Primera practica calificada de Ingeniería de Control II

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fecha: 03/05/11

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problema (1)

$$G_p(s) = \frac{1}{s(s+2)}$$, hallar kp, kd

* $W_n = 0,5$

* $\xi = 0,7$

sabemos que PD

$$G_c(s) = k_d\left(s + \frac{k_p}{k_d}\right)$$

$$z = \frac{k_p}{k_d}$$

$$\boxed{G_c(s) = k_d(s+z)}$$

$$\Rightarrow G(s) = G_c(s) \cdot G_p(s)$$

$$G(s) = k_d(s+z) \cdot \frac{1}{s(s+2)}$$

$$G(s) = \frac{k_d(s+z)}{s(s+2)}$$

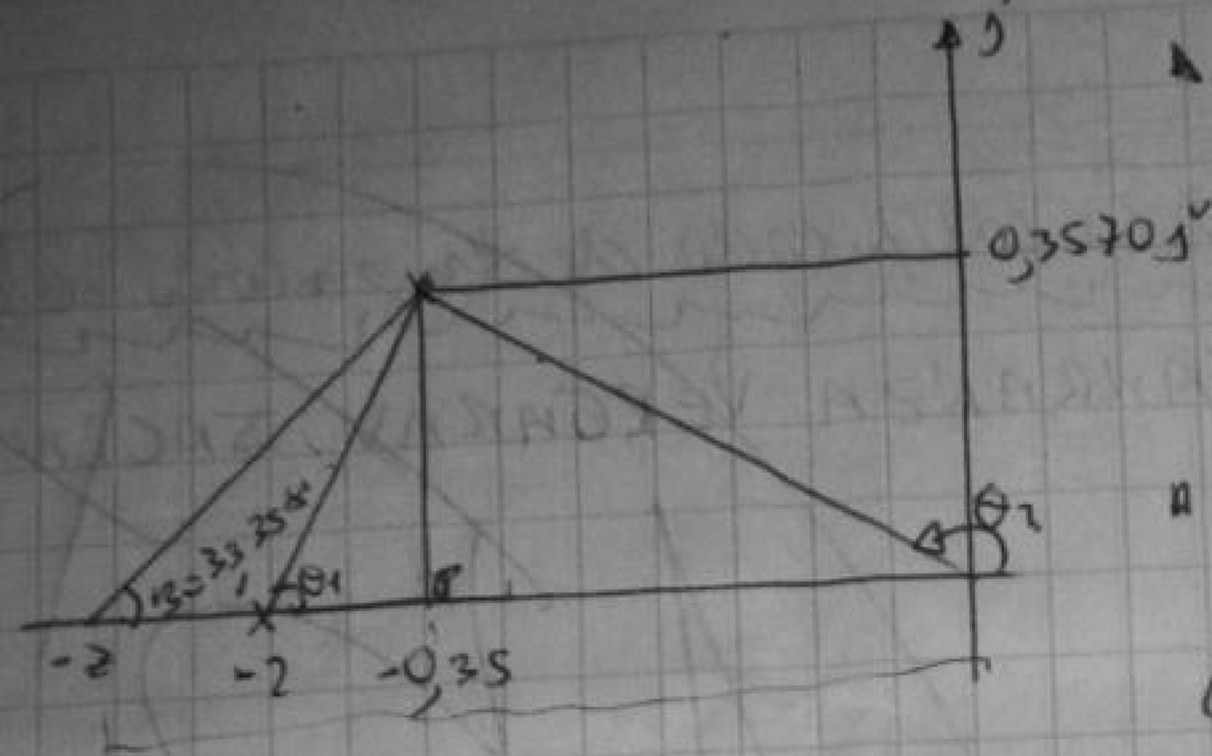
hallando: $s = -\sigma + wj$

* $\sigma = \xi W_n = 0,5 \cdot 0,7 \Rightarrow \boxed{\sigma = 0,35}$

* $W = W_n\sqrt{1-\xi^2} = 0,5\sqrt{1-0,7^2} \Rightarrow \boxed{W = 0,3570}$

Finalmente tenemos: $s = -0,35 + 0,3570j$

polos: $-z, 0, -2$



$180 - \theta_2 = \operatorname{arctg}\left(\frac{0,3570}{0,35}\right)$

$180 - \theta_2 = 45,5672$

$\theta_2 = 134,4328°$

