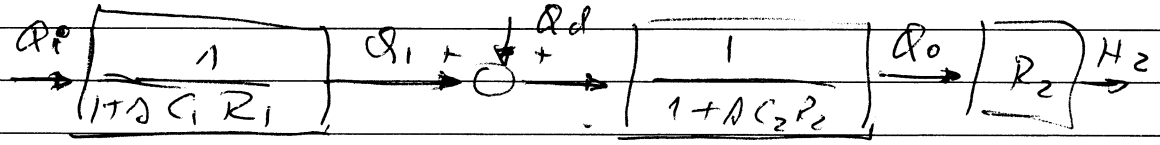
TESIS, Época Normal, 26-Junho-2010

1) $\begin{cases} q_i = q_1 + C_1 \dfrac{dh_1}{dt}, \quad \dfrac{h_1}{R_1} = q_1 \\ q_1 + q_d = q_0 + \dfrac{dh_2}{dt} \cdot C_2, \quad \dfrac{h_2}{R_2} = q_0 \end{cases}$

$\begin{cases} Q_i = Q_1 + s C_1 H_1, \quad H_1/R_1 = Q_1 \\ Q_1 + Q_d = Q_0 + s C_2 H_2, \quad H_2/R_2 = Q_0 \end{cases}$

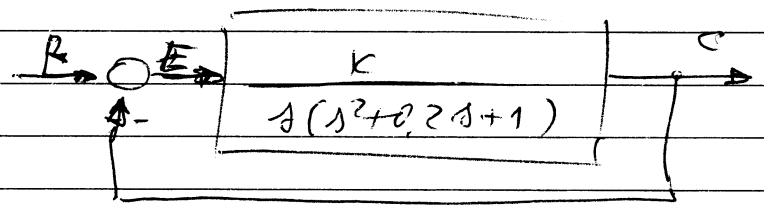
$Q_i = Q_1 + s C_1 R_1 Q_1$

$Q_1 + Q_d = Q_0 + s C_2 R_2 Q_0$



$$H_2 = \frac{R_2}{1+s C_2 R_2}\left(Q_d + \frac{1}{1+s C_1 R_1} Q_i\right)$$

2)



$s^2 + 0{,}2s + 1 = 0 \rightarrow s = -0{,}1 \pm j\,0{,}995$

- centróide $= \dfrac{0 - 0{,}1 - 0{,}1}{3} = -\dfrac{0{,}2}{3} = -0{,}066 = \sigma_0$
- assíntotas $= \pm 180° \; e \pm 60°$
- ângulo de partida $-\dfrac{\pi}{2} - \left(+\pi - \text{arctg}\dfrac{0{,}995}{0{,}1}\right) - \theta = -\pi$

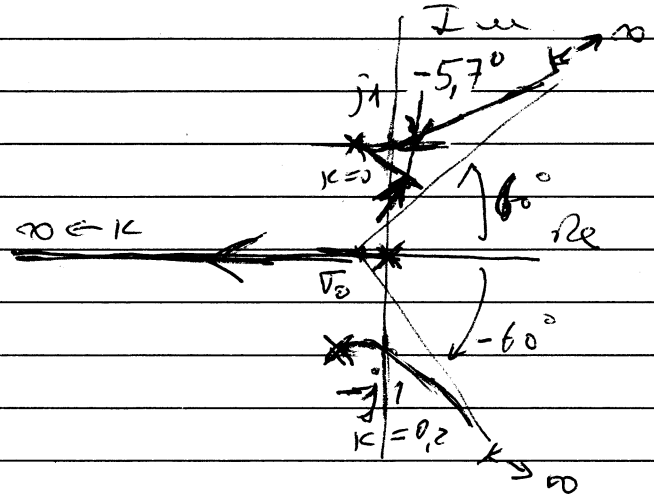
$\theta = -1{,}7 + 1{,}470\,6 = 0{,}9 \text{ rad} = 5{,}74 \text{ graus}$

s^3	1	1	
s^2	0,2	K	
s^1	$\frac{0{,}2 - K}{0{,}2}$	$\rightarrow 0{,}2 - K > 0$	
s^0	K	$\rightarrow K > 0$	
		$0 < K < 0{,}2$	

$$\frac{\dfrac{K}{s(s^2+0{,}2s+1)}}{1 + \dfrac{K}{s(s^2+0{,}2s+1)}} = \frac{K}{s^3 + 0{,}2s^2 + s + K}$$

