$w \quad p$

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FLUID SYSTEM TECHNIK

Prof. Dr. Ing. Peter Pelz

Sommersemester 2010

Grundlagen der Turbomaschinen und Fluidsysteme

Vorrechenübung 1

	W_m	p_0	T_R	V_0	A_b	R	γ
L	2	-1	0	3	2	2	0
M	1	1	0	0	0	0	0
T	-2	-2	0	0	0	-2	0
E	0	0	1	0	0	-1	0

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	W_m	p_0	$T_0 R$	V_0	A_b	R	γ
L	2	-1	2	3	2	2	0
M	1	1	0	0	0	0	0
T	-2	-2	-2	0	0	-2	0
E	0	0	0	0	0	-1	0

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	W_{pM}	p_0	T_R	V_0	A_b	R	γ
L	2_{+11}	-1	2	3	2	2	0
M	-1_{-1}	1	0	0	0	0	0
T	-2_{+2}	-2	-2	0	0	-2	0
E	0	0	0	0	0	-1	0

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	W_{12}	p_0	T_R	V_0	A_b	R	γ
L	3	-1	2	3	2	2	0
A	0	1	0	0	0	0	0
T	0	-2	-2	0	0	-2	0
E	0	0	0	0	0	-1	0

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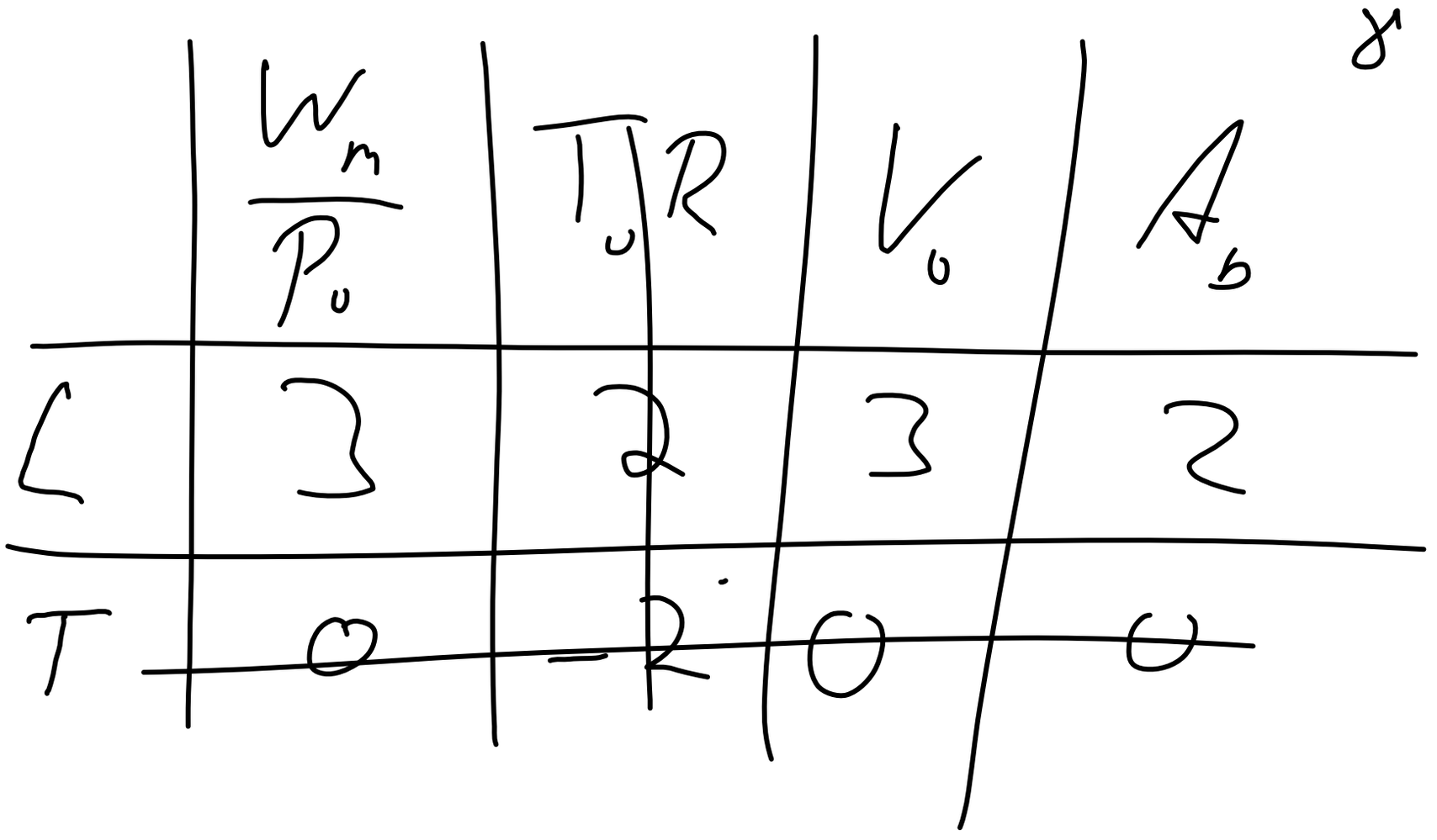

