

Confirmed Labs:

T 6:10-7:00 pm

R 9:00-9:50 AM

F 2:10-3:00 pm

In CAE Lab

2121A Bainer

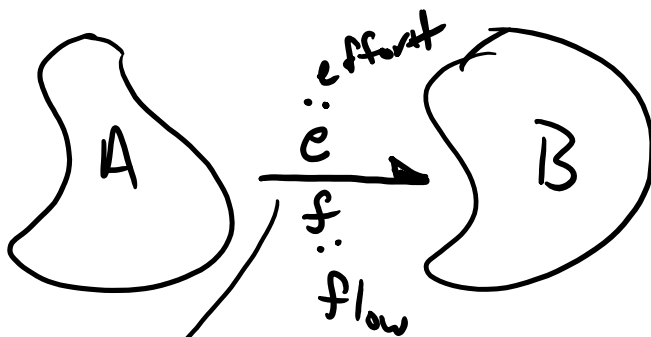
Must attend 1 lab session per lab assignment +

* 1 per two weeks

Starts tomorrow

Bond Graph Basic

Components A and B make up a system



Bond
represents the power
flow from A to B
direction
of arrow

eg. e : force
 f : velocity

$$P = e \cdot f$$

$$E = \int P dt = \int e \cdot f dt$$

energy

$$\frac{dE}{dt} = P$$

Sign convention:

positive effort \times positive flow = positive powerpositive power from A to B \Rightarrow (A) \rightarrow (B)

Other variables:

" " "

C - IL

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

$$f = \frac{dmv}{dt}$$

Other variables:

"momentum"

$$p = \int e dt$$

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

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

"displacement"

$$q = \int f dt$$

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

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

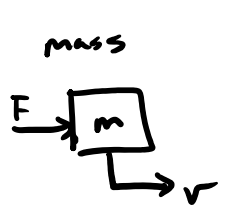
Effort, flow, momentum, displacement for different domains: only use SI units!!

	e	f	P	Q
translation	F [N]	v [$\frac{m}{s}$]	p [N·s]	x [m]
rotation	τ [N·m]	ω [$\frac{rad}{s}$]	h [N·m·s]	θ [rad]
electrical	e [V]	i [A]	λ [V·s]	q [A·s] <small>(Coulombs)</small>
hydraulic	P [$\frac{N}{m^2}$]	Q [$\frac{m^3}{s}$] <small>flux</small>	P_p [$\frac{N}{mi} \cdot s$] <small>↑ pressure momentum</small>	V [m^3]

Examples of System components

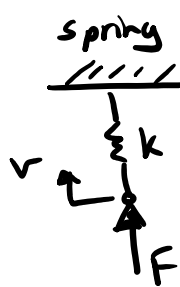
n-port bond

1 "port" single e & f variable

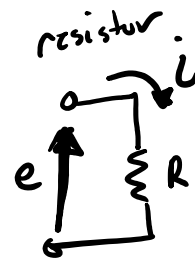


$$\frac{F}{v} \rightarrow I : m$$

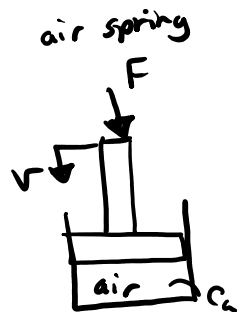
↑ inertia



$$\frac{F}{v} \rightarrow C : \frac{1}{k}$$

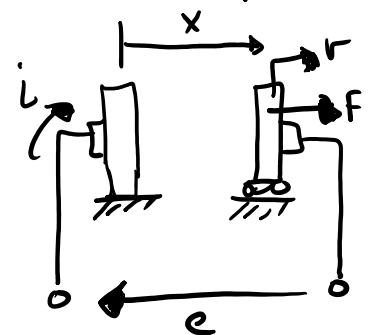


$$\frac{e}{i} \rightarrow R : R$$



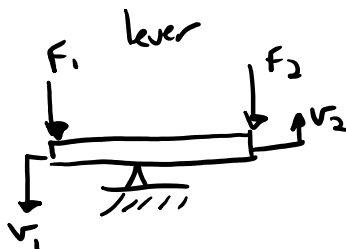
$$\frac{F}{v} \rightarrow C : C_a$$

variable capacitor

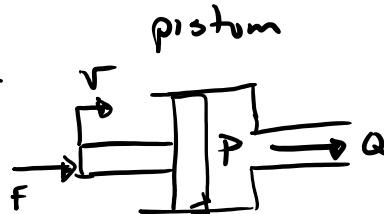


$$\frac{e}{i} \rightarrow TF \frac{F}{v}$$

2 "port"

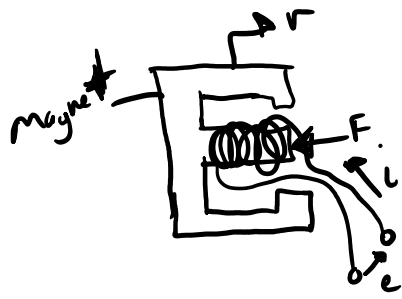


$$\frac{F_1}{v_1} \rightarrow TF \frac{F_2}{v_2}$$



$$\frac{F}{v} \rightarrow TF \frac{P}{Q}$$





$$e \Rightarrow G Y \frac{F}{v}$$

$$\Rightarrow TF \leftarrow v$$

3-Port

