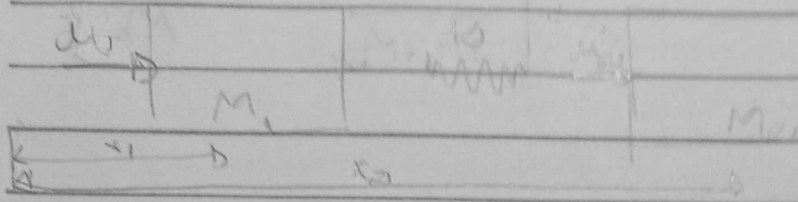


Aula 01, 10

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$$x_G = \bar{x} = \frac{M_1 x_1 + M_2 x_2}{M_1 + M_2} = \frac{M_1 x_1 + M_2 x_2}{M}$$

$$\delta = x_1 - x_2$$

$$\dot{\delta} = \dot{x}_1 - \dot{x}_2$$

$$1^a \text{ lei: } m_1 + m_2 = M \ddot{x}$$

$$m_2 + k(x_2 - x_1) = M_2 \ddot{x}_2$$

$$m_1 - k(x_2 - x_1) = M_1 \ddot{x}_1$$

$$\ddot{x} = \frac{m_1 + m_2}{M} \ddot{x} \quad \text{e} \quad \ddot{\delta} = \frac{m_1}{M_1} \ddot{x}_1 - \frac{m_2}{M_2} \ddot{x}_2 - \frac{kM\delta}{M_1 M_2}$$

$$u = \begin{bmatrix} m_1 \\ m_2 \end{bmatrix} \quad \delta = \begin{bmatrix} \bar{x} \\ \delta \\ \dot{x} \\ \dot{\delta} \end{bmatrix} \quad \dot{\delta} = \begin{bmatrix} \dot{\bar{x}} \\ \dot{\delta} \\ \ddot{x} \\ \ddot{\delta} \end{bmatrix}$$

Espaço de Estados:

$$\begin{bmatrix} \dot{\bar{x}} \\ \dot{\delta} \\ \ddot{x} \\ \ddot{\delta} \end{bmatrix} = \begin{bmatrix} 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 \\ 0 & -\frac{kM}{M_1 M_2} & 0 & 0 \end{bmatrix} \begin{bmatrix} \bar{x} \\ \delta \\ \dot{x} \\ \dot{\delta} \end{bmatrix} + \begin{bmatrix} 0 & 0 \\ 0 & 0 \\ \frac{1}{M} & \frac{1}{M} \\ \frac{1}{M_1} & \frac{1}{M_2} \end{bmatrix} \begin{bmatrix} u_1 \\ u_2 \end{bmatrix}$$

$$\dot{Z} = AZ + Bu \rightarrow DZ = AZ + Bu$$

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$$\begin{bmatrix} \dot{x} \\ \delta \end{bmatrix} = \begin{bmatrix} \frac{M_1}{M} & \frac{M_2}{M} \\ 1 & -1 \\ -1 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} \quad L = \begin{bmatrix} M & M_2 \\ M_1+M_2 & M \\ M & -M_1 \\ M_1+M_2 & M \end{bmatrix}$$

$$L = \begin{bmatrix} 1 & M_2/M \\ 1 & -M_1/M \end{bmatrix}$$

$$\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} 1 & M_2/M & 0 & 0 \\ 1 & -M_1/M & 0 & 0 \end{bmatrix} \begin{bmatrix} \dot{x} \\ \delta \\ x_1 \\ \delta \end{bmatrix}$$

$$y = C\bar{z}$$
$$\dot{\bar{z}} = A\bar{z} + Bw$$