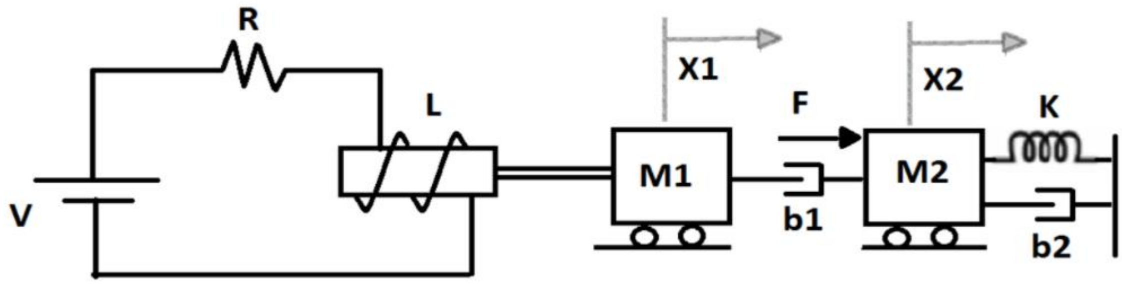

$$v = iR + L\frac{di}{dt} + K_b\dot{x}_1$$

$$M_1\ddot{x}_1 = K_i i - b_1(\dot{x}_1 - \dot{x}_2)$$

$$M_2\ddot{x}_2 = F - b_1(\dot{x}_2 - \dot{x}_1) - b_2\dot{x}_2 - kx_2$$

V.E:

$$\begin{bmatrix} X_1 \\ X_2 \\ X_3 \\ X_4 \\ X_5 \end{bmatrix} = \begin{bmatrix} x_1 \\ \dot{x}_1 \\ x_2 \\ \dot{x}_2 \\ i \end{bmatrix}$$

$$\begin{bmatrix} u_1 \\ u_2 \end{bmatrix} = \begin{bmatrix} v \\ F \end{bmatrix}$$

$$\begin{bmatrix} y_1 \\ y_2 \end{bmatrix} = \begin{bmatrix} x_2 \\ x_1 \end{bmatrix} = \begin{bmatrix} X_3 \\ X_1 \end{bmatrix}$$

Derivamos los estados:

$$\boldsymbol{\dot{X}_1 = X_2}$$

$$\boldsymbol{\dot{X}_3 = X_4}$$

$$\dot{X}_5 = \frac{di}{dt} = ?$$

$$\frac{v - iR - K_b\dot{x}_1}{L} = \frac{di}{dt}$$

$$\boldsymbol{\dot{X}_5 = \frac{u_1 - X_5R - K_bX_2}{L}}$$

$$\dot{X}_2 = \ddot{x}_1 = ?$$

$$\ddot{x}_1 = \frac{K_i i - b_1(\dot{x}_1 - \dot{x}_2)}{M_1}$$

$$\boldsymbol{\dot{X}_2 = \frac{K_iX_5 - b_1(X_2 - X_4)}{M_1}}$$

$$\dot{X}_4 = \ddot{x}_2 = ?$$

$$\ddot{x}_2 = \frac{F - b_1(\dot{x}_2 - \dot{x}_1) - b_2\dot{x}_2 - kx_2}{M_2}$$

$$\dot{\boldsymbol{X}}_{\boldsymbol{4}} = \frac{\boldsymbol{u_2 - b_1(X_4 - X_2) - b_2X_4 - kX_3}}{\boldsymbol{M_2}}$$

$$\boxed{\begin{bmatrix} \dot{X}_1 \\ \dot{X}_2 \\ \dot{X}_3 \\ \dot{X}_4 \\ \dot{X}_5 \end{bmatrix} = \begin{pmatrix} 0 & 1 & 0 & 0 & 0 \\ 0 & -b_1/M_1 & 0 & b_1/M_1 & K_i/M_1 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & b_1/M_2 & -k/M_2 & -(b_1+b_2)/M_2 & 0 \\ 0 & -K_b/L & 0 & 0 & -R/L \end{pmatrix} \begin{bmatrix} X_1 \\ X_2 \\ X_3 \\ X_4 \\ X_5 \end{bmatrix} + \begin{pmatrix} 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 1/M_2 \\ 1/L & 0 \end{pmatrix} \begin{bmatrix} u_1 \\ u_2 \end{bmatrix}}$$

$$\boxed{\begin{bmatrix} y_1 \\ y_2 \end{bmatrix} = \begin{pmatrix} 0 & 0 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \end{pmatrix} \begin{bmatrix} X_1 \\ X_2 \\ X_3 \\ X_4 \\ X_5 \end{bmatrix}}$$