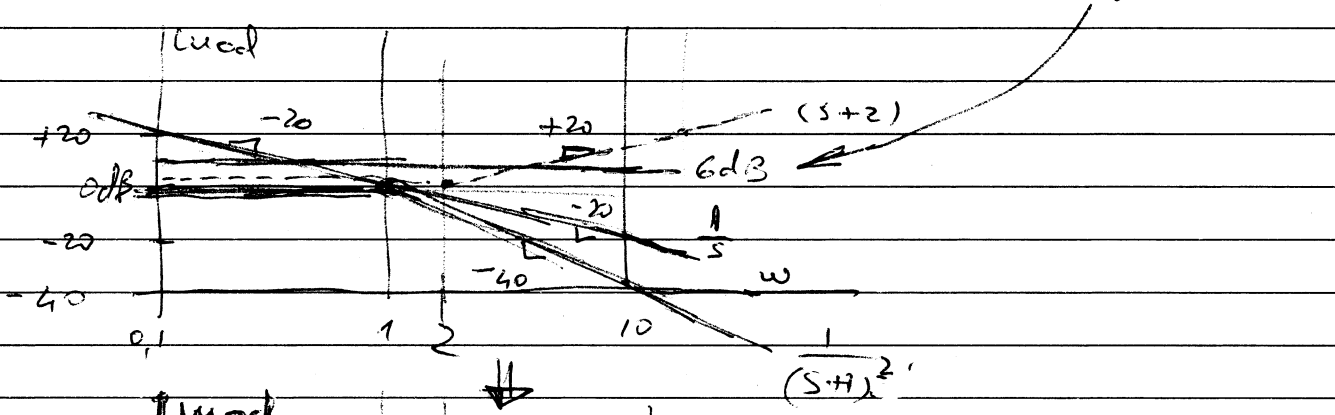
para $K = 0{,}2$ vem $0{,}2s^2 + 0{,}2 = 0 \Rightarrow s = \pm j$

