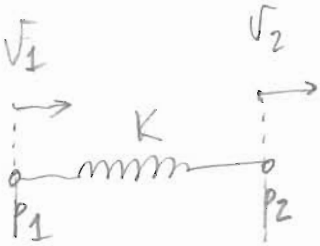
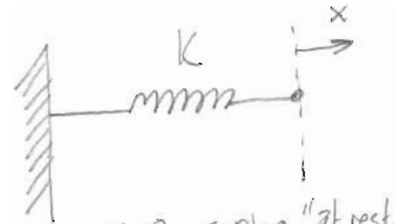
17 Feb 2015
Add-ON

Translational Mechanical Systems

System Components





1.) Translational Spring

K: spring constant

A bit more tricky when both points p_1 and p_2 are moving. $F = Kx$ with x being "change of spring length from its rest length"

$x=0$ spring "at rest" no tension. $F=0$

We have $\boxed{F = K.x}$

Q: Where does $F = K.x$ comes from?

In fact, this is an inductive storage element. We have

Accross variable $(v_2 - v_1) \propto$ Derivative of Through Variable (F)

We have, $(v_2 - v_1) = \frac{1}{K}\frac{d}{dt}F \rightarrow K(v_2 - v_1)dt = dF$

Take integral of both sides

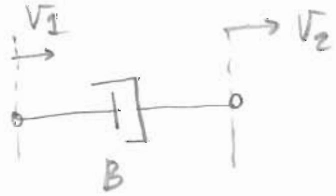
$$K\int_0^t (v_2 - v_1)\,dt = \int_0^t dF \rightarrow K\left[(x_2 - x_1)_t - (x_2 - x_1)_{t=0}\right] = F - F_0$$

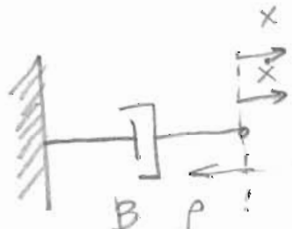
Length of spring at t

length of spring at $t=0$

If spring "at rest" at $t=0$

$\rightarrow F_0 = 0$. We can abbreviate x for "difference from rest length".





2) Translational Damper

B: Viscous Damping.

$v_{21} = v_2 - v_1 = \frac{1}{B}F$

"Energy Dissipator"

Thru variable $\propto$ Accross Variable

$\boxed{f_d = B\dot{x}}$ Opposes motion

$B > 0$ viscous damping coefficient.

Note: Reference directions are arbitrary BUT it is always a good idea to stick with a convention. Then signs are according to the chosen reference directions.

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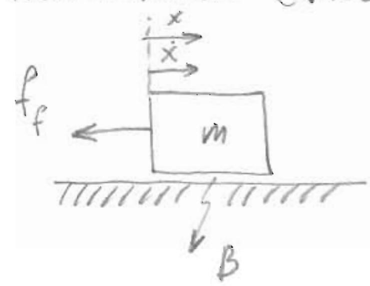
3.) Translational (Viscous) Friction

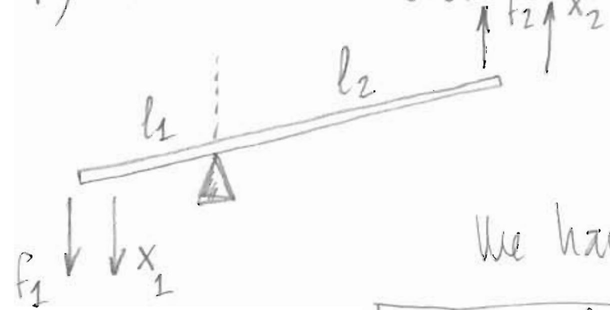


Similar to Viscous Damper

$$\boxed{f_f = B\dot{x}}$$

$B > 0$ Viscous friction coefficient.

4.) Translational "Lever"



It is like a "mechanical transformer". Trades force with displacement.

We have "terminal equations":

$$\boxed{f_1 \cdot l_1 = f_2 \cdot l_2} \quad \& \quad \boxed{\frac{x_1}{l_1} = \frac{x_2}{l_2}}$$

5.) Translational Mass: (Capacitive Energy storage) Newton's Second Law of Motion

$$m\ddot{x} = f_{net}$$

f_{net}: Net forces acting on a mass m in the direction of

x: displacement of mass m.