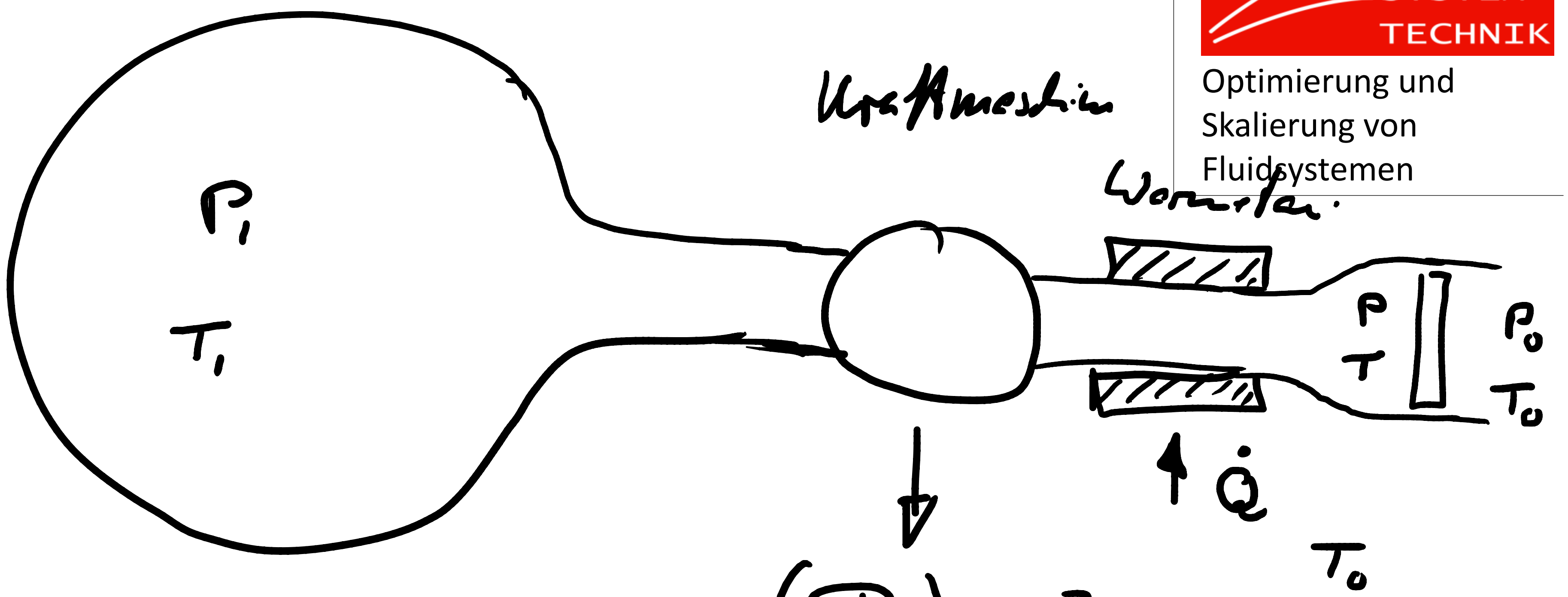
TECHNISCHE UNIVERSITÄT DARMSTADT
FLUID SYSTEM TECHNIK
Optimierung und Skalierung von Fluidsystemen

Ernst Becker: Thermodynamik

Heft

Exergie



$$\max(P_T) = ?$$

Optimierungsaufgabe → Exergie.

$$P_{W} + \dot{Q} = \dot{m}(h_{t2} - h_{t1})$$

1\. HS für $\overline{\frac{\partial}{\partial t}} \equiv 0$

$$P_{W} = -P_T$$

$$h_{t2} = h$$

$$h_{t1} = h_1$$

1\. HS:

$$P_T = \dot{m}(h_1 - h) + \dot{Q} \qquad (1)$$

2\. HS: $\overline{\frac{\partial}{\partial t}} = 0$

$$\dot{m}(s - s_1) = \frac{\dot{Q}}{T_0} + \underbrace{\Delta \dot{S}_{irr}}_{\text{Dissipat.}} \qquad (2)$$

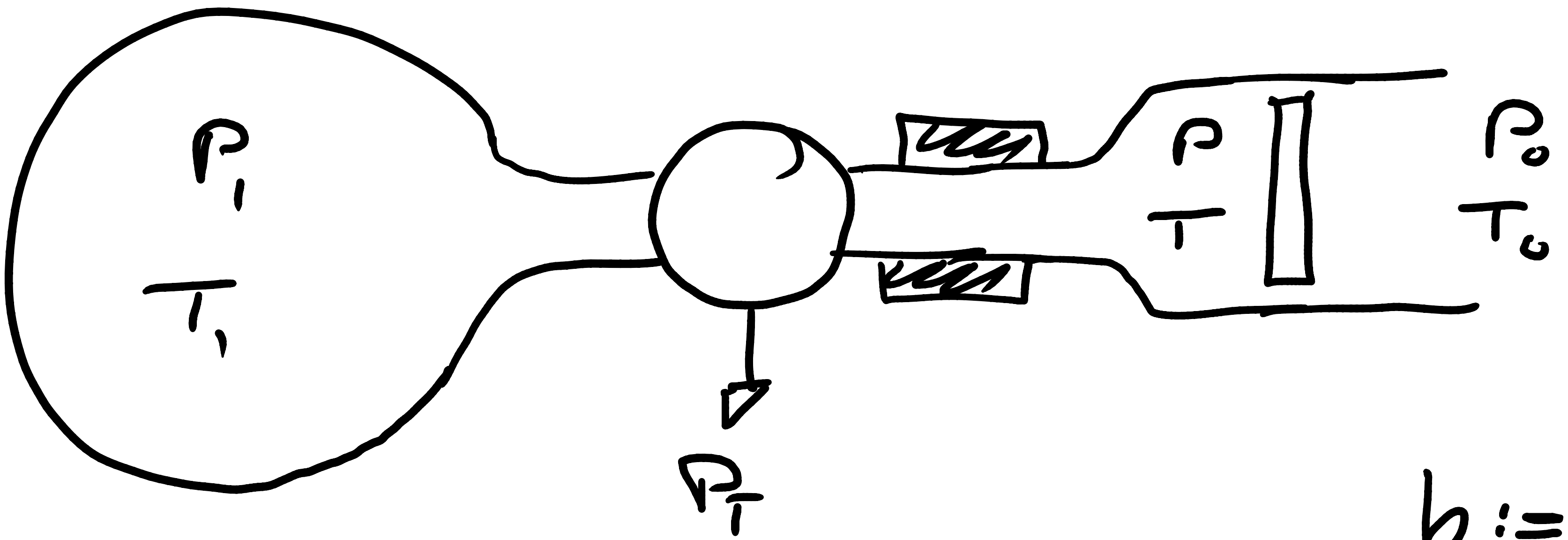
(2) in (1)

$$P_T = \dot{m}\left[(h_1 - T_0 s_1) - (h - T_0 s)\right] - \underbrace{T_0 \Delta \dot{S}_{irr}}$$

ideale Maschine

$\eta = 1$

$$P_{T, \eta=1} = \dot{m}\left[(h_1 - T_0 s_1) - (h - T_0 s)\right]. \qquad \eta = 0.9$$



