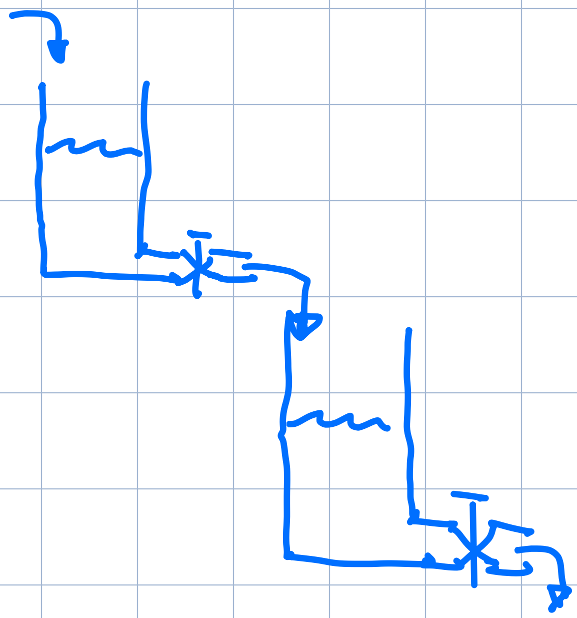
SISTEMI INTERCONNESSI



SOTTOSISTEMI

- SERIE (CASCATA)
- PARALLELO
- RETROAZIONE NEGATIVA (FEEDBACK NEGATIVO)

SERIE

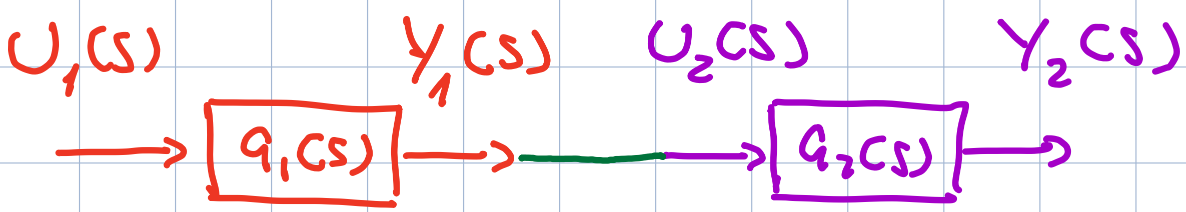
SUPPONIAMO DI AVERE DUE SOTTOSISTEMI (LTI - TC SISO)

$\Sigma_1 : \quad Y_1(s) = G_1(s)\, U_1(s)$

$\Sigma_2: \quad Y_2(s) = G_2(s)\, U_2(s)$

L'INTERCONNESSIONE SERIE IMPLICA

a) INDIVIDUARE CHI "VIENE" PRIMA E CHI DOPO



b) L'INGRESSO DEL SOTTO SISTEMA A VALLE (DOPO) È UGUALE ALL'USCITA DEL SOTTO SISTEMA A MONTE (PRIMA)

DETERMINIAMO FDT DEL SISTEMA IN SERIE

$$\begin{cases} Y_1(s) = G_1(s)\, U_1(s) \\ Y_2(s) = G_2(s)\, U_2(s) \end{cases}$$

$$U_2(s) = Y_1(s)$$

$$Y(s) = Y_2(s) = G_2(s) \cdot G_1(s)\, U_1(s) =$$

$$= G_2(s)\, G_1(s)\, U(s)$$

QUALI SONO I POLI DELLA SERIE?

$$\text{POLI\_SERIE} \subseteq \text{POLI\_}\Sigma_1 \cup \text{POLI\_}\Sigma_2$$

$$G_1(s) = \frac{s+1}{(s+2)(s+5)}$$

$$G_2(s) = \frac{1}{(s+1)(s+6)}$$

$$G_2(s) \cdot G_1(s) = \frac{1}{\cancel{(s+1)}(s+6)} \cdot \frac{\cancel{s+1}}{(s+2)(s+5)}$$

