Induktivität und Kapazität

Konti:

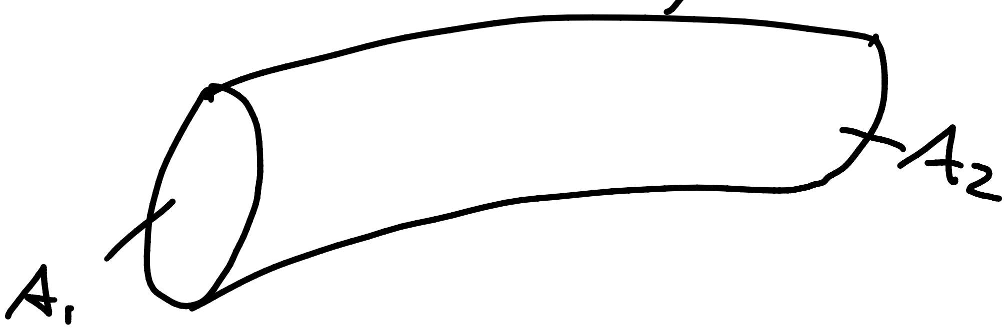
$$\frac{Dm}{Dt} = 0$$

$$\frac{\partial}{\partial t}\int_V \rho \, dV + \oint_S \rho \vec{u} \cdot \vec{n} \, dS = 0$$

S_W

A_2

A_1



$$\int_0^L \frac{\partial}{\partial t}(\rho A)\, ds - \dot{m}_1 + \dot{m}_2 = 0.$$

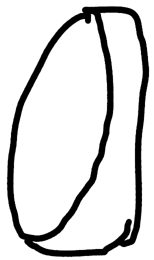
TECHNISCHE UNIVERSITÄT DARMSTADT
FLUID SYSTEM TECHNIK
Grundlagen der Turbomaschinen und Fluidsysteme

Spezialfall 0-D Hydrostatik

$$\dot{p}\,\underbrace{V H_{eff}}_{C} - Q_1 + Q_2 = 0$$

C hydraulische Kapazität.

1-D



$$\frac{1}{\rho_E a_E}\frac{Dp}{Dt} + a_E \frac{\partial \bar{u}}{\partial s} = 0$$

Zusammenhang Nachgiebigkeit und Schallgeschwindigkeit.

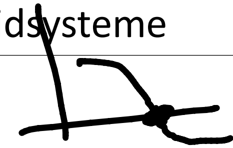
$$a_E^2 := \frac{1}{\varrho_E \mathcal{H}_E}$$

$$\mathcal{H}_E := \frac{1}{\varrho A} \frac{\partial \varrho A}{\partial p}\bigg|_{\substack{s=\text{const} \\ T=\text{const} \\ \vdots}}$$

$$= \underbrace{\mathcal{H}_\varrho}_{\text{Stoffgröße}} + \underbrace{\mathcal{H}_A}_{\text{Systemgröße}}$$

$:=$ Definition

$=$ Gleichheit



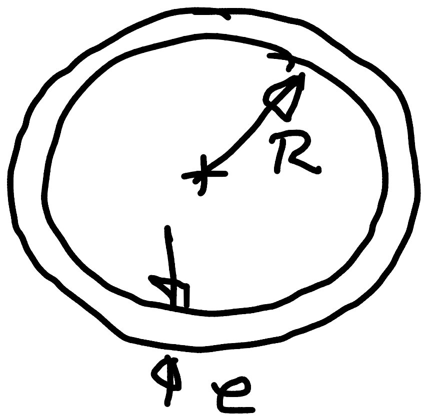
$\equiv$ Identität $\quad f(x) \equiv 0$

$\approx$

$\sim \quad \propto$ Proportionalität mit Dimensionshomogenität.

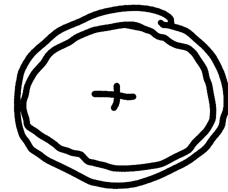
$$\mathcal{H}_A = \frac{1}{E}\frac{2R}{e}$$

für das dünnwandige Rohr

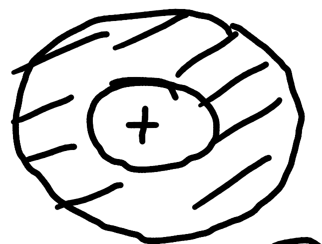


$$\mathcal{H}_A = \begin{cases} \dfrac{1}{E}\dfrac{D}{e} & \dfrac{D}{e} \gg 1 \\ \dfrac{1}{E}\dfrac{D}{e}\left[\dfrac{2e}{D}(1+\nu) + \dfrac{D}{D+e}\right] & \\ \dfrac{2(1+\nu)}{E} & \dfrac{D}{e} \ll 1 \end{cases}$$