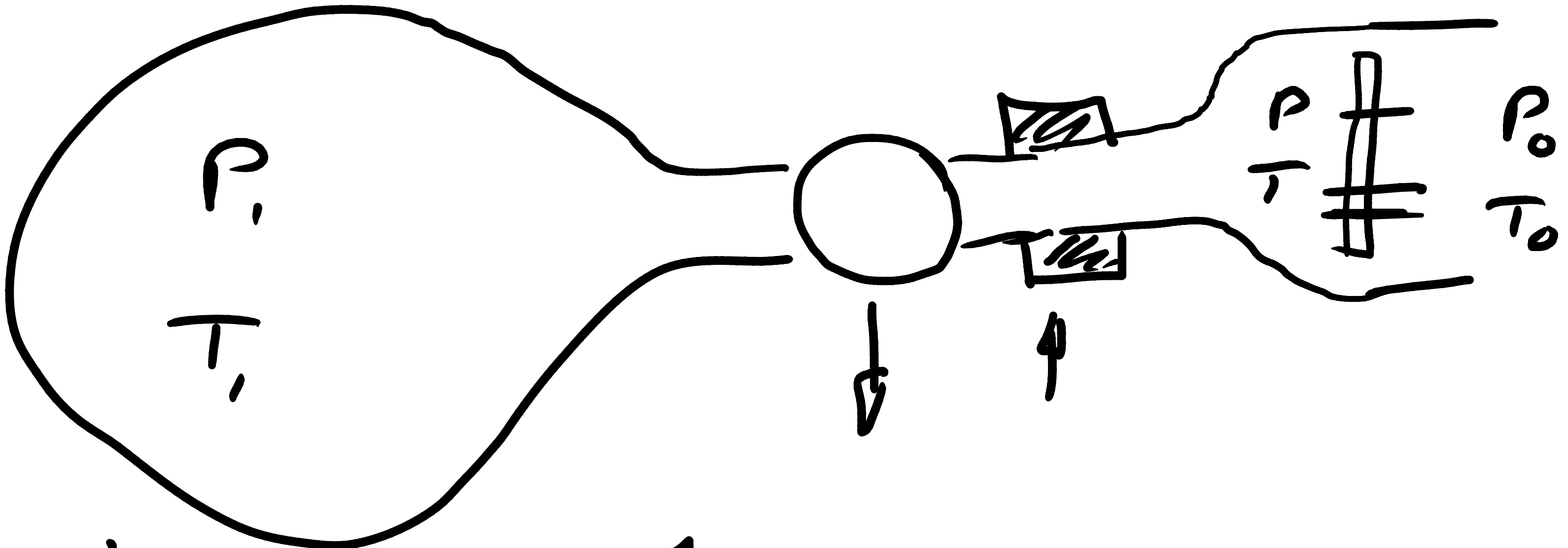
$$h_t := e + \frac{p}{\rho} + \frac{c^2}{2} + \psi$$

$$\hat{P}_T = P_{T,\eta=} - \frac{\dot m}{\rho}(p_0 - p)$$

$$= \dot m \left[h_1 - T_0 s_1 - (\underbrace{h - \frac{p}{\rho}}_{e}) + T_0 s - \frac{p_0}{\rho} \right]$$

$$\hat{P}_T = \dot{m}\left[h_1 - T_0 s_1 - e(s,T) + T_0 s - \frac{p_0}{\rho}\right].$$

$\cancel{\hat{P}_{Topt} := \dot{m}\, h_1 - T}$ $\qquad ex_1 := h_1 - h_0 - T_0(s_1 - s_0)$



$$\frac{\partial \hat{P}_T}{\partial \rho} \overset{!}{=} 0 \qquad \frac{\partial \hat{P}_T}{\partial s} \overset{!}{=} 0 \qquad \text{Optimierungsbeding.}$$

$$= -\dot{m}(-p + p_0) \qquad = -\dot{m}(T - T_0)$$

$$p = p_0 \qquad T = T_0$$

Literaturempfehlung zur Wellenkraft.

