi^2 + 3{,}291)\zeta^2 = 3{,}291$

$\zeta^2 = \frac{3{,}291}{\pi^2 + 3{,}291}$

$\zeta = \sqrt{0{,}25} = 0{,}5$

$T_{s\,5\%} = \frac{3}{\zeta\omega_n} = 3s$

$\omega_n = 2$

$G_{MA}(s) = G_p(s)\cdot G_c(s) = \frac{K_p}{s^2+3s}$

$G_{MF}(s) = \frac{G_{MA}}{1+G_{MA}} = \frac{\frac{K_p}{s^2+3s}}{1+\frac{K_p}{s^2+3s}}$

$G_{MF}(s) = \frac{K_p}{s^2+3s+K_p}$

G_{MF} = 2^{a} FORMA CANÔNICA

$$\frac{K_p}{s^2+3s+K_p} = \frac{\omega_n^2}{s^2+2\zeta\omega_n s+\omega_n^2}$$

T_s(DESEJADO) = 3SEG

T_s(REAL)

$3 = 3\zeta\omega_n$

$3 = 2\cdot 0{,}5\,\omega_n$

$\omega_n = 3$

$\omega_n^2 = K_p = 9$

$$T_s = \frac{3}{\zeta\omega_n} = \frac{3}{0{,}5\cdot 3} = 2\,\text{SEG}$$

$$G_{MF} = \frac{9}{s^2+3s+9}\ (\text{REAL}) \qquad G_{MF} = \frac{4}{s^2+2s+4}\ (\text{DESEJADO})$$

$$\ddot{y} - \dot{y} + \sqrt{y} = u$$

$$\sqrt{y} = \sqrt{y_0} + \frac{1}{2\sqrt{y_0}}(y - y_0)$$

$$s^2Y(s) - sY(s) + \left[\ \right] = U(s)$$

$$\dot{\sqrt{y}} = \dot{\sqrt{y_0}} + \frac{\dot{y}}{2\sqrt{y_0}} - \frac{\dot{y}_0}{2\sqrt{y_0}}$$

$$s^2Y(s) - sY(s) + \sqrt{y_0} + \frac{\Delta Y(s)}{2\sqrt{y_0}} = U(s)$$

P/ EQUILÍBRIO: $0 = \dot{y} \rightarrow u_0 = \sqrt{y_0} = 1$

$$\left(s^2 - s + \frac{1}{2}\right)Y(s) + 1 = U(s)$$

$$\left(s^2 - s + \frac{1}{2}\right)\Delta Y(s) = (U - U_0)$$

$$\frac{\Delta Y(s)}{\Delta U(s)} = \frac{1}{s^2 - s + 0{,}5}$$

$\Delta U(s)$

$s^2 - s + 0{,}5 = 0$

$$\Delta = \frac{1 \pm \sqrt{1 - 4\cdot 0{,}5}}{2} = \frac{1 \pm \sqrt{1-2}}{2}$$

$s = \frac{1+i}{2}$ → INSTÁVEL

OU

$s = \frac{1-i}{2}$ → INSTÁVEL

SISTEMA INSTÁVEL → PÓLOS À DIREITA