

Si calcolino gli errori di posizione, di velocità e di accelerazione che si ottengono sollecitando il sistema con funzione di trasferimento:

$$G(s) = \frac{s^2 + 2s + 5}{s^3 + 5s^2 + 6s + 4} \quad (1)$$

con i seguenti segnali:

1. un gradino $r(t) = 1(t)$
2. una rampa $r(t) = t \cdot 1(t)$
3. una parabola: $r(t) = t^2 \cdot 1(t)$
4. il segnale $r(t)$ di Figura 1

$$G(s) = \frac{s^2 + 2s + 5}{s^3 + 5s^2 + 6s + 4} = L(s) \quad \text{A ciclo aperto}$$



Routh: $P_c(s) = s^3 + 5s^2 + 6s + 4$

$$\begin{array}{c|cc} s^3 & 1 & 6 \\ s^2 & 5 & 4 \\ s^1 & \frac{26}{5} & 0 \\ s^0 & 4 & \end{array} \quad \text{A. STABILE}$$

$$\frac{30 \cdot 4}{5} = \frac{26}{5}$$

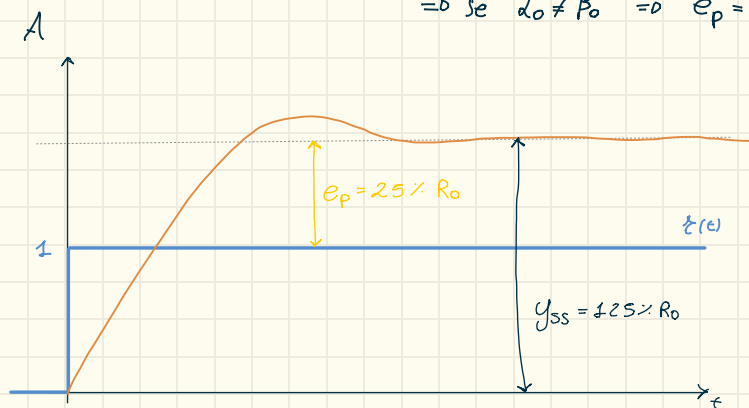
$$V_f = \lim_{s \rightarrow 0} s \cdot R(s) \cdot G(s) = s \cdot \frac{1}{s} \cdot \frac{s^2 + 2s + 5}{s^3 + 5s^2 + 6s + 4} = \frac{5}{4}$$

$$\Rightarrow e_{ss} = V_f - R_0 = \frac{5}{4} - 1 = \frac{5-4}{4} = \frac{1}{4} = 25\% \quad \text{IN PIU'!}$$

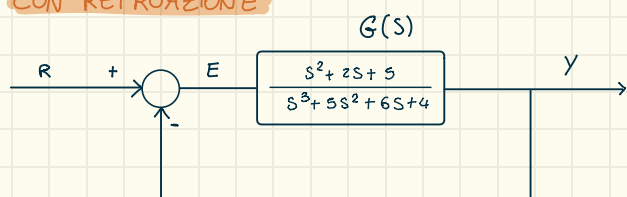
METODO CON LA TABELLA

Dato $G(s) = \frac{\beta_n s^n + \dots + \beta_1 s + \beta_0}{d_n s^n + \dots + d_1 s + d_0}$ ha nostra $G(s)$ ha $\begin{cases} \beta_0 = 5 \\ d_0 = 4 \end{cases}$ con $\beta_0 \neq d_0$

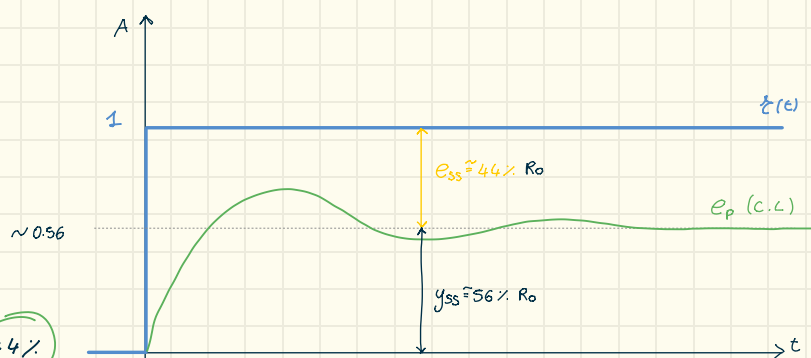
$$\Rightarrow \text{se } d_0 \neq \beta_0 \Rightarrow e_p = \left| \frac{\beta_0 - d_0}{d_0} \right| = \frac{5-4}{4} = \frac{1}{4} = 25\% \quad \text{di } R_0 \quad \text{dove } R_0 \text{ è il gain del riferimento (1)}$$



CON RETROAZIONE



$$e_p = \frac{1}{1+\mu} \quad \text{con } \mu = \lim_{s \rightarrow 0} G(s) = \frac{5}{4} \Rightarrow e_p = \frac{4}{9} \approx 44\%$$



$$G(s) = \frac{s^2 + 2s + 5}{s^3 + 5s^2 + 6s + 4}$$

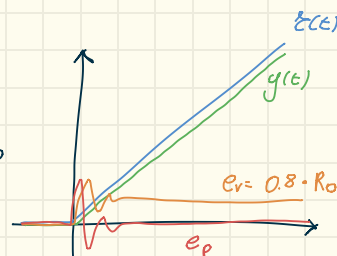
Con $r(t) = t \cdot 1(t) \Rightarrow R(s) = \frac{1}{s^2} \quad \beta_0 \neq d_0 \Rightarrow e_p = \infty$