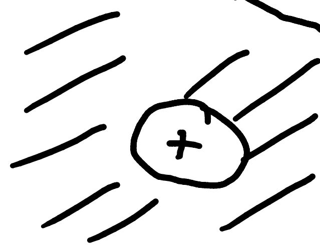
$\neq fn(D)$!



dünnw. Rohr



dickwand. Rohr



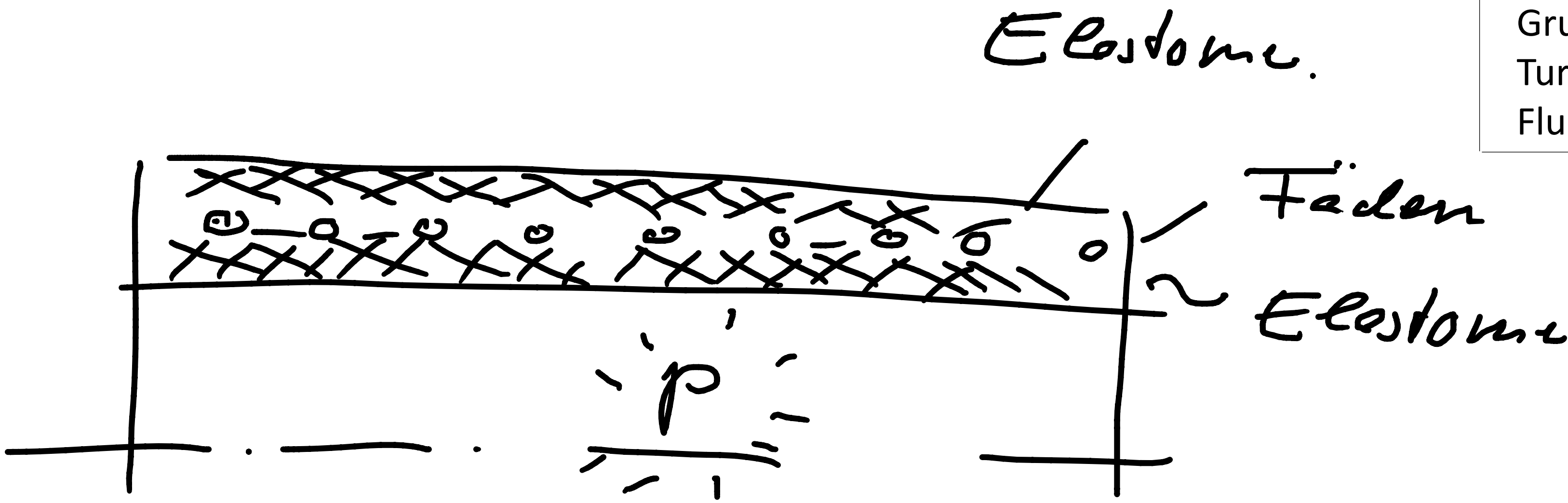
Bohr.

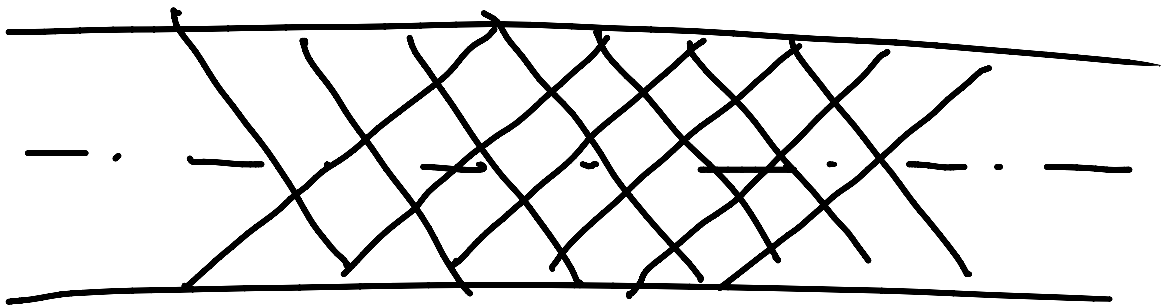
Bestimmung von J_A.

