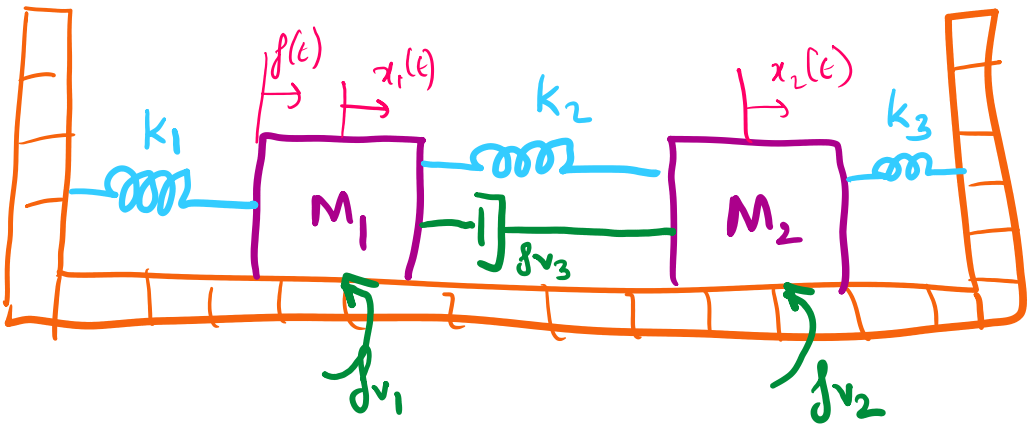
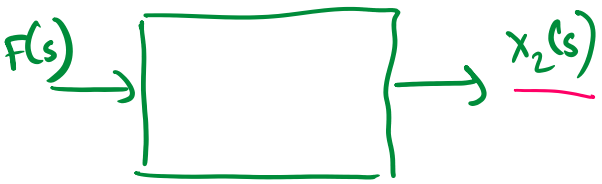
Problem: Find the TF $X_2(s)/F(s)$ for the system given



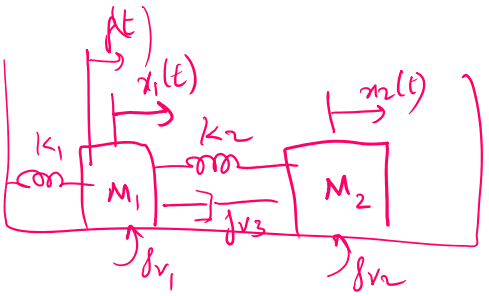


Soln

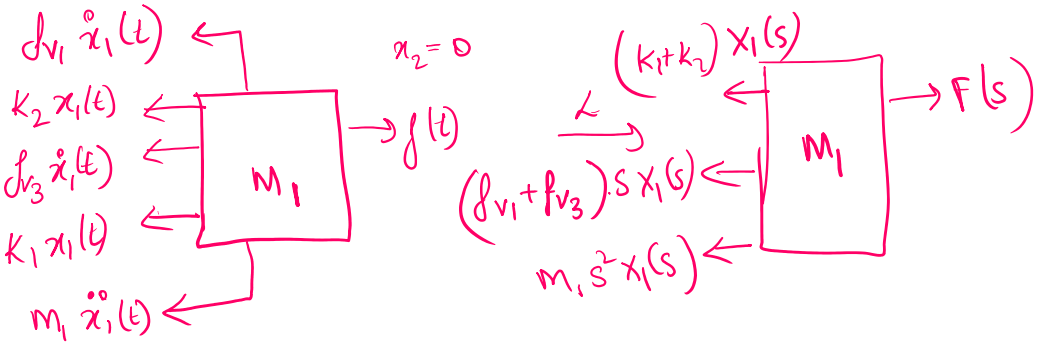
Forces on M_1 due to

(A) its own motion

(B) the motion of M_2 transmitted to M_1 through the system.