Ocean Waves and Oscillating Systems

Johannes Falnes

Cambridge University Press

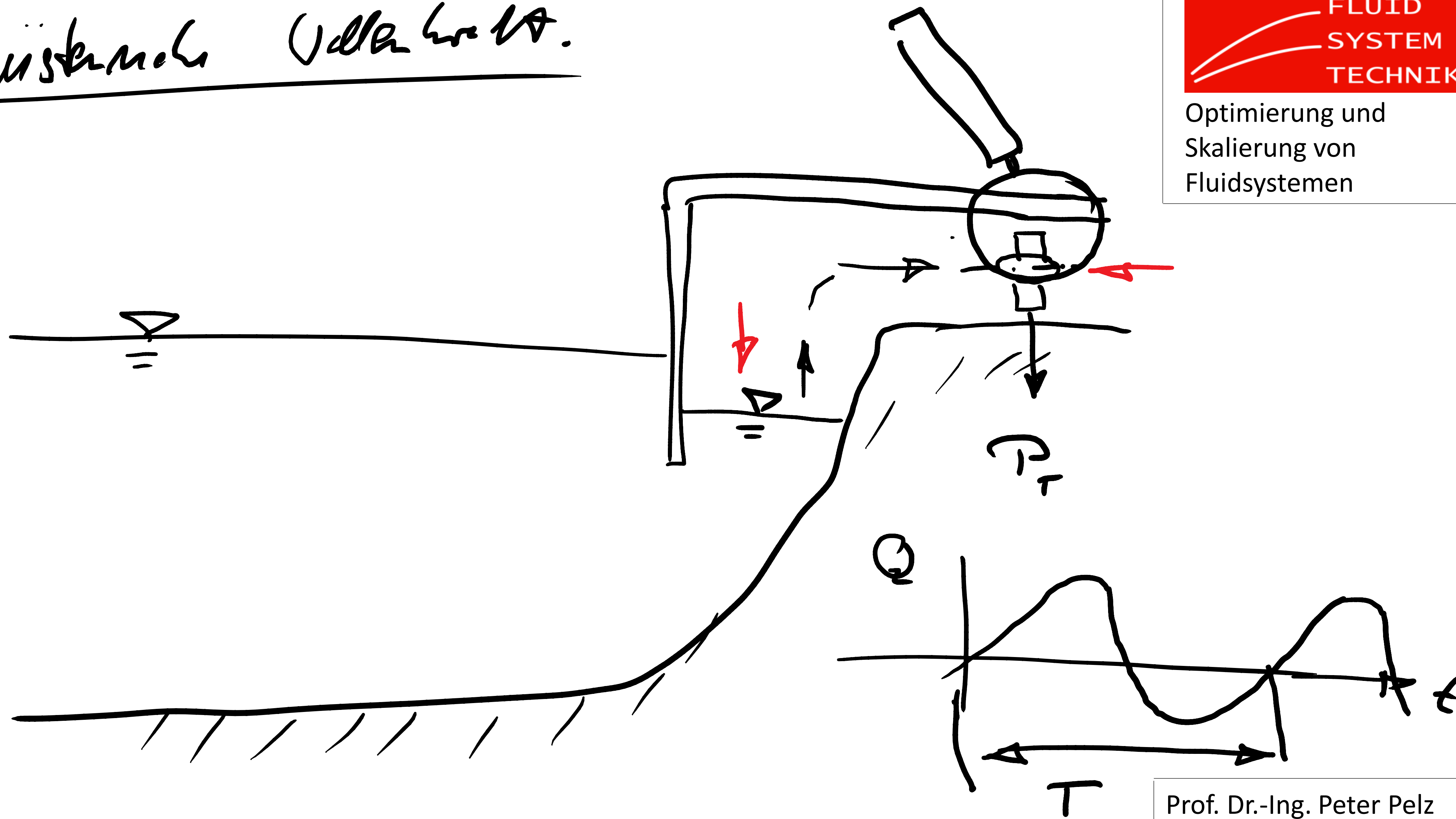
ISBN 0-521-01749-1

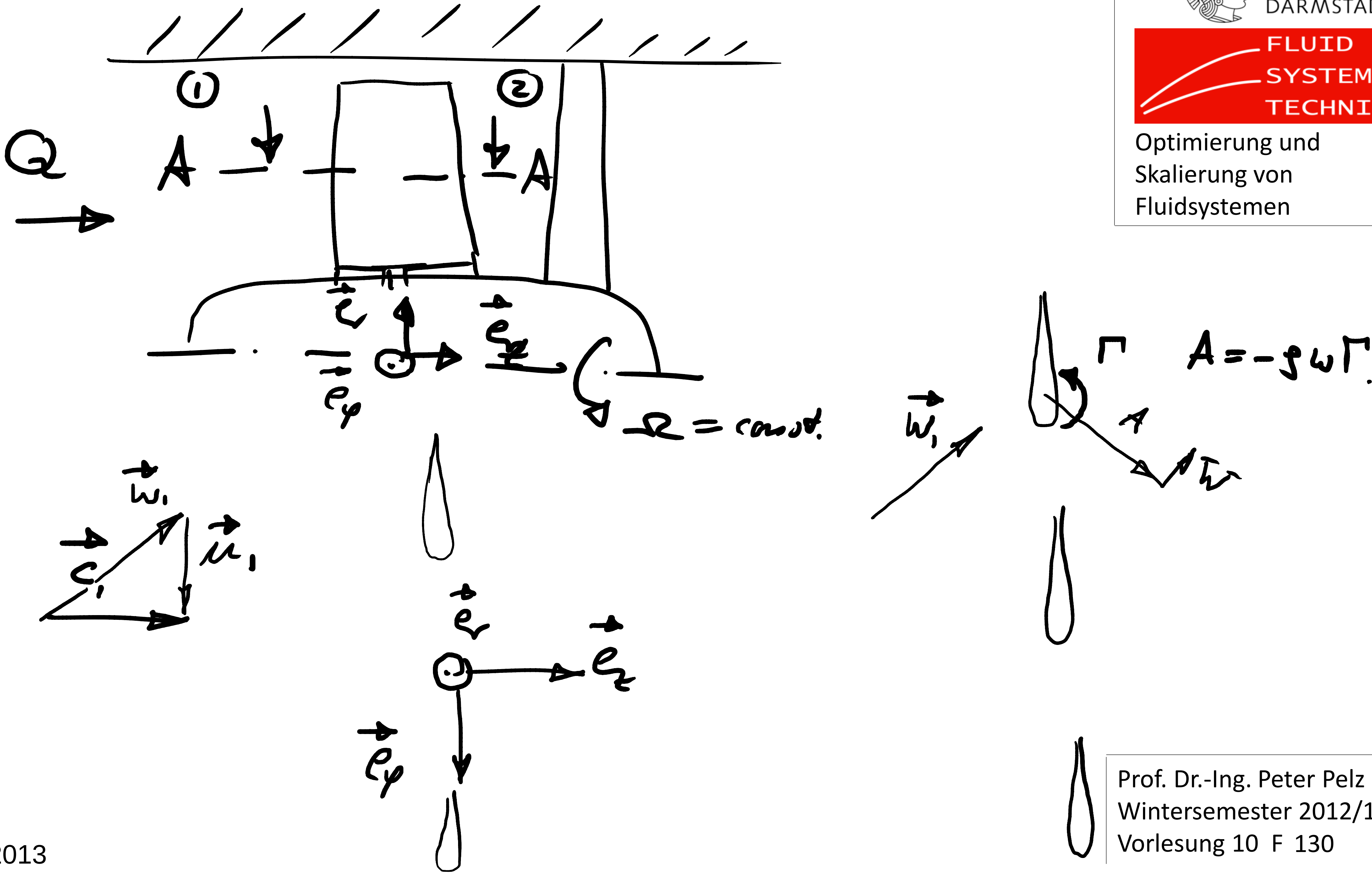
Marine Hydrodynamics

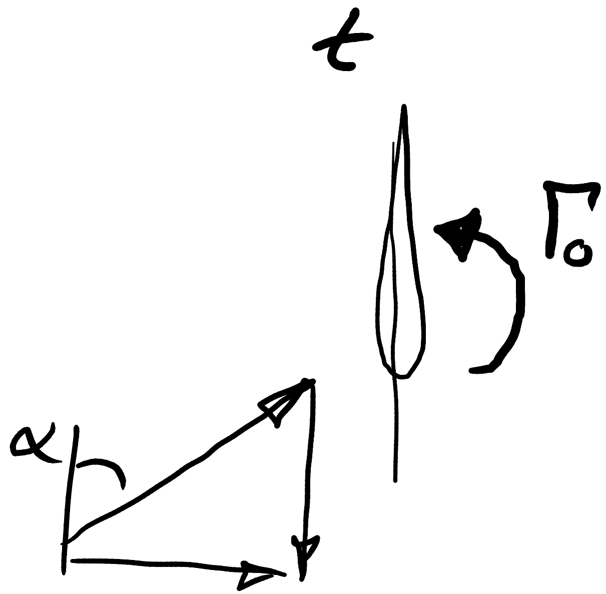
Newman ; Prof a. Caltech.