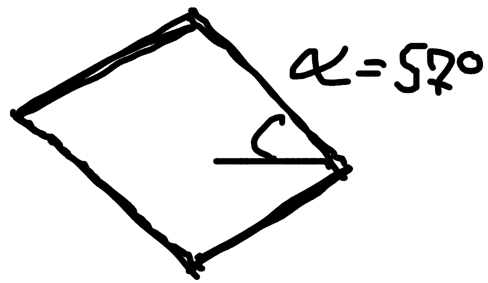
1.) Analytisch ← Kräftegleichgew. / Kinematik / Materialgesetz

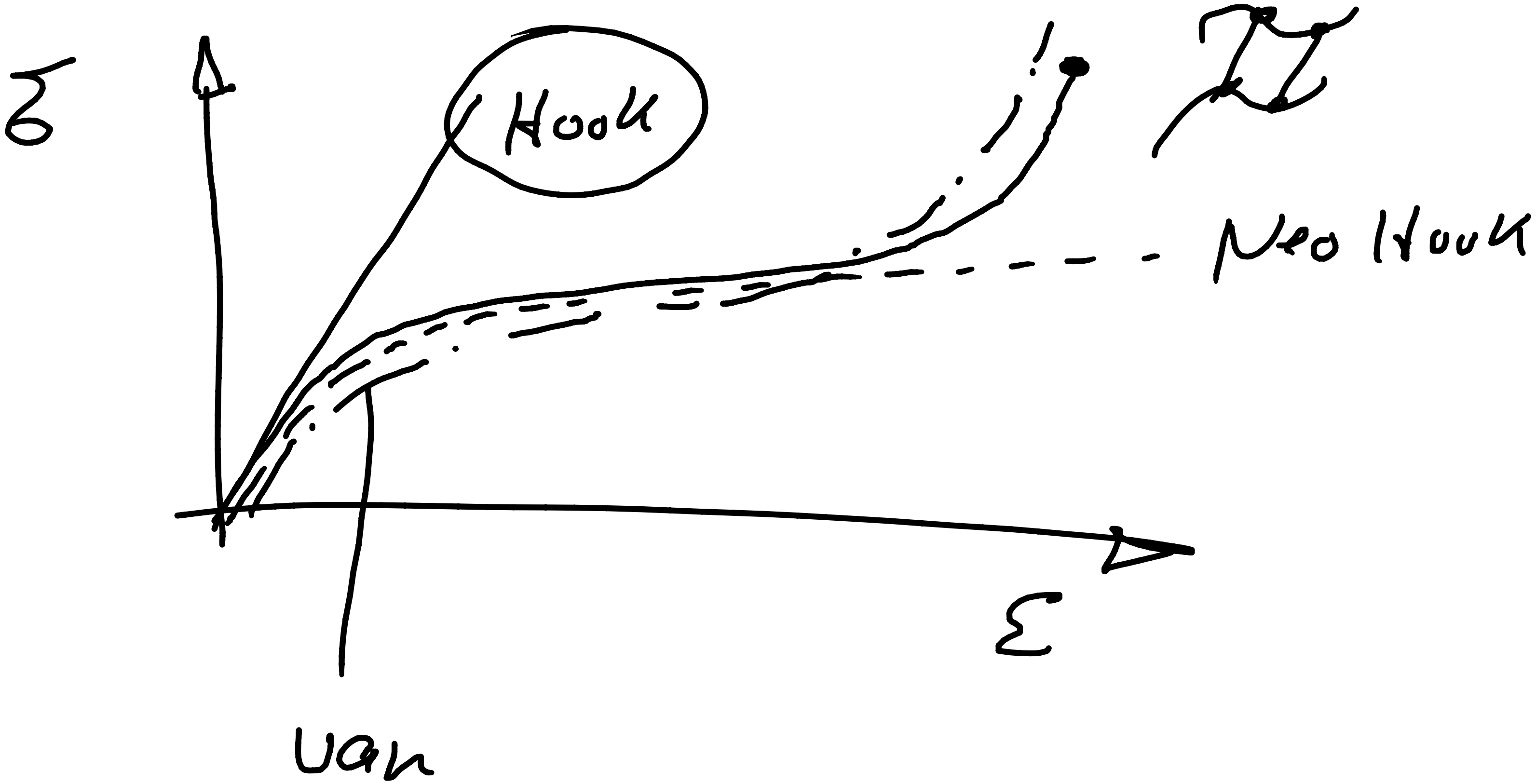
2.) Finite Elemente Berechng. FE
da wir annehmen, daß das Rohr keine Trägheit ($_h S_n \ll S^4$) hat
→ quasistatische FE-Berechng.

