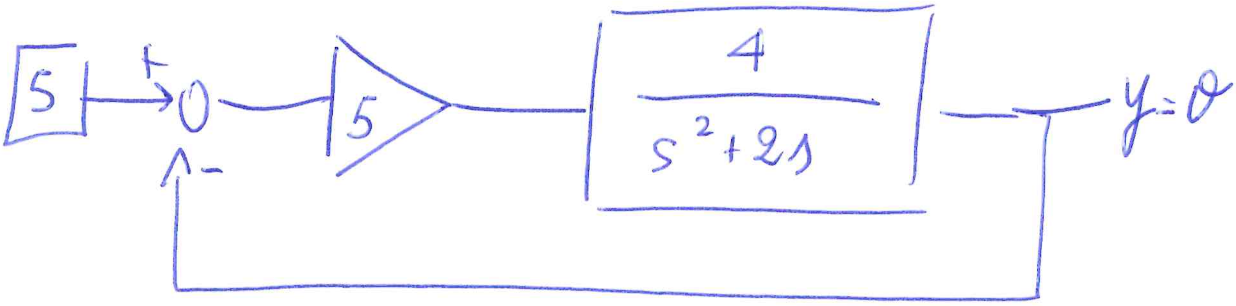
6/12/2017

Es. 1

$$F_v^{\theta} = \frac{4}{s(s+2)}$$



$$W_{\theta^d}^{\theta} = \frac{\frac{20}{s^2+2s}}{1+\frac{20}{s^2+2s}} = \frac{20}{s^2+2s+20} \rightarrow \text{es 1-B) 1)}$$

poli: $\frac{-2 \pm \sqrt{4-80}}{2} = \frac{-2 \pm 2\sqrt{19}}{2} = -1 \pm \sqrt{19}\,j$

$a = -1 \qquad b = 4.36$

$\zeta = -\frac{a}{\sqrt{a^2+b^2}} = 0.22 \qquad \omega_n = \sqrt{a^2+b^2} = 4.47$ rad/s

$\boxed{S\% \approx 50\%} \qquad \boxed{T_{eq} = 1\,s}$

ES.1 → bis

$$\frac{20}{s^2 + 2s + 20} = \frac{\mu \omega_n^2}{s^2 + 2\xi\omega_n s + \omega_n^2}$$

$\mu \omega_n^2 = 20$ → $\omega_n = \sqrt{20} = 4.47$

$\omega_n^2 = 20$

$\cancel{2}\xi\omega_n = \cancel{2}$ $\xi = \frac{1}{\omega_n} =$

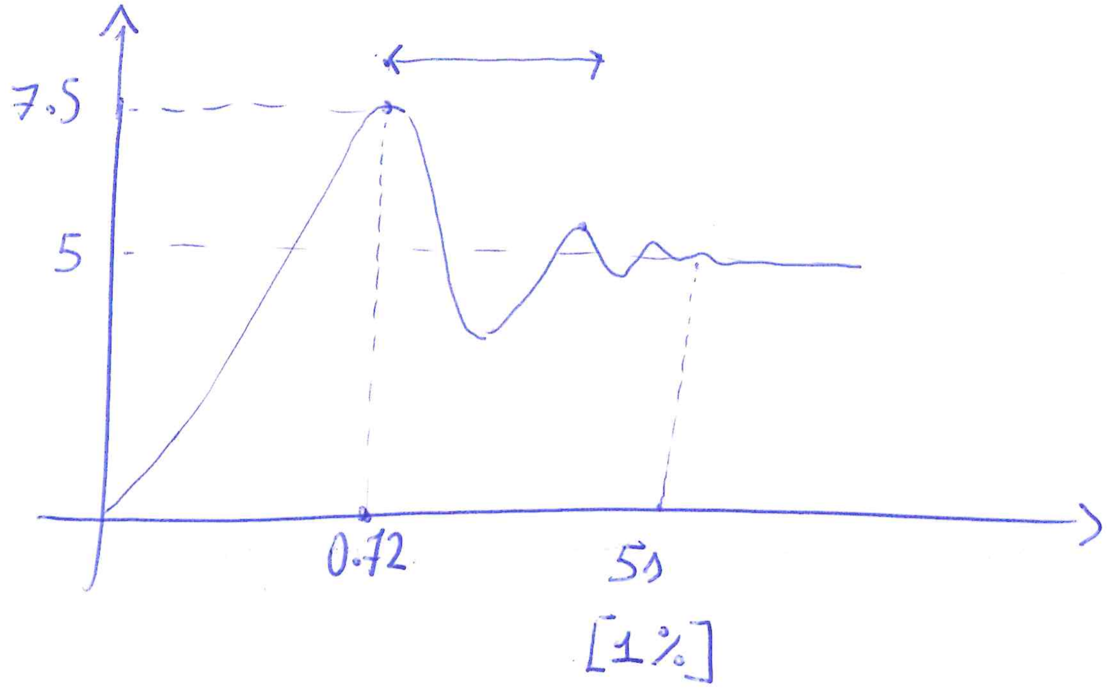
$$\xi = \frac{1}{\omega_n} = \frac{1}{4.47} = 0.22$$

