Peter Hiernickel

	Blindwiderstand	Scheinwiderstand	Blindleitwert	Scheinleitwert	Arbeit
	Reaktanz	Impedanz	Suszeptanz	Admittanz	
Induktivität	$X_L = \omega L$	$\underline{Z}_L = j\omega L$	$B_L = \frac{1}{X_L}$	$\underline{Y}_L = \frac{1}{\underline{Z}_L}$	$W_L = \frac{1}{2} \cdot L I_L^2$
Kapazität	$X_C = \frac{1}{\omega C}$	$\underline{Z}_C = \frac{1}{j\omega C}$	$B_C = \frac{1}{X_C}$	$\underline{Y}_C = \frac{1}{\underline{Z}_C}$	$W_C = \frac{1}{2} \cdot C U_C^2$
Widerstand		$\underline{Z}_R = R$		$\underline{Y}_R = \frac{1}{\underline{Z}_R}$	$W_R = U \cdot I \cdot t$

$R = \frac{U}{I}$ $\quad \underline{Z} = \frac{\underline{U}}{\underline{I}} = \frac{U^2}{\underline{S}^*} = \frac{\underline{S}}{I^2}$ $\quad \underline{Y} = \frac{\underline{I}}{\underline{U}} = \frac{1}{\underline{Z}}$

	*	=	Konjugiert Komplex
	—	=	Komplex
	menu	→	2 → 9
	e^{jx} →	$x \cdot \frac{180}{\pi}$	= Winkel
		$\frac{2\pi}{3}$	= 120°

$$U_m = \frac{1}{T} \cdot \int_0^T u(t)\,dt$$

$$U_{eff} = \sqrt{\frac{1}{T} \cdot \int_0^T u^2(t)\,dt}$$

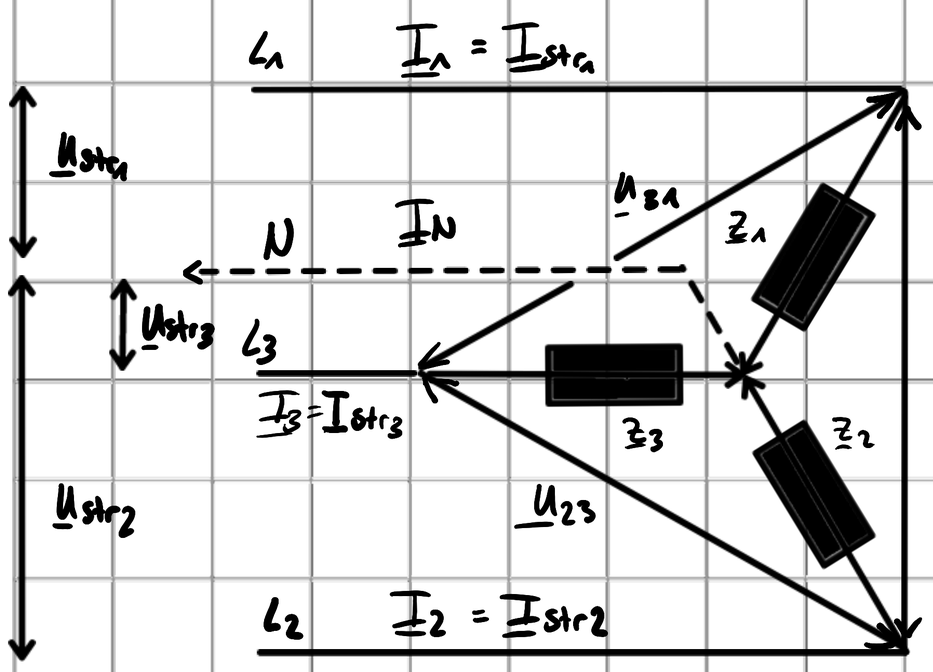
$$P_m = \frac{1}{T} \cdot \int_0^T u(t) \cdot i(t)\,dt$$

