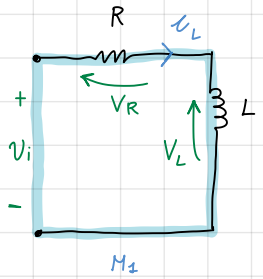
Circuito Ohmico Induttivo (VENTILATORE)

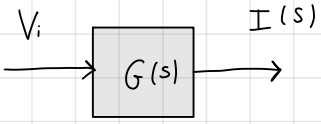


- $v_R = R \cdot i_L$
- $v_L = L \cdot \frac{di_L}{dt}$
- $LKT_{M_1}: v_i - v_L - v_R = 0$

$\mathcal{L} \rightleftharpoons$

- $V_R = R\, I(s)$ (2)
- $V_L = sL\, I(s)$ (2)
- $V_i(s) - V_L(s) - V_R(s) = 0$ (3)

OBBIETTIVO



$$I(s) \overset{(2)}{=} \frac{1}{sL} \cdot V_L(s) \overset{(3)}{=} \frac{1}{sL}\left(V_i(s) - V_R(s)\right) = \frac{1}{sL}\left(V_i(s) - RI(s)\right)$$

$$= I(s) + \frac{R}{sL} I(s) = \frac{1}{sL} V_i(s)$$

$$= 0 \quad \frac{I(s)}{V_i(s)} = \frac{\frac{1}{sL}}{1 + \frac{R}{sL}} = \boxed{\frac{1}{sL + R}} \quad G(s)$$

$$\rightarrow G(s) = \underbrace{\frac{1}{R}}_{\left[\frac{1}{\Omega}\right]} \cdot \frac{1}{s\left(\frac{L}{R}\right) + 1}$$

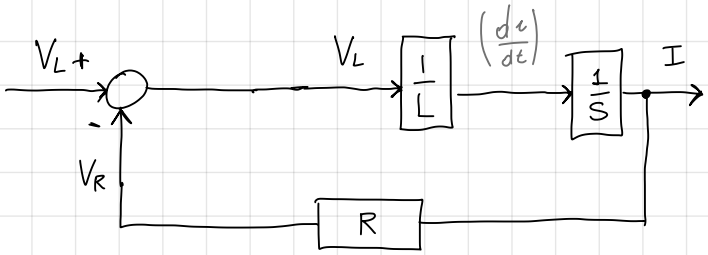
↑ Costante di tempo

← Evidenzia la forma : $\frac{1}{sT + 1}$ ↑ costante di tempo

La funzione di trasferimento in questione **ha una dimensione**!

FOTO 1

SCHEMA A BLOCCHI



$$\frac{I(s)}{V_i(s)} \quad \frac{\frac{1}{sL}}{1 + R \cdot \frac{1}{sL}} = \frac{1}{sL + R}$$

SPAZIO DI STATO

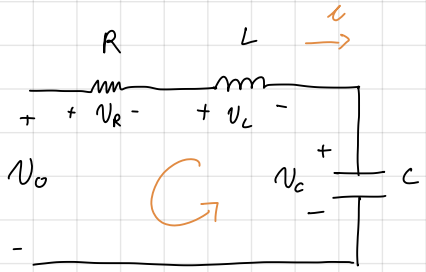
$u = v_i \qquad y = i \qquad x = i$

$$\begin{cases} \dot{x} = \frac{1}{L}(u - R \cdot x) \\ y = x \end{cases} \qquad \begin{cases} \dot{x} = -\left(\frac{R}{L}\right) x + \frac{1}{L} u \\ y = x \end{cases}$$

↙ Reciproco della costante di T

$$\sim \begin{cases} \dot{x} = \underline{\underline{A}} x + \underline{\underline{B}} y \\ y = \underline{\underline{C}} x + \underline{\underline{D}} u \end{cases} \quad {}_{1\times 1}$$

CIRCUITO RLC



$$\begin{cases} v_R = R\,i \\ v_L = L\,\dfrac{di}{dt} \\ v_C = C\,\dfrac{dv_o}{dt} \\ v_i - v_o - v_L - v_R = 0 \end{cases} \rightarrow v_o = v_i - v_L - v_R$$

$\dot{x}_1 = i$ (x_1: Var Stato) $\qquad \dot{x}_2 = v_o$ (x_2: Var Stato)