$\xi = 0.22$ → $S\% = 50^\circ$

$\tau_\varphi = \frac{1}{\xi\omega_n} = 1\,s$

coffee

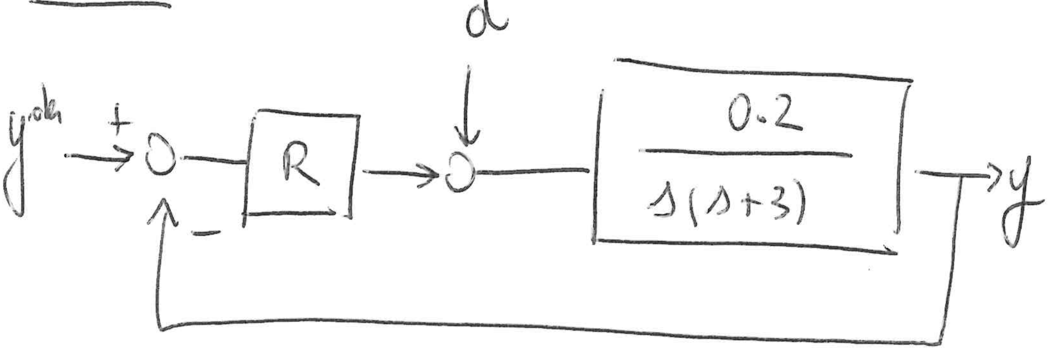
ES 1/2



$$t_{MAX} = \frac{\pi}{\omega_n\sqrt{1-\zeta^2}} = 0.72$$ primo massimo

$$\ddot{\theta} + 2\dot{\theta} + 20\theta = 20\,\theta_{des}$$

Es. 2/1



? R :

S1 Prec. statica

S2 $d = \text{cost.}$ $\geq 97\%$

S3 $y^o = t$ $e_\infty \leq 0.6$

S4 $S\% \leq 15$

S5 $T_{a2\%} \leq 4s$

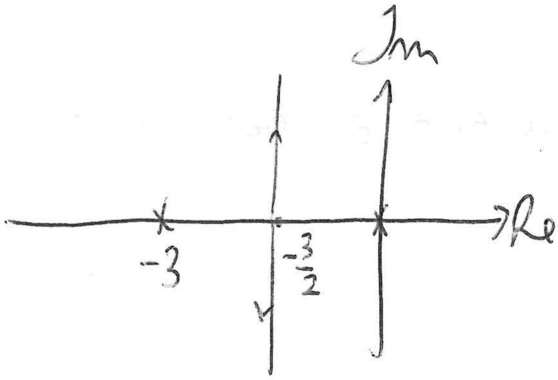
S1 "gratis"

S2 : $\frac{1}{K_R} \leq 0.03 \rightarrow \boxed{K_R > 33.\bar{3}}$ ⇒ S2b

S3 : $\boxed{e_\infty = \frac{\Sigma}{K_R K_p}} = \frac{1}{K_R(0.066)} \leq 0.6 \rightarrow K_R \geq \frac{1}{(0.6)(0.066)} = 25$

→ S3c

<u>R(s) = K_R</u>



es.2/2

$\Omega 2$ b

$d = D \qquad D(s) = \frac{D}{s}$

$$W_d^y(s) = \frac{\frac{0.2}{s(s+3)}}{1 + \frac{0.2 K_R}{s(s+3)}} = \frac{0.2}{s(s+3) + 0.2 K_R}$$

$$\mu_d^y = \frac{1}{K_R} \rightarrow y_\infty = \frac{D}{K_R}$$

Att. $\qquad \frac{\frac{D}{K_R}}{D} = \frac{1}{K_R} \leq 0.03 \rightarrow K_R \geq 33.\overline{3}$

Es 2/3

$\cancel{S}$:

$S_1 + S_2 \simeq R = k_R$

S_3 C

~~Errore~~1 $y^{de} = t$ $Y^{de}(s) = \frac{1}{s^2}$

$$W^{e}_{y^{de}} = \frac{1}{1 + \frac{0.2\,k_R}{s(s+3)}} = \frac{s(s+3)}{s(s+3) + 0.2\,K_R}$$