Σ_1 BIBO STABILE

Σ_2 BIBO STABILE

L'INTERCONNESSIONE SERIE È

BIBO STABILE?

$$\xrightarrow{u_1} \boxed{G_1(s)} \xrightarrow{y_1 = u_2} \boxed{G_2(s)} \xrightarrow{y_2}$$

SE UNO DEI DUE (O TUTTI E DUE)

NON È BIBO STABILE?

$$G_1(s) = \frac{s-1}{(s+1)(s+4)} \qquad G_2(s) = \frac{1}{(s-1)(s+6)}$$

A PARTIRE DAI MODI DI Σ_1 E Σ_2 SE NE GENERANO DI NUOVI?

$$G_1(s) = \frac{1}{(s+1)(s+2)} \qquad G_2(s) = \frac{1}{(s+2)}$$

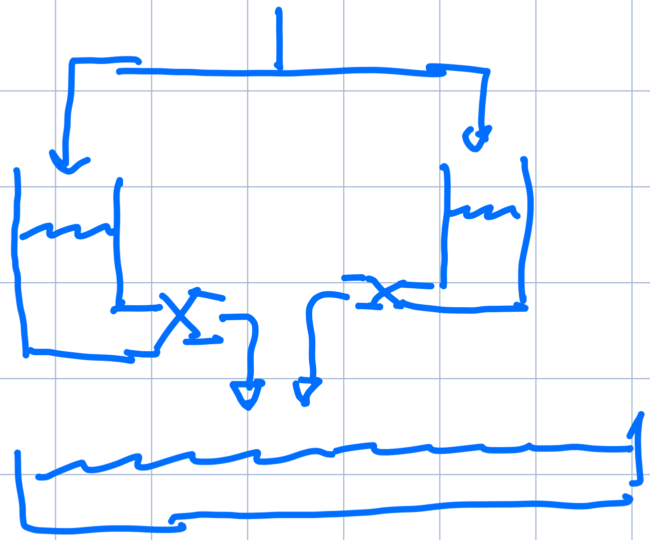
$$e^{-t},\ e^{-2t} \qquad\qquad e^{-2t}$$

$$G_2(s)G_1(s) = \frac{1}{(s+1)(s+2)^2}$$

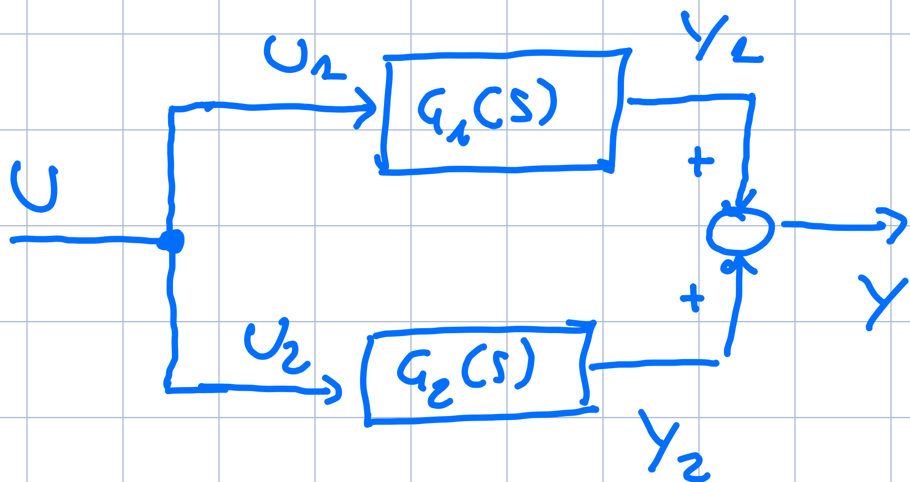
$$e^{-t},\ e^{-2t},\ t \cdot e^{-2t}$$

$$\to \boxed{\Sigma_1} \to \boxed{\Sigma_2} \to \dots \to \boxed{\Sigma_n} \to$$

$$G_n(s)\, G_{n-1}(s)\, G_{n-2}(s) \cdots G_2(s)\, G_1(s)$$



PARALLELO



$$
\begin{cases}
Y_1(s) = G_1(s)\,U_1(s) \\
Y_2(s) = G_2(s)\,U_2(s) \\
Y(s) = Y_1(s) + Y_2(s) \\
U_1(s) = U(s), \quad U_2(s) = U(s)
\end{cases}
$$

