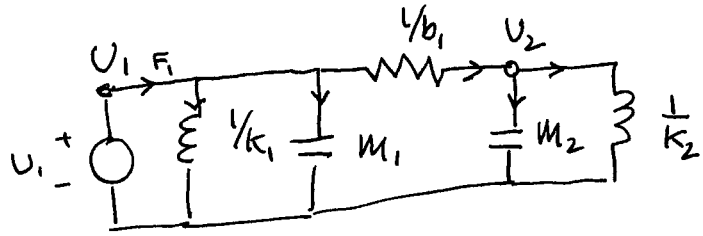
1.

(a)



(b)

$$F_1 = \frac{U_1}{\frac{s}{k_1}} + \frac{U_1}{\frac{1}{M_1 s}} + \frac{U_1 - U_2}{1/b_1}$$

$$\frac{U_1 - U_2}{1/b_1} = \frac{U_2}{\frac{1}{M_2 s}} + \frac{U_2}{s/k_2}$$

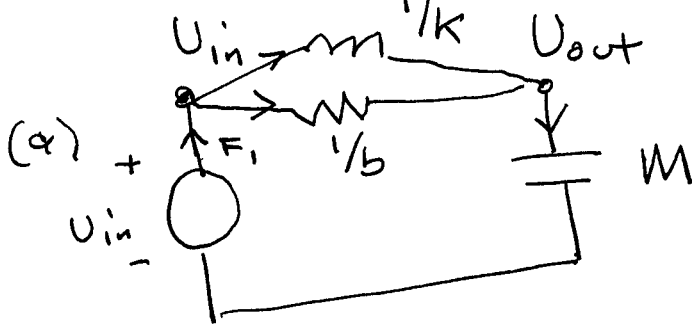
$$\left.\begin{aligned} f_1 &= u_1 k_1 + \ddot{u}_1 M_1 + (u_1 - u_2) b_1 \\ b_1 (u_1 - u_2) &= M_2 \ddot{u}_2 + u_2 k_2 \end{aligned}\right\}$$

(c) U_1 is given @ $U_1 b_1 = U_2 \left[b_1 + M_2 s + \frac{k_2}{s} \right]$

$$\frac{U_2}{U_1} = \frac{b_1 s}{b_1 s + M_2 s^2 + k_2}$$

2.

(a)



(b)

$$F_1 = \frac{U_{in} - U_{out}}{s/k} + \frac{U_{in} - U_{out}}{1/b}$$

$$\frac{U_{in} - U_{out}}{s/k} + \frac{U_{in} - U_{out}}{1/b} = \frac{U_{out}}{\frac{1}{ms}}$$

$$f_1 = [u_{in} - u_{out}]k + b[\dot{u}_{in} - \dot{u}_{out}]$$

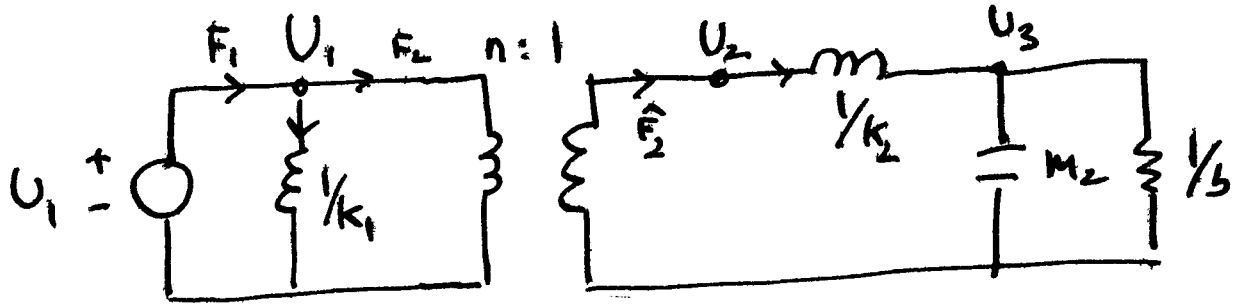
$$k(u_{in} - u_{out}) + b(\dot{u}_{in} - \dot{u}_{out}) = M\ddot{u}_{out}$$

(c)

$$U_{in}\left[\frac{k}{s} + b\right] = U_{out}\left[ms + b + \frac{k}{s}\right]$$

$$\frac{U_{out}}{U_{in}} = \frac{\left(\frac{k}{s} + b\right)}{ms + b + k/s}$$

(3)



(a)

$$n = \frac{l_1}{l_2}$$

(b)

$$F_1 = \frac{U_1}{s/k_1} + F_2 \quad \Longrightarrow \quad \dot{f}_1 = u_1 k \dot{f}_2$$

$$F_2 n = \hat{F}_2$$

$$f_2 n = \hat{f}_2$$

$$U_1 / n = U_2$$

$$u_1 / n = u_2$$

$$\hat{F}_2 = \frac{U_2 - U_3}{s/k_2}$$

$$\dot{\hat{f}}_2 = (u_2 - u_3) k_2$$

$$(u_2 - u_3) k_2 = \ddot{u}_3 M_2 + b \dot{u}_3$$

$$\frac{U_2 - U_3}{s/k_2} = \frac{U_3}{\frac{1}{M_2 s}} + \frac{U_3}{\frac{1}{b}}$$