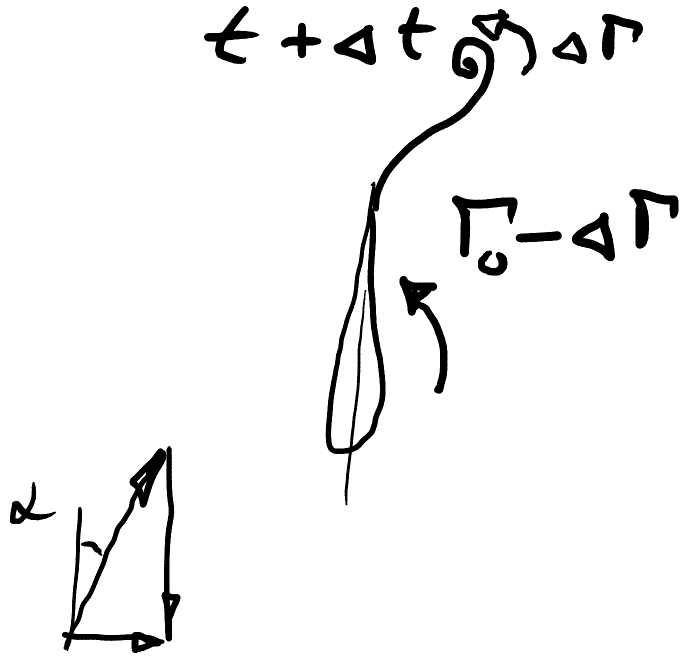
MIT-Press

Küstennahe Wellenkraftw.




Q
A
A
①
②
$\vec{e}_r$
$\vec{e}_z$
$\vec{e}_\varphi$
$\Omega = \text{const.}$
$\vec{w}_1$
$\vec{c}_1$
$\vec{u}_1$
Γ
$A = -\rho w \Gamma$.
A
$\vec{w}$





$$A = -\rho\,\Gamma\, w$$

$$A = \frac{\rho}{2}\, l\, c_A\, w^2$$

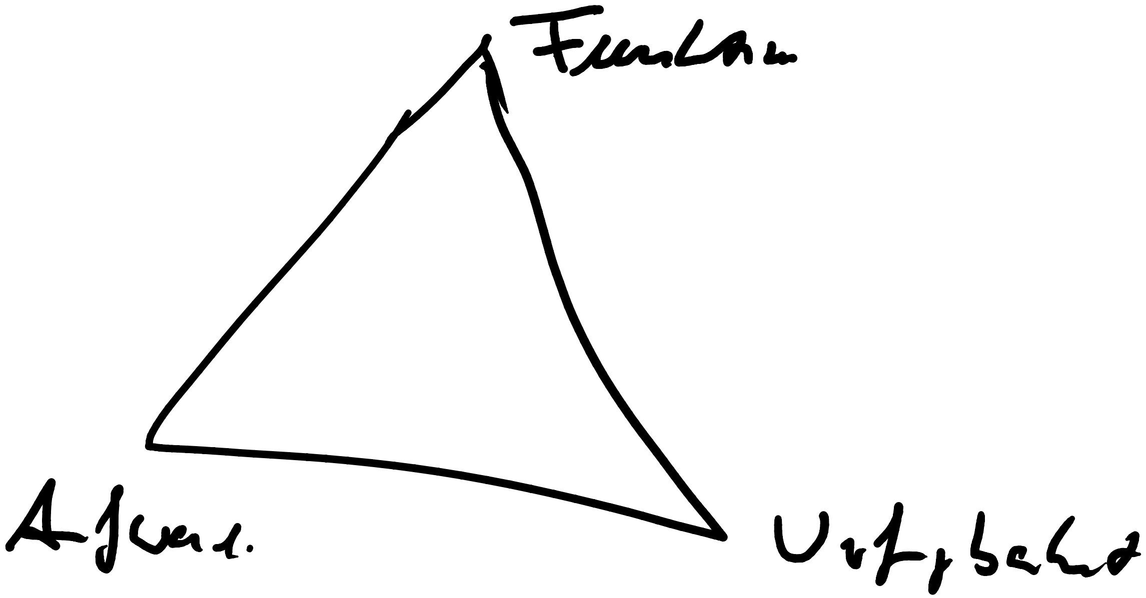
$$c_A = 2\pi\alpha$$

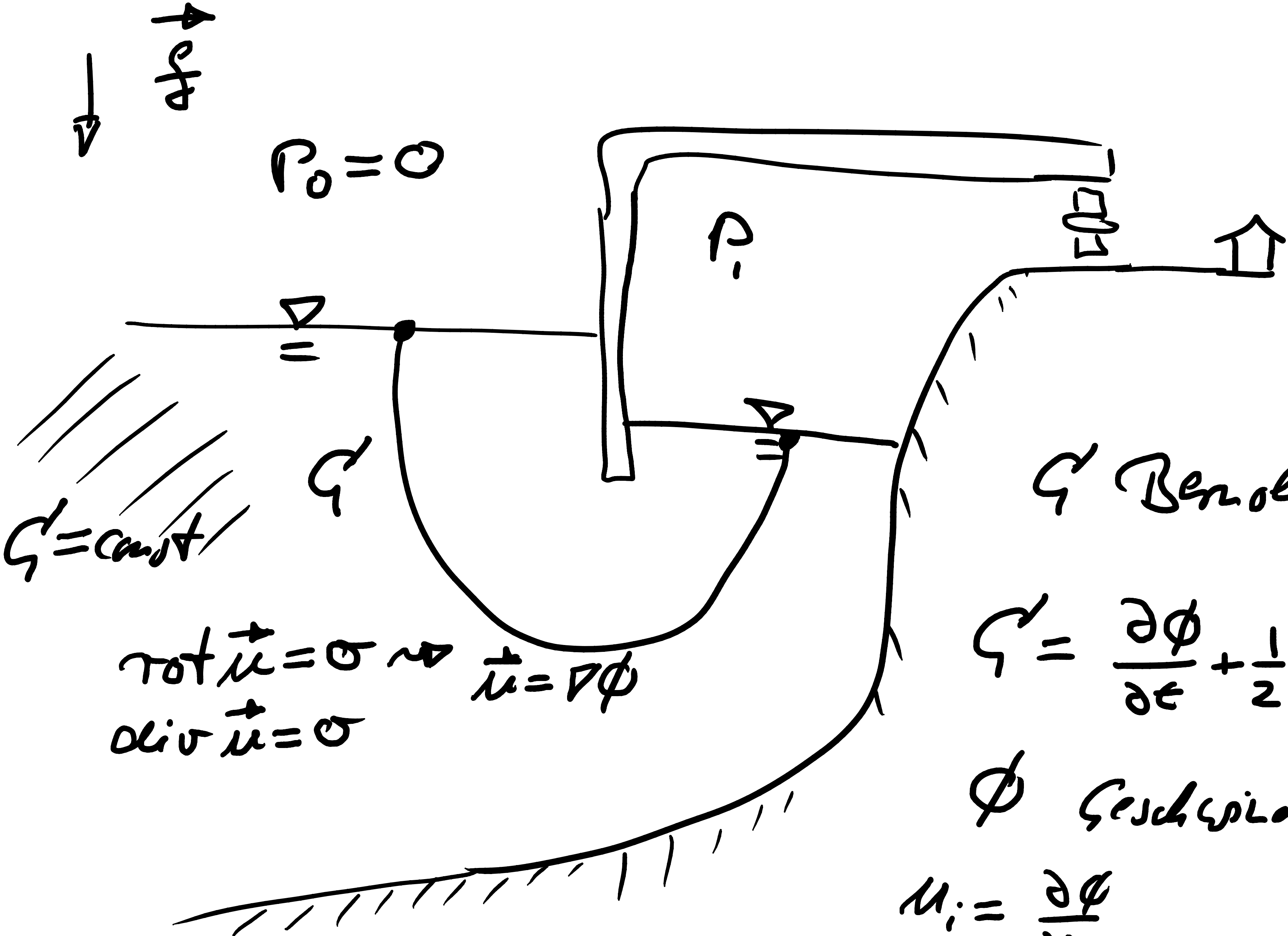
$$\frac{D\Gamma}{Dt} \overset{!}{=} 0$$ Kelvinsch Wirbel