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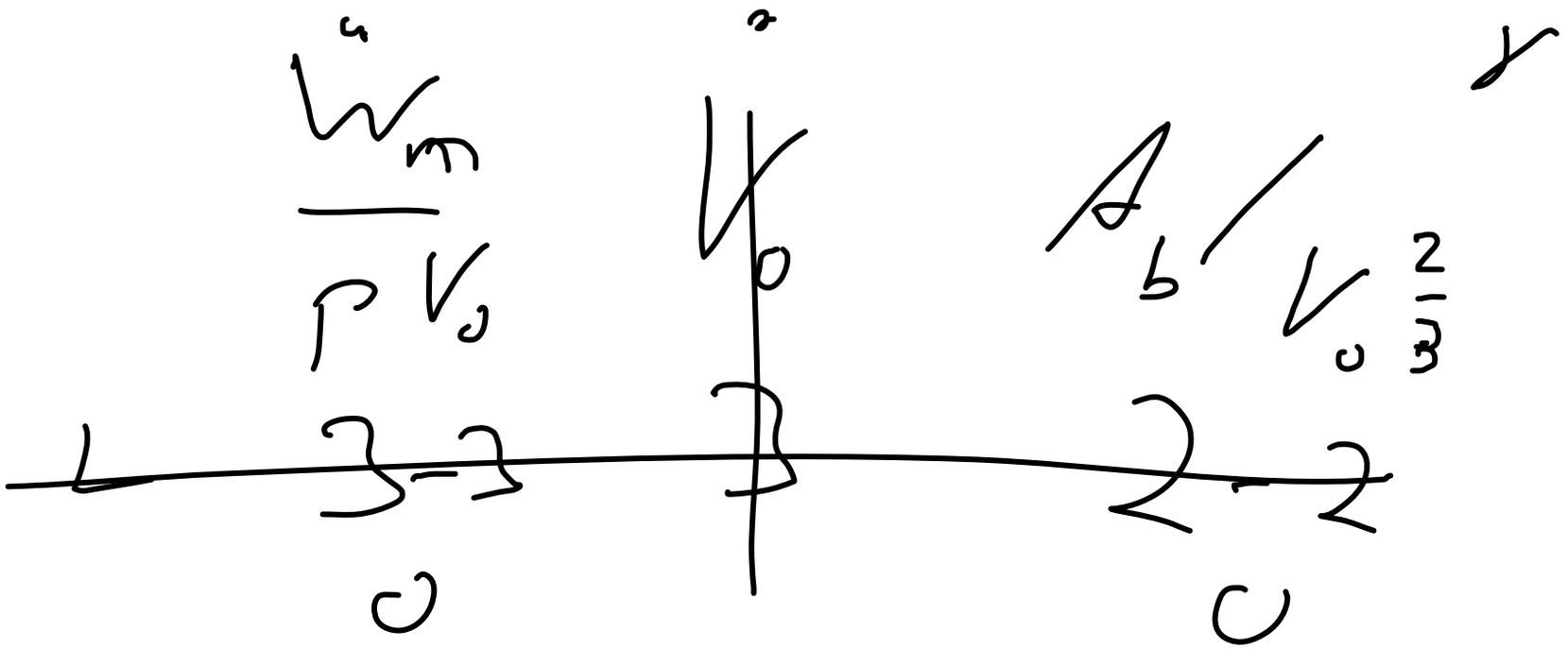

$$\frac{W_m}{p_0 V_0}, \frac{A_b}{V_0^{2/3}}, \gamma$$

$$W_m = p_0 V_0 f\left(\frac{A_b}{V_0^{2/3}}, \gamma\right)$$

$$\frac{W_m}{p_0 V_0} = f\left(\frac{A_b}{V_0^{2/3}}, \gamma\right)$$

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$$f_6 = f\left(p_3, T_6, V_6, A_5, R, \gamma\right) \quad [L\,M\,T\,\Theta]$$

	f_6	p_3	$T_6 \cdot R$	V_6	A_5	R	γ
L	0	1	2	3	2	2	0
M	0	1	0	0	0	0	0
T	-1	2	-2	0	0	-2	0
Θ	0	0	0	0	0	1	0