$u = v_i$ (IN) $\qquad y = v_o$ (OUT)

$$\dot{x}_1 = \frac{1}{L}\left(u - v_o - R x_1\right)$$

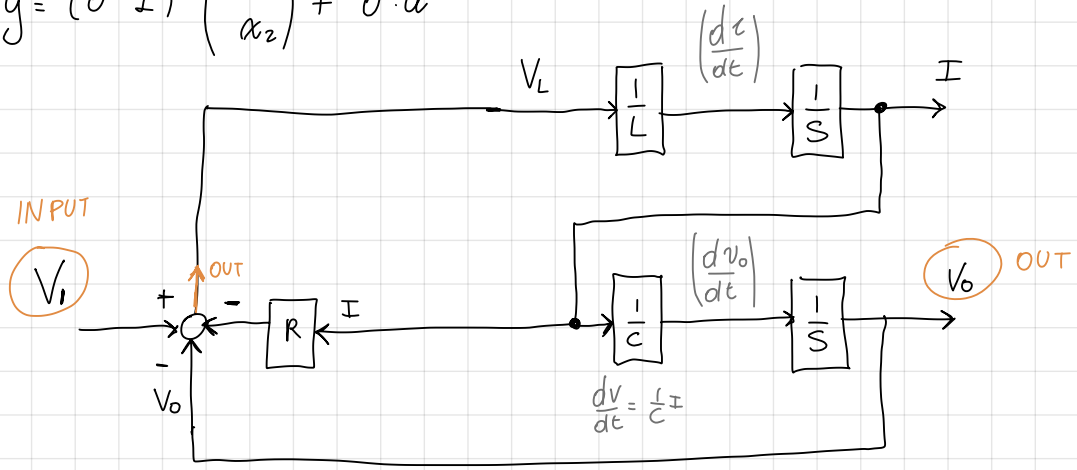
$$\dot{x}_2 = \frac{1}{C} x_1$$

$$y = x_2$$

$$\begin{cases} \dot{x}_1 = -\dfrac{R}{L} x_1 - \dfrac{1}{L} x_2 + \dfrac{1}{L} u \\ \dot{x}_2 = \dfrac{1}{C} x_1 \\ y = x_2 \end{cases}$$

$$\begin{cases} \dot{x} = \begin{pmatrix} \dot{x}_1 \\ \dot{x}_2 \end{pmatrix} = \underbrace{\begin{pmatrix} -\frac{R}{L} & \frac{1}{L} \\ \frac{1}{C} & 0 \end{pmatrix}}_{A} \begin{pmatrix} x_1 \\ x_2 \end{pmatrix} + \underbrace{\begin{pmatrix} \frac{1}{L} \\ 0 \end{pmatrix}}_{B} u \\ y = (0 \;\; 1) \begin{pmatrix} x_1 \\ x_2 \end{pmatrix} + 0 \cdot u \end{cases}$$

X2 punto è influenzata da u, ma non direttamente!



Troviamo G(s) tra V_i e V_o

$$(1)\quad V_o = \frac{1}{SC} \cdot I = \frac{1}{SC} \cdot \left(\frac{1}{SL} V_L\right) = \frac{1}{SC} \cdot \left[\frac{1}{SL}\left(-RI - V_o + V_i\right)\right]$$

$\rightarrow$ Solve for I $\rightarrow$ $\quad I = -\frac{R}{SL} I - \frac{1}{SL} V_o + \frac{1}{SL} V_i \rightarrow \left(1 + \frac{R}{SL}\right) I = \frac{1}{SL}\left(V_i - V_o\right)$

$\Rightarrow$ $\quad I = \dfrac{1}{R + SL}\left(V_i - V_o\right)$ (2)

→ Sub I in (1) → $V_o = \frac{1}{SC} \cdot \frac{1}{R+SL} \cdot (V_i - V_o)$

→ Solve for V_o → $V_o = \frac{1}{S^2LC + RCS + 1} V_i$

→ Siccome $G(S)$ Tra V_i (IN) e V_o (OUT)

