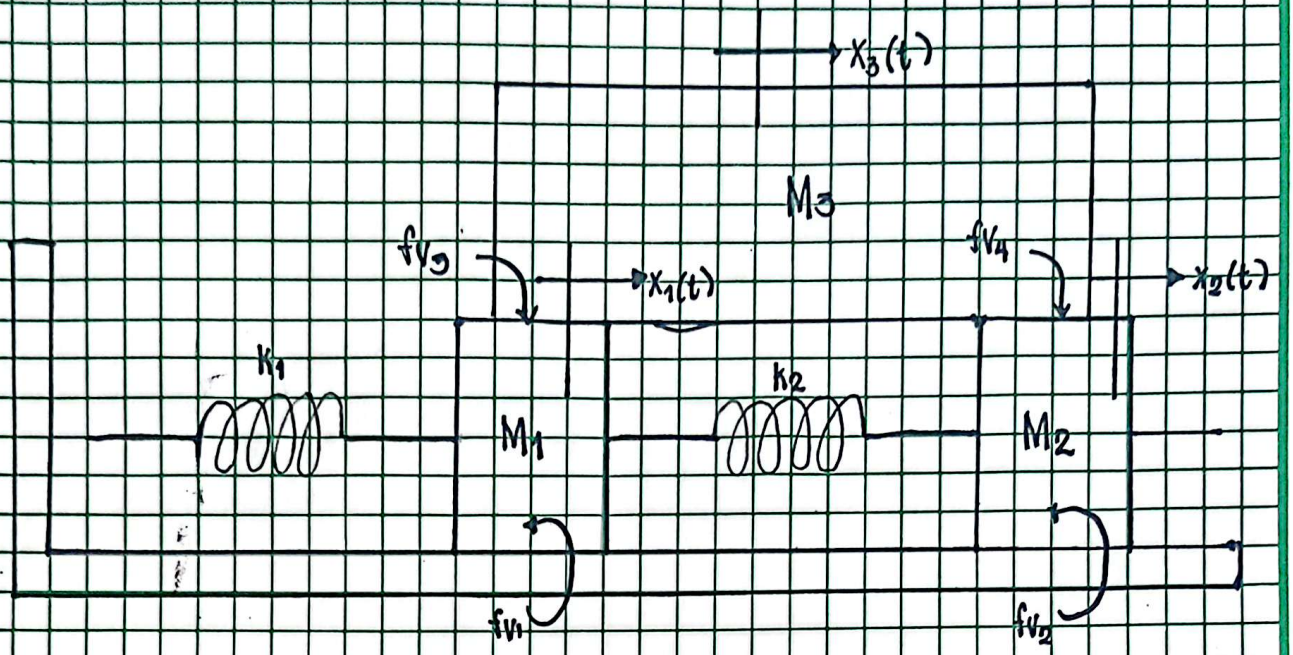
PROBLEM 1



FOR M_1

$$0 = M_1\ddot{x}_1 + B_1\dot{x}_1 + B_3\dot{x}_1 + K_1x_1 + K_2x_1 - B_3\dot{x}_3 - K_2x_2$$

$$f(t) = M_2\ddot{x}_2 + B_2\dot{x}_2 + B_1\dot{x}_2 + K_2x_2 - B_1\dot{x}_3 - K_2x_1$$

$$0 = M_3\ddot{x}_3 + B_3\dot{x}_3 + B_4\dot{x}_3 - B_1\dot{x}_1 - B_2x_2$$

$x_1 = x_1(t)$ $\quad x_3 = x_2(t)$ $\quad x_5 = x_3(t)$

$x_2 = \dot{x}_1(t)$ $\quad x_4 = \dot{x}_2(t)$ $\quad x_6 = \dot{x}_3(t)$

$\dot{x}_1 = \dot{x}_1(t) = x_2$ $\quad \dot{x}_3 = \dot{x}_2(t) = x_4$ $\quad \dot{x}_5 = \dot{x}_3(t) = x_6$

$\dot{x}_2 = \ddot{x}_2(t)$ $\quad \dot{x}_4 = \ddot{x}_2(t)$ $\quad \dot{x}_6 = \ddot{x}_3$

$$\dot{x} = 0x_1 + x_2 + 0x_3 + 0x_4 + 0x_5 + 0x_6 + 0u_1$$

$$\dot{x}_2 = -\left(\frac{K_1 + K_2}{M_1}\right)x_1 - \left(\frac{B_1 + B_3}{M_1}\right)x_2 + \left(\frac{K_2}{M_1}\right)x_3 + 0x_4 + 0x_5 + \left(\frac{B_3}{M_1}\right)x_6 + 0u_1$$

$$\dot{x}_3 = 0x_1 + 0x_2 + 0x_3 + x_4 + 0x_5 + 0x_6 + 0u_1$$

$$\dot{x}_4 = \left(\frac{K_2}{M_2}\right)x_1 + 0x_2 - \left(\frac{K_2}{M_2}\right)x_3 - \left(\frac{B_2 + B_4}{M_2}\right)x_4 - 0x_5 + \left(\frac{B_4}{M_2}\right)x_6 + 0u_1$$

$$\dot{x}_5 = 0x_1 + 0x_2 + 0x_3 + 0x_4 + 0x_5 + x_6 + 0u_1$$

$$\dot{x}_6 = 0x_1 + \left(\frac{B_1}{M_3}\right)x_2 - 0x_3 + \left(\frac{B_2}{M_3}\right)x_4 + 0x_5 - \left(\frac{B_3 + B_4}{M_3}\right)x_6 + 0u_1$$

$Y_1 = X_1 + OU_1$
$Y_2 = X_3 + OU_1$
$Y_3 = X_5 + OU_1$

STATE SPACE EQUATION

$$\begin{bmatrix} \dot{X}_1 \\ \dot{X}_2 \\ \dot{X}_3 \\ \dot{X}_4 \\ \dot{X}_5 \\ \dot{X}_6 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 & 0 & 0 & 0 \\ -\left(\frac{K_1+K_2}{M_1}\right) & -\left(\frac{B_1+B_3}{M_1}\right) & \frac{K_2}{M_1} & 0 & 0 & \frac{B_3}{M_1} \\ 0 & 0 & 0 & 1 & 0 & 0 \\ \frac{K_2}{M_2} & 0 & -\frac{K_2}{M_2} & -\frac{B_2+B_4}{M_2} & 0 & \frac{B_4}{M_2} \\ 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & \frac{B_1}{M_3} & 0 & \frac{B_2}{M_3} & 0 & -\frac{B_2+B_4}{M_3} \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ X_3 \\ X_4 \\ X_5 \\ X_6 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ \frac{1}{M_2} \\ 0 \\ 0 \\ 0 \end{bmatrix} U_1$$

$$Y = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ X_3 \\ X_4 \\ X_5 \\ X_6 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix} U_1$$

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