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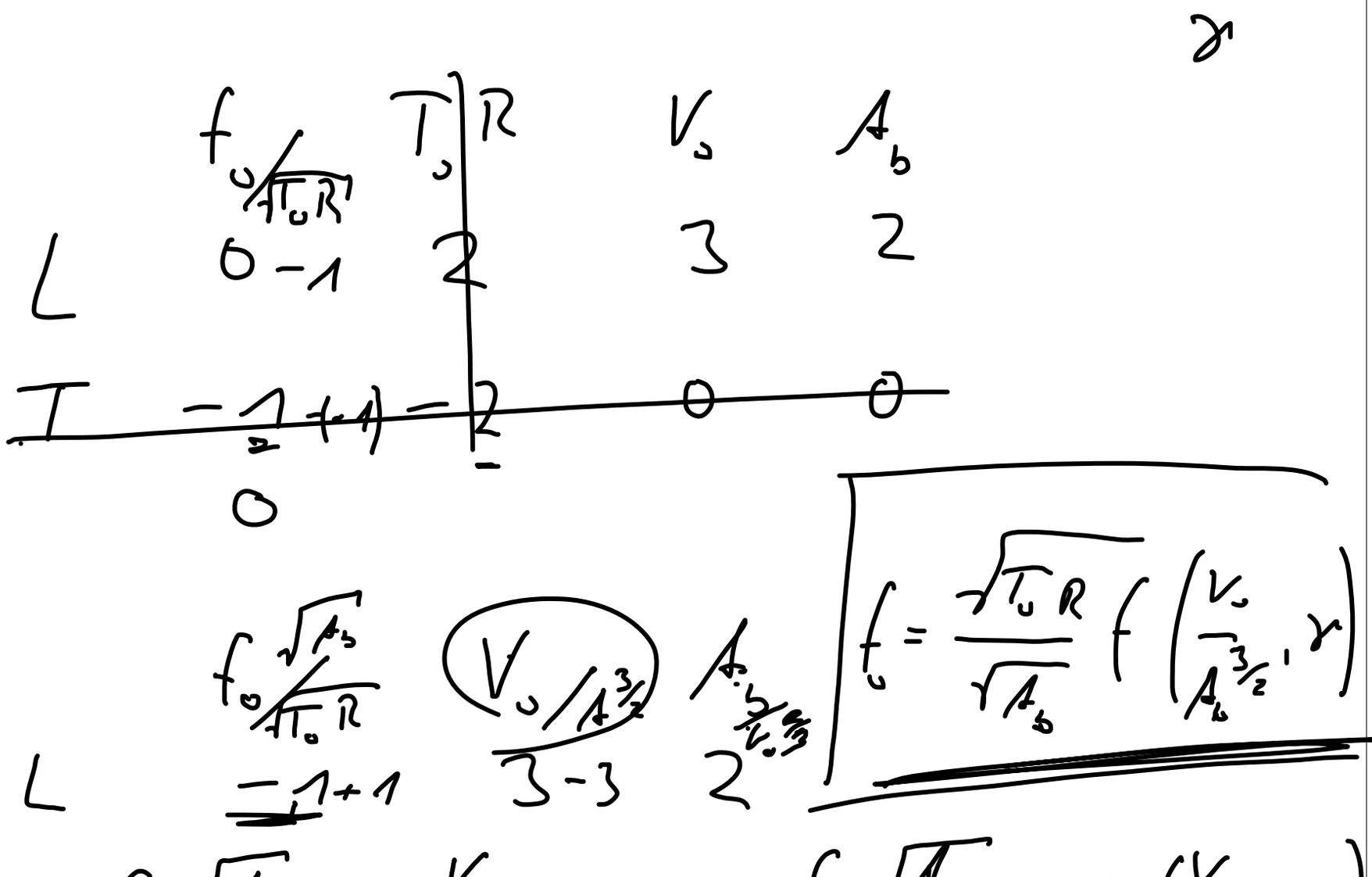

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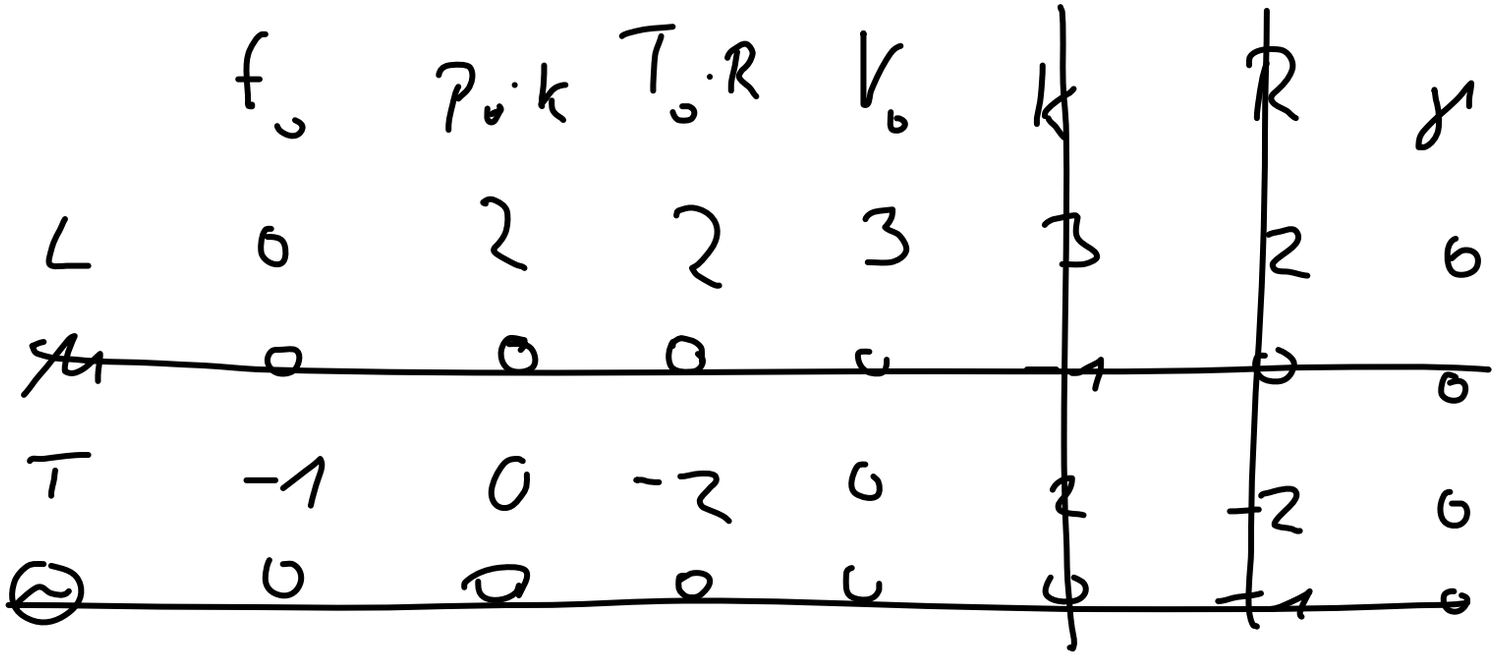
$$f_0 = f(p_0, T_0, V_0, k, R, y) \quad [L\,M\,T\,\Theta]$$