Notwendig z.B bei armierten Schläuche







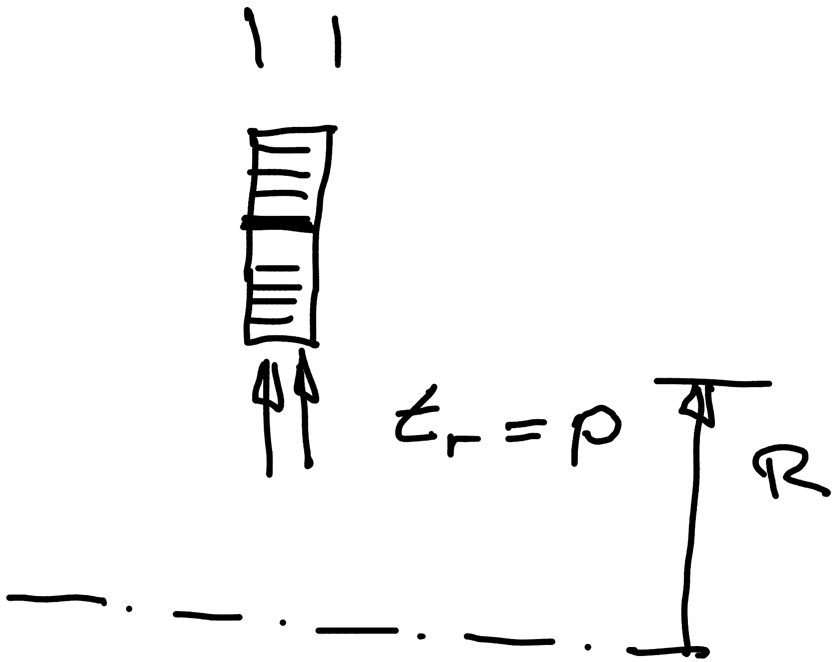


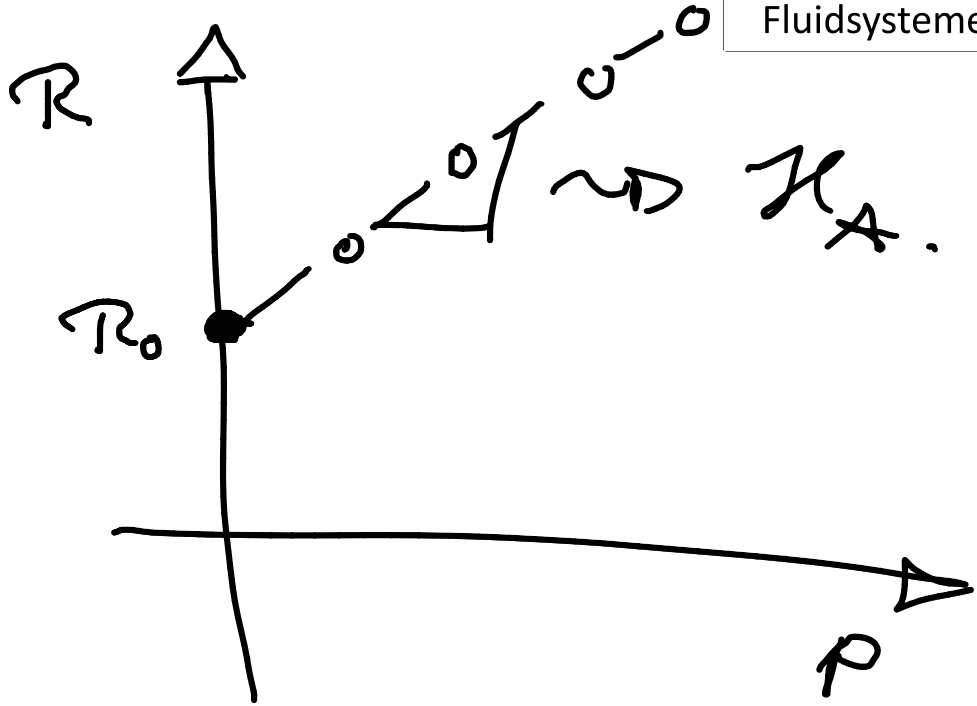
nichtlinear FE Solver

1.) Material
2.) große Deformation.
3.) Kontakt.

z.B.
* Abaqus
* Marc

$\mathcal{H}_A$ aus FE-Rechnung bestimmen.