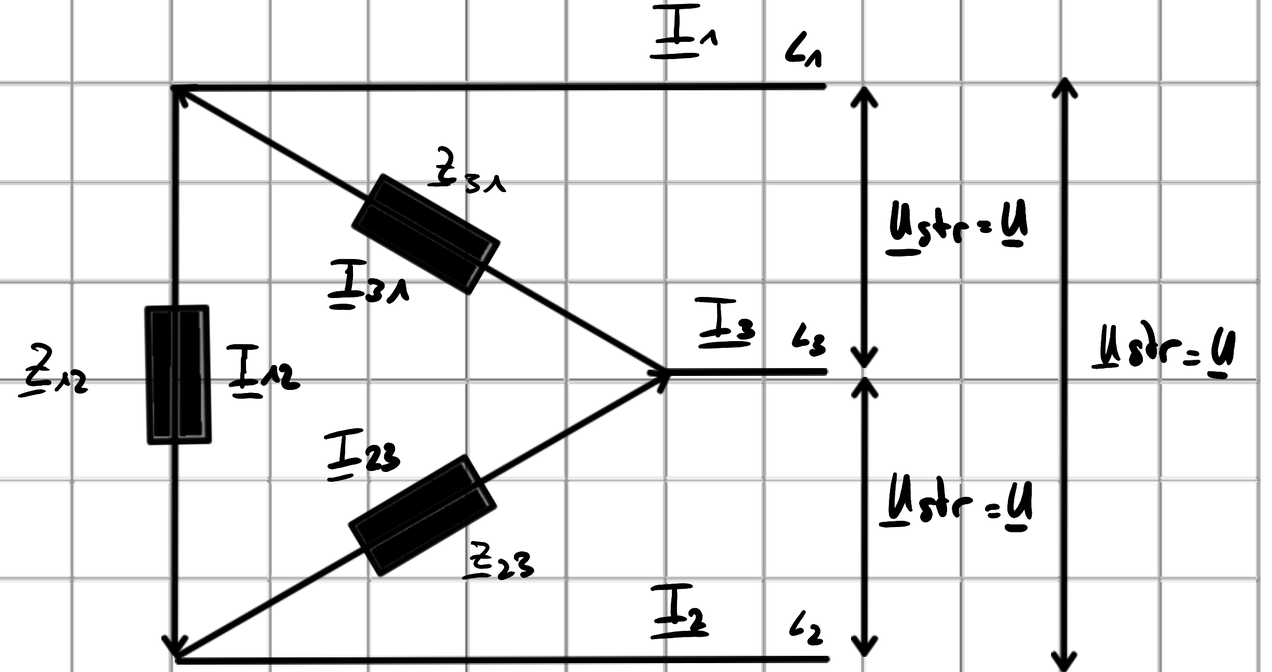
Komplexe Leistung

$\underline{S} = P + jQ$

$\underline{S} = \underline{U} \cdot \underline{I}^* = \underline{I}^2 \cdot \underline{Z} = U \cdot I \cdot e^{j(\varphi_u - \varphi_i)} = \frac{U^2}{\underline{Z}^*}$

Wirkleistung	P	=	$U \cdot I \cdot \cos(\varphi)$	3Ph	P	= $S \cdot \cos(\varphi)$
Blindleistung	Q	=	$U \cdot I \cdot \sin(\varphi)$	3Ph	Q	= $S \cdot \sin(\varphi)$
Scheinleistung	S	=	$U \cdot I = \sqrt{P^2 + Q^2}$	3Ph	S	= $\sqrt{3} \cdot U \cdot I$
Leistungsfaktor	λ	=	$\cos(\varphi) = \frac{P}{S} = \frac{R}{Z}$	3Ph	W_b	= $Q \cdot t$
			$\lvert\varphi\rvert = \arctan\left(\frac{Im}{Re}\right)$			





$\underline{I} = \underline{I}_{str}$ $\quad \underline{I}_N = \underline{I}_1^{0°} + \underline{I}_2^{-120°} + \underline{I}_3^{+120°}$ $\quad \underline{I} = I_{str} \cdot \sqrt{3}$ $\quad \underline{I} = \underline{I}_{str} \cdot \sqrt{3} \cdot e^{j30°}$

$U = U_{str} \cdot \sqrt{3}$ $\quad \underline{U} = U_{str} \cdot \sqrt{3} \cdot e^{j30°}$ $\quad \underline{U} = \underline{U}_{str}$

