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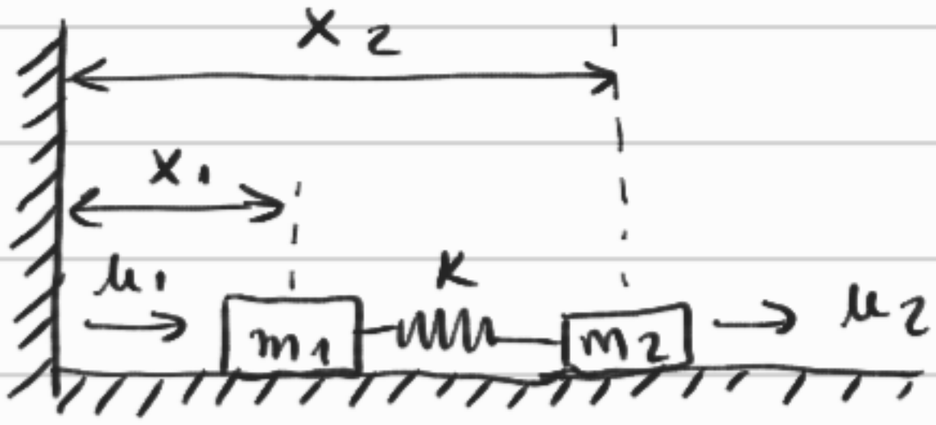

$$\bar{x} = \frac{m_1 x_1 + m_2 x_2}{M}, \text{ com } m_1 + m_2 = M$$

$$\delta = x_1 - x_2$$

$$\rightarrow \ddot{\bar{x}} = \frac{u_1 + u_2}{M} \quad ; \quad \ddot{\delta} = -\frac{KM\delta}{m_1 m_2} + \frac{u_1}{m_1} - \frac{u_2}{m_2}$$

$$\dot{z} = A \cdot z + B \cdot u$$

$$\rightarrow \begin{bmatrix} \dot{\bar{x}} \\ \dot{\delta} \\ \ddot{\bar{x}} \\ \ddot{\delta} \end{bmatrix} = \begin{bmatrix} 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 \\ 0 & \frac{-KM}{m_1 m_2} & 0 & 0 \end{bmatrix} \cdot \begin{bmatrix} \bar{x} \\ \delta \\ \dot{\bar{x}} \\ \dot{\delta} \end{bmatrix} + \begin{bmatrix} 0 & 0 \\ 0 & 0 \\ \frac{1}{M} & \frac{1}{M} \\ \frac{1}{m_1} & -\frac{1}{m_2} \end{bmatrix} \cdot \begin{bmatrix} u_1 \\ u_2 \end{bmatrix}$$

$$\rightarrow \begin{bmatrix} \bar{x} \\ \delta \end{bmatrix} = \begin{bmatrix} \frac{m_1}{M} & \frac{m_2}{M} \\ 1 & -1 \end{bmatrix} \cdot \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} \quad ; \quad \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} 1 & \frac{m_2}{M} & 0 & 0 \\ 1 & -\frac{m_1}{M} & 0 & 0 \end{bmatrix} \cdot \begin{bmatrix} \bar{x} \\ \delta \\ \dot{\bar{x}} \\ \dot{\delta} \end{bmatrix}$$

$$y = C \cdot z$$

$$\therefore \begin{cases} \dot{z} = Az + Bu \\ y = Cz \end{cases}$$