$\rightarrow$ Wirbelschlepp $\rightarrow$ Laut

$\rightarrow$ Welle anregen.

Pitchverstellung ist i.d.R. kein Ersatz
von rech. V-Feld.





$\text{rot}\,\vec{u} = 0 \rightsquigarrow \vec{u} = \nabla\phi$

$\text{div}\,\vec{u} = 0$

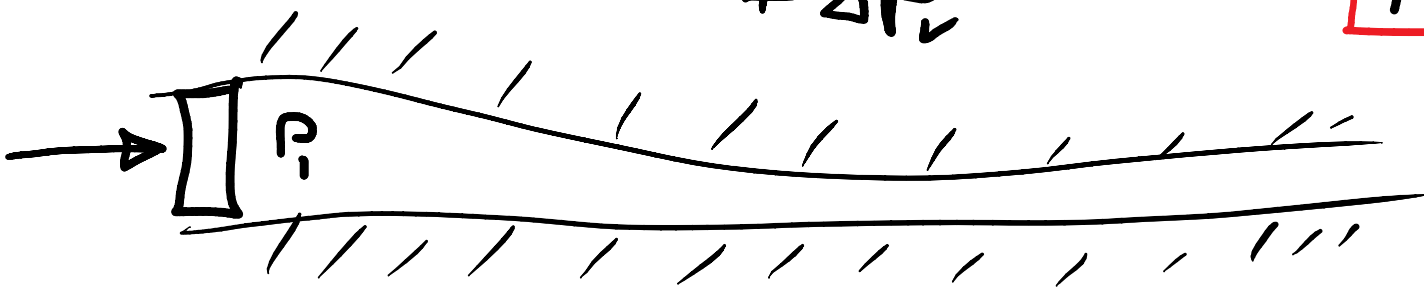
G Bernoulli'sche Konstante.

$$G = \frac{\partial\phi}{\partial t} + \frac{1}{2}\frac{\partial\phi}{\partial x_i}\frac{\partial\phi}{\partial x_i} + gz + \frac{p}{\rho}$$

ϕ Geschwindigkeitspotential.

$$u_i = \frac{\partial\phi}{\partial x_i}$$

$$p_1 + \frac{\rho}{2} u_1^2 + \rho g z_1 = p_2 + \frac{\rho}{2} u_2^2 + \rho g z_2 + \int_1^2 \rho \dot{u}\, ds + \Delta p_v$$



$$\operatorname{rot} \vec{u} = 0 \quad \rightsquigarrow \quad \vec{u} = \nabla \phi$$

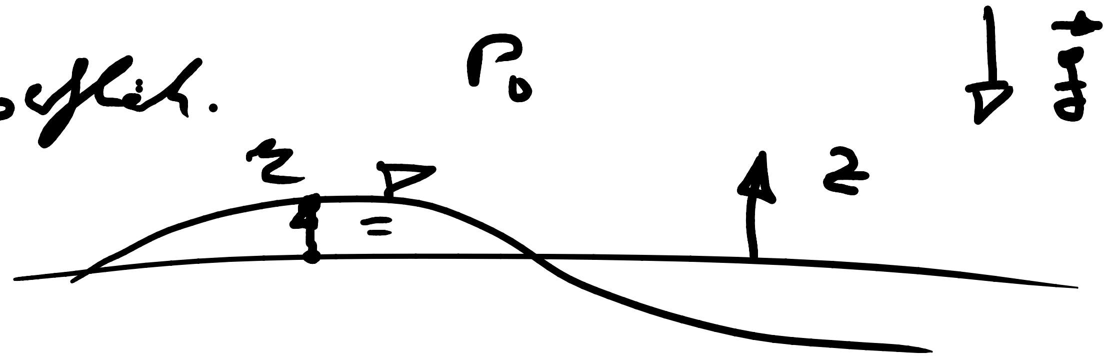
$$\Longleftrightarrow$$

$$\frac{\partial \phi}{\partial t} + \frac{1}{2} \frac{\partial \phi}{\partial x_i} \frac{\partial \phi}{\partial x_i} + g z = C$$

Randbeding. a. starre Wänd.

$$\frac{\partial \phi}{\partial n} = 0 : \quad \vec{u} \cdot \vec{n} = 0 \qquad \text{kinematische R.B.}$$

Randbedingung an der freien Oberfläche.



$$\left[\frac{\partial \phi}{\partial t} + \frac{u^2}{2}\right]_{z=\zeta} + g\zeta + \frac{p_0}{\rho} = C$$

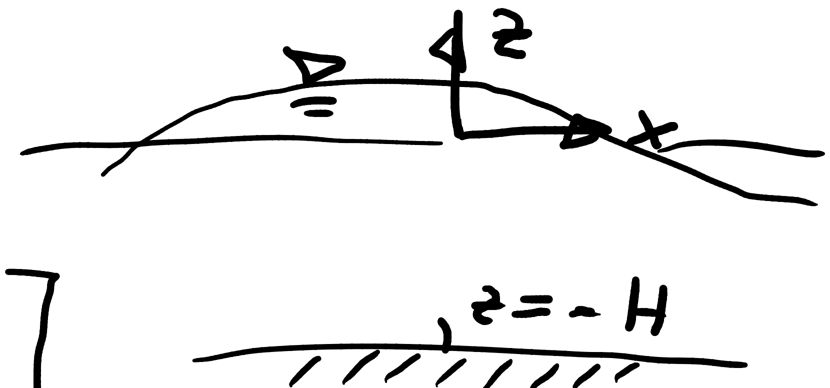
$$\left[\frac{\partial \phi}{\partial t} + \frac{u^2}{2}\right]_{z=\zeta} + g\zeta = C - \frac{p_0}{\rho} \equiv 0.$$

$$\frac{u^2}{2} \ll \frac{\partial \phi}{\partial t}$$

R.B $\quad z = \eta \;\to\; z = 0$

$$\boxed{\left.\frac{\partial \phi}{\partial t}\right|_{z=0} = -g\,\eta\,.}$$

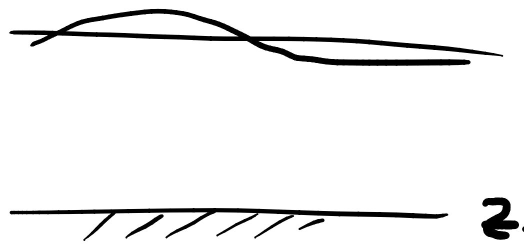
dynamische R.B
für Oberwelle.