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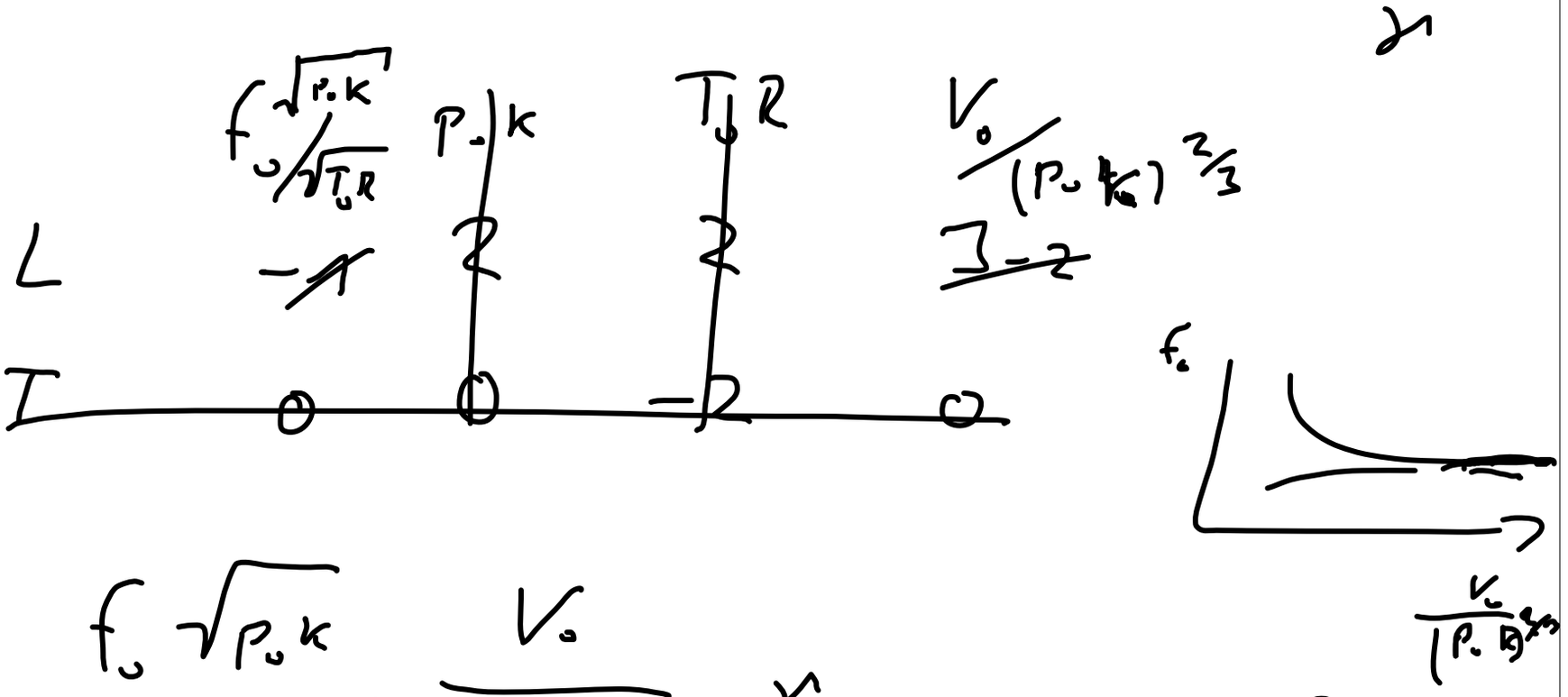

$$\frac{f_0\sqrt{p_0 k}}{\sqrt{T_0 R}} \quad \frac{V_0}{(p_0 k)^{2/3}} \quad \gamma$$

$$f_0 = \frac{\sqrt{T_0 R}}{\sqrt{p_0 k_0}}\, f\left(\frac{V_0}{p_0 k^{2/3}}, \gamma\right)$$