$\theta_1 = \operatorname{arctg}\left(\frac{0,3570}{1,65}\right)$

$\theta_1 = 12,2085°$

$\Rightarrow \beta - \theta_1 - \theta_2 = 180°$

$\beta - 12,2085° - 134,4328° = 180°$

$\beta = 326,6413$

$\beta = 33,3585$

$\Rightarrow \tan(33,3585) = \dfrac{0,3570}{z - 0,35} = 0,6583 \Rightarrow z - 0,35 = 0,5423$

$z = 0,8923$

$\Rightarrow G_c(s) = K_d(s + 0,8923)$

$G(s) = \dfrac{K_d(s+0,8923)}{s(s+2)}$, $|G(s)| = 1$, $s = -0,35 + 0,3570j$

$$\left| \frac{K_d(s+0,8923)}{s(s+2)} \right|_{s=-0,35+0,3570j} = 1$$

$$\left| \frac{K_d(0,5423 + 0,3570j)}{(-0,35+0,3570j)(1,65+0,3570j)} \right| = 1$$

$$\frac{K_d\sqrt{0,5423^2 + 0,3570^2}}{\sqrt{0,35^2+0,3570^2} \cdot \sqrt{1,65^2+0,3570^2}} = 1$$

$K_d = 1,2999$

$z = \dfrac{K_p}{K_d} \Rightarrow 0,8923 = \dfrac{K_p}{1,2999} \Rightarrow K_p = 1,1599$

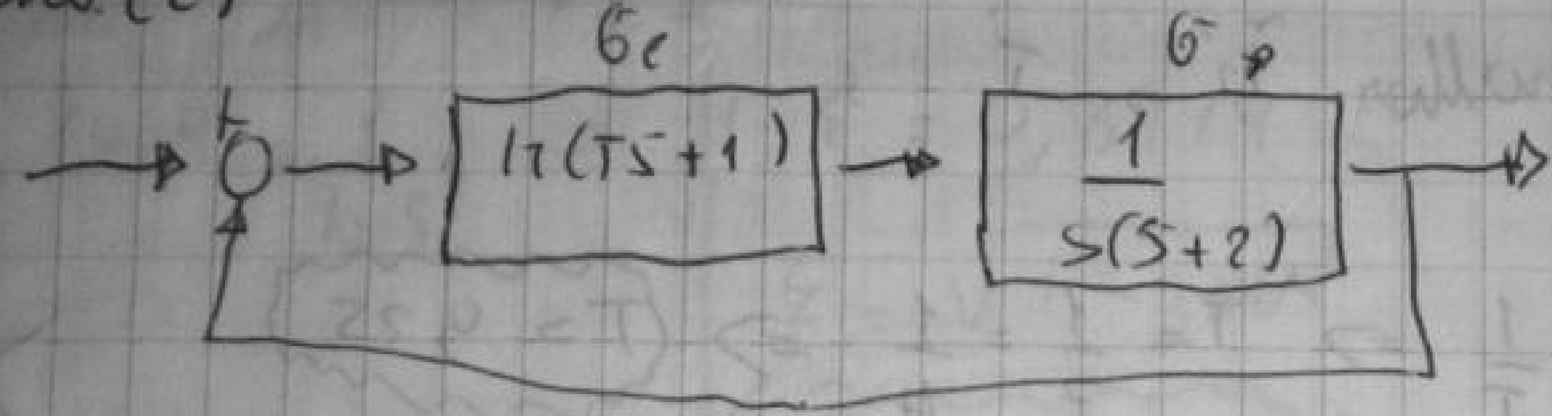
$G_c(s) = 1,2444\,(S + 0,8923)$

$K_d = 1,2444$

$K_p = 1,1542$

Rpt.

problema (2)