ES:

$$G(s) = \frac{s^2 + 2s + 5}{s^3 + 5s^2 + 6s + 5}$$

con $R(s) = \frac{1}{s} \Rightarrow e_p = 0$ perché $\beta_0 = d_0$

$$\beta_0 \neq d_0 \Rightarrow \text{se } R(s) = \frac{1}{s^2} \Rightarrow e_r = \left| \frac{2-6}{5} \right| = \frac{4}{5} = 0.8 = 80\% R_0 \quad \text{errore negativo}$$



Es:

$$G(s) = \frac{(s+1)(s+2)}{s(s+5) + s^2 - 2s + 2}$$

$$= \frac{s^2 + 3s + 2}{2s^2 + 3s + 2}$$

$$P_c(s) = 2s^2 + 3s + 2$$

Dipende dall'ultimo

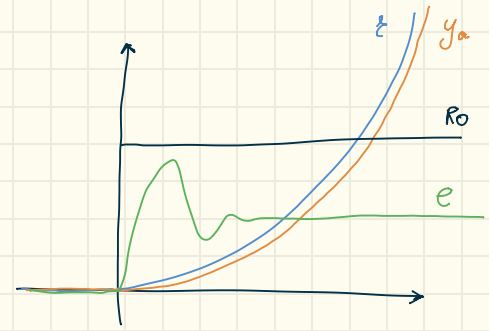
s^2	2	2
s^1	3	0
s^0	2	

$$\beta_0 = d_0 = 0 \Rightarrow e_p = 0$$

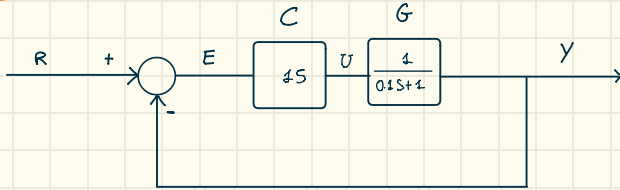
$$\beta_1 = d_1 = 0 \Rightarrow e_v = 0$$

$$\beta_2 \neq d_2 = 0 \Rightarrow e_a = \left| \frac{\beta_2 - d_2}{d_0} \right| = \left| \frac{1-2}{2} \right| = 0.5 = 50\%$$

A.S.



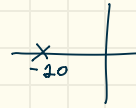
Es:



$$C = 15$$

$$G(s) = \frac{1}{0.1s+1}$$

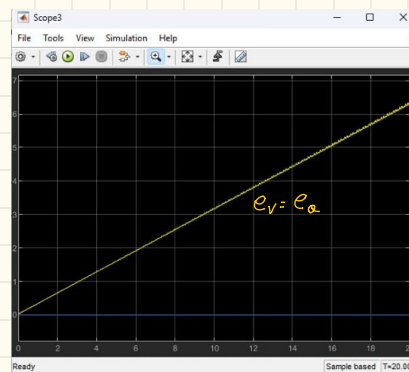
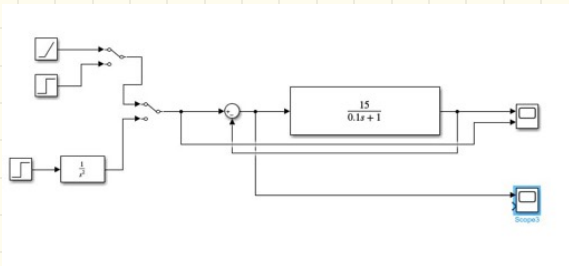
$$\rightarrow L(s) = \frac{15}{0.1s+1} \rightarrow \bar{s} = -10$$



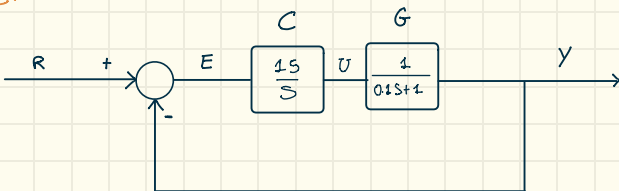
• $u = 1(t)$ $U(s) = \frac{1}{s}$ $\mu_p = \lim_{s \rightarrow \infty} \frac{15}{0.1s+1} = 15 \Rightarrow e_p = \frac{1}{1+\mu_p} = \frac{1}{16} = 0.062 \approx 6\%$

• $u = t \cdot 1(t)$ $U(s) = \frac{1}{s^2}$ $\mu_v = \lim_{s \rightarrow 0} s \cdot \frac{15}{0.1s+1} = 0 \Rightarrow \frac{1}{\mu_v} \rightarrow \infty$

Infatti non ci sono le derivate integrali



Es:



$$\sim L(s) = \frac{15}{s(\frac{1}{10}s+1)}$$

Tipo 1 $\Rightarrow e_p = 0$

$$\mu_v = \lim_{s \rightarrow 0} s \cdot \frac{15}{s(\frac{1}{10}s+1)} = 15 \Rightarrow e_v = \frac{1}{15} \approx 0.067 \approx 6.7\%$$