$$f_0 \sim \frac{1}{\sqrt{p_0 k_0}}$$

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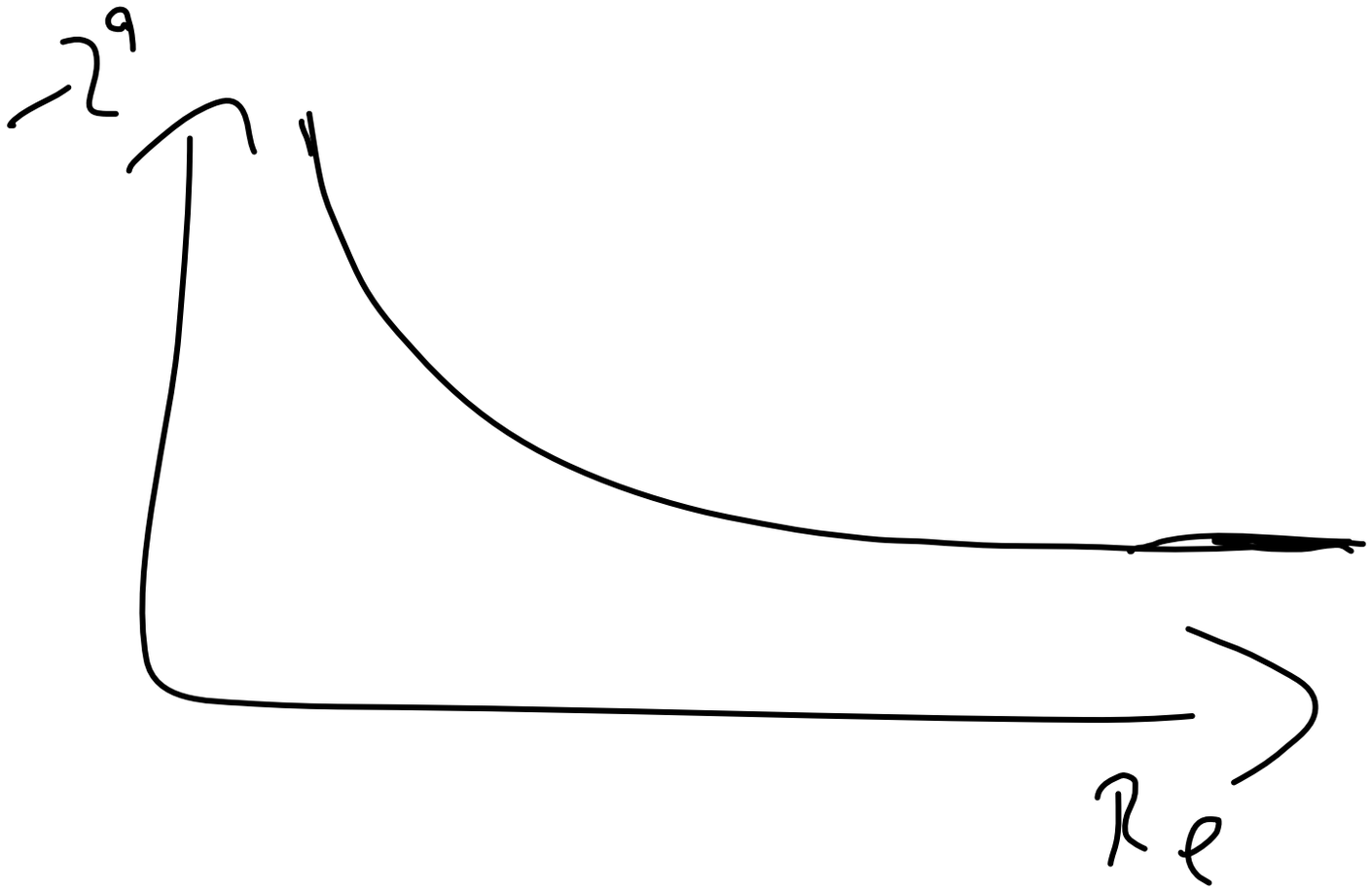

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$$f_0 \sim \sqrt{T_0}$$

$$f_1 \sim \sqrt{T_1}$$

$$\frac{f_0}{f_1} = \frac{\sqrt{T_0}}{\sqrt{T_1}}$$

$$f_1 = \sqrt{\frac{T_1}{T_0}} \cdot f_0$$

$$f_1 = \sqrt{\frac{353\,k}{293\,k}} \cdot 1\,Hz = \sqrt{1,2048} \cdot 1\,Hz$$

$$f_1 = 1,0976\,Hz \simeq 1,1\,Hz$$

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$$\Delta p_t = f(d, n, Q, \nu, \rho) \quad [L M T]$$

$$P_f = f(\Delta p_t, d, n, Q, \nu, \rho) \quad [L M T]$$

	$\Delta p_t/\rho$	d	n	Q	ν	ρ	t
L	2	1	0	3	2	-3	
M	0	0	0	0	0	1	
T	-2	0	-1	-1	-1	0	

	$\Delta p_t/\rho \cdot n^2$	d	n/ν	Q/n	ν
L	2	1	0 -2	3	2
T	-2 +2 = 0	0	-1 +1 = 0	-1 +1 = 0	-1

