EA721 - P2 - 2s2003

① $G_1(s)$ = tabela

MG: 3.51 dB
MF: 11.43° ⇒ estável pois MG e MF são positivos

b) $K_0 \approx j\omega G_1(j\omega)$

$G_1(j\omega) = \frac{K_0}{j\omega}$ ⇒ $20\log|G_1(j\omega)| = 20\log K_0 - 20\log\omega$ ⇒

$25.96 = 20\log K_0 - 20\log .0.1$ ⇒ $25.96 = 20\log K_0 + 20$ ⇒ $\log K_0 = \frac{25.96-20}{20}$

$K_0 = 1,98$

) Projeto avanço MF=45

$\phi_m = 45 - 11.43 = 33.57 + 5° = \boxed{38.57°}$ objetivo

$K = K_c\alpha$

b) $P(s) = \frac{K_c\alpha(Ts+1)}{\alpha Ts+1} \cdot G_1(s) = \frac{(Ts+1)}{(\alpha Ts+1)} \cdot \underbrace{K_c\alpha G_1(s)}_{G_2(s)}$

- Como não foi pedido nenhuma mudança nas constantes de erro, faz-se $K = K_c\alpha = 1$

$\text{sen } 38.57° = \frac{1-\alpha}{1+\alpha}$ ⇒ $0.623(1+\alpha) = 1-\alpha$ ⇒ $\alpha(0.623+1) = 1-0623$ ⇒ $\alpha = 0.232$

$\omega_m = \frac{1}{T\sqrt{\alpha}}$

Mag do centro em ω_m: $20\log\frac{1}{\sqrt{\alpha}} = 2.05$ dB

$G_1(j\omega)|_{dB} = -2.05$ ⇒ $\omega_c = 1.41$ rad/s

$\omega_m = \omega_c = \frac{1}{T\sqrt{\alpha}} = 1.41$ ⇒ $T = \frac{1}{1.41\sqrt{0.232}} = 1.47$

zero: $\frac{1}{T} = 0.679$

polo: $\frac{1}{\alpha T} = 2.92$

$K_c = \frac{1}{\alpha} = 4.31$ $\quad C(s) = \frac{K_c\alpha(Ts+1)}{(\alpha Ts+1)} = \frac{K_c\alpha T(s+1/T)}{\alpha T(s+1/\alpha T)} = \frac{K_c(s+1/T)}{(s+1/\alpha T)} = \frac{4.31(s+0.679)}{(s+2.92)}$

EA721 - P2 - 1s 2003

② $P(s) = \frac{1}{s^2}$ MF: 45° ±5°

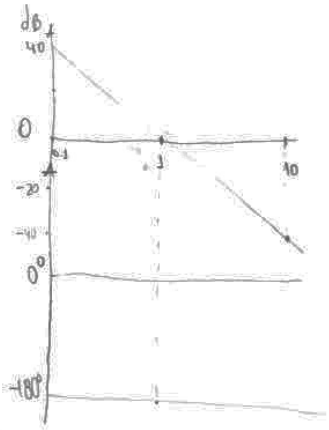
freq cruz = $\omega = 1$ rad/s MF = 180+180 = 0°

$\phi_m = 50°$

$\alpha = \frac{1-\text{sen}50}{1+\text{sen}50} = 0.132$

Mag. contro. em ω_m: $20 \log \frac{1}{\sqrt{\alpha}} = 8.77$ dB

$|P(j\omega)|_{dB} = -8.77$ dB



$|P(j\omega)| = \frac{1}{\omega^2} = \sqrt{\alpha} \Rightarrow \omega^2 = \frac{1}{\sqrt{\alpha}} \Rightarrow \omega = \sqrt{\frac{1}{\sqrt{\alpha}}} = 1.657$ rad/s

$\omega_m = \omega_c = 1.657$ rad/s $= \frac{1}{T\sqrt{\alpha}} \Rightarrow T\sqrt{\alpha} \cdot 1.657 = 1 \Rightarrow T = \frac{1}{1.657\sqrt{\alpha}} = 1.657$

zero $= \frac{1}{T} = 0.603$

polo $= \frac{1}{\alpha T} = 4.55$

$C(s) = \frac{7.57(s+0.603)}{(s+4.55)}$

$K_c \alpha = 1 \Rightarrow K_c = \frac{1}{\alpha} = 7.57$

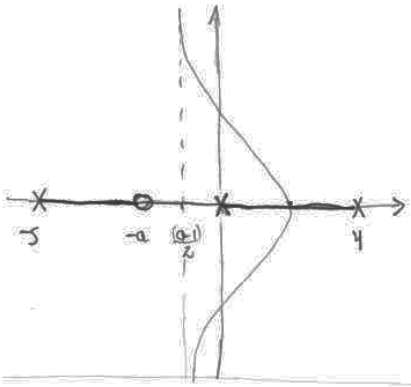
③ $C(s) = K(1 + a/s)$ $P(s) = \frac{1}{(s+5)(s-4)}$ $K\left(1+\frac{a}{s}\right) = \frac{(s+a)K}{s}$