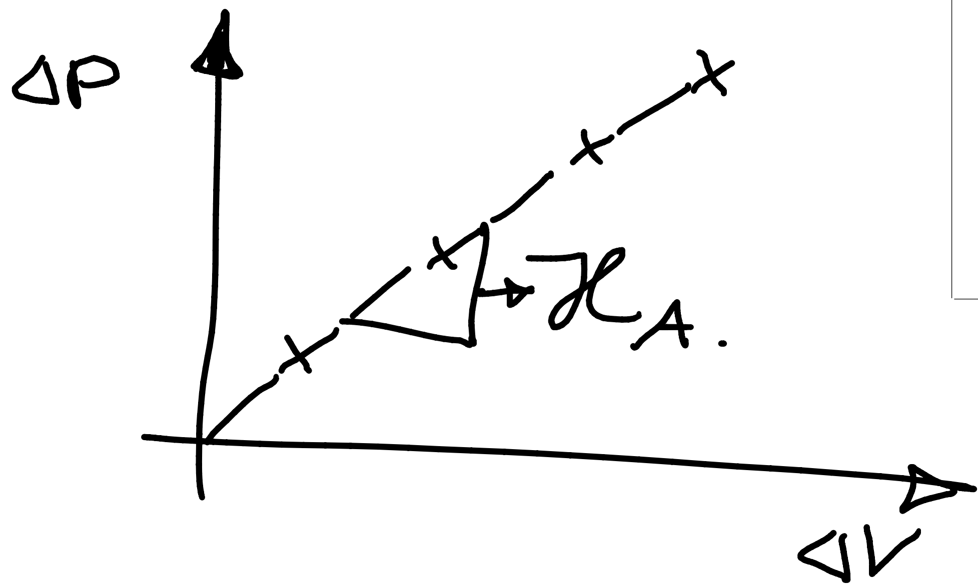


ca. 1000 €

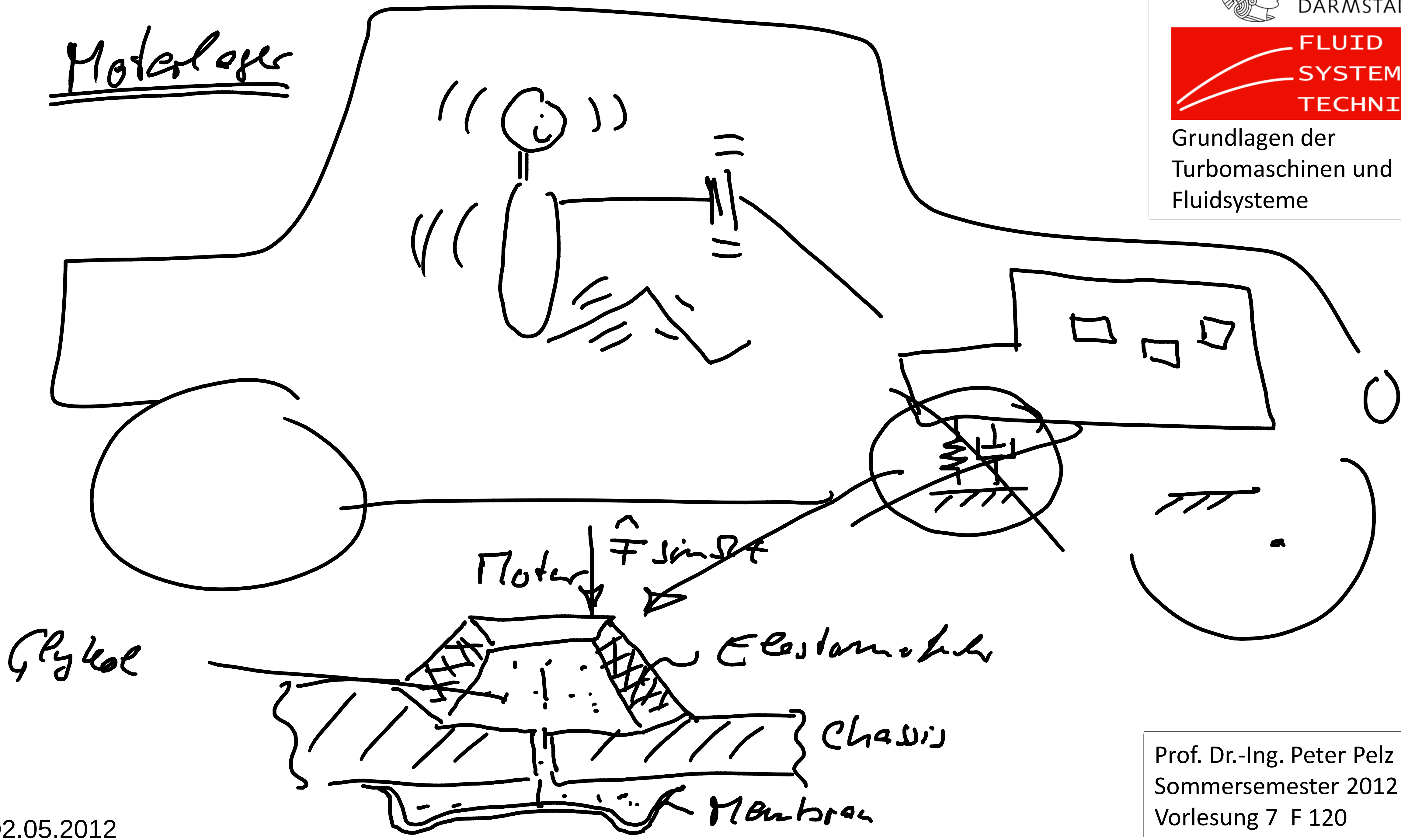
1.) Analytisch

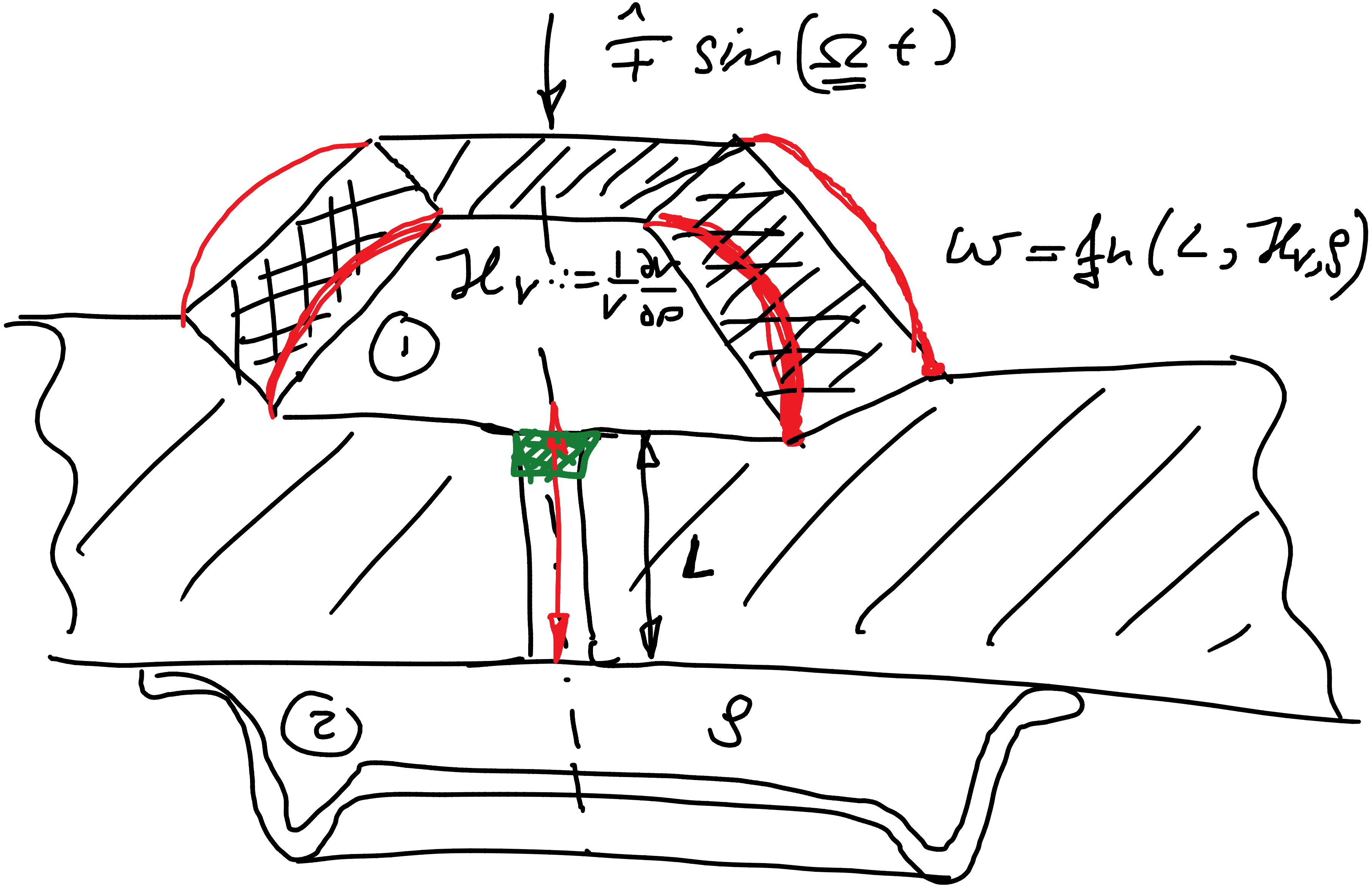
2.) FE-Methode

3.) Experimentell



Motorlager


Motor
$\hat{F} \sin \Omega t$
Glykol
Elastomerlager
Chassis
Membran

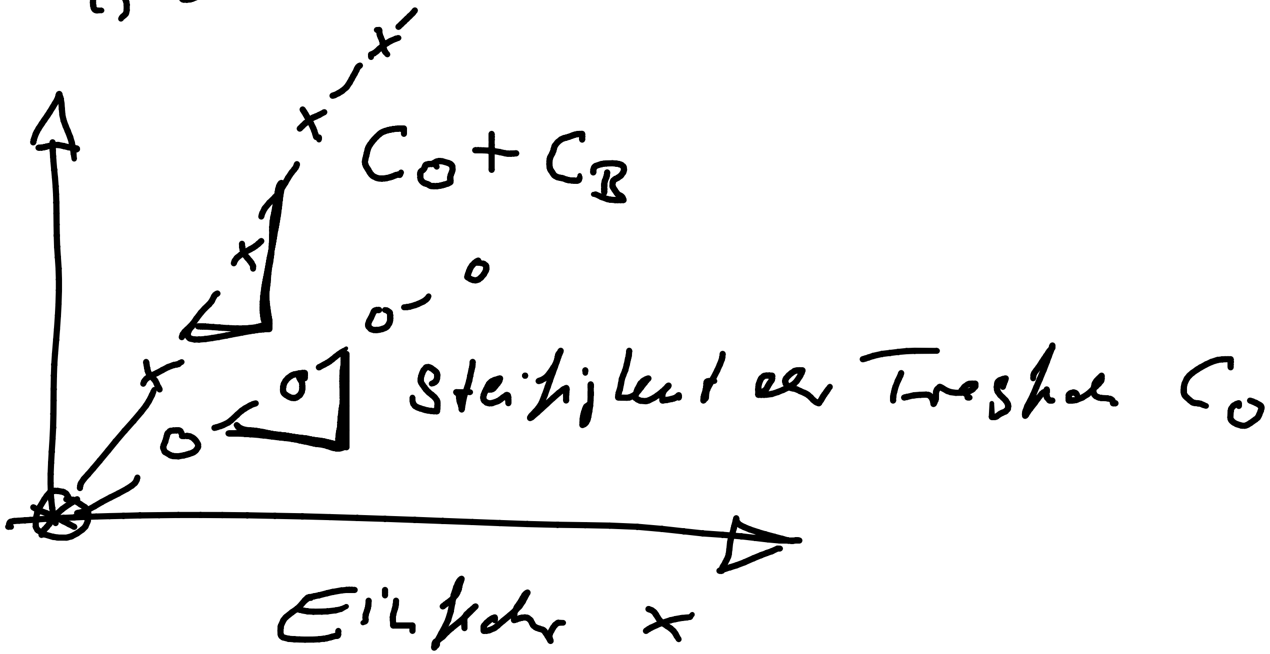


$\omega = fn(L, \mathcal{K}_v, \rho)$