Spezialfall harmonische Welle

$$\eta = B \exp\left[\, i\,(\omega t - kx)\right]$$

$$\Delta \phi \overset{!}{=} 0$$



$$\Rightarrow \Phi = f(z) * \exp[i(\omega t - kx)]$$

Produktansatz für das Potential

$$\omega = \frac{2\pi}{T}$$

k Wellenzahl

f(z) Tiefenfkt.

$$-k^2 f + f'' = 0$$

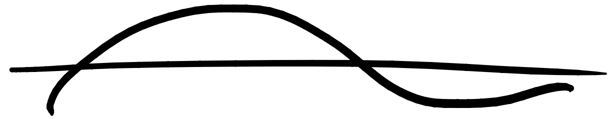
$$\frac{\partial \phi}{\partial t} = 0 \quad \text{an } z = -H$$

$$\rightsquigarrow f_{1,2} = \exp(\pm kz)$$

$$\Rightarrow \underline{\underline{f = A \cosh(z + H)}}$$

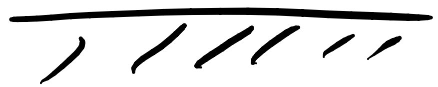
PDGL $\Delta \Phi = \sigma .$

$\sigma = \frac{\partial \phi}{\partial t} + \dots$

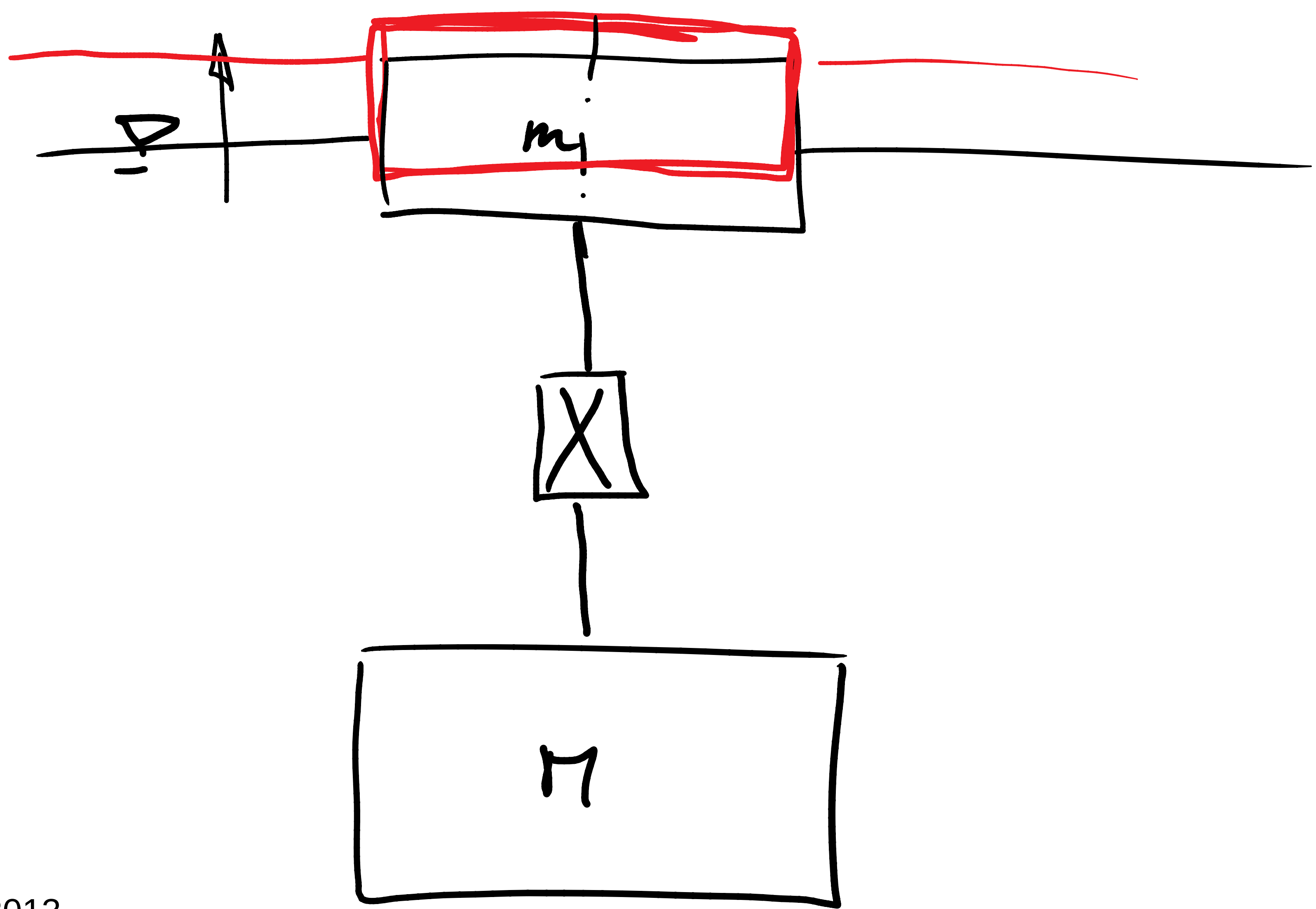


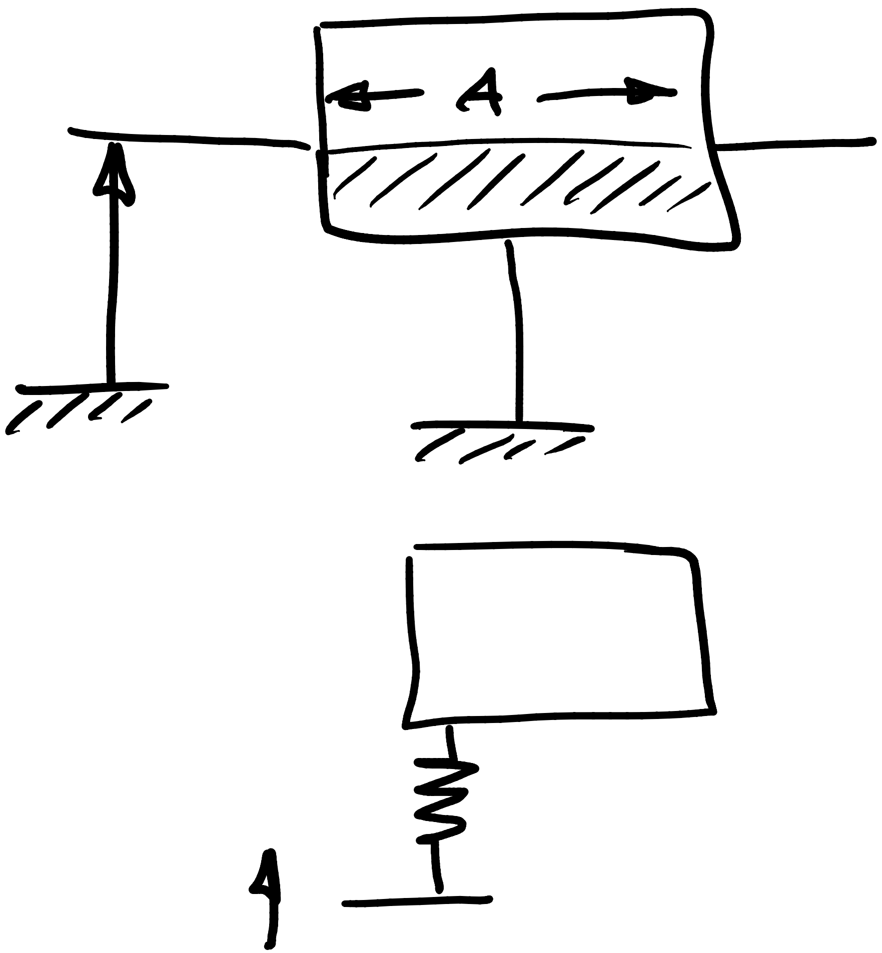
DGL

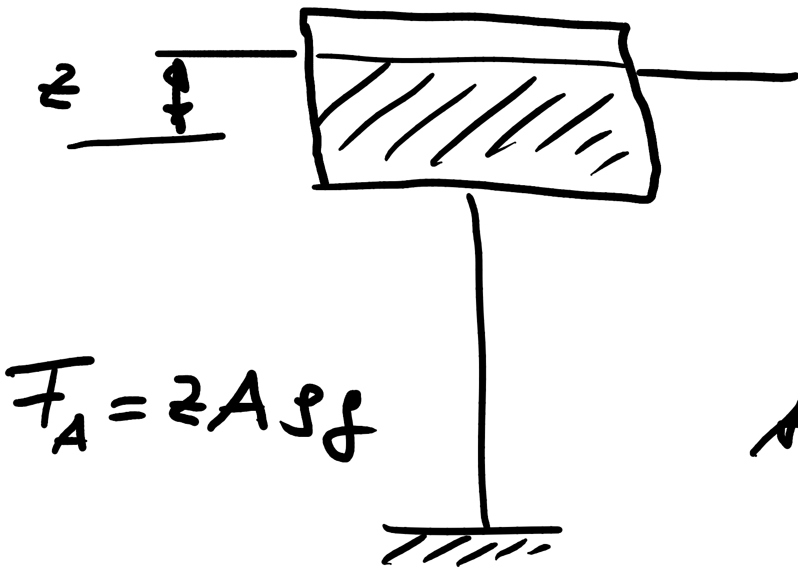
↳ Eigenwertproblem.