$$Y_1(s) = G_1(s)\, U(s)$$

$$Y_2(s) = G_2(s)\, U(s)$$

$$Y(s) = Y_1(s) + Y_2(s) = G_1(s)\,U(s) + G_2(s)\,U(s)$$

$$= \left(G_1(s) + G_2(s)\right) U(s)$$

$$\text{POLI\_PAR} \subseteq \text{mcm}\left(\text{POLI\_}\Sigma_1,\ \text{POLI\_}\Sigma_2\right)$$

$$G_1(s) = \frac{1}{(s+4)(s-1)}$$

$$G_2(s) = -\frac{1}{(2s+3)(s-1)}$$

$$G_1(s) + G_2(s) = \frac{1}{(s+4)(s-1)} - \frac{1}{(2s+3)(s-1)}$$

$$= \frac{2s+3-s-4}{(s+4)(2s+3)(s-1)} = \frac{\cancel{s-1}}{(s+4)(2s+3)\cancel{(s-1)}}$$

Σ_1 BIBO STABILE

Σ_2 BIBO STABILE

PARALLELO BIBO STABILE

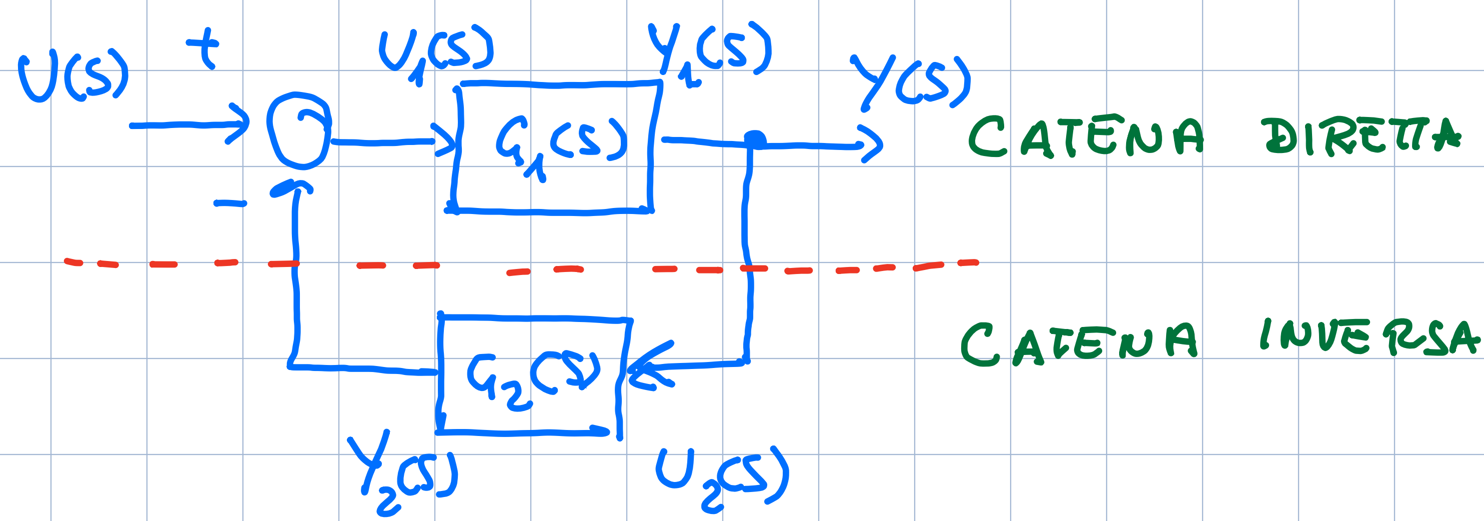
SE UNO DEI DUE (OR ESCLUSIVO)

NON È BIBO STABILE ALLORA

IL PARALLELO NON È BIBO STABILE

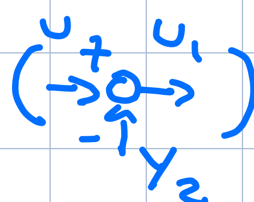
NON SI GENERANO MODI NUOVI.