$S = -2 \pm 2j$

$\Rightarrow G_c(s) = K(TS+1) = KT\left(S + \frac{1}{T}\right)$, $K' = KT$; $z = \frac{1}{T}$

$G_c(s) = K'(S+z)$

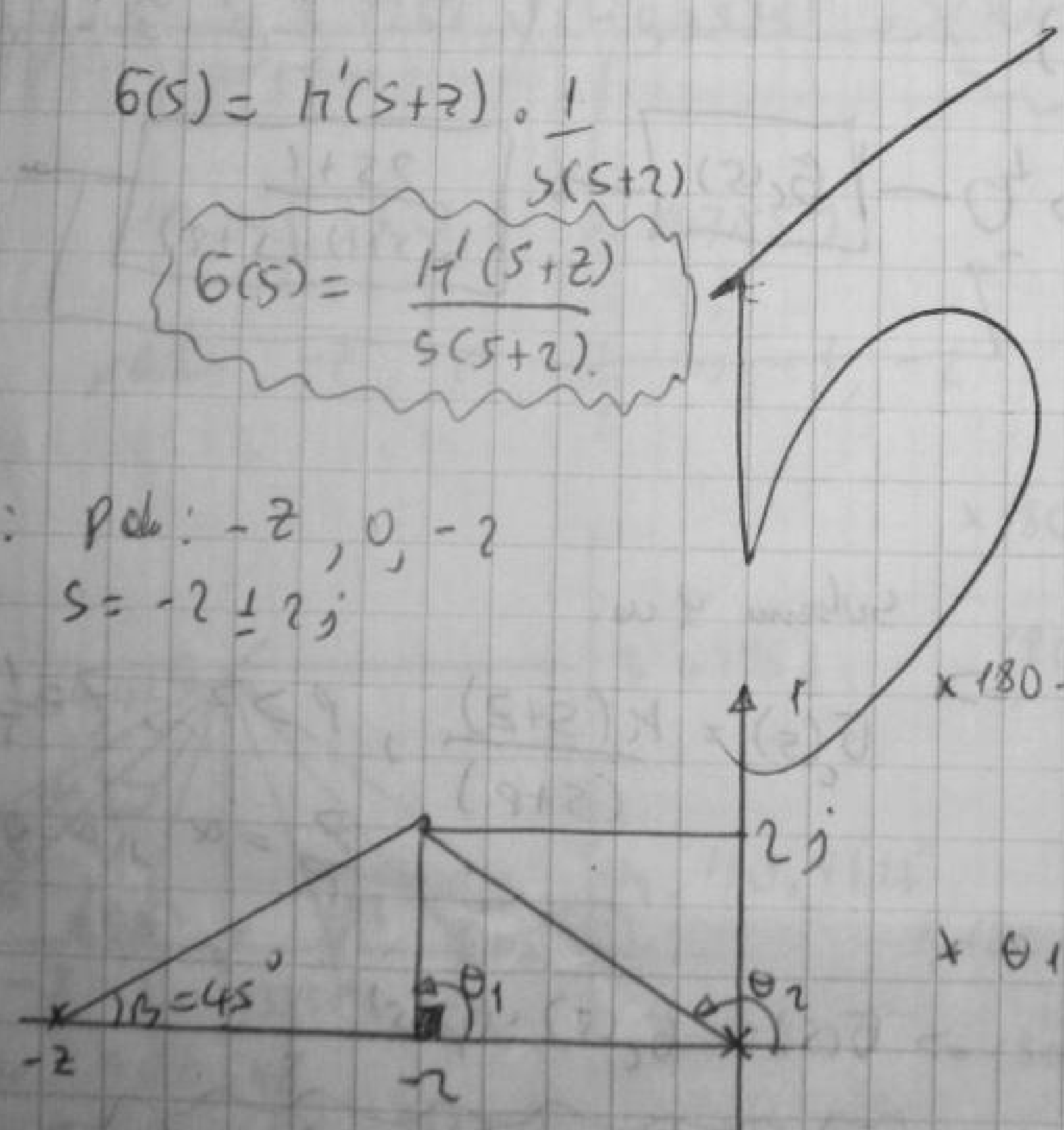
$G(s) = G_c(s) \cdot G_p(s)$

$G(s) = K'(S+z) \cdot \frac{1}{S(S+2)}$

$G(s) = \frac{K'(S+z)}{S(S+2)}$

Los polos: polos: $-z$, 0, -2

$S = -2 \pm 2j$



$\measuredangle\ 180 - \theta_2 = \arctan\left(\frac{2}{2}\right) = 45$

$\theta_2 = 135°$

$\measuredangle\ \theta_1 = 90°$

$\beta - \theta_1 - \theta_2 = 180°$

$\beta - 90 - 135° = 180$

$\beta = 405$

$\beta = 45°$

$\tan(45°) = \frac{2}{z-2} = 1$

$z = 4$

$G_c(s) = K'(S+4)$

$G(s) = \frac{K'(S+4)}{S(S+2)}$, $|G(s)| = 1$

$$\left|\frac{h'(s+4)}{s(s+2)}\right|_{s=-2+2j} = 1 \Rightarrow \left|\frac{h'(2+2j)}{(-2+2j)(2j)}\right| = 1$$

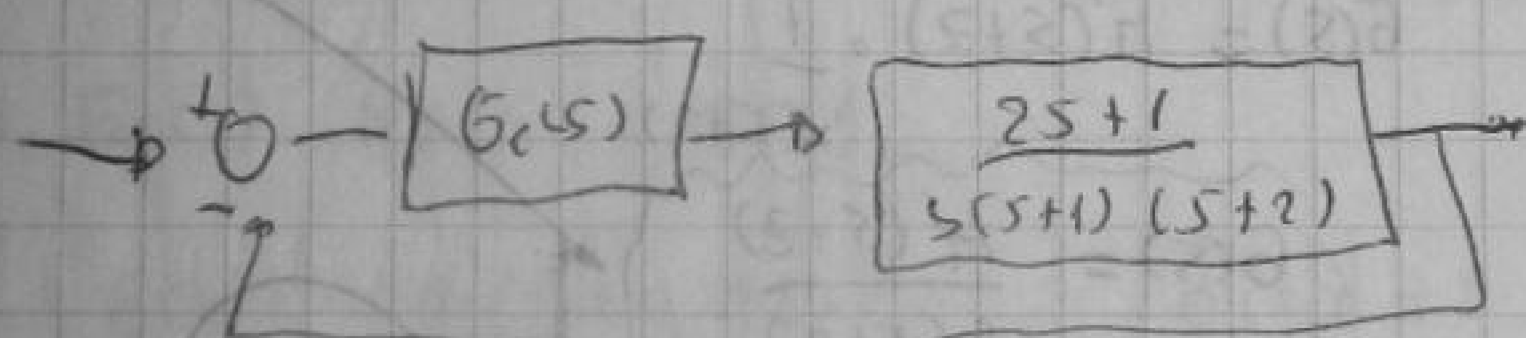
$$\frac{h'\sqrt{4+4}}{\sqrt{4+4}\cdot\sqrt{4}} = 1 \Rightarrow \boxed{h' = 2}$$

y i den hallar h', T

- $z = \frac{1}{T} \Rightarrow T = \frac{1}{z} = \frac{1}{4} \Rightarrow \boxed{T = 0{,}25}$
- $h' = hT \Rightarrow 2 = h \cdot 0{,}25 \Rightarrow \boxed{h = 8}$

$$\boxed{G(s) = \frac{2(0{,}25s+1)}{s(s+2)}}$$

problema (3)