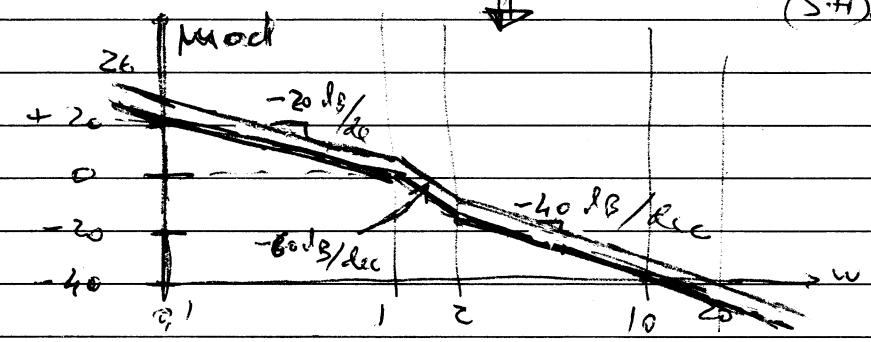
2

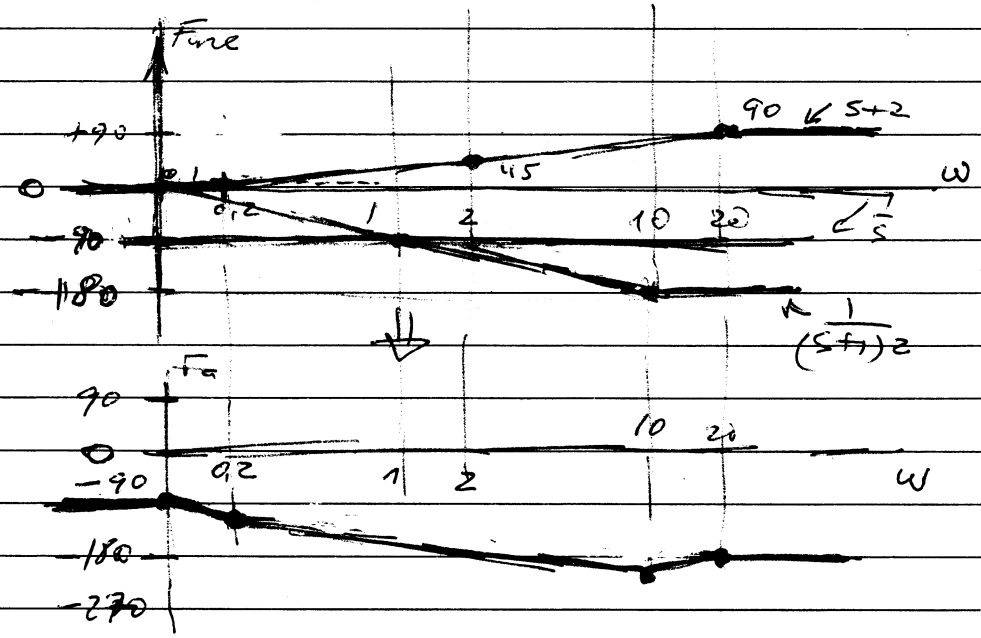


3) $G(s) = \dfrac{s+2}{s(s+1)^2} = 2\,\dfrac{\frac{s}{2}+1}{s(s+1)^2}$

$20\log_{10} 2 = 6dB$

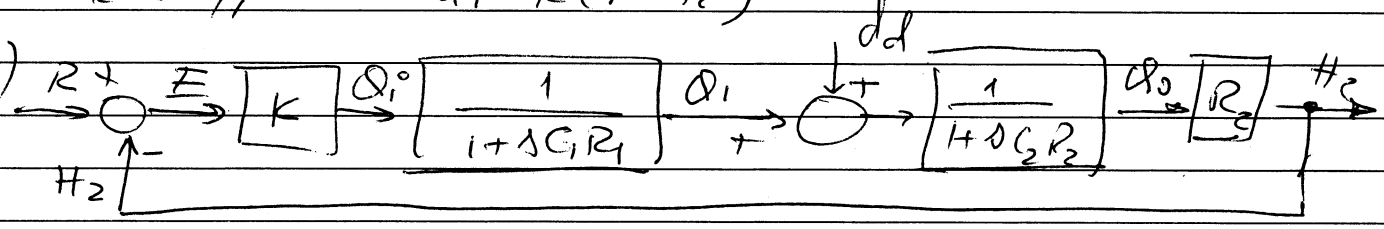






4) $r - h_2 = e$
$k\,e = q_i$ $\Rightarrow$ $Q_i = k(r - H_2)$

4a)



4b)

$$\frac{H_2}{Qd} = \frac{(1+sC_1R_1)R_2}{(1+sC_1R_1)(1+sC_2R_2)+kR_2} = \frac{\frac{R_2}{1+sC_2R_2}}{1+k\frac{1}{1+sC_1R_1}\frac{R_2}{1+sC_2R_2}}$$

$$Qd = \frac{1}{s}$$

$$H_2 = \frac{(1+sC_1R_1)R_2}{(1+sC_1R_1)(1+sC_2R_2)+kR_2} \cdot \frac{1}{s}$$

$$h_2(\infty) = \lim_{s\to 0} s H_2(s) = \frac{(1+0)R_2}{(1+0)(1+0)+kR_2} = \frac{R_2}{1+kR_2}$$

4c)

$$(1+sC_1R_1)(1+sC_2R_2)+kR_2 = 0$$

$$s^2C_1C_2R_1R_2 + s(C_1R_1+C_2R_2) + 1 + kR_2 = 0$$

$$s^2 + s\frac{C_1R_1+C_2R_2}{C_1C_2R_1R_2} + \frac{1+kR_2}{C_1C_2R_1R_2} = 0$$

$$\omega_n = \sqrt{\frac{1+kR_2}{C_1C_2R_1R_2}} \qquad 2\zeta\omega_n = \frac{C_1R_1+C_2R_2}{C_1C_2R_1R_2}$$

$$\zeta = \frac{\frac{C_1R_1+C_2R_2}{C_1C_2R_1R_2}}{2\sqrt{\frac{1+kR_2}{C_1C_2R_1R_2}}} = \frac{C_1R_1+C_2R_2}{2\sqrt{1+kR_2}\sqrt{C_1C_2R_1R_2}}$$