Wellenkraftwerke off shore



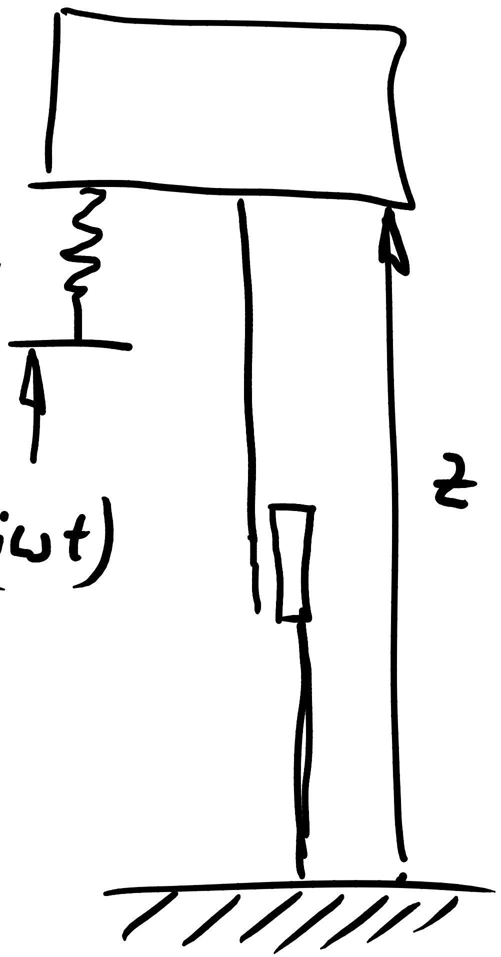




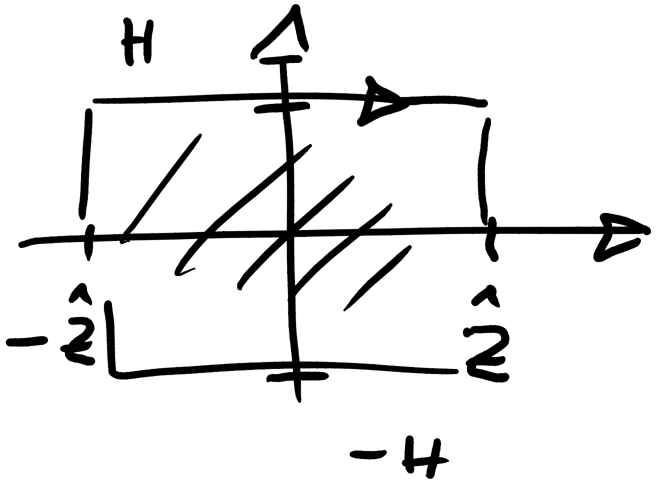
$F_A = z A \rho g$

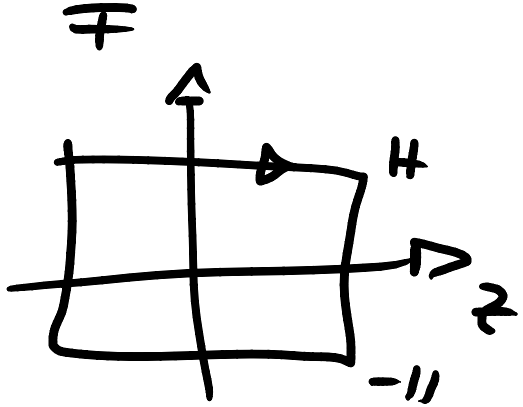
Archimedisches Gesetz

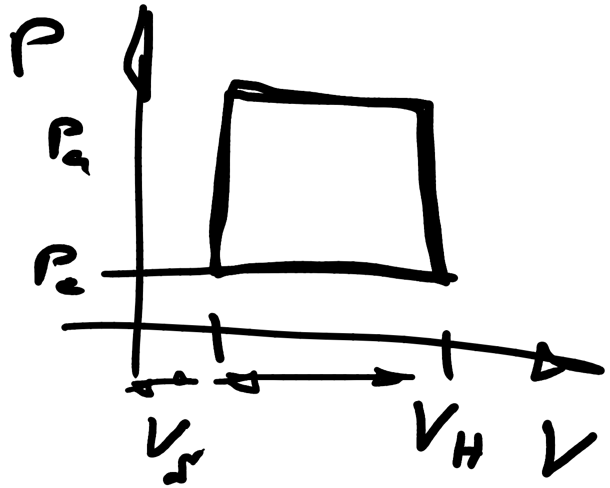
