

$$H = \frac{0,5}{s(s+3)}$$

$$C = k$$

$$X_s = \frac{1}{s} \text{ (degrau)}$$

$$\frac{X}{X_s} = \frac{CH}{1+CH} = \frac{\frac{0,5k}{s(s+3)}}{1 + \frac{0,5k}{s(s+3)}}$$

$$= \frac{\frac{0,5k}{s(s+3)}}{\frac{s(s+3) + 0,5k}{s(s+3)}} = \frac{0,5k}{s^2 + 3s + 0,5k}$$

$$\frac{E}{X_s} = \frac{1}{1+CH} = \frac{1}{\frac{s(s+3) + 0,5k}{s(s+3)}}$$

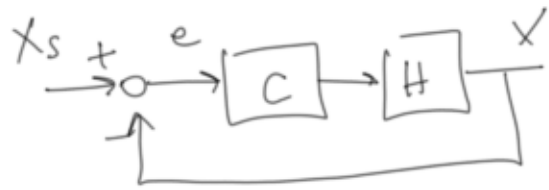
$$= \frac{s(s+3)}{s^2 + 3s + 0,5k}$$

$$\lim_{t \rightarrow \infty} e(t) = \lim_{s \rightarrow 0} sE(s)$$

$$\lim_{s \rightarrow 0} \cancel{s} \left(\frac{s^2 + 3s}{s^2 + 3s + 0,5k} \right) \frac{1}{\cancel{s}} = 0$$

$$\lim_{t \rightarrow \infty} e(t) = e_{ss} = 0$$

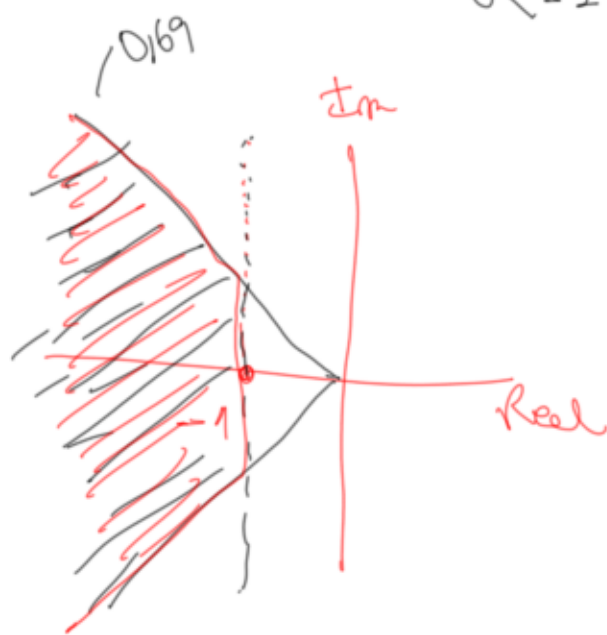
ne um k!



b) Amplitud modos

$$T_s = \frac{4}{\zeta \omega_n} \leq 4$$

$$\zeta \omega_n > 1$$



$$\sigma < -1$$

$$\frac{x}{x_0} = \frac{0,5k}{s^2 + 3s + 0,5k}$$

$$\frac{E}{x_0} = \frac{s^2 + 3s}{s^2 + 3s + 0,5}$$

$$\frac{k r \omega_n^2}{s^2 + 2\zeta \omega_n s + \omega_n^2}$$

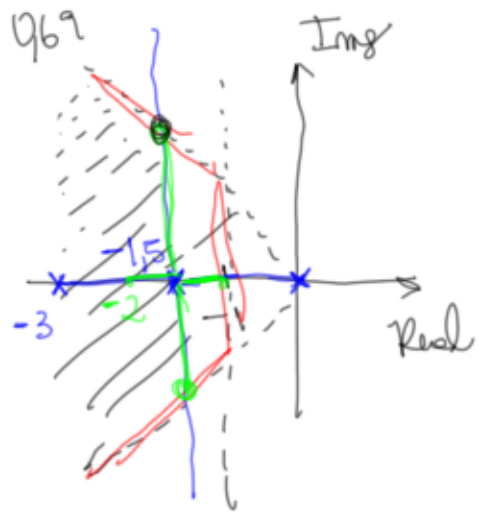
$$p_{1,2} = -\underbrace{\zeta \omega_n}_{\neq 0} \pm \sqrt{1 - \zeta^2} \omega_n i$$

c) $M_s = e^{-\left(\frac{\zeta \pi}{\sqrt{1 - \zeta^2}}\right)} = 0,05$

$$\frac{-\zeta \pi}{\sqrt{1 - \zeta^2}} = \ln(0,05) = -2,99$$

$$\frac{\zeta}{\sqrt{1 - \zeta^2}} = 0,95 \Rightarrow \frac{\zeta^2}{1 - \zeta^2} = 0,9025 \Rightarrow \zeta^2 = 0,9025 - 0,9025 \zeta^2$$

$$\zeta^2 = 0,48 \quad \zeta > 0,69$$



lugar das raízes
polos da MF

$$k=0 \quad \text{polos MF} = \text{polos MA}, \quad H = \frac{0,5}{s(s+3)} \quad \begin{cases} r_1 = 0 \\ r_2 = -3 \end{cases}$$

$$k = \infty \quad \text{polos MF} = \text{zeros MA}, \quad \begin{cases} z_1 = \infty \\ z_2 = \infty \end{cases}$$

MF: $\frac{0,5k}{s^2 + 3s + 0,5k} \Rightarrow s^2 + 3s + 0,5k = 0 \Rightarrow \frac{-3 \pm \sqrt{9 - 4 \cdot 0,5k}}{2}$

$$4 < k < 9,42$$

$p_1 = -1$ $\frac{-3 \pm \sqrt{9 - 2k}}{2} = -1 \Rightarrow \sqrt{9 - 2k} = 1 \Rightarrow 9 - 2k = 1 \Rightarrow k = 4$

$p = -1,5 \pm \sqrt{1 - 1,2} \omega_m i = -1,5 \pm 1,57i \parallel \frac{k \omega_m^2}{s^2 + 2,17 \omega_m s + \omega_m^2}$
 $-3 \omega_m \rightarrow -1,5 = -0,69 \omega_m$
 $\omega_m = 2,17 \text{ rad/s} \rightarrow \omega_m^2 = 0,5k \rightarrow k = 9,42 \text{ rad/s}$