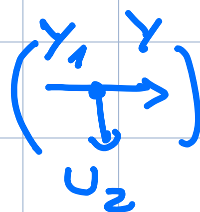
RETROAZIONE NEGATIVA



$U_1(S) \longleftarrow$ "SEGNALE DI ERRORE"

$$\begin{cases} Y_1(S) = G_1(S)\, U_1(S) \\ Y_2(S) = G_2(S)\, U_2(S) \\ U_1(S) = U(S) - Y_2(S) \\ Y(S) = Y_1(S) \\ Y(S) = U_2(S) \end{cases}$$





$$Y_1(s) = G_1(s)\left(U(s) - Y_2(s)\right) =$$

$$= G_1(s)\left(U(s) - G_2(s)\,U_2(s)\right)$$

$$Y(s) = G_1(s)\left(U(s) - G_2(s)\,Y(s)\right)$$

$$Y(s) + G_1(s)\,G_2(s)\,Y(s) = G_1(s)\,U(s)$$

$$\left(1 + G_1(s)\,G_2(s)\right)Y(s) = G_1(s)\,U(s)$$

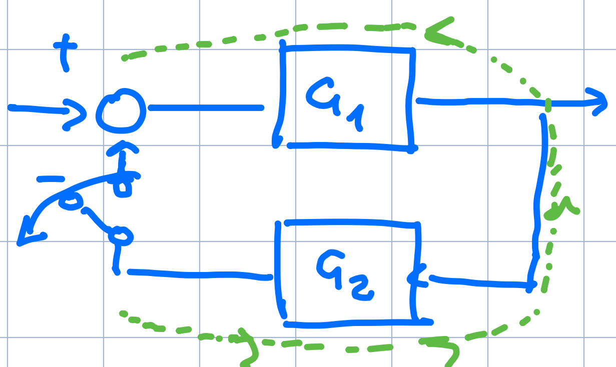
$$Y(s) = \frac{G_1(s)}{1 + G_1(s)\,G_2(s)}\,U(s)$$

$$G_1 = \frac{n_1}{d_1} \qquad G_2 = \frac{n_2}{d_2}$$

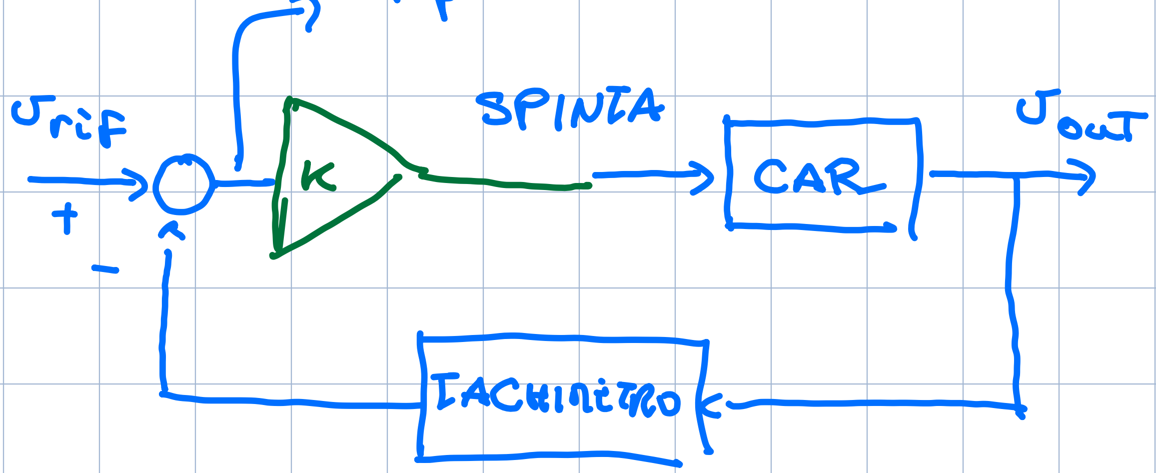
$$\frac{G_1(s)}{1 + G_1(s)\,G_2(s)} = \frac{\dfrac{n_1}{d_1}}{1 + \dfrac{n_1}{d_1}\,\dfrac{n_2}{d_2}} =$$

