→ As equações diferenciais foram obtidas nos exercícios da aula 27/08

2. $x = [x \ y \ \dot{x} \ \dot{y}]^T$

$\dot{x} = [\dot{x} \ \dot{y} \ \ddot{x} \ \ddot{y}]^T$

$$A = \begin{bmatrix} 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ -K_1/m & K_1/m & -b/m & b/m \\ K_1/m & -\frac{(K_1+K_2)}{m} & b/m & -b/m \end{bmatrix}$$

$\dot{x} = Ax + B \cdot z$

↳ matriz referente ao nível $z(t)$

$B = [0 \ 0 \ 0 \ \frac{K_2}{m}]^T$

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3. $x = [x \ y \ \dot{x} \ \dot{y}]^T$

$\dot{x} = [\dot{x} \ \dot{y} \ \ddot{x} \ \ddot{y}]^T$

$$A = \begin{bmatrix} 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ -K/m & K/m & -b/m & b/m \\ K/m & -K/m & b/m & -b/m \end{bmatrix} \qquad B = \begin{bmatrix} 0 \\ 0 \\ \frac{1}{M} \\ 0 \end{bmatrix}$$

$\dot{x} = Ax + BU$

↳ matriz referente à força $u(t)$

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4. $x = [x_1 \ x_2 \ x_G \ \theta \ \dot{x}_1 \ \dot{x}_2 \ \dot{x}_G \ \dot{\theta}]^T$

$\dot{x} = [\dot{x}_1 \ \dot{x}_2 \ \dot{x}_G \ \dot{\theta} \ \ddot{x}_1 \ \ddot{x}_2 \ \ddot{x}_G \ \ddot{\theta}]^T$

$$B = \begin{bmatrix} 0 & 0 & 0 & 0 & \frac{K_P}{m_1} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & \frac{K_P}{m_2} & 0 & 0 \end{bmatrix}^T$$

$$A = \begin{bmatrix} 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ -\frac{(K+K)}{m_1} & 0 & \frac{K_1}{m_1} & \frac{K_1 l}{m_1} & -\frac{K_1}{m_1} & 0 & \frac{b_1}{m_1} & \frac{b_1 l}{m_1} \\ 0 & -\frac{(K_1+K)}{m_2} & \frac{K_2}{m_2} & -\frac{K_2 l}{m_2} & 0 & -\frac{b_2}{m_2} & \frac{b_2}{m_2} & -\frac{b_2 l}{m_2} \\ \frac{K_1}{m} & \frac{K_2}{m} & -\frac{(K_1+K_2)}{m} & \frac{(K_2-K_1)l}{m} & \frac{b_1}{m} & \frac{b_2}{m} & -\frac{(b_1+b_2)}{m} & \frac{(b_2-b_1)l}{m} \\ \frac{K_1 l}{J} & -\frac{K_2 l}{J} & \frac{(K_2-K_1)l}{J} & -\frac{(K_1+K_2)l^2}{J} & \frac{b_1 l}{J} & -\frac{b_2 l}{J} & \frac{(b_2-b_1)l}{J} & \frac{(b_1-b_2)l^2}{J} \end{bmatrix}$$

5.

$$X = [x \;\; \theta \;\; \dot{x} \;\; \dot{\theta}]^T$$

$$\dot{X} = [\dot{x} \;\; \dot{\theta} \;\; \ddot{x} \;\; \ddot{\theta}]^T$$

$$B = \left[0 \;\; 0 \;\; \frac{1}{(M+m) - \frac{m^2 l^2}{J}} \;\; \frac{-mgl}{J(M+m) - m^2 l^2}\right]^T$$

$$A = \begin{bmatrix} 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & \frac{-m^2 l^2}{J(M+m) - m^2 l^2} & 0 & 0 \\ 0 & \frac{mgl(M+m)}{J(M+m) - m^2 l^2} & 0 & 0 \end{bmatrix}$$

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$$x = [x \;\; \dot{x} \;\; I]^T$$

$$\dot{x} = [\dot{x} \;\; \ddot{x} \;\; \dot{I}]^T$$

$$A = \begin{bmatrix} 0 & 1 & 0 \\ \frac{2K I_0^2}{m x_0^3} & 0 & \frac{-2K I_0}{m x_0^2} \\ 0 & 0 & -\frac{R}{L} \end{bmatrix} \qquad B = \begin{bmatrix} 0 \\ 0 \\ \frac{1}{L} \end{bmatrix}$$