$\underline{S}_{str} = \underline{U}_{str} \cdot \underline{I}_{str}^*$ $\quad \underline{S}_{str} = \underline{U}_{str} \cdot \underline{I}_{str}^*$

$\underline{S} = \underline{S}_{str_1} + \underline{S}_{str_2} + \underline{S}_{str_3} = \underline{S} \cdot 3 \rightarrow sym$ $\quad \underline{S} = \underline{S}_{str_1} + \underline{S}_{str_2} + \underline{S}_{str_3} = \sqrt{3} \cdot \underline{U} \cdot \underline{I}^* \rightarrow sym$

$\underline{Z}_{Ges}^* = \underline{Z} \cdot 3$

$\Delta \rightarrow Y$ $\quad \underline{Z}_{31} = \frac{\underline{Z}_{31} \cdot \underline{Z}_{12}}{\underline{Z}_{12} + \underline{Z}_{23} + \underline{Z}_{31}}$

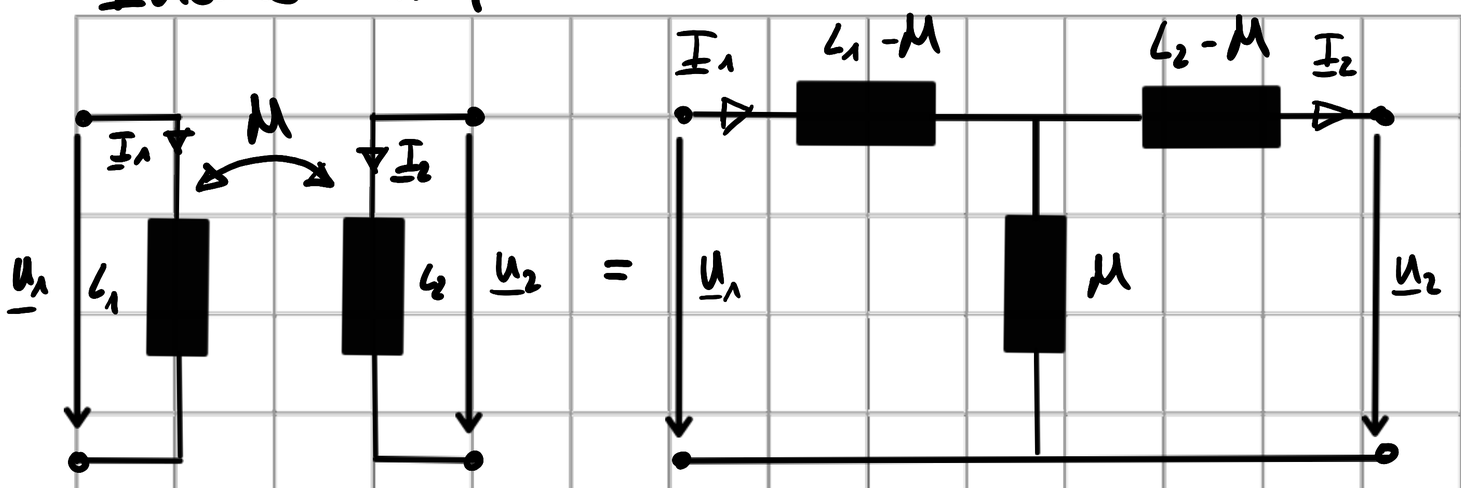
$Y \rightarrow \Delta$ $\quad \underline{Y}_{31} = \frac{\underline{Y}_3 \cdot \underline{Y}_1}{\underline{Y}_1 + \underline{Y}_2 + \underline{Y}_3}$

Bei gleichen R $\quad R_Y = \frac{R_\Delta}{3}$

Bei gleichen C $\quad C_Y = 3 \cdot C_\Delta$

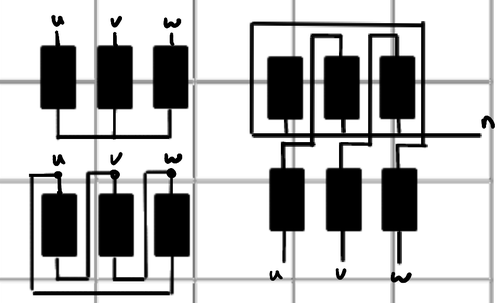
Bei gleichen L $\quad L_Y = \frac{L_\Delta}{3}$

