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Disciplina: Sistema de Controle I

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Atividades Cap. 05

5.3)

$$\frac{C(s)}{R(s)} = \frac{\omega_n^2}{s^2 + 2\zeta\omega_n s + \omega_n^2}$$

$M_p = 5\%$

$= 0{,}05$

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

M_p ↑

Definindo um valor máximo para 5% de critério será $\zeta = 0{,}69$

Assim:

$$0{,}05 = e^{-(\zeta/\sqrt{1-\zeta^2})\pi}$$

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

$$-3 = -\left(\frac{\zeta\pi}{\sqrt{1-\zeta^2}}\right)$$

$$\zeta = \frac{3\sqrt{1-\zeta^2}}{\pi}$$

$$t_s = \frac{4}{\sigma}$$

$$2 = \frac{4}{0{,}69 \cdot \omega_n}$$

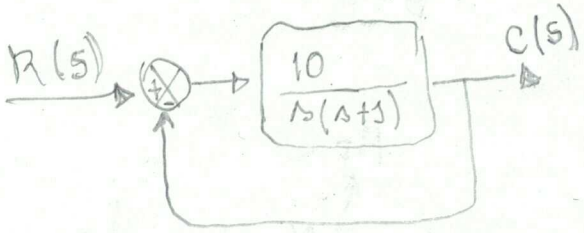
$$\omega_n = \frac{4}{1{,}38} = 2{,}89$$

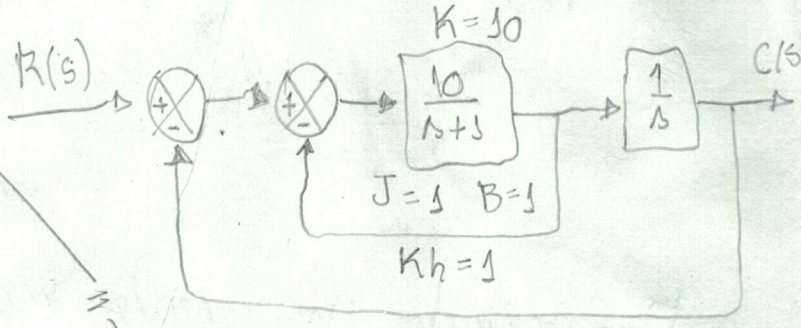
$$\frac{C(s)}{R(s)} = \frac{8{,}352}{s^2 + 3{,}988 s + 8{,}352}$$

5.7)

Coeficiente de amortecimento = 0,158 = ζ

Frequência natural não amortecida = 3,16 rad/s = W_n





$$\frac{\frac{10}{s(s+1)}}{\frac{10}{s(s+1)}+1} = \frac{10\,s(s+1)}{[10+s(s+1)]\,s(s+1)}$$

$$\frac{10}{10+s^2+s} = \frac{10}{s^2+s+10}$$

$$\frac{K}{Js^2+(B+KK_h)s+K}$$

$$= \frac{10}{s^2+(1+10K_h)s+10} \rightarrow 3,16$$

$$K_h = \frac{2\sqrt{KJ}\,\zeta - B}{K} = \frac{2\sqrt{10\cdot 1}\cdot 0,5 - 1}{10}$$

$$K_h = \frac{2,162}{10} = 0,216$$

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5.12)

tempo de pico (t_p) (peak time) $= \frac{\pi}{w_d}$

tempo de acomodação (t_s) (settling time) $\rightarrow \begin{cases} 2\% = \frac{4}{\sigma} \\ 5\% = \frac{3}{\sigma} \end{cases}$.

máximo sobressinal (M_p) (Maximum overshoot) $= e^{-(\sigma/w_d)\pi}$

tempo de subida (t_r) (rise time) $= \frac{\pi - \beta}{w_d}$

w_n = A partir de t_s e ζ

$\beta = \tan^{-1}\left(\frac{w_d}{\sigma}\right)$ $\quad \sigma = \zeta w_n$

$w_d = w_n\sqrt{1-\zeta^2}$

$$\frac{C(s)}{R(s)} = \frac{36}{s^2+2s+36} = \frac{K}{Js^2+(B+KK_n)s+K}$$

$\zeta = \frac{B+KK_n}{2\sqrt{KJ}}$ $\quad w_n = \sqrt{K/J} = \sqrt{36/1} = 6$

$= \frac{2}{2\cdot\sqrt{36\cdot 1}} = \frac{1}{6}$ $\quad \sigma = \frac{6}{6} = 1$

$$\beta = \tan^{-1}\left(\frac{w_n\sqrt{1-\zeta^2}}{w_n\zeta}\right) = \tan^{-1}\left(\frac{\sqrt{1-\left(\frac{1}{6}\right)^2}}{\frac{1}{6}}\right) = \tan^{-1}\left(\frac{6\sqrt{0,972}}{1}\right)$$

$\tan^{-1}(5,915) = 1,403$ rad

$M_p = e^{-(1/5,915)\pi} = e^{-0,531} = 0,588$

$w_d = w_n\sqrt{1-\zeta^2} = 5,915$ rad/s

$t_r = \frac{3,14 - 80,404}{5,915} = 0,293s$

$t_p = \frac{3,14}{5,915} = 0,530s$

$t_{s\ 2\%} = \frac{4}{1} = 4s$