$Ts = 3$

$mp = 30\%$

sabemos q ue:

$$\Rightarrow G_c(s) = \frac{k(s+z)}{(s+p)}, \quad p > z, \quad z = \frac{1}{T}, \quad p = \frac{1}{\alpha T}$$

$$\frac{z}{p} = \alpha, \quad \alpha = 0{,}1 \Rightarrow \boxed{p = 10z}$$

$$\Rightarrow G(s) = G_c(s) \cdot G_p(s)$$

$$\boxed{G(s) = \frac{k(s+z)(2s+1)}{(s+p)\, s(s+1)(s+2)}}$$

$$\Rightarrow Ts = 3 = \frac{4}{\sigma} = \frac{4}{\xi W_n} \Rightarrow \boxed{\xi W_n = 1{,}3333}$$

$$W_n = \frac{1{,}3333}{0{,}3579}$$

$$\boxed{W_n = 3{,}7253}$$

$Mp = 30\% = e^{\frac{-\xi\pi}{\sqrt{1-\xi^2}}} = 0,3$

$\ln(0,3) = \frac{-\xi\pi}{\sqrt{1-\xi^2}}$

$-1,2039 = -\frac{\xi\pi}{\sqrt{1-\xi^2}} \Rightarrow (0,3837)^2 + 1 = \frac{\xi^2}{1-\xi^2} + 1$