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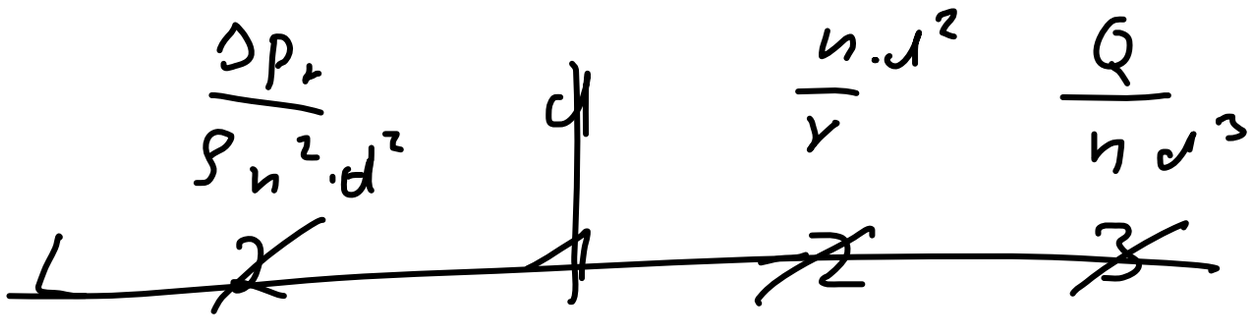

$$\frac{\Delta p_t}{\rho n^2 d^2} \qquad \frac{n d^3}{\nu} \qquad \frac{Q}{n d^3}$$

$$\downarrow \qquad \downarrow \qquad \downarrow$$

$$\psi \qquad Re \qquad \varphi$$

$$- \qquad - \qquad -$$

Betrachtung der Rauhigkeit

$$\frac{k}{d}$$

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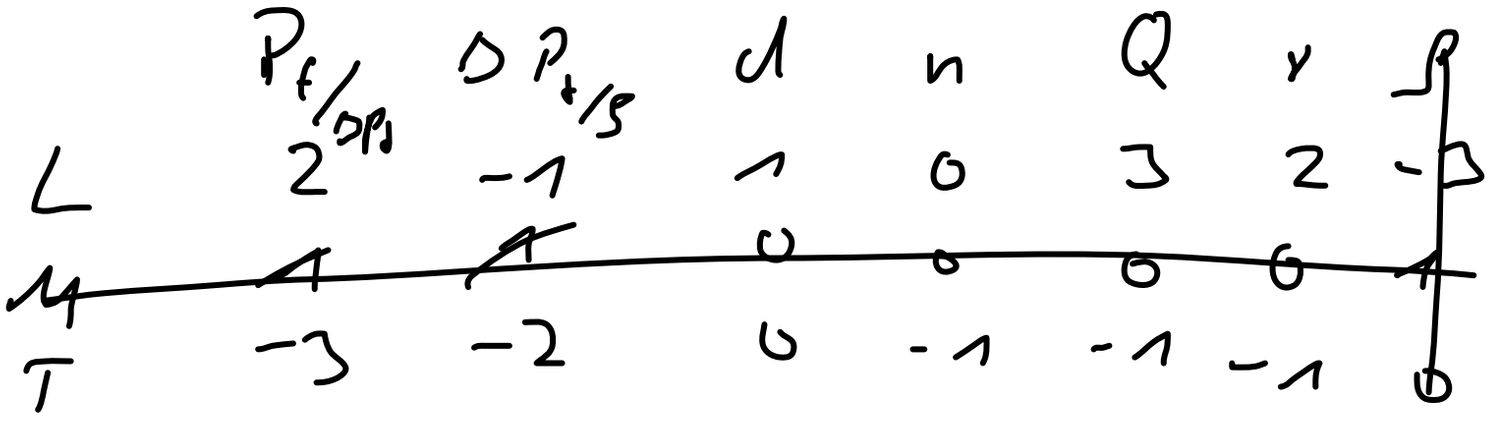

