ZHAW Zurich University of Applied Sciences
Winterthur

Zusammenfassung EAT
Studienwochen 1-5

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Zf. EAT SW 1-5

1 Transformator

1.1 Durchflutungsgesetz

$$\begin{aligned}\theta_l &= \int_A \vec{j}\, d\vec{A} \\ &= \oint_l \vec{H}\, d\vec{l} \\ &= N \cdot I\end{aligned}$$

1.2 Materialgesetz

$$\begin{aligned}B &= \mu \cdot H \\ &= \mu_r \cdot \mu_0 \cdot H\end{aligned}$$

$$\mu_0 = 4 \cdot \pi \cdot 10^{-7}\ \frac{\mathrm{Vs}}{\mathrm{Am}}$$

Sättigung????

1.3 Magnetischer Fluss

$$\phi = \int_A \vec{B}\, d\vec{A}$$

$$u_i = \frac{d}{dt}\phi \cdot N$$

1.4 Induktivität

$$L = \frac{\psi}{i}$$

$$\begin{aligned} u_i &= L \cdot \frac{d}{dt} i \\ &= \frac{d}{dt} \psi \end{aligned}$$

$$\theta_l = \frac{B}{\mu_r \cdot \mu_0} \cdot l_{\mathrm{Fe}}$$

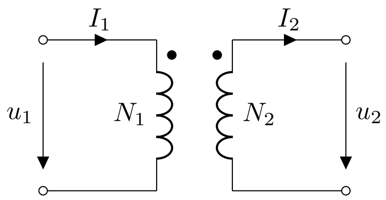
$$\begin{aligned} \phi &= B \cdot A_{\mathrm{Fe}} \\ &= \frac{\mu_0 \cdot N \cdot I \cdot A_{\mathrm{Fe}}}{\frac{l_{\mathrm{Fe}}}{\mu_r} + l_\delta} \end{aligned}$$

$$\begin{aligned} \psi &= N \cdot \phi \\ &= \frac{\mu_0 \cdot N^2 \cdot I \cdot A_{\mathrm{Fe}}}{\frac{l_{\mathrm{Fe}}}{\mu_r} + l_\delta} \end{aligned}$$

$$\Lambda = \frac{\mu_0 \cdot A_{\mathrm{Fe}}}{\frac{l_{\mathrm{Fe}}}{\mu_r} + l_\delta}$$

$$\begin{aligned} L &= \Lambda \cdot N^2 \\ &= \frac{\mu_0 \cdot A_{\mathrm{Fe}}}{\frac{l_{\mathrm{Fe}}}{\mu_r} + l_\delta} \cdot N^2 \end{aligned}$$

1.5 Übergänge



$$\begin{aligned} \ddot{u} &= \frac{N_1}{N_2} \\ &= \frac{u_1}{u_2} \\ &= \frac{I_2}{I_1} \end{aligned}$$

$$\begin{aligned} u_1 &= \frac{d}{dt}\,\psi_1 \\ &= N_1 \cdot \frac{d}{dt}\,\phi_h + L_{\sigma 1} \cdot \frac{d}{dt}\,i_1 \end{aligned}$$

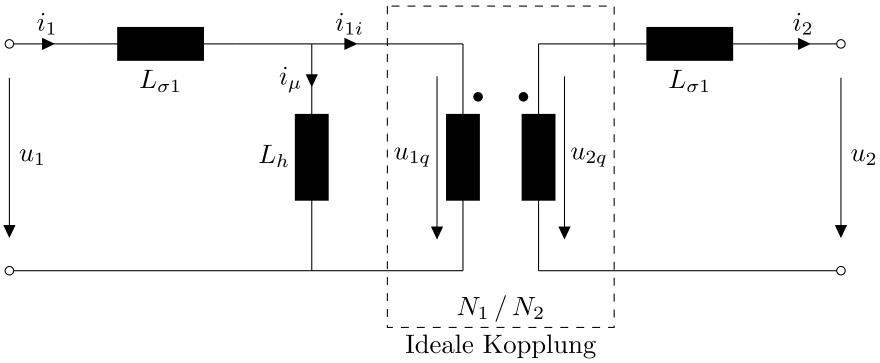
$$\begin{aligned} u_2 &= \frac{d}{dt}\,\psi_2 \\ &= N_2 \cdot \frac{d}{dt}\,\phi_h + L_{\sigma 2} \cdot \frac{d}{dt}\,i_2 \end{aligned}$$

$$i_\mu = \frac{B_h}{\mu_0 \cdot \mu_r} \cdot l_h$$

$$i_2 = \ddot{u} \cdot (i_1 + i_\mu)$$

$$\begin{aligned} \theta_h &= \oint_{l_h} H\, d\vec{l} \\ &= H_h \cdot l_h \\ &= \frac{B_h}{\mu_0 \cdot \mu_r} \cdot l_h \\ &= N_1 \cdot i_1 - N_2 \cdot i_2 \\ &= \frac{1}{\ddot{u}} \cdot u_1 - \frac{1}{\ddot{u}} \cdot L_{\sigma 1} \cdot \frac{d}{dt}\,i_1 - L_{\sigma 2} \cdot \frac{d}{dt}\,i_2 \end{aligned}$$