$1,1469 = \frac{1}{1-\xi^2} \Rightarrow 1-\xi^2 = 0,8714$

$\xi = \sqrt{1-0,8714}$

$\xi = 0,3579$

$\Rightarrow$ hallando $s = -\sigma + Wj$

$\sigma = \xi W_n = 0,3579 \cdot 3,7253 \Rightarrow \sigma = 1,3333$

$W = W_n\sqrt{1-\xi^2} = 3,7253 \cdot \sqrt{1-0,3579^2} \Rightarrow W = 3,4785$

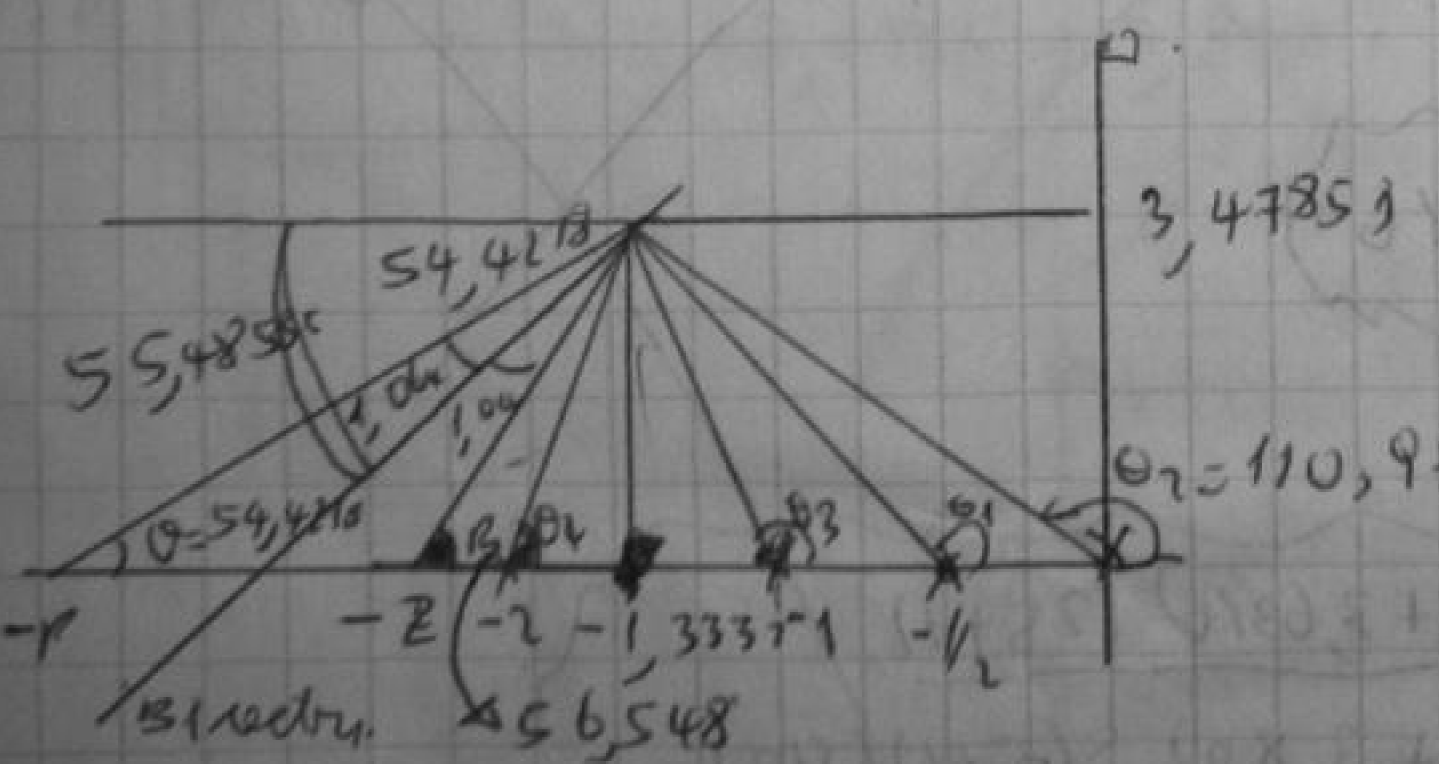
$s = -1,3333 + 3,4785j$

polos: $-z, -p, -\frac{1}{2}, 0, -1, -2$

$\times\ 180 - \theta_2 = \operatorname{arctg}\left(\frac{3,4785}{1,3333}\right)$

$180 - \theta_2 = 69,0283$

$\theta_2 = 110,9717^\circ$



$\times\ 180 - \theta_1 = \operatorname{arctg}\left(\frac{3,4785}{0,5}\right)$

$180 - \theta_1 = 81,8203$

$\theta_1 = 98,1797$

$\beta - \theta - \theta_1 - \theta_2 - \theta_3 - \theta_4 = 180$