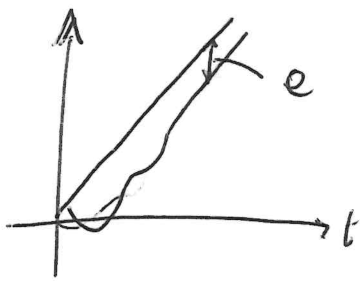
$$E(s) = W^{e}_{y^{de}}(s) \cdot Y_{de}(s) = \frac{s(s+3)}{s^2 + 3s + 0.2K_R} \cdot \frac{1}{s^2}$$

$$= \frac{s+3}{s[s^2+3s+0.2K_R]} \quad \text{Ok}$$

$$e_\infty = sE(s)\Big|_{s\to 0} = \frac{3}{0.2K_R} = \frac{15}{K_R} < 0.6$$

$$K_R > \frac{15}{0.6} = 25$$

$e \to$ cost. $e = y_{de} - y$ $\to \boxed{y \to y_{de} - e}$



Specifiche c.regime $\Rightarrow$ Controllore poli e zeri nell'origine

$R = k_P$ Compito 5.4

ES 2 (3/12)

P_{CAR}: $s^2 + 3s + 0.2K_R$ occhio

Stabilità $\forall K_R \geq 0$

☆ 1 $L(s) = \frac{0.2}{s(s+3)}$ $\bar{K} = 0.2$

$K = \left(\frac{1}{0.2}\right) \cdot (1.5)(1.5) = 5 \cdot \frac{3}{2} \cdot \frac{3}{2} = \frac{45}{4} = 11.25$

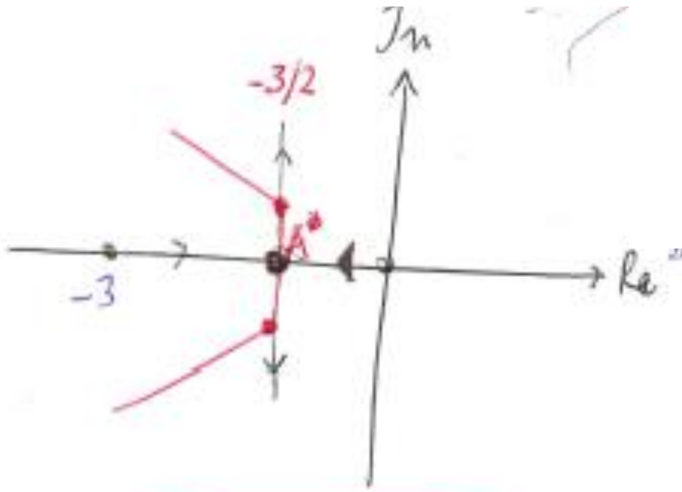
Moltiplicare R e P (Aggregarli)

e poi sommarne il NUM e il DEN.

Es 2/4

s_4 $\quad S_\% \le 15 \Rightarrow \boxed{\zeta \ge 0.52}$

$$\boxed{S5) \qquad A^* = -\frac{6}{T^*} = -\frac{3}{2}}$$



verifichiamo ω_n $\quad \boxed{K_R = 33.4}$

poli cc

$\Delta = 9 - 4(6{,}68) < 0$

$P_{CAR}: \quad s^2 + 3s + 0.2 * 33.4 = s^2 + 3s + 6.68$

$\omega_n^2 = 6.68 \longrightarrow \omega_n = 2.58$ rad/s

$2\zeta\omega_n = 3 \qquad \zeta = \frac{3}{2\omega_n} = \frac{3}{2\cdot(2.58)} = \boxed{0.58}$

$\boxed{\text{ok}}$ $\qquad \boxed{\text{OK}}$

ES 2 /5

se la specifica su t_a fosse più stringenti?