Idealer Trafo



P_{Fe}	:	Eisenverluste
R_1, R_2'	:	Widerstand Spule
$L_{1\sigma}, L_{2\sigma}'$	:	Streufluss Spule
L_m	:	Hauptfluss Spule
I_μ	:	Magnetisierungsstrom
I_{Fe}	:	Eisenverluststrom
M	:	Gegeninduktivität
k	:	Kopplungsfaktor

Grossbuchstabe : HS-Seite } Dreieck Stern Zickzack
Kleinbuchstabe : NS-Seite }
Kennzahl Ph.versch. : $n \cdot 30°$
Kleines n : mit Neutralleiter
Yyn0 : nicht zur Verteilung
Yzn5 : kleine Verteiler
Dy 5 : grosse Verteiler
Yd 5 : Maschinentrafos



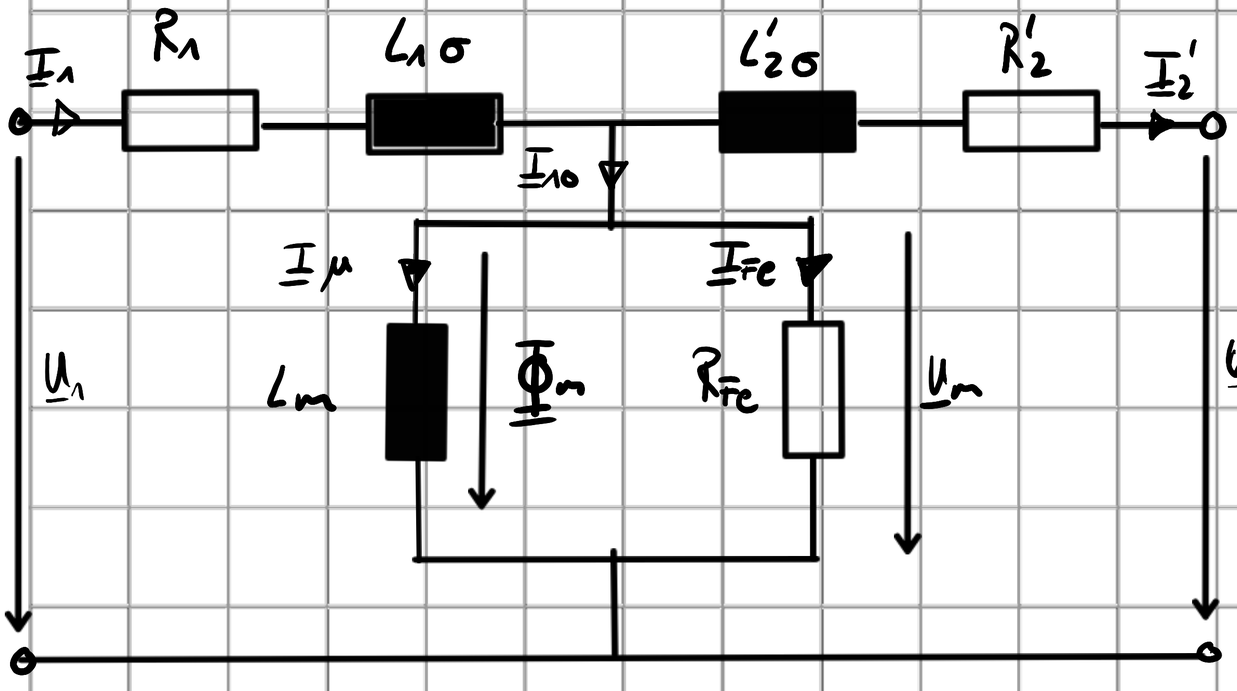
$$U_{ind} = N \cdot \frac{d\Phi}{dt} = N\omega\Phi = \omega BAN$$

