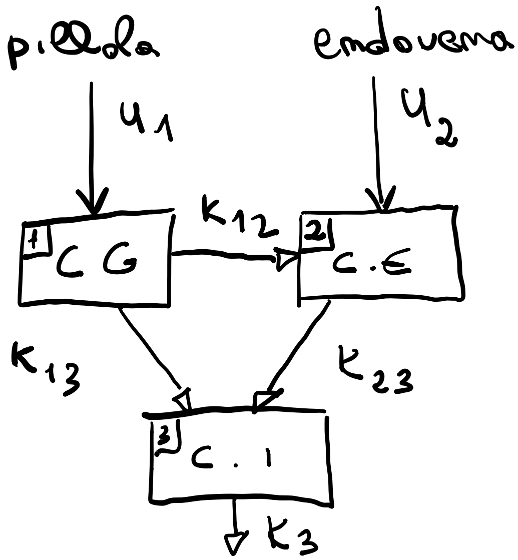


$k_{12} = 0{,}5\ h^{-1}$

$k_{23} \geq 0\ h^{-1}$

$k_{13} = 0{,}5\ h^{-1}$

$k_3 = 0{,}5\ h^{-1}$

$V_3 = 2\,cc$

$x_1, x_2, x_3 \rightarrow [mg]$ $\qquad$ $u_{1,2} \rightarrow \left[\frac{mg}{h}\right]$

$\dot{x}_1, \dot{x}_2, \dot{x}_3 \rightarrow \left[\frac{mg}{h}\right]$

$\frac{mg}{h}$ $\qquad$ $[mg]$

$$\begin{cases} \dot{x}_1 = u_1 - \underbrace{(k_{12}+k_{13})}_{h^{-1}} x_1 \\ \dot{x}_2 = u_2 + k_{12} x_1 - k_{23} x_2 \\ \dot{x}_3 \rightarrow 0 = k_{13} x_1 + \cancel{k_{23} x_2} - k_3 x_3 \rightarrow 0 \\ y = \dfrac{x_3}{V} \end{cases}$$

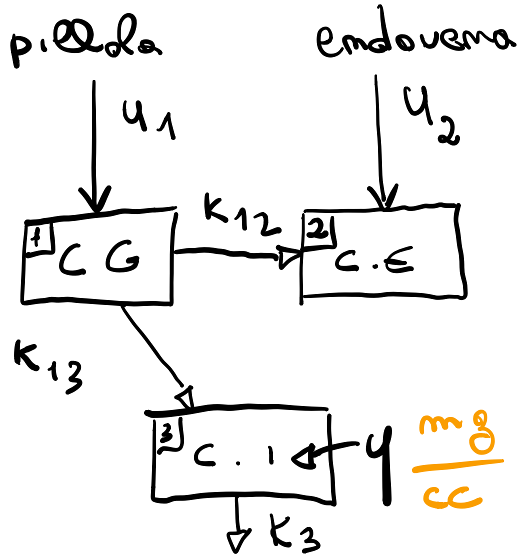
$\rightarrow x_1 = 0$

$x_3 \rightarrow mg$

$V \rightarrow cc = cm^3$

$$\tilde{x} = \begin{bmatrix} 0 \\ \alpha \in \mathbb{R} \\ 0 \end{bmatrix}$$

1. x_3 deve partire da $\emptyset$
2. $\dot{x}_3$ deve rimanere a $\emptyset$



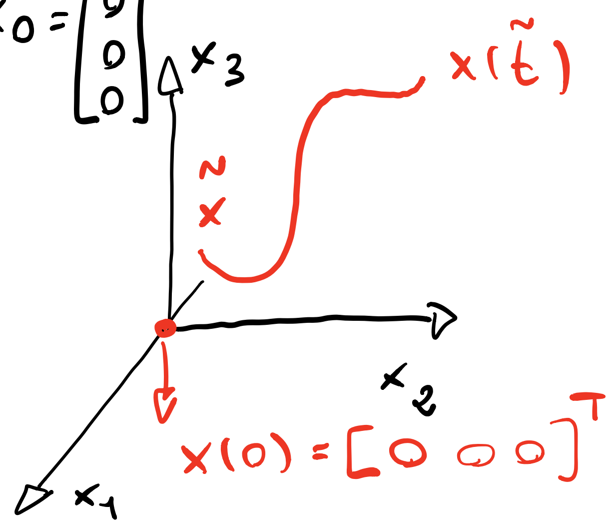
$$\tilde{x} = \begin{bmatrix} \alpha \\ \beta \end{bmatrix}$$

