Funzione di trasferimento

$$G(p) = \frac{n(p)}{d(p)}$$

zeri : radici di $n(p)$ $(G = 0)$
poli : radici di $d(p)$ $(G = \infty)$

<u>f.d.t. in forme tipiche</u>

$$G(p) = \begin{cases} \dfrac{\beta_r\, p^{n-r} + \beta_{r+1}\, p^{n-r-1} + \cdots + \beta_n}{p^n + \alpha_1 p^{n-1} + \cdots + \alpha_n} \\[2ex] \rho\, \dfrac{(p-z_1)(p-z_2)\cdots(p-z_{n-r})}{(p-p_1)(p-p_2)\cdots(p-p_n)} \\[2ex] \mu\, \dfrac{(1+s\tau_1)(1+s\tau_2)\cdots(1+s\tau_{n-r})}{s^g(1+sT_1)(1+sT_2)\cdots(1+sT_{n-g})}, \quad g \geq 0 \\[2ex] \mu\, \dfrac{s^{-g}(1+s\tau_1)(1+s\tau_2)\cdots(1+s\tau_{n-r-g})}{(1+sT_1)(1+sT_2)\cdots(1+sT_n)}, \quad g \leq 0 \end{cases}$$

t.c. (ultime due forme)

r : grado relativo o surplus di poli

z_i : zeri, p_i : poli

ρ : costante di trasferimento $= \beta_r$

μ : guadagno (generalizzato)

g : tipo

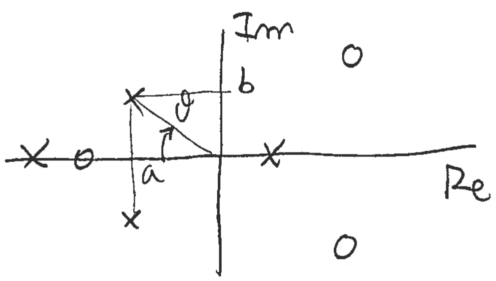
τ_i, T_i : costanti di tempo

Il caso di poli (o zeri) complessi

$$(p-p_i)(p-\bar{p}_i) = (p-(a+ib))(p-(a-ib)) = p^2 - 2as + \overbrace{(a^2+b^2)}^{\substack{(\text{b. pulsazione}) \\ \omega_n^2 = \text{pul. naturale}}} =$$
$$= p^2 + 2\xi\omega_n s + \omega_n^2$$

$$\xi = -\frac{a}{\omega_n} = \cos\vartheta \quad \text{smorzamento}$$
$$\vartheta = \operatorname{atan}\left(-\frac{b}{a}\right)$$

<u>Il piano complesso</u>

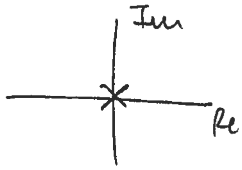


x : poli
o : zeri

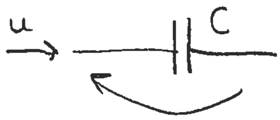
Esempi

Integratore

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



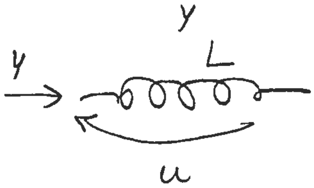
Condensatore



$$G = \frac{1}{Cs}$$

idem

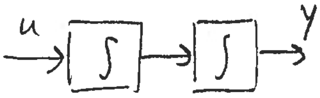
Induttore



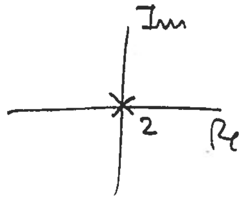
$$G = \frac{1}{Ls}$$

idem

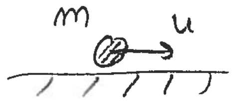
Doppio integratore



$$G = \frac{1}{s^2}$$



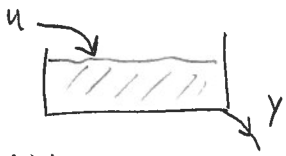
Massa senza attrito
(Legge di Newton)



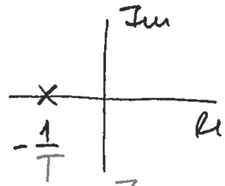
$$G = \frac{1}{ms^2}$$

idem

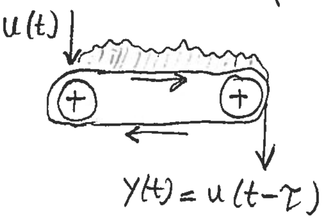
Serbatoio



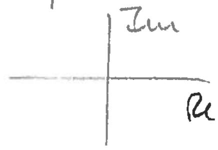
$$G = \frac{1}{1+sT}$$



Ritardatore puro



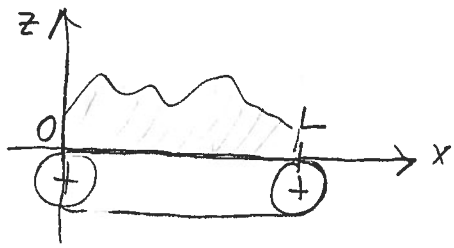
$$G = e^{-\tau s} \quad (?!)$$



Il ritardatore puro

$n = ?$

Lo stato del sistema è dato dall'altezza z della sabbia per $x \in [0, L]$, quindi dalla <u>funzione</u> $z = z(x) \rightarrow n = \infty$!



$$y(t) = u(t-\tau) \underset{\underset{(\varepsilon = -\tau)}{\uparrow}}{=} u(t+\varepsilon) = \sum_{0}^{\infty}{}_i \; u^{(i)}(t) \frac{\varepsilon^i}{i!} = u(t) \sum_{0}^{\infty}{}_i \frac{(\varepsilon s)^i}{i!} =$$

$$= u(t)\, e^{\varepsilon s} = u(t)\, e^{-\tau s}$$

$n(s) = e^{-\tau s}$

$d(s) = 1$