$$k = \frac{\partial F}{\partial z} = \varrho g A$$



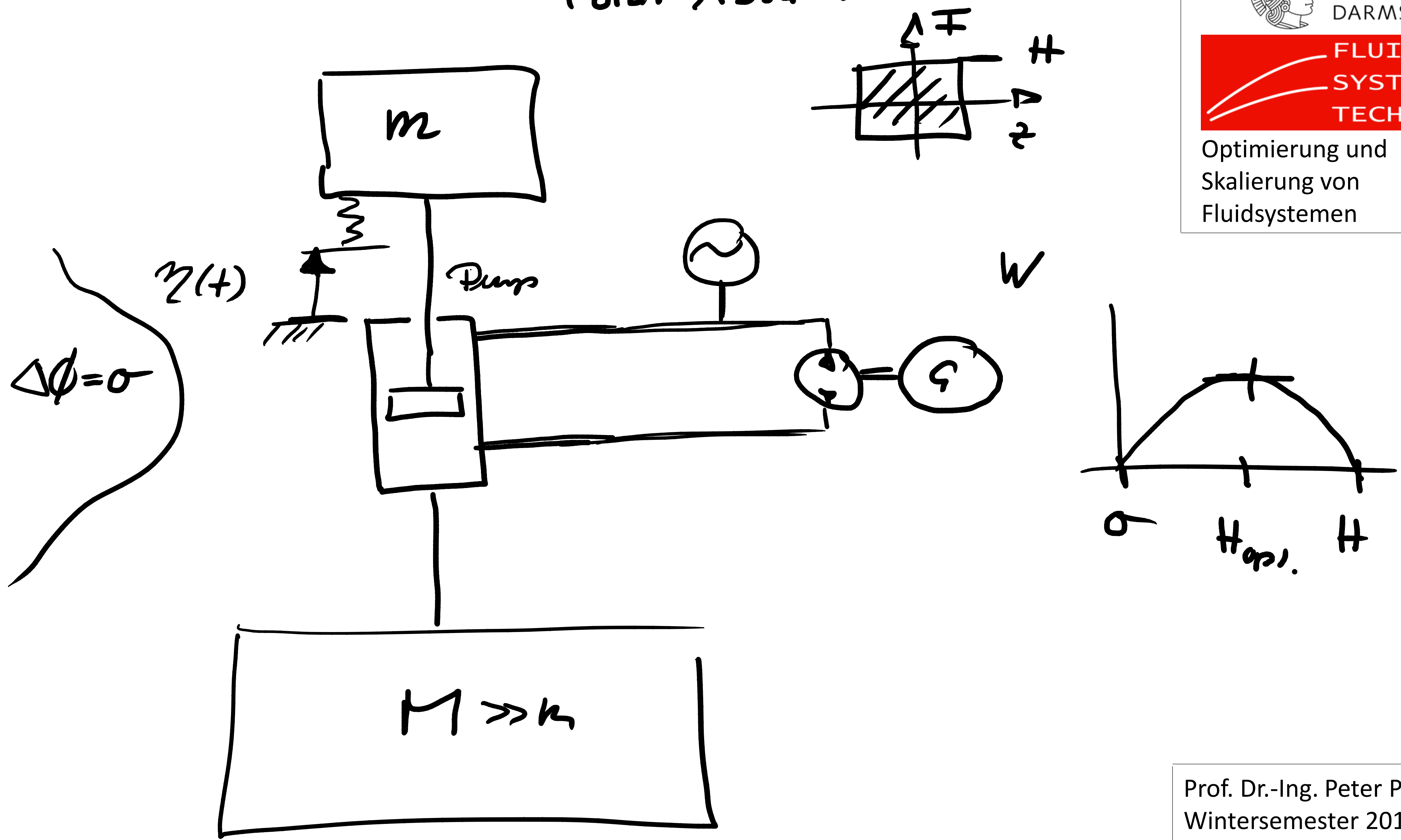
$\hat{z} \exp(i\omega t)$



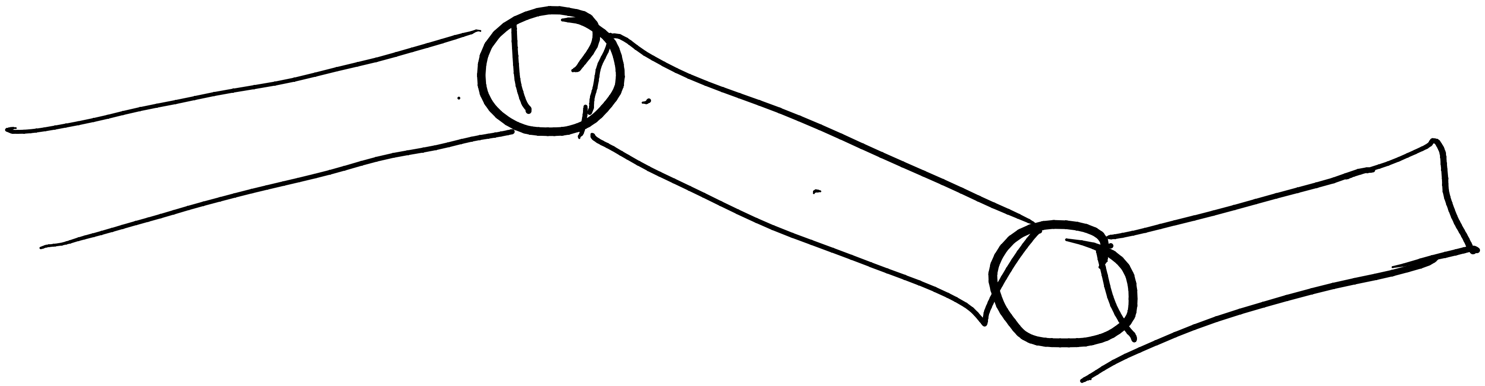




Point Absorber.



Optimierung und Skalierung von Fluidsystemen



Pelamis.