

(b)  $u_3 = 0$

node  $u_1$ : 
$$\bar{f} = \frac{U_1}{\frac{1}{m_1 s}} + \frac{U_1 - U_2}{\frac{s}{k_1}} + \frac{U_1}{\frac{s}{k_2}} \Rightarrow \bar{f} = m_1 U_1 s + \frac{k_1(U_1 - U_2) + k_2 U_1}{s}$$

node  $u_2$ : 
$$\frac{U_1 - U_2}{\frac{s}{k_1}} = \frac{U_2}{\frac{1}{b_2}} + \frac{U_2}{\frac{1}{m_2 s}} \Rightarrow \left[ \frac{U_1 - U_2}{s} \right] k_1 = b_2 U_2 + m_2 U_2 s$$

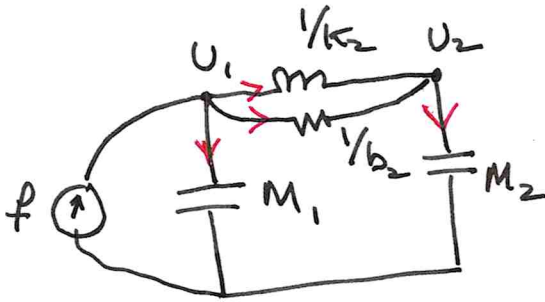
(c): 
$$\dot{\bar{f}} = m_1 \ddot{u}_1 + k_1(u_1 - u_2) + k_2 u_1$$

$$(u_1 - u_2)k_1 = b_2 \dot{u}_2 + m_2 \ddot{u}_2$$

(d): From node  $u_2$ : 
$$\frac{U_2}{U_1} = \frac{k_1}{m_2 s^2 + b_2 s + k_1}$$

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(a)



(b) node  $U_1$  
$$F = \frac{U_1 - U_2}{\frac{s}{k_2}} + \frac{U_1 - U_2}{\frac{1}{b_2}} + \frac{U_1}{\frac{1}{M_1 s}} \Rightarrow \bar{i} = \left[ \frac{k_2}{s} + b_2 \right] [U_1 - U_2] + M_1 s U_1$$

node  $U_2$  
$$\frac{U_1 - U_2}{\frac{1}{k_2}} + \frac{U_1 - U_2}{\frac{1}{b_2}} = \frac{U_2}{\frac{1}{M_2 s}} \Rightarrow \left[ \frac{k_2}{s} + b_2 \right] [U_1 - U_2] = M_2 s U_2$$

(c) 
$$\ddot{p} = k_2(u_1 - u_2) + b_2(\dot{u}_1 - \dot{u}_2) + M_1 \ddot{u}_1$$

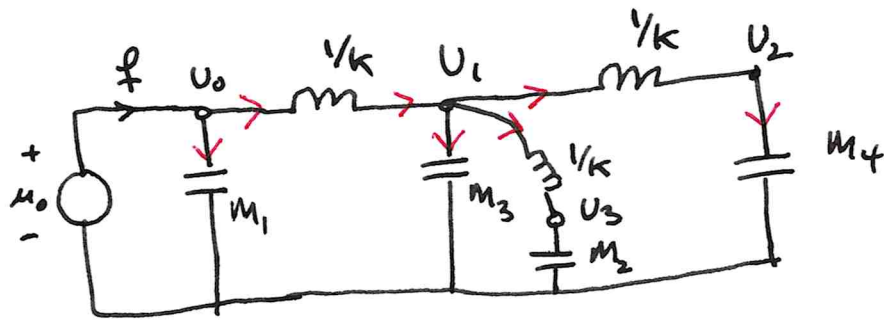
$$k_2(u_1 - u_2) + b_2(\dot{u}_1 - \dot{u}_2) = M_2 \ddot{u}_2$$

(d) from node  $U_2$ :

$$\left[ \frac{k_2}{s} + b_2 \right] U_1 = \left[ M_2 s + \frac{k_2}{s} + b_2 \right] U_2$$

$$\frac{U_2}{U_1} = \frac{k_2 + b_2 s}{M_2 s^2 + b_2 s + k_2}$$

3.



$$(a) \quad (1) \quad F = u_0 M_1 s + \frac{(u_0 - u_1) k}{s}$$

$$(2) \quad \frac{(u_0 - u_1) k}{s} = u_1 M_3 s + \frac{u_1 k (u_1 - u_3)}{s} + \frac{u_1 - u_2}{s} k$$

$$(3) \quad \frac{(u_1 - u_3) k}{s} = u_3 M_2 s$$

$$(4) \quad \frac{(u_1 - u_2) k}{s} = u_2 M_4 s$$

$$(b) \quad \dot{f} = \ddot{u}_0 M_1 + (u_0 - u_1) k$$

$$(u_0 - u_1) k = \ddot{u}_1 M_3 + k(u_1 - u_3) + k(u_1 - u_2)$$

$$(u_1 - u_3) k = \ddot{u}_3 M_2$$

$$(u_1 - u_2) k = \ddot{u}_2 M_4$$

(c)

substitute (3)  $\rightarrow$  (2) removing  $U_2$   
(4)  $\rightarrow$  (2) removing  $U_3$

new eqn (1)

$$(1) \quad \frac{U_0 - U_1}{s} k = M_3 s U_1 + \frac{U_1}{\frac{s}{k} + \frac{1}{M_2 s}} + \frac{U_1}{\frac{s}{k} + \frac{1}{M_4 s}}$$

$$(4) \quad \frac{U_1 - U_2}{s} k = U_2 M_4 s$$

from (1)

$$\frac{U_1}{U_0} = \frac{k}{\left[ M_3 s^2 + k + \frac{M_2 k s^2}{M_2 s^2 + k} + \frac{M_4 k s^2}{M_4 s^2 + k} \right]}$$

from (4)

$$\frac{U_2}{U_1} = \frac{k}{M_4 s^2 + k}$$

$$\boxed{\frac{U_2}{U_0} = \frac{U_1}{U_0} \cdot \frac{U_2}{U_1}}$$