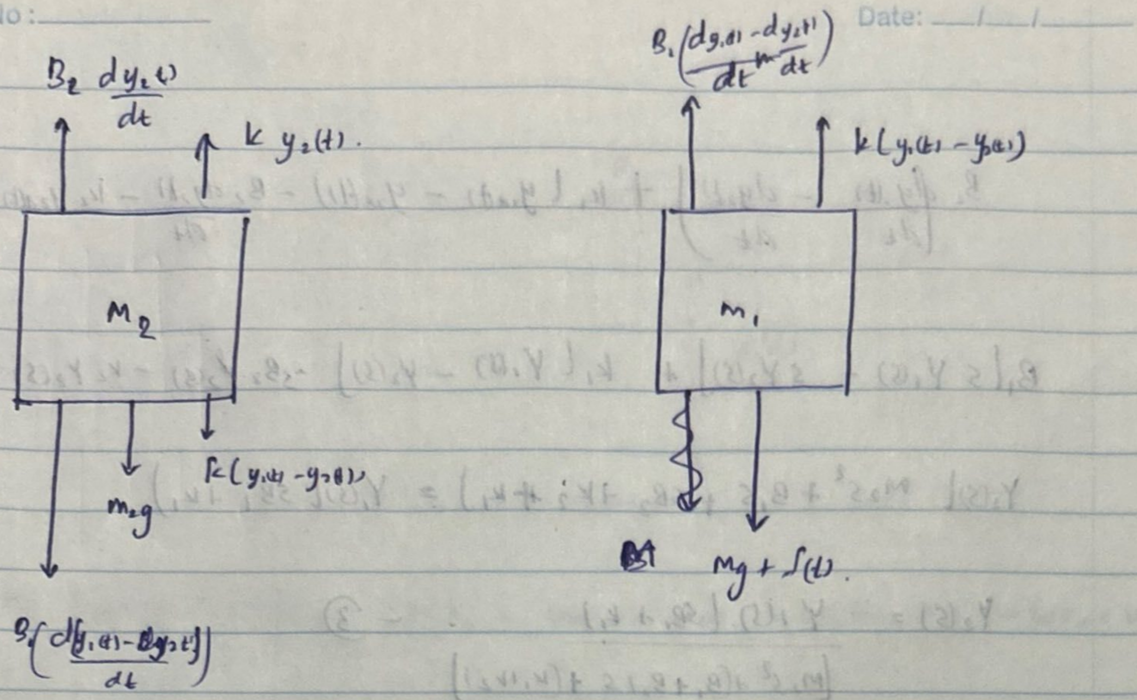
1.



at equilibrium.

$$\cancel{M_2 g = k y_{2,0}} \qquad M_2 g = k_2 y_2^{\circ}(t) - k_1(y_1^{\circ} - y_2^{\circ})(t).$$

$$M_1 g = k_1(y_1^{\circ} - y_2^{\circ}(t))$$

$$y_1(t) = y_1^{\circ}(t) + y_{1d}(t) \quad — (1)$$

$$y_2(t) = y_2^{\circ}(t) + y_{2d}(t) \quad — (2)$$

$$\frac{dy_1(t)}{dt} = \frac{dy_{1d}(t)}{dt}, \quad \frac{dy_2(t)}{dt} = \frac{dy_{2d}(t)}{dt}$$ Since $y_1^{\circ}(t)$ and $y_2^{\circ}(t)$ are constant.

$F = ma$ ↓ for M_2

$$M_2 g + B_1\left(\frac{dy_1(t)}{dt} - \frac{dy_2(t)}{dt}\right) + k(y_1(t) - y_2(t)) - B_2\frac{dy_2(t)}{dt} - k y_2(t) = M_2\frac{d^2y_2(t)}{dt^2}$$

$$M_2 g + B_1\left(\frac{dy_1(t)}{dt} - \frac{dy_2(t)}{dt}\right) + k_1[y_1^{\circ}(t) + y_{1d}(t) - y_2^{\circ}(t) - y_{2d}(t)] - B_2\frac{dy_2(t)}{dt} - k[y_2^{\circ}(t) + y_{2d}(t)] = M_2\frac{d^2y_2(t)}{dt}.$$

$$\cancel{M_2 g - k_1[y_1^{\circ}(t) - y_2^{\circ}(t)] +}$$

$$\underbrace{M_2 g - [k_2 y_2^{\circ}(t) - k_1[y_1^{\circ}(t) - y_2^{\circ}(t)]]}_{=0} + B_1\left(\frac{dy_1(t)}{dt} - \frac{dy_2(t)}{dt}\right) + k_1[y_{1d}(t) - y_{2d}(t)] - k_2 y_{2d}(t) = M\frac{d^2y_2(t)}{dt^2}.$$