$C(s)P(s) = K\frac{(s+a)}{s(s+5)(s-4)}$ $n=3$ $m=2$ $n-m=2$

assin: +90, -90

$\sigma_a = \frac{-5+4+a}{2} = \frac{a-1}{2} \Rightarrow < 0$ se $a < 1$

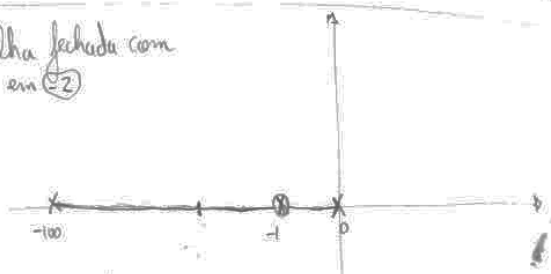
Quando $K \to \infty$, é estável se $a < 1$



④ $C(s) = K_P + K_D s$ $P(s) = \frac{100}{s(s+1)(s+100)}$

Sistema em malha fechada com pólo dominante em -2

$C(s)P(s) = \frac{K_D(s + K_P/K_D).100}{s(s+1)(s+100)} = \frac{K_D 100(s+1)}{s(s+1)(s+100)}$



$\frac{K_P}{K_D} = 1 \Rightarrow K_P = K_D$

$\left|\frac{K_D 100(s+1)}{s(s+1)(s+100)}\right| = 1 \Rightarrow K_D \cdot 100(-1) = \frac{100 K_D}{196} = 1$

$s = -2$ $-2(-1)\,98$ $\Rightarrow K_D = \frac{196}{100} = 1.96$

EA721 - P2 - 2s2003

⑤

⑥ $P(s) = \frac{0.15}{s(s+1)(s+5)}$ $C(s) = K$

$n = 3$ $m = 0$ $n - m = 3$ Assint: $+60, -60, 180$

$\sigma_a = \frac{0 - 1 - 5}{3} = \frac{-6}{3} = -2$

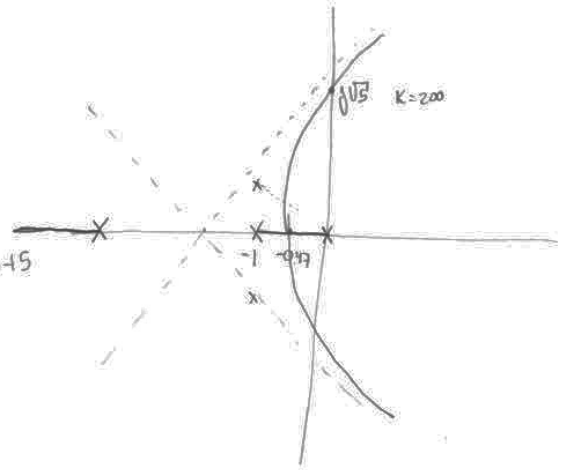
$D'N - DN' = 0$

$D = (s^2+1)(s+5) = s^3 + 5s^2 + s^2 + 5 = s^3 + 6s^2 + 5$, $D' = 3s^2 + 12s + 5$

$N(s) = 0.15$ $N' = 0$

$(3s^2 + 12s + 5)\,0.15 = 0 \Rightarrow s_1 = -3.52$

$s_2 = -0.47$



$D(j\omega) + KN(j\omega) = (j\omega)^3 + 6(j\omega)^2 + 5j\omega + 0.15K = 0$

$= -j\omega^3 - 6\omega^2 + 5j\omega + 0.15K = 0$

$= (0.15K - 6\omega^2) + j(5\omega - \omega^3) = 0$ ±0

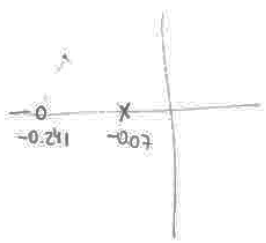
$0.15K = 6\omega^2 \Rightarrow K = \frac{6 \cdot 5}{0.15} = 200$

$5\omega = \omega^3 \Rightarrow \omega^2 = 5 \Rightarrow \omega = \pm\sqrt{5}$

)- $\angle(-1+j) - 90 - \angle(-1+j+5) = -\angle(-1+j) - 90 - \angle(4+j) = -135 - 90 - 14.03 = -239°$

$\angle G(s) - 239 = -180 = 59°$

)- $C(s) = \frac{1.45s + 0.35}{s + 0.07} = \frac{1.45(s + 0.241)}{(s + 0.07)}$



Atraso

$c(0) = 5$

$c(\infty) = 1.45$