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② $M\ddot{x} + b(\dot{x} - \dot{y}) + K_1(x - y) = 0$

$m\ddot{y} + b(\dot{y} - \dot{x}) + K_1(y - x) + K_2(y - z) = 0$

$X_1 = x \qquad \dot{X}_1 = X_3$

$X_2 = y \qquad \dot{X}_2 = X_4$

$X_3 = \dot{x} \qquad \dot{X}_3 = \frac{[-b(\dot{x} - \dot{y}) - K_1(x - y)}{M} \quad \frac{- b(X_3 - X_4) - K_1(X_1 - X_2)}{M}$

$X_4 = \dot{y}$

$\dot{X}_4 = \frac{[-b(y - x) - K_1(y - x) - K_2(y - z)]}{m} = -$

$\dot{X}_4 = \frac{[-b(X_4 - X_3) - K_1(X_2 - X_1) - K_2(X_2 - z)]}{m}$

$$A = \begin{bmatrix} 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ -\frac{K_1}{M} & \frac{K_1}{M} & -\frac{b}{M} & \frac{b}{M} \\ \frac{K_1}{m} & -\frac{2K_2}{m} & \frac{b}{m} & -\frac{b}{m} \end{bmatrix} \quad B = \begin{bmatrix} C \\ 0 \\ 0 \\ \frac{K_2}{m} \end{bmatrix} \quad C = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \end{bmatrix} \quad D = [0]$$

③ $\begin{cases} m\ddot{y} + b(\dot{y} - \dot{x}) + K(y - x) = 0 \\ M\ddot{x} - b(\dot{y} - \dot{x}) - K(y - x) = u \end{cases}$

$$x = \begin{bmatrix} y \\ x \\ \dot{x} \\ \dot{y} \end{bmatrix} \qquad \dot{x} = Ax + B$$

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$$\begin{bmatrix} \dot{x} \\ \dot{y} \\ \ddot{x} \\ \ddot{y} \end{bmatrix} = \begin{bmatrix} 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ -\frac{K}{M} & \frac{K}{M} & -\frac{b}{M} & \frac{b}{M} \\ \frac{K}{m} & -\frac{K}{m} & \frac{b}{m} & -\frac{b}{m} \end{bmatrix} \begin{bmatrix} x \\ y \\ \dot{x} \\ \dot{y} \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ \frac{1}{M} \\ 0 \end{bmatrix} u(t)$$

⑤ $M\ddot{x} + m\ddot{x} - ml\dot{\theta}^2 \operatorname{sen}\theta - ml\ddot{\theta}\cos\theta = u$

$\frac{4}{3}ml^2\ddot{\theta} - mgl\operatorname{sen}\theta + \ddot{x}\cos\theta = 0$

$$w(t) = \begin{bmatrix} x \\ \theta \\ \dot{x} \\ \dot{\theta} \end{bmatrix}$$

$$\begin{bmatrix} \dot{x} \\ \dot{\theta} \\ \ddot{x} \\ \ddot{\theta} \end{bmatrix} = \begin{bmatrix} w_{i1} \\ w_{i2} \\ w_{i3} \\ w_{i4} \end{bmatrix} = \begin{bmatrix} w_3 \\ w_4 \\ \left(g - \frac{ml\omega_4^2}{M+m}\cos\omega_2\right)\operatorname{sen}\omega_2 - \frac{u+ml\cos\omega_2}{M+m} \\ \left(u(t) + ml\omega_4^2\operatorname{sen}\omega_2 + \frac{3}{4}mg\operatorname{sen}\omega_2\cos\omega_2\right)\left(\frac{4l}{3} + \frac{ml\cos^2\omega_2}{M+m}\right)^{-1} \end{bmatrix}$$

⑥ $m\ddot{x} = mg - \frac{Kx^2}{r^2}$ $\qquad \dot{x}_1 = x_2$

$\dot{x}_2 = g - \frac{Kx_3^2}{mx_1^2}$

$L\frac{di}{dt} + Ri = V$ $\qquad \dot{x}_3 = -\frac{R}{L}x_3 + \frac{1}{L}V$

$$A = \begin{bmatrix} 0 & 1 & 0 \\ \frac{2Kx_3^2}{mx_1^3} & 0 & -\frac{2Kx_3}{mx_1^2} \\ 0 & 0 & -\frac{R}{L} \end{bmatrix} \qquad B = \begin{bmatrix} 0 \\ 0 \\ \frac{1}{L} \end{bmatrix}$$