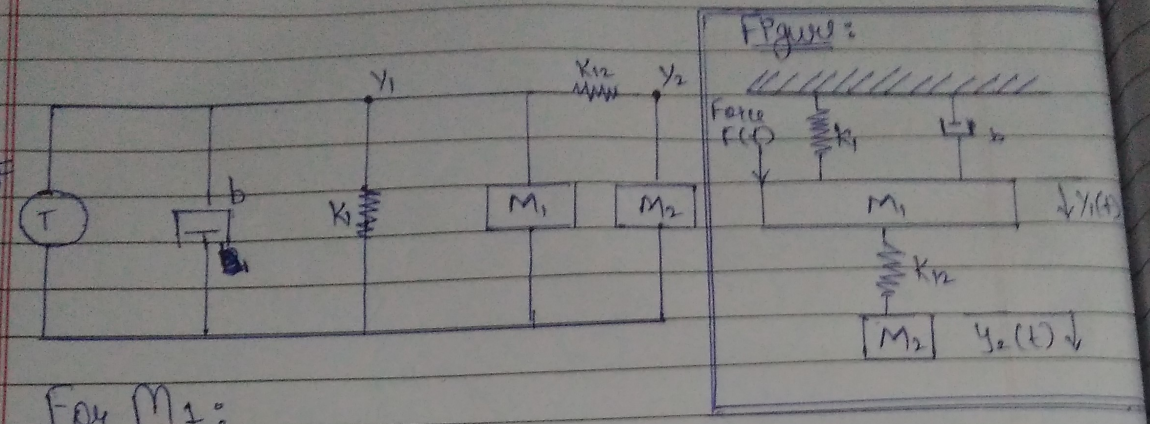
# Problem 1




For $M_1$:

$$F = M_1 \frac{d^2y_1}{dt^2} + b\frac{dy_1}{dt} + k_1 y_1 + k_{12}(y_1 - y_2) = F \quad \text{——} (1)$$

For $M_2$:

$$M_2 \frac{d^2y_2}{dt^2} + k_{12} y_2 = k_{12} y_1 \quad \text{——} (2)$$

$$M_2 \frac{d^2y_2}{dt^2} + K_{12}(y_2 - y_1) = 0$$

Given:

$F = 2\sin(10t)$

$M_1 = 100$

$K_1 = 50$

$b = 50$

To get:

$M_2 = ?$

$K_{12} = ?$

Taking the Laplace transform of both equations and writing the result in matrix form

$$\begin{bmatrix} M_1 s^2 + bs + k_1 + k_{12} & -k_{12} \\ -k_{12} & M_{12} s^2 + k_{12} \end{bmatrix} \begin{pmatrix} y_1(s) \\ y_2(s) \end{pmatrix} = \begin{pmatrix} F(s) \\ 0 \end{pmatrix}$$

$$\begin{pmatrix} y_1(s) \\ y_2(s) \end{pmatrix} = \frac{1}{\Delta} \begin{bmatrix} M_2 s^2 + k_{12} & k_{12} \\ k_{12} & M_1 s^2 + bs + k_1 \end{bmatrix} \begin{pmatrix} F(s) \\ 0 \end{pmatrix}$$

$\therefore$

$$\Delta = (M_2 s^2 + k_{12})(M_1 s^2 + bs + k_1 + k_{12}) - k_{12}^2$$

we have

$f(t) = a \sin \omega_0 t$, we have $y_1(s)$ given by

$$y_1(s) = \frac{a M_2 \omega_0 (s^2 + k_{12}/M_2)}{(s^2 + \omega_0^2)\,\Delta(s)}$$

In steady state, set the zero of the transfer function so,

$$\omega_0^2 = \frac{k_{12}}{M_2}$$

$\therefore$ given $\omega_0 = 10$ from equation of force

$\therefore$ $100 M_2 = k_{12}$