$\beta - \theta - 98,1797 - 110,9717 - 95,474 - 79,15 = 180^\circ$ $\times\ 180 - \theta_3 = \operatorname{arctg}\left(\frac{3,4785}{0,3333}\right) = 84,5$

$\beta - \theta = 563,7754$

$\theta_3 = 95,474$

$\beta - \theta = 7,178^\circ$

$\cdot\ \theta_4 = \operatorname{arctg}\left(\frac{3,4785}{0,6667}\right)$

$\theta_4 = 79,1500$

$\Rightarrow \tan(54,4218) = \dfrac{3,4785}{P - 1,3333} = 1,3979$

$\boxed{P = 3,8216}$

$\Rightarrow \tan(56,548) = \dfrac{3,4785}{Z - 1,3333} = 1,5135$

$\boxed{Z = 3,6316}$

$G(s) = \dfrac{K(s+3,6316)(2s+1)}{(s+3,8216)\,s(s+1)(s+2)}$, $|G(s)| = 1$

$s = -1,3333 + 3,4785$

$$\left| \frac{K(s+3,6316)(2s+1)}{(s+3,8216)(s)(s+1)(s+2)} \right| = 1$$

$s = -1,333 + 3,4785j$

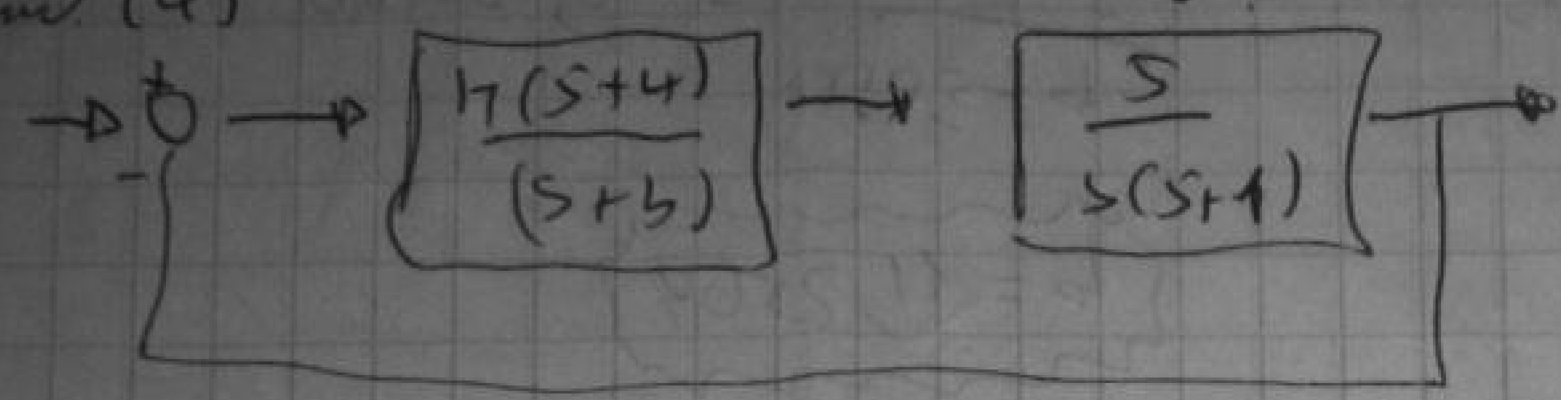
$$\left| \frac{K(2,2983+3,4785j)(-1,666+6,957j)}{(2,4883+3,4785j)(-1,333+3,4785j)(-0,3333+3,4785j)(0,6667+3,4785j)} \right|$$

