

- HW3 due today
- Lab 2 posted
- HW4 due in one week

3-15

$$\frac{e}{i} \rightarrow \overset{T}{\dot{G}V} \frac{F}{v} I:n \Rightarrow \frac{e}{i} \rightarrow C : \frac{M}{T}$$

$$e = Tr \quad p = \int F dt$$

$$Tl = F \quad p = mv$$

$$\frac{e}{i} \rightarrow C$$

$$\downarrow$$

$$q = ce$$

$$p = \int T_i dt = T \underbrace{\int i dt}_l$$

$$p = mv$$

$$e = Tr$$

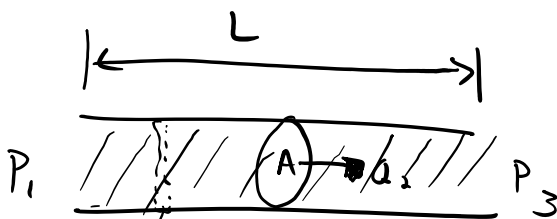
$$p = Tq$$

$$mv = Tq$$

$$m \frac{e}{T} = Tq$$

$$e = \frac{T^2}{m} q$$

3.6



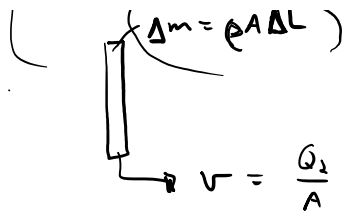
$$P_2 = P_1 - P_3$$

↑ pressure drop

$$\Delta m = \rho A \Delta L$$

$$P P_2 = \int^t P_2 dt = \left(\rho \frac{L}{A} \right) Q_2$$

$$P = \frac{k_s}{m^3}$$



$$\rho = \frac{m_3}{m_0}$$

ρA mass per unit length
fluid momentum

$$\Delta M \dot{v} = F$$

$\frac{\Delta M v}{\Delta t}$ infinitesimal momentum

$$P_h = \int_0^L v \, dm$$

$$\int_0^t P_2 \, dt = \int_0^t \frac{F}{A} \, dt = \frac{1}{A} \int_0^t F \, dt = \frac{1}{A} P$$

$$\Delta m \frac{\dot{Q}}{A} = PA \Rightarrow \left(\frac{\Delta m}{A} \frac{dQ}{dt} = PA \right) \Rightarrow \frac{\Delta m}{A} \int dQ = \int PA \, dt$$

$$P_2 = \rho \frac{L}{A} Q_2$$

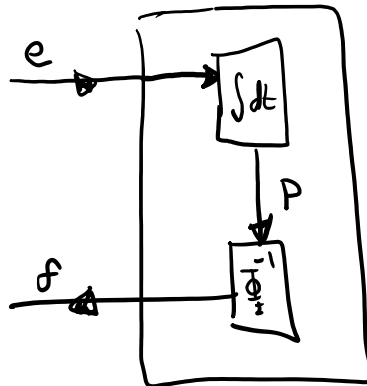
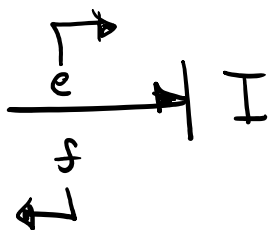
$$\frac{\Delta m}{A} Q = AP$$

$$\rho \frac{\Delta L}{A} Q = AP$$

$$\rho \frac{\Delta L}{A} Q = P$$

Causality of Inertia

Integral Causality



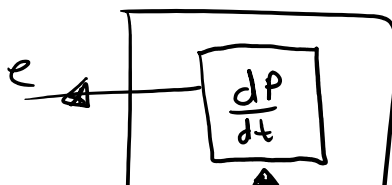
non-linear

$$f = \Phi_I^{-1}(p) = \Phi_I^{-1}(\int e \, dt)$$

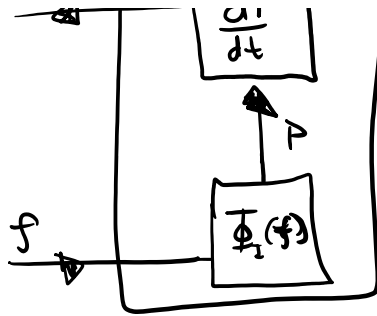
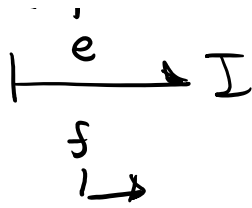
linear

$$f = I \int e \, dt$$

Derivative Causality



$$e = \frac{d}{dt} (\Phi_I(f))$$



$$e = \int \frac{d}{dt} f$$

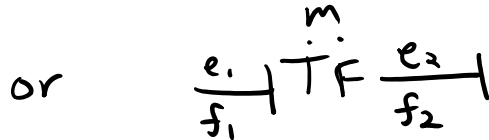
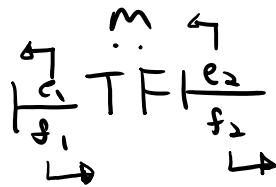
$$p = \int e dt$$

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

Causality of 2-Ports

Each of TF & GY has two options

TF



$$e_1 = m e_2$$

$$f_2 = m f_1$$

output s

input s

$$e_2 = \frac{1}{m} e_1$$

input s

$$f_1 = \frac{1}{m} f_2$$

output s

GY

