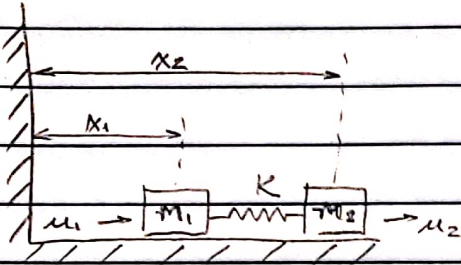


Exercício



$$\begin{cases} \bar{x} = \frac{m_1 \cdot x_1 + m_2 \cdot x_2}{m_1 + m_2} = \frac{m_2 \cdot x_1 + m_2 \cdot x_2}{M} \\ \delta = x_1 - x_2 \end{cases}$$

Sistema dinâmico:

$$\begin{cases} \ddot{\bar{x}} = \frac{u_1 + u_2}{M} \\ \ddot{\delta} = \frac{-KM}{m_1 \cdot m_2} \delta + \frac{u_1}{M_1} - \frac{u_2}{M_2} \end{cases}$$

Espaço de estados:

$$\begin{bmatrix} \dot{\bar{x}} \\ \dot{\delta} \\ \ddot{\bar{x}} \\ \ddot{\delta} \end{bmatrix} = \begin{bmatrix} 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 \\ 0 & -KM/m_1 \cdot m_2 & 0 & 0 \end{bmatrix} \begin{bmatrix} \bar{x} \\ \delta \\ \dot{\bar{x}} \\ \dot{\delta} \end{bmatrix} + \begin{bmatrix} 0 & 0 \\ 0 & 0 \\ 1/M & 1/M \\ 1/m_1 & -1/m_2 \end{bmatrix} \begin{bmatrix} u_1 \\ u_2 \end{bmatrix} \Rightarrow \dot{z} = Az + Bu$$

Com variáveis \bar{x} e δ

$$\begin{bmatrix} \bar{x} \\ \delta \end{bmatrix} = \begin{bmatrix} m_1/M & m_2/M \\ 1 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

$$y = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} 1 & m_2/M & 0 & 0 \\ 1 & -m_1/M & 0 & 0 \end{bmatrix} \begin{bmatrix} \bar{x} \\ \delta \\ \dot{\bar{x}} \\ \dot{\delta} \end{bmatrix} \Rightarrow y = Cz \quad \begin{cases} \dot{z} = Az + Bu \\ y = Cz \end{cases}$$