Kanallänge wird auf die Schleuderdrehzahl Ω abgestimmt

1. Versuch: Geschlossener Kanal. x

Druck-kraft F



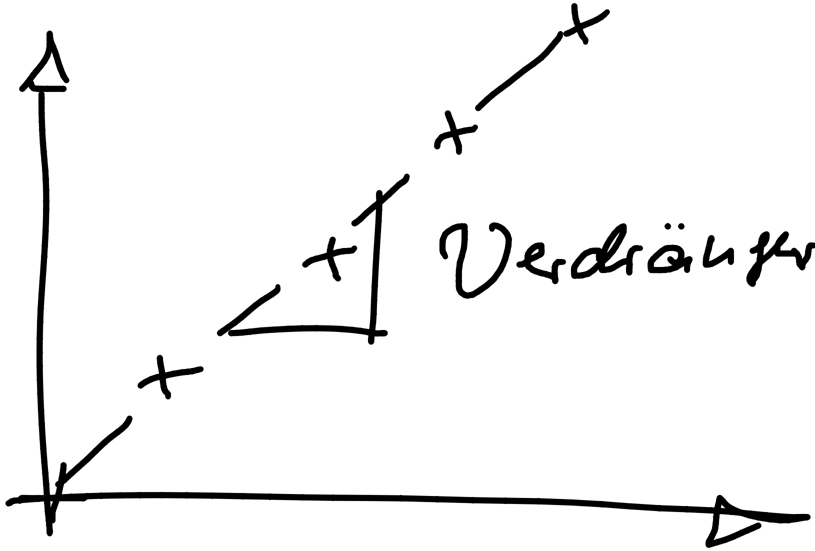
2. Versuch: offener Kanal o

→ c_0

c_B

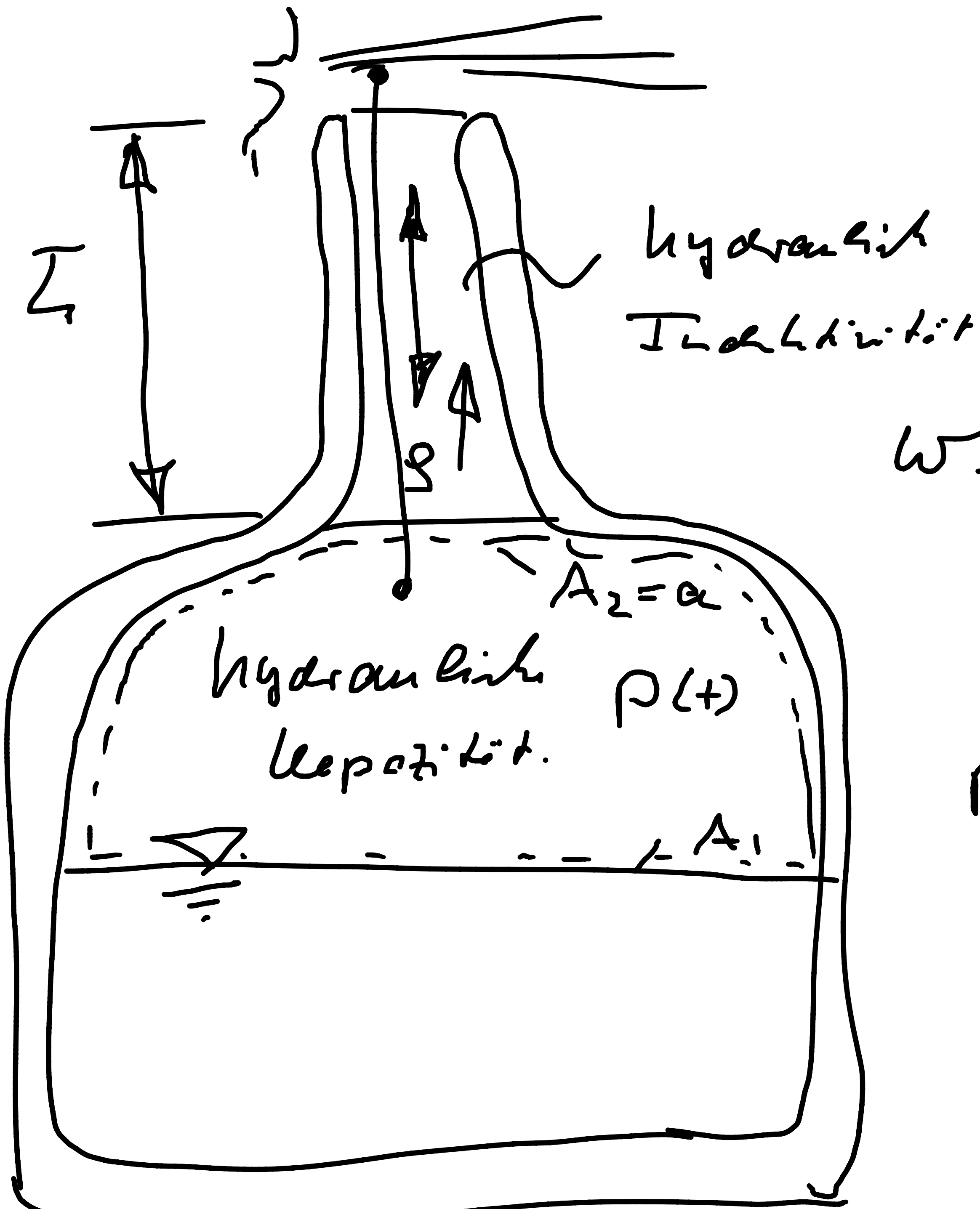
Bei offenem Kanal:

Volumen.



Verdrängerfläche $A := \frac{dV}{dz}$

Einkor z



$$\omega = fn(L, \rho, \mathcal{H}_s V)$$

$$\dot{p}\, \mathcal{H}_s V + Q_2 = 0$$

$$p + \underbrace{\frac{\rho}{2} u_1^2}_{\approx 0} = p_0 + \underbrace{\frac{\rho}{2} u_0^2}_{R} + \underbrace{\int_0^L \rho \dot{u}\, ds}_{L}$$

$$\underbrace{\dot{p}\, \mathcal{H}_s V}_{\text{Kapazität}} + u_0 \mathfrak{A} = 0$$

ohne Dämpfung

$$p = \cancel{\underbrace{\frac{\rho}{2} u_0 |u_0|}_{\text{Dämpfung}}} + \underbrace{\rho L \dot{u}_0}_{\text{Induktivität}} + p_0$$

Trägheit

hier Austrittsverlust.

$\rightarrow$ Schwingungs-differentialgleichung

$$\mathcal{H}_s = \frac{1}{\rho} \frac{\partial \rho}{\partial p}\Big|_s \quad , \text{ sofern } \underline{\underline{\omega}} \gg \omega_T$$

$$= \frac{1}{\gamma p}\Big|_0 = \frac{1}{\gamma p_0}$$