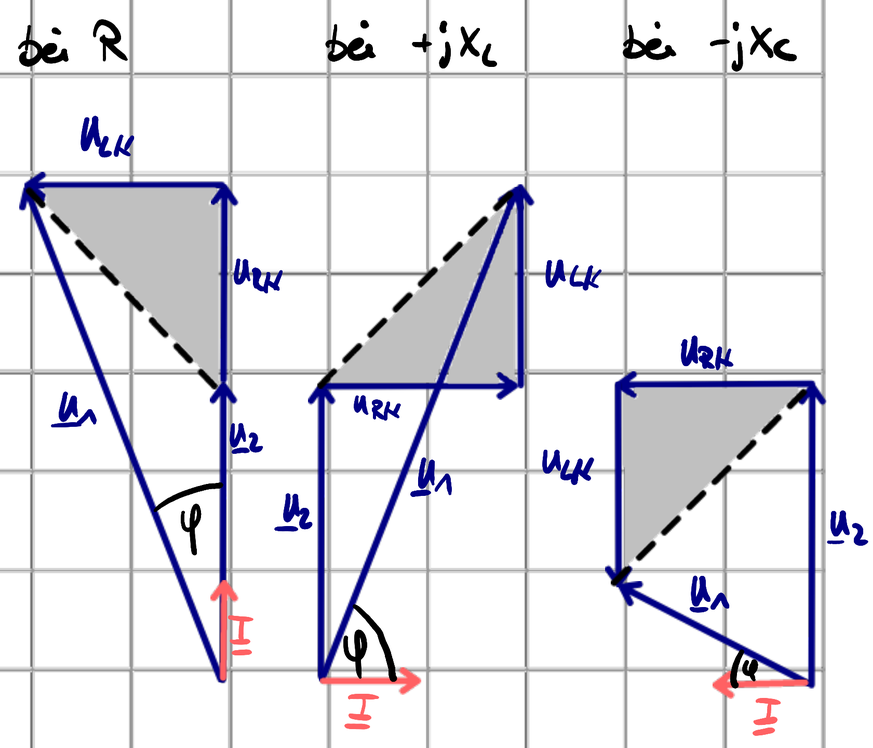
$$B = \mu H$$

$$M = k \cdot \sqrt{L_1 \cdot L_2}$$

$$\bar{u} = \frac{N_1}{N_2} = \frac{U_1}{U_2} = \frac{I_2}{I_1} = \sqrt{\frac{R_1}{R_2}} = \sqrt{\frac{L_1}{L_2}} = \sqrt{\frac{Z_1}{Z_2}}$$

Realer (unbelasteter, einphasiger) Trafo





Leerlauf: $R_1, L_{1\sigma}$

$$I_2' = 0 \qquad I_{10} = I_\mu + I_{Fe}$$

$$U_1 = R_1 \cdot I_1 + j\omega L_{1\sigma} \cdot I_1 + U_2'$$

$$U_2' = j\omega L_m \cdot I_\mu = U_m$$

$$P_{10} = I_{Fe} \cdot U_1$$

Kurzschluss: R_{Fe}, L_m

$$I_K = I_{1N} = \frac{S_{1N}}{U_{1N}}$$

$$U_2' = 0$$

$$U_m = j\omega L_m I_\mu = R_2' I_2' + j\omega L_{2\sigma}' I_2'$$

$$P_K = I_{1N}^2 \cdot (R_1 + R_2')$$

Nennbetrieb:

$$R_1 = R_2' \; ; \quad R_2' = R_2 \left(\frac{N_1}{N_2}\right)^2 ;$$

$$I_2' = I_2 \frac{N_2}{N_1} \; ; \quad L_{\sigma 1} = L_{\sigma 2}' \; ; \quad L_{2\sigma}' = L_{2\sigma} \left(\frac{N_1}{N_2}\right)^2 ;$$

$$U_2' = U_1 - Z_K \cdot I_{1N} \; ; \quad U_2' = U_2 \frac{N_1}{N_2} \; ;$$

$$\eta = \frac{S_1 - P_V}{S_1} \qquad \eta_T = \frac{P_{2N}}{P_{2N} + P_K + P_{10}} \cdot 100\%$$