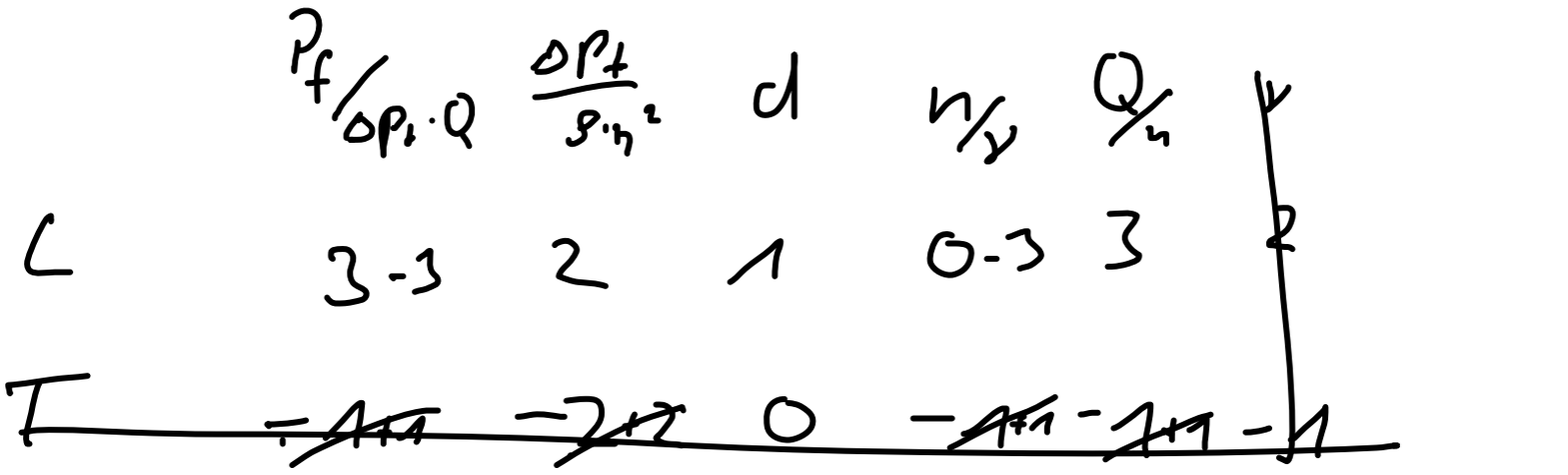

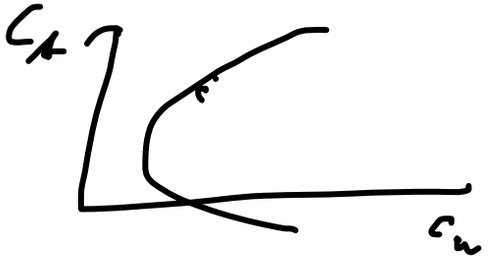

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$$\frac{P_f}{\Delta p_t \, Q} \qquad \frac{\Delta p_t}{\rho n^2 d^2} \; d \; \frac{n \cdot d^2}{\nu} \; \frac{Q}{n d^3}$$

$$L \qquad 0 \qquad 2-2 \qquad \nearrow \qquad -2+2 \qquad 3-3$$

$$\frac{P_f}{\Delta p_t \, Q} \rightarrow \eta$$

$$\frac{\Delta p_t}{\rho n^2 d^2} \rightarrow \psi$$

$$\frac{n \cdot d^2}{\nu} \rightarrow Re$$

$$\frac{Q}{n d^3} \rightarrow \varphi$$

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$$\frac{\varphi}{\varphi'} = 1 = \frac{Q}{n d^3} \cdot \frac{n' d^{3'}}{Q'} = 1$$

$$= \frac{Q}{Q'} \frac{n'}{n} \frac{d^{3'}}{d^3}$$

$$= \mu_Q \mu_n^{-1} \mu_d^{-3}$$

$$\mu_Q = \frac{Q'}{Q}$$

$$\mu_n = \frac{n'}{n}$$

$$\mu_d = \frac{d'}{d}$$

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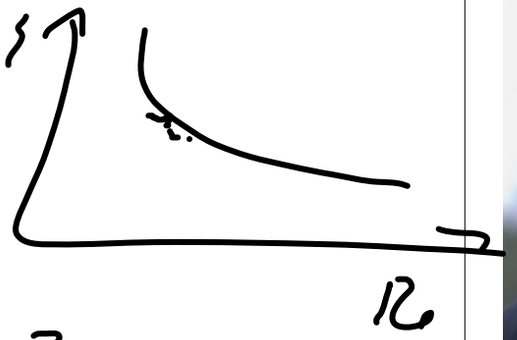
$$Re \qquad \frac{\mu_n \mu_u^2}{\mu_\gamma} = 1 \qquad \frac{d'}{d} = \frac{1}{r_0} = k$$

$$\mu_n = \frac{\mu_\gamma}{\mu_u^2} \Rightarrow \mu_n = \frac{1}{k^2} = k^{-2}$$

$$\varphi \qquad \frac{\mu_Q}{\mu_u^3 \mu_n} \Rightarrow \mu_Q = k$$



$$\psi_1 \qquad \frac{\mu_{\Delta p}}{\mu_Q \mu_n^2 \mu_u^2} \Rightarrow \mu_{\Delta p} = k^{-2}$$

$$P = \Delta p \, Q$$

$$\mu_P = \mu_{\Delta p} \mu_Q = k^{-2} k = k^{-1}$$

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	Δp_v	Q	d	ρ	ν
L	-1	3	1	-3	2
M	1	0	0	1	0
T	-2	-1	0	0	-1

	$\frac{\Delta p_v}{Q^2}$	$\frac{Q}{\nu}$	d	ρ
L	-7	1	1	-3
M	1	0	0	1

	$\frac{\Delta p_v}{Q^2 \rho}$	$\frac{Q}{\nu}$	d
L	-4	1	1

$$\frac{\Delta p_v d^4}{Q^2 \rho} \;,\; \frac{Q}{\nu d}$$

$$\downarrow \qquad \downarrow$$

$$\zeta \qquad Re$$

$$\zeta = f(Re)$$

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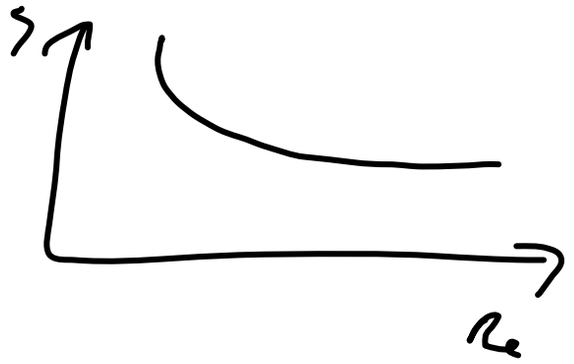
$$\zeta = \frac{\Delta p_v \cdot d^4}{Q^2 \rho} \overset{Re \to \infty}{=} \zeta_\infty$$