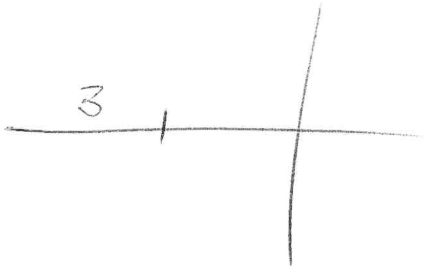
$T_{a2\%} = 2$ secondi $\quad (T^* = 2)$

$$\boxed{A^* = -3}$$

$$C(s) = K_R \cdot \frac{s+3}{s+6} \cdot \frac{6}{3} = 2K_R \frac{s+3}{s+6}$$

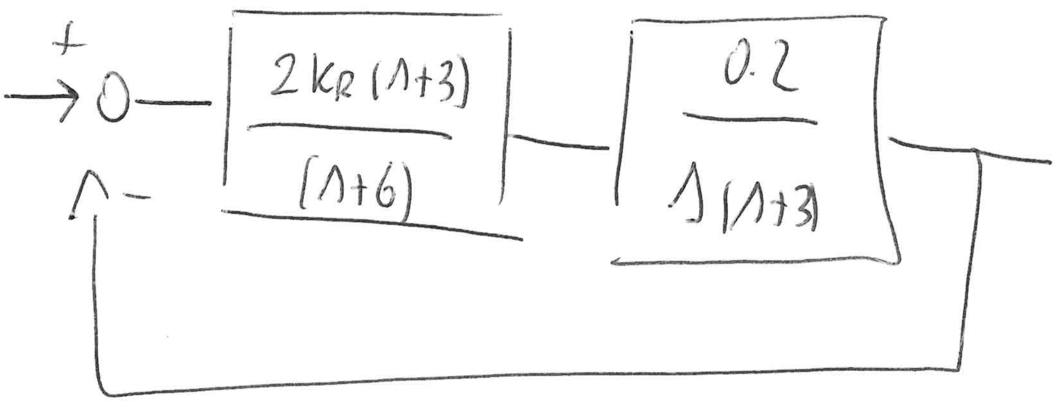
$$L(s) = \frac{0.2}{s\cancel{(s+3)}} \cdot \frac{2\cancel{(s+3)}}{(s+6)} = $$

$$= \frac{0.4}{s(s+6)}$$



$$k_{\substack{\text{p. doppio} \\ \text{in } -3}} = \frac{1}{0.4} \cdot 3 \cdot 3 = \boxed{22.5}$$

EJ 2./G



EQ CARATT. $1 + \frac{2K_R \cancel{(s+3)}}{s+6} \cdot \frac{0.2}{s\cancel{(s+3)}} = 0$

$$1 + \frac{2K_R\, 0.2}{s(s+6)} = 1 + \frac{0.4K_R}{s(s+6)} =$$

$$= \frac{s(s+6) + 0.4K_R}{s(s+6)}$$

$$s^2 + 6s + 0.4K_R = s^2 + 6s + 13.36$$

$\omega_n^2 = 13.36$ $\qquad \omega_n = 3.65$

$2\zeta\omega_n = 6$ $\qquad \zeta = 3/\omega_n = 0.82$ $\boxed{OK}$

E13 /1

$$W_{y^{dn}}^{y} = \frac{\frac{10(6s+2)}{s(s+1)}}{1+\frac{10(6s+2)}{s(s+1)}} = \frac{10(6s+2)}{s(s+1)+10(6s+2)} =$$

$$= \frac{10(6s+2)}{s^2+61s+20} = \frac{60s+20}{s^2+61s+20}$$

$$W_0^Y = \frac{1}{s+4} \cdot \frac{\frac{6s+2}{s(s+1)}}{1+\frac{10(6s+2)}{s(s+1)}} =$$

$$= \frac{1}{s+4} \cdot \frac{6s+2}{s(s+1)+10(6s+2)} =$$

$$= \frac{1}{s+4} \cdot \frac{6s+2}{(s^2+61s+20)}$$

ES 3/2

$y^{d_0} = 2$ $\quad y \to 2$

$\Sigma = 5$

$y^{d_1} = 5t$ TIPO 1 $y \to 5t - \dfrac{\Sigma}{K_R K_P}$ $\quad K_R = 10$

$e \to$ cost. $\quad K_P = 2$

$d = 4 \left[\frac{1}{s} \to 1 \right]$ $\quad y \to 1 \cdot \dfrac{1}{10} = \dfrac{1}{40}$

$d = 3\cos(5t)$

$y^{regim} = 3 \cdot |W_d^y(j5)| \cos\left(5t + \angle W_d^y(j5)\right)$

$y^{tot} = 2 + \left(5t - \dfrac{5}{20}\right) + \left(\dfrac{1}{40}\right) + \left(\quad \right)$

$W_d^y(0) = \dfrac{1}{10}$ $\quad d = 4 \Rightarrow y_\infty = 4 \cdot \dfrac{1}{10} = \dfrac{4}{10} = \dfrac{2}{5}$

$\boxed{d = \text{cst.}: \quad \mu_d = \dfrac{1}{40} \Rightarrow y^\infty_{d=4} = 4 \cdot \dfrac{1}{40} = \dfrac{1}{10}}$