$\boxed{K = 6,6116}$

$$\boxed{G(s) = \frac{6,6116(s+3,6316)(2s+1)}{(s+3,82)\,s(s+1)(s+2)}}$$

$$TS = \frac{\dfrac{6,6116(s+3,6316)(2s+1)}{(s+3,82)\,s(s+1)(s+2)}}{1 + \dfrac{6,6116(s+3,6316)(2s+1)}{(s+3,82)(s)(s+1)(s+2)}}$$

problema (4)



$T_s = 0,785$

$\xi = 0,8$

$G_c(s) = \frac{K(s+4)}{(s+6)}$; $G(s) = \frac{K(s+4)\,5}{(s+6)\,s(s+1)}$

$Z = 4$

hallando $s = -\sigma + Wj$

$0,785 = \frac{4}{\xi W_n} \Rightarrow \xi W_n = 5,0955 = \sigma$

$W_n = \frac{5,0955}{0,8} \Rightarrow W_n = 6,3693$

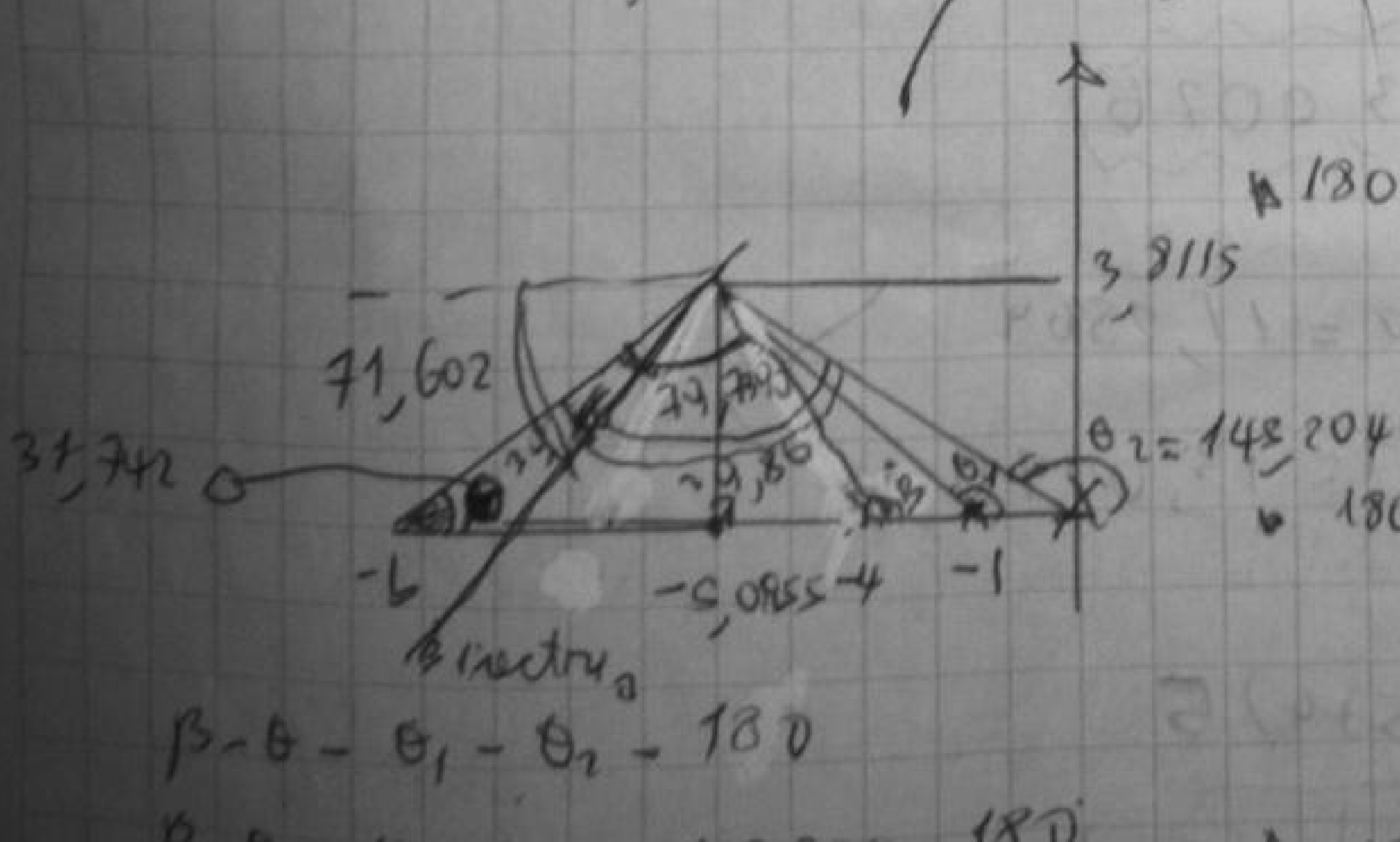
$W = W_n\sqrt{1-\xi^2} = 6,3693\sqrt{1-0,8^2} \Rightarrow W = 3,8215$

