Consider a two degree of freedom system as shown below:

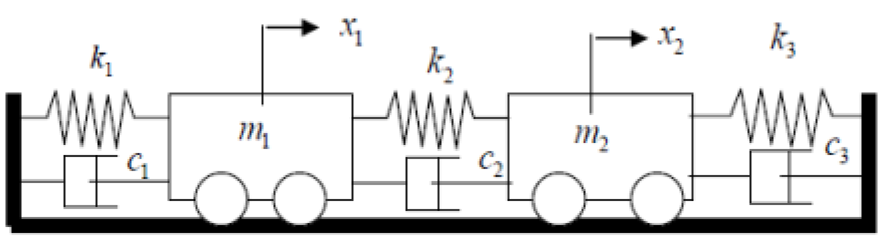

Figure 1: Two degree of Freedom system

The stiffness matrix is given by the equation below:

$$\begin{bmatrix} m_1 & 0 \\ 0 & m_2 \end{bmatrix} \begin{pmatrix} \ddot{x}_1 \\ \ddot{x}_2 \end{pmatrix} + \begin{bmatrix} k_1 + k_2 & -k_2 \\ -k_2 & k_2 + k_3 \end{bmatrix} \begin{pmatrix} x_1 \\ x_2 \end{pmatrix} + \begin{bmatrix} c_1 + c_2 & -c_2 \\ -c_2 & c_2 + c_3 \end{bmatrix} \begin{pmatrix} \dot{x}_1 \\ \dot{x}_2 \end{pmatrix} = 0$$

Step 1: Transform the equation to system of differential equations:

The stiffness matrix can be represented using a system of two differential equations

$$m_1\ddot{x_1} + (k_1 + k_2)x_1 - k_2x_2 + (c_1 + c_2)\dot{x_1} - c_2\dot{x_2} = 0 - - - (1)$$

$$m_2\ddot{x_2} - k_2x_1 + (k_2 + k_3)x_2 - c_2\dot{x_1} + (c_2 + c_3)\dot{x_2} = 0 - - - (2)$$

Step 2: Rearrange the Equations by making $\ddot{x_1}$ and $\ddot{x_2}$ the subject of the formula

The equation can be rearranged as follows:

$$m_1\ddot{x_1} = -(k_1 + k_2)x_1 + k_2x_2 - (c_1 + c_2)\dot{x_1} + c_2\dot{x_2} - - - (4)$$

$$m_2\ddot{x_2} = k_2x_1 - (k_2 + k_3)x_2 + c_2\dot{x_1} - (c_2 + c_3)\dot{x}_2 - - - (5)$$

Also, the equation (4) and (5) can be designed such that:

$$\ddot{x_1} = \frac{1}{m_1}(-(k_1 + k_2)x_1 + k_2x_2 - (c_1 + c_2)\dot{x_1} + c_2\dot{x_2}) \; - -(6)$$

$$\ddot{x_2} = \frac{1}{m_2}\;(k_2x_1 - (k_2 + k_3)x_2 + c_2\dot{x_1} - (c_2 + c_3)\dot{x}_2) - -(7)$$

Step 3: Transform to four system of equation for Matlab

Let $x(1) = x_1$, $x(2) = x_2$, $x(3) = \dot{x_1}$, $x(4) = \dot{x}_2$

$$\dot{x_1} = x(3)$$

$$\dot{x}_2 = x(4)$$

$$\ddot{x_1} = \frac{1}{m_1}(-(k_1 + k_2)x_1 + k_2x_2 - (c_1 + c_2)\dot{x_1} + c_2\dot{x_2}) \; - -(6)$$

$$\ddot{x_2} = \frac{1}{m_2}\ (k_2 x_1 - (k_2 + k_3)x_2 + c_2\dot{x_1} - (c_2 + c_3)\dot{x}_2) - -(7)$$