

$$F_m + F_K + F_B = F_S$$

$$m \cdot \frac{dv_m}{dt} + Kx_k + Bv_B = F_S$$

$$F_m = m v_m$$

$$F_B = B \cdot v_B = B \cdot v_m$$

$$= B \cdot \frac{dx_m}{dt}$$

$$= F_S - Kx_k - B \frac{dx_m}{dt}$$

$$\Rightarrow$$

$$\frac{dx_k}{dt} = v_k = \frac{dx_m}{dt}$$

$$\begin{pmatrix} \dot{x}_k \\ \dot{x}_m \end{pmatrix} = \begin{pmatrix} \frac{1}{m} \\ -B \frac{1}{m} - Kx_k + F_S \end{pmatrix}$$

(2)

$$\begin{aligned}
 \begin{bmatrix} \dot{x}_K \\ \dot{x}_M \end{bmatrix} &= \begin{bmatrix} 0 \\ -K \end{bmatrix} \\
 &\downarrow \\
 \dot{x}(t) &=
 \end{aligned}
 \qquad
 \begin{aligned}
 \begin{bmatrix} 1/M \\ -B/M \end{bmatrix} &\begin{bmatrix} x_K \\ x_M \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} F_s \\
 &\downarrow \\
 &x(t) + B \cdot u(t)
 \end{aligned}
 \qquad
 \begin{aligned}
 &A
 \end{aligned}$$

	Constitutive	dynamic
mass	$x = Mv$	$F = \frac{dp}{dt}$ $u = \frac{d\phi}{dt}$
inductor	$\phi = L \cdot i$	
spring	$F = k \cdot x$	$v = \frac{dx}{dt}$ $i = \frac{dq}{dt}$
capacitor	$u = \frac{1}{C} q$	
damper	$F = Bv$	
resistor	$u = Ri$	

I  
1-p

$v$

flow

$i$

$p$

momentum

$\phi$

mass

$$p = mv$$

$$\phi = Li$$

$$v = \frac{1}{m} p$$

$$i = \frac{1}{L} \phi$$

C  
e-q

effort

$F$

$u$

position

$x$

$q$

spring

capacitor

$$F = kx$$

$$u = \frac{1}{C} q$$

$$x = \frac{1}{k} F$$

$$q = C u$$

C: 1/k

C: C

R  
e-f

effort

$F$

$u$

flow

$v$

$i$

dampen

resistor

$$F = Bv$$

$$u = Ri$$

$$v = \frac{1}{B} F$$

$$i = \frac{1}{R} u$$

C: 1/B

C: C

flow gen-position

$$v = \frac{dx}{dt}$$

$$i = \frac{dq}{dt}$$

effort gen-momentum

$$F = \frac{dp}{dt}$$

$$u = \frac{d\phi}{dt}$$

$$\int \rightarrow x = \frac{dp}{dt}$$

$$p = \frac{dq}{dt}$$