$\Rightarrow s = -5,0955 + 3,8215\,j$

Graficamos:

$s = -5,0955 + 3,8115\,j$

polo: $-4, -6, 0, -1$



$180 - \theta_2 = \arctan\left(\frac{3,8115}{5,0955}\right) = 36,796$

$\theta_2 = 143,204$

$180 - \theta_1 = \arctan\left(\frac{3,8115}{4,0955}\right) = 42,929$

$\theta_1 = 137,071$

$180 - \theta_3 = \arctan\left(\frac{3,8115}{1,0955}\right) = 73,964$

$\theta_3 = 106,030$

$\beta - \theta - \theta_1 - \theta_2 = 180$

$\beta - \theta - 137,057 - 143,204 = 180$

$\beta - \theta = 460,261$

$\beta - \theta = 79,730$

$\Rightarrow \tan(31,742) = \dfrac{3,8115}{b-5,0955} = 0,6186$

$$\boxed{b = 11,2564}$$

sokanr

$$\boxed{G_c = \frac{k(s+4)}{(s+11,2564)}}$$

$G(s) = \dfrac{k(s+4)\ 5}{(s+11,2564)(s)(s+1)}$, $|G(s)| = 1$

$s = -5,0955 + 3,8115j$

$$\left|\frac{k(s+4)s}{(s+11,2564)(s)(s+1)}\right|_{s=-5,0955+3,8115j} = 1$$

$$\left|\frac{k(5,4775+19,0575)}{(-5,0955+3,8115j)(-4,0955+3,8115j)(6,1614+3,8115j)}\right| = 1$$

$$\frac{k\sqrt{5,4775^2+19,0575^2}}{\sqrt{5,0955^2+3,8115^2}\sqrt{4,0955^2+3,8115^2}\sqrt{6,1614^2+3,8115^2}} = 1$$

$$\boxed{k = 13,0076}$$

peden Holl.

$b = 11,2564$

$k = 13,0076$

$$G(s) = \frac{13,0076(s+4)\,5}{(s+11,2564)\,s\,(s+1)}$$