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$$B_1\left(\frac{dy_1(t)}{dt} - \frac{dy_2(t)}{dt}\right) + k_1\left(y_{1a}(t) - y_{2a}(t)\right) - B_2\frac{dy_2(t)}{dt} - k_2 y_{2a}(t) = M_2\frac{d^2y_2(t)}{dt}$$

$$B_1\left[sY_1(s) - sY_2(s)\right] + k_1\left[Y_1(s) - Y_2(s)\right] - sB_2Y_2(s) - k_2Y_2(s) = M_2 s^2 Y_2(s)$$

$$Y_2(s)\left[M_2s^2 + B_1s + sB_2 + k_2 + k_1\right] = Y_1(s)\left[sB_1 + k_1\right]$$

$$Y_2(s) = \frac{Y_1(s)\left[sB_1 + k_1\right]}{\left[M_2s^2 + (B_1+B_2)s + (k_1+k_2)\right]} \quad - (3)$$

for M_1 ↓ $f = ma$.

$$M_1 g + f(t) - k_1\left(y_1(t) - y_2(t)\right) - B_1\left(\frac{dy_1(t)}{dt} - \frac{dy_2(t)}{dt}\right) = M_1\frac{d^2y_1(t)}{dt^2}$$

$$\cancel{M_1 g} + f(t) - \cancel{M_1 g} - k_1\left(y_{1a}(t) - y_{2a}(t)\right) - B_1\left(\frac{dy_1(t)}{dt} - \frac{dy_2(t)}{dt}\right) = M_1\frac{d^2y_1(t)}{dt^2}$$

$$F(s) - k_1\left[Y_1(s) - Y_2(s)\right] - B_1s\left[Y_1(s) - Y_2(s)\right] = s^2M_1Y_1(s)$$

$$f(s) = \left[M_1s^2 + k_1 + B_1s\right]Y_1(s) - Y_2(s)\left[k_1 + B_1s\right]$$

from (3)

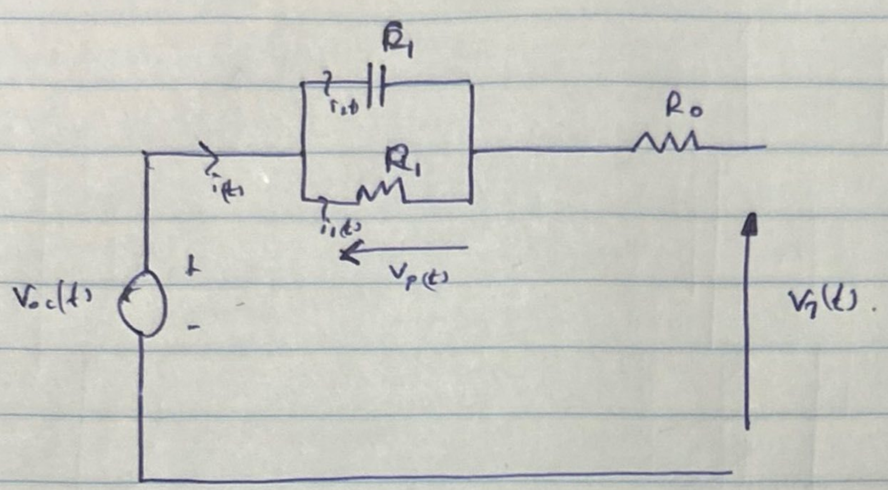
$$f(s) = \left[M_1s^2 + B_1s + k_1\right]Y_1(s) - \frac{(k_1+B_1s)\left[Y_1(s)(sB_1+k_1)\right]}{\left[M_2s^2 + (B_1+B_2)s + (k_1+k_2)\right]}$$

$$f(s) = Y_1(s)\left[\frac{(M_1s^2+B_1s+k_1)\left[M_2s^2+(B_1+B_2)s+(k_1+k_2)\right] - (sB_1+k_1)^2}{M_2s^2+(B_1+B_2)s+(k_1+k_2)}\right]$$

$$\frac{Y_1(s)}{f(s)} = \frac{M_2s^2 + (B_1+B_2)s + (k_1+k_2)}{\left[(M_1s^2+B_1s+k_1)\left[M_2s^2+(B_1+B_2)s+(k_1+k_2)\right] - (sB_1+k_1)^2\right]}$$

Atlas

2).



$$V_{oc}(t) - V_p(t) - i(t)R_0 = V_T(t). \Rightarrow k\,SOC(t) - V_p(t) - i(t)R_0 = V_T(t).$$

$$i(t) = i_1(t) + i_2(t).$$

$$i(t) = \frac{V_p(t)}{R} + \frac{C\,dV_p(t)}{dt}$$

$$\frac{dV_p(t)}{dt} = -\frac{V_p(t)}{RC} + \frac{i(t)}{C}$$

$$\frac{dSOC(t)}{dt} = \frac{i(t)}{Q}.$$

$$\begin{bmatrix} \frac{dV_p(t)}{dt} \\ \frac{dSOC(t)}{dt} \end{bmatrix} = \begin{bmatrix} -\frac{1}{RC} & 0 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} V_p(t) \\ SOC(t) \end{bmatrix} + \begin{bmatrix} \frac{1}{C} \\ \frac{1}{Q} \end{bmatrix} i(t)$$

$$V_T(t) = \begin{bmatrix} -1 & k \end{bmatrix} \begin{bmatrix} V_p(t) \\ SOC(t) \end{bmatrix} + \begin{bmatrix} -R_0 \end{bmatrix} i(t)$$