$$\frac{V_o}{V_i} = G(S) = \frac{1}{S^2LC + RCS + 1}$$

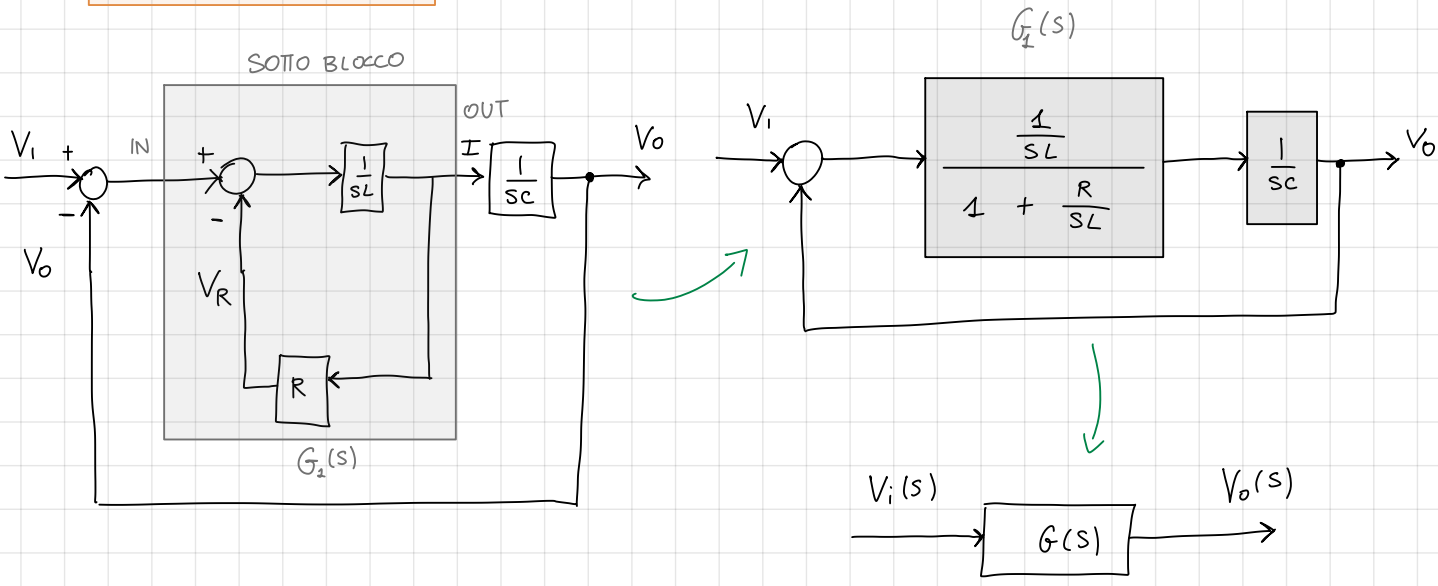
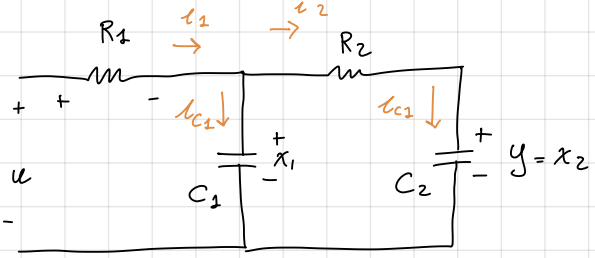


FOTO 2

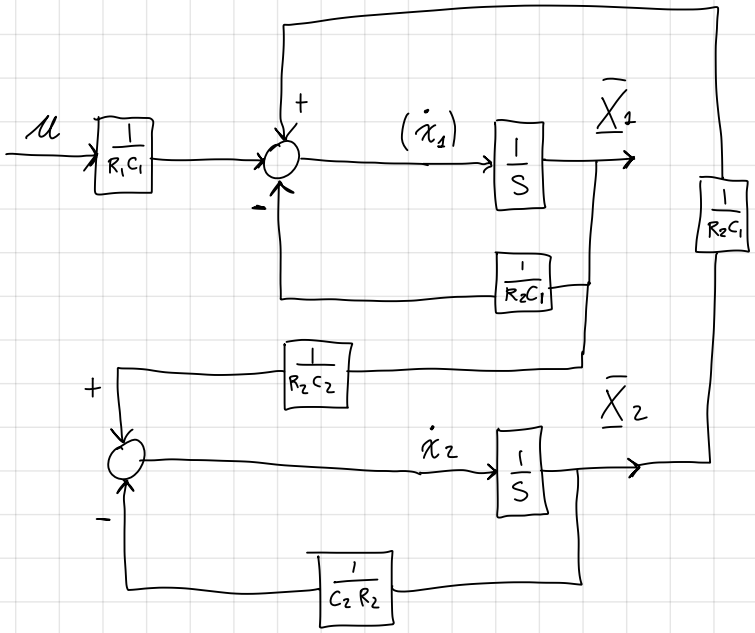


$$\begin{cases} C_1 \dot{x}_1 = \dfrac{u - x_1}{R_1} - \dfrac{1}{R_2}(x_1 - x_2) \\ C_2 \dot{x}_2 = \dfrac{1}{R_2}(x_1 - x_2) \end{cases}$$

v_{R1} — i_{C1} — i_{C2}

$$= 0$$

$$\begin{cases} \dot{x}_1 = -\dfrac{1}{C_1}\left(\dfrac{1}{R_1} \cdot \dfrac{1}{R_2}\right) x_1 + \dfrac{1}{R_2 C_1} x_2 + \dfrac{1}{C_1 R_1} u \\ \dot{x}_2 = \dfrac{1}{R_2 C_2} x_1 - \dfrac{1}{C_2 R_2} x_2 \\ y = x_2 \end{cases}$$



Funzione di Trasf x_2 (OUT) e u (IN)

FOTO