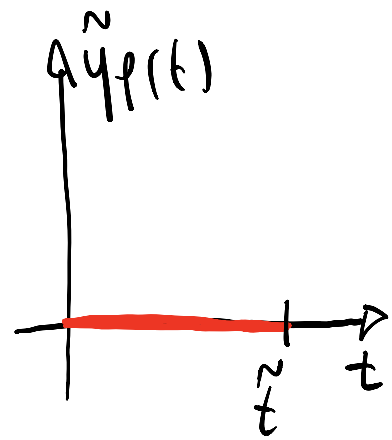
$$x_0 = \begin{bmatrix} 0 \\ \beta \end{bmatrix} \rightsquigarrow \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

$$y = \frac{x_3}{V}$$

$$\tilde{x} = \begin{bmatrix} 0 \\ \alpha \\ 0 \end{bmatrix}$$

$$\tilde{x} \neq x_0 = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$

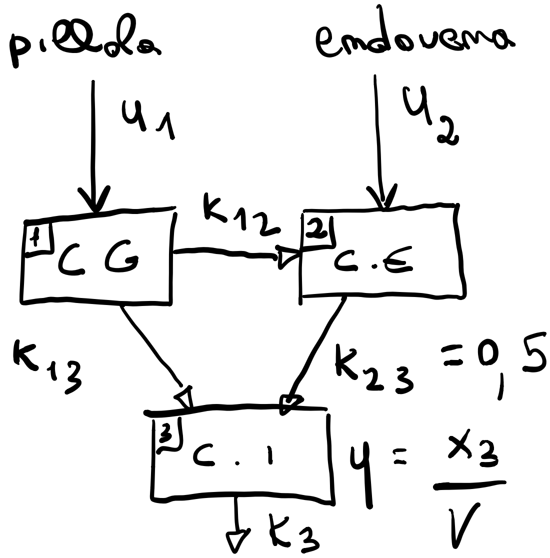




$$A = \begin{bmatrix} -(k_{12}+k_{13}) & 0 & 0 \\ k_{12} & -k_{23} & 0 \\ k_{13} & k_{23} & -k_3 \end{bmatrix} \in \mathbb{R}^{3\times 3}$$

$$B \in \mathbb{R}^{n \times n_u} \in \mathbb{R}^{3 \times 2} \qquad B = \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 0 & 0 \end{bmatrix}$$

$$C = \begin{bmatrix} 0 & 0 & 1/V \end{bmatrix} \qquad D = \emptyset$$



$$y = \frac{x_3}{V}$$

$$\begin{cases} \hat{x}_1 = x_1 + x_2 \\ \hat{x}_2 = x_1 - x_2 \\ \hat{x}_3 = x_3 \end{cases} \qquad \hat{x} = \begin{bmatrix} \hat{x}_1 \\ \hat{x}_2 \\ \hat{x}_3 \end{bmatrix}$$

$$\begin{cases} \dot{x}_1 = u_1 - (k_{12} + k_{13})\,x_1 \\ \dot{x}_2 = u_2 + k_{12}\,x_1 - k_{23}\,x_2 \\ \dot{x}_3 = k_{13}\,\overset{1}{x_1} + k_{23}\,\overset{2}{x_2} - k_3\,\overset{3}{x_3} \\ y = \dfrac{x_3}{V} \end{cases}$$

$$0{,}5\,(x_1 + x_2) \rightarrow \hat{x}_1$$

$$0{,}5 \cdot \hat{x}_1 - 0{,}5\,x_3$$

$$\hat{x}_1 = x_1 + x_2 \qquad x_1 = \hat{x}_1 - x_2$$

$$\hat{x}_2 = x_1 - x_2 \qquad x_2 = \hat{x}_1 - \hat{x}_2$$

$$x_1 = \hat{x}_1 - x_1 + \hat{x}_2 \rightarrow 2x_1 = \hat{x}_1 + \hat{x}_2$$

$$x_1 = \frac{\hat{x}_1 + \hat{x}_2}{2}$$

$$x_2 = \frac{\hat{x}_1 + \hat{x}_2}{2} - \hat{x}_2 = \frac{\hat{x}_1 - \hat{x}_2}{2}$$

$$\begin{cases} x_1 = \dfrac{\hat{x}_1 + \hat{x}_2}{2} \\ x_2 = \dfrac{\hat{x}_1 - \hat{x}_2}{2} \\ x_3 = \hat{x}_3 \end{cases}$$

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$$\hat{x}_1 = x_1 + x_2$$
$$\hat{x}_2 = x_1 - x_2$$

$$\begin{cases} \dot{\hat{x}}_1 = \dot{x}_1 + \dot{x}_2 \\ \dot{\hat{x}}_2 = \dot{x}_1 - \dot{x}_2 \\ \dot{\hat{x}}_3 = \dot{x}_3 \end{cases}$$