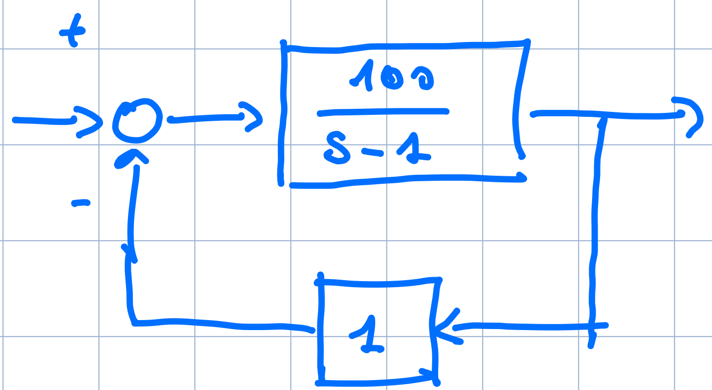
$$= \frac{\dfrac{n_1}{d_1}}{\dfrac{d_1 d_2 + n_1 n_2}{d_1 d_2}} = \frac{n_1 d_2}{n_1 n_2 + d_1 d_2}$$

$$G_1(s)\;G_2(s)$$ LOOP GAIN



$= v_{in} - v_{out,m}$



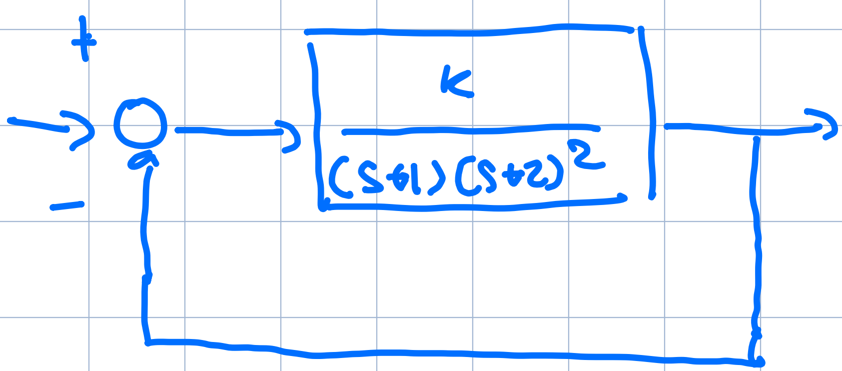


$$G_1(S) = \frac{100}{S-1}$$

$$G_2(S) = 1$$

$$\frac{G_1(S)}{1 + G_1(S)\,G_2(S)} = \frac{\frac{100}{S-1}}{1 + \frac{100}{S-1} \cdot 1} =$$

$$= \frac{\dfrac{100}{\cancel{s-1}}}{\dfrac{s-1+100}{\cancel{s-1}}} = \frac{100}{s+99}$$



$$G_1(s) = \frac{K}{(s+1)(s+2)^2} \qquad G_2(s) = 1$$

$$\frac{G_1(s)}{1+G_1(s)\,G_2(s)} = \frac{\dfrac{K}{(s+1)(s+2)^2}}{1+\dfrac{K}{(s+1)(s+2)^2}\cdot 1} =$$

K

$$= \frac{\overline{(s+1)\cancel{(s+2)^2}}}{\frac{(s+1)(s+2)^2+k}{(s+1)\cancel{(s+2)^2}}} = \frac{k}{(s+1)(s+2)^2+k}$$