(A) Hold M_2 still and move M_1 to the right

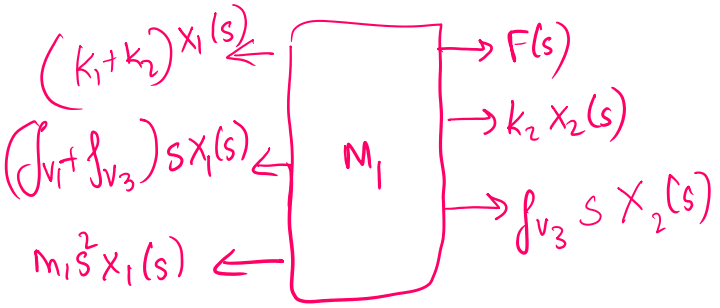


(B) Hold M_1 still and move M_2 to the right

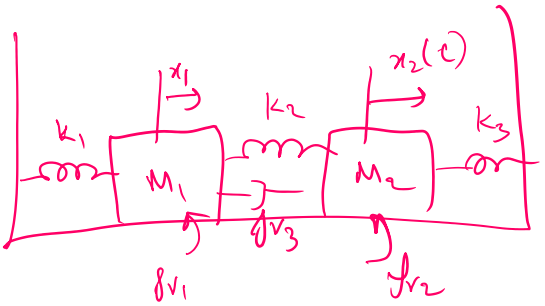
$f_{v_1} = 0 \quad m\ddot{x}_1 = 0$

(B) Hold M_1 still and move M_2 to the right

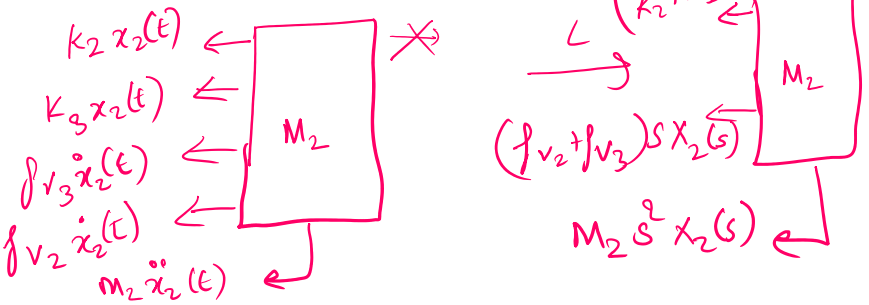
Combine A & B



Similarly for M_2.



(A) Hold M_1 still and move M_2 to the right



(B) Hold M_2 still and move M_1 to the right

Combine (A) & B

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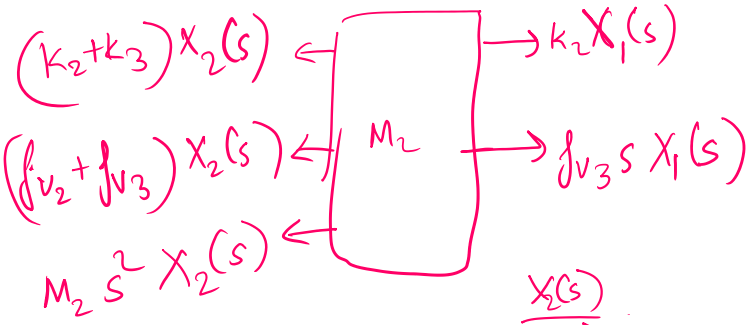

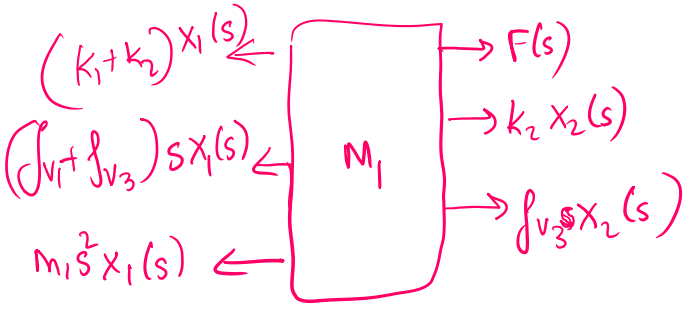

$\frac{X_2(s)}{F(s)}$

M_1

$$\left[M_1 s^2 + (f_{v_1}+f_{v_3})s + (K_1+K_2)\right] X_1(s) = F(s) + \left[K_2 + f_{v_3} s\right] X_2(s) \quad \text{--- (1)}$$

term 1

M_2

$$\left[M_2 s^2 + (f_{v_2}+f_{v_3})s + (K_2+K_3)\right] X_2(s) = \left[K_2 + f_{v_3} s\right] X_1(s) \quad \text{--- (2)}$$

term 2

(2) $$X_1(s) = \frac{\text{term 2} \cdot X_2(s)}{K_2 + f_{v_3} s} \quad \text{--- (3)}$$

$$\text{term 1} \times \frac{\text{term 2} \cdot X_2(s)}{K_2 + f_{v_3} s} = F(s) + \left[K_2 + f_{v_3} s\right] X_2(s)$$

$$\left[\frac{T_1 \times T_2}{K_2 + f_{v_3} s} - \left[K_2 + f_{v_3} s\right]\right] X_2(s) = F(s)$$

$$\boxed{\frac{X_2(s)}{F(s)} = \frac{K_2 + f_{v_3} s}{T_1 \times T_2 - \left[K_2 + f_{v_3} s\right]^2}}$$

$$\boxed{\frac{X_2(s)}{F(s)} = \frac{K_2 + f_{v_3} s}{\Delta}}$$

$F(s)$ Δ

$$\Delta = \begin{vmatrix} M_1 s^2 + (f_{v1} + f_{v3})s + (K_1 + K_2) & K_2 + f_{v3} s \\ K_2 + f_{v3} s & M_2 s^2 + (f_{v2} + f_{v3})s + (K_2 + K_3) \end{vmatrix}$$