$0{,}5 \quad 0{,}5 \to 1$

$$\dot{x}_1 = u_1 - (k_{12} + k_{13})\, x_1$$

$$\Downarrow$$

$$u_1 - x_1 = u_1 - \frac{\hat{x}_1 + \hat{x}_2}{2}$$

$0{,}5 \qquad 0{,}5$

$$\dot{x}_2 = u_2 + k_{12}\, x_1 - k_{23}\, x_2$$

$$= u_2 + 0{,}5\,(x_1 - x_2) =$$

$$= u_2 + 0{,}5\,\hat{x}_2$$

$$\dot{\hat{x}}_1 = u_2 + 0,5\,\hat{x}_2 + u_1 - \frac{\hat{x}_1 + \hat{x}_2}{2}$$

$$= u_1 + u_2 + \cancel{\frac{\hat{x}_2}{2}} - \frac{\hat{x}_1}{2} - \cancel{\frac{\hat{x}_2}{2}}$$

$$= -\frac{\hat{x}_1}{2} + u_1 + u_2$$

$$\dot{\hat{x}}_2 = u_1 - \frac{\hat{x}_1 + \hat{x}_2}{2} - u_2 - 0,5\,\hat{x}_2$$

$$= u_1 - u_2 - \frac{\hat{x}_1}{2} - \frac{\hat{x}_2}{2} - \frac{\hat{x}_2}{2}$$

$$= -\frac{\hat{x}_1}{2} - \hat{x}_2 + u_1 - u_2$$

$$\dot{\hat{x}}_3 = \dot{x}_3 = k_{13}x_1 + k_{23}x_2 - k_3 x_3 =$$

$$= 0,5\,(x_1 + x_2) - 0,5\,x_3 =$$

$$= 0,5\,\hat{x}_1 - 0,5\,\hat{x}_3 =$$

$$= \frac{\hat{x}_1}{} - \frac{\hat{x}_3}{}$$

$$2 \qquad \overline{2}$$

$$\begin{cases} \dot{\hat{x}}_1 = -\dfrac{\hat{x}_1}{2} + u_1 + u_2 \boxed{+\ \hat{x}_2} \\ \dot{\hat{x}}_2 = -\dfrac{\hat{x}_1}{2} - \hat{x}_2 + u_1 - u_2 \\ \dot{\hat{x}}_3 = \dfrac{\hat{x}_1}{2} - \dfrac{\hat{x}_3}{2} \end{cases}$$

NON RIENTRA

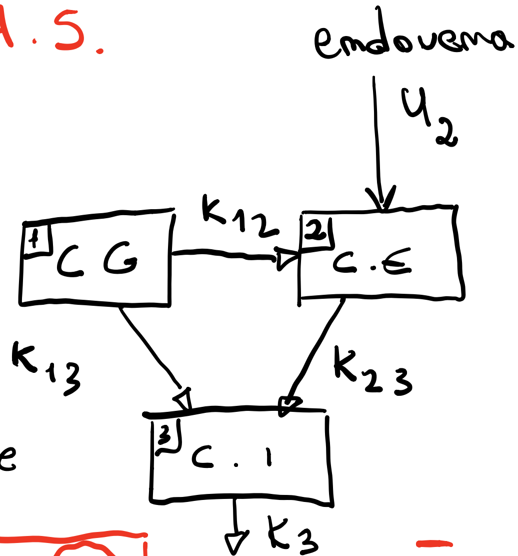
$$y = \frac{\hat{x}_3}{V}$$

$$\tilde{\hat{x}} \neq \hat{x}_0$$

$\tilde{y}(\cdot)$ identicamente nullo

$$\tilde{\hat{x}} = \begin{bmatrix} 0 \\ \alpha \\ 0 \end{bmatrix}$$

IPOTESI → A.S.



valore uscita a regime

$$\boxed{\bar{y} = \mu \cdot \bar{u}}$$

0,5 mg

$$\bar{u} = \frac{\bar{y}}{\mu} = \frac{0,5\,mg}{\mu}$$

$$x\ell = e^{At} x_0 \quad \to \quad \lambda_i \in \mathbb{R}, \quad \lambda_i \leq 0$$

$$\begin{bmatrix} e^{\lambda_1 t} & \emptyset \\ \emptyset & \ddots \; e^{\lambda_n t} \end{bmatrix} x_0 \xrightarrow[t \to \infty]{} 0$$

$$y\ell = c\, e^{At} x_0 \xrightarrow[t \to \infty]{} 0$$