$$\psi = \frac{\Delta p_t}{\rho d^2 n^2}$$

$$\psi = \frac{\Delta p_t}{\rho d^2 n^2} \Rightarrow \psi = \zeta_\infty \cdot \frac{Q^2 \rho}{d^4} \cdot \frac{1}{\rho d^2 n^2}$$

$$= \zeta_\infty \frac{Q^2}{d^6 n^2} \qquad \varphi = \frac{Q}{d^3 n}$$

$$\psi = \zeta_\infty \varphi^2$$

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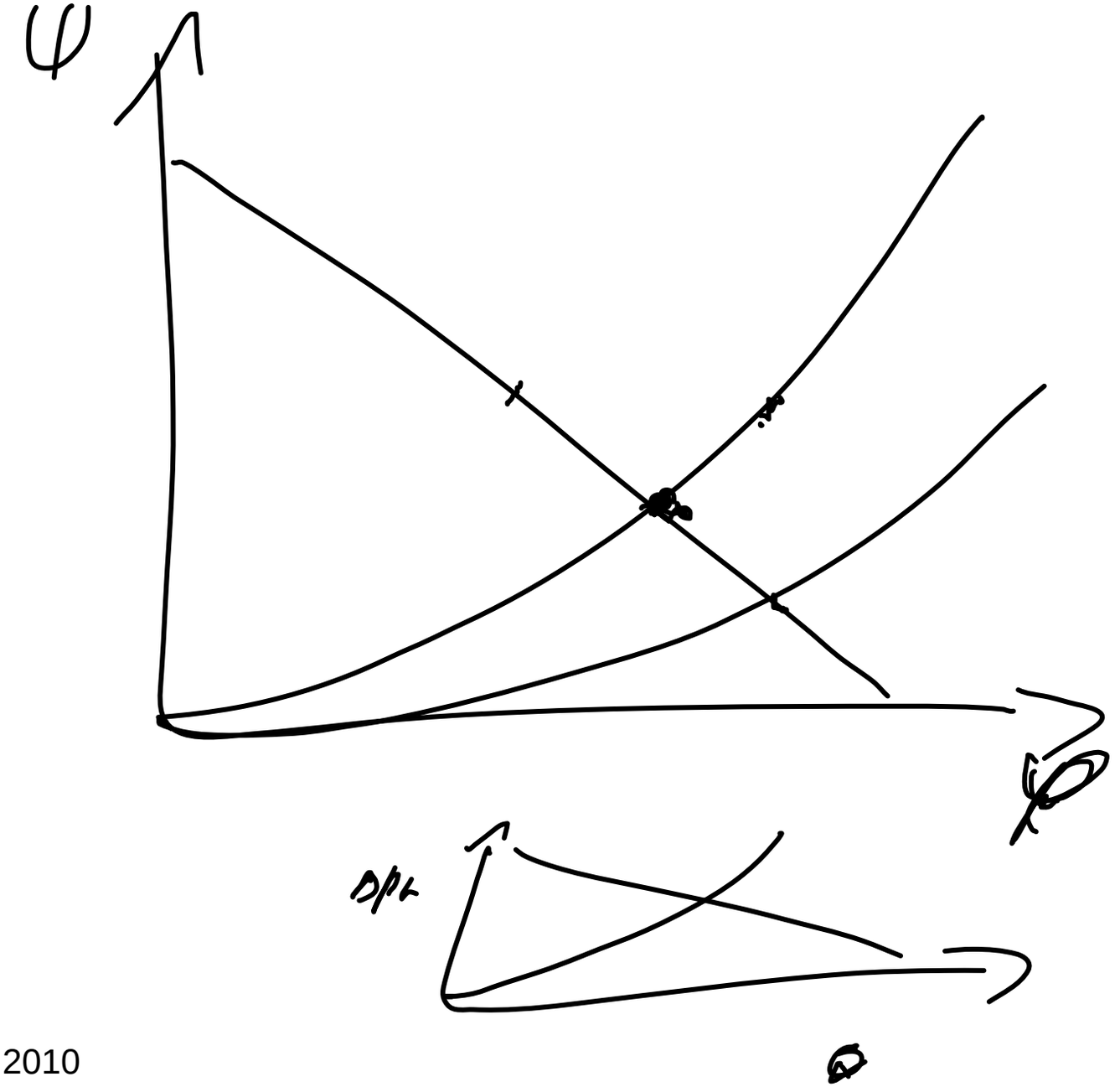

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$$\frac{1-\eta}{1-\eta'} = 1 + V\left[\frac{\psi_{v,f}}{\psi'_{v,f}} - 1\right]$$

$$V = \frac{\psi_{v,f}}{\psi_{v,\Sigma}}$$

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