1.6 Übergänge - Komplex



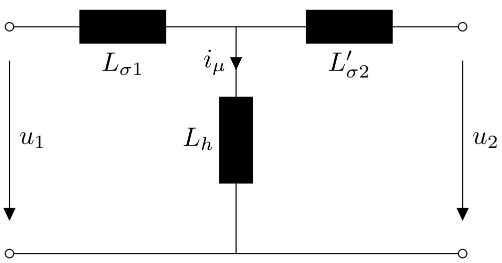
$$X_\sigma = f \cdot L_\sigma$$

$$\underline{U}_2 = \frac{1}{\ddot{u}} \cdot (\underline{U}_1 - j \cdot X_{\sigma 1} \cdot \underline{I}_1) - j \cdot X_{\sigma 2} \cdot \underline{I}_2$$

$$\underline{I}_2 = \ddot{u} \cdot (\underline{I}_1 - \underline{I}_{\mu 1})$$

$$\begin{aligned} \ddot{u} &= \frac{u_{1q}}{u_{2q}} \\ &= \frac{i_2}{i_{1i}} \end{aligned}$$

1.7 Ersatzschaltung

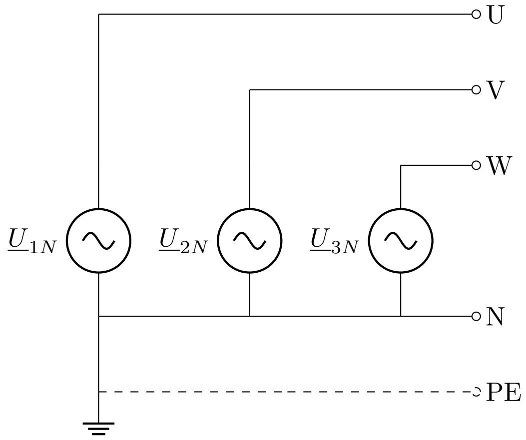


$$X'_{\sigma 2} = \ddot{u} \cdot X_{\sigma 2}$$

1.8 Leistung

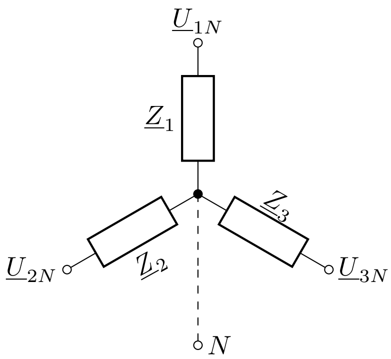
$$\underline{S}_0 = \underline{U}_{10} \cdot \underline{I}_{10}$$

2 Drehstrom



$$\underline{U}_{kN} = U_Y \cdot \exp\left(-\frac{2}{3} \cdot (k-1) \cdot \pi \cdot i\right)$$
$$u_k(t) = \hat{U} \cdot \cos(\omega \cdot t - \cdot (k-1) \cdot \pi)$$
$$k \in \{1, 2, 3\}$$
$$\hat{U} = \sqrt{2} \cdot U_Y$$

2.1 Symmetrisch belastete Sternschaltung



$$\underline{I}_k = \frac{\underline{U}_{kN}}{\underline{Z}}, \quad k \in \{1, 2, 3\}$$

$$\underline{I}_N = \underline{I}_1 + \underline{I}_2 + \underline{I}_3 = 0 \text{ A}$$

$$(\underline{U}_Y, \underline{I}_Y) \in \{(\underline{U}_{1N}, \underline{I}_1), (\underline{U}_{2N}, \underline{I}_2), (\underline{U}_{3N}, \underline{I}_3)\}$$

$$\underline{S} = 3 \cdot \underline{U}_Y \cdot \underline{I}_Y^*$$

2.2 Symmetrisch belastete Dreiecksschaltung

$$\underline{U}_{12} = \underline{\mathrm{U}}_{1N} - \underline{\mathrm{U}}_{2N}, \quad \underline{U}_{23} = \underline{\mathrm{U}}_{2N} - \underline{\mathrm{U}}_{3N}, \quad \underline{U}_{31} = \underline{\mathrm{U}}_{3N} - \underline{\mathrm{U}}_{1N}$$

$$\underline{I}_{12} = \frac{\underline{U}_{12}}{\underline{Z}}, \quad \underline{I}_{23} = \frac{\underline{U}_{23}}{\underline{Z}}, \quad \underline{I}_{31} = \frac{\underline{U}_{31}}{\underline{Z}}$$

$$\underline{I}_1 = \underline{I}_{12} - \underline{I}_{31}, \quad \underline{I}_2 = \underline{I}_{23} - \underline{I}_{12}, \quad \underline{I}_3 = \underline{I}_{31} - \underline{I}_{23}$$

$$(\underline{U}_\triangle, \underline{I}_\triangle) \in \left\{ \left(\underline{U}_{12}, \frac{\underline{I}_1}{\sqrt{3}}\right), \left(\underline{U}_{23}, \frac{\underline{I}_2}{\sqrt{3}}\right), \left(\underline{U}_{31}, \frac{\underline{I}_3}{\sqrt{3}}\right) \right\}$$

$$\underline{S} = 3 \cdot \underline{U}_\triangle \cdot \underline{I}_\triangle^*$$

2.3 Asymmetrisch belastete Sternschaltung (Vierleiter)

$$\underline{I}_1 = \frac{\underline{U}_{1N}}{\underline{Z}_1}, \quad \underline{I}_2 = \frac{\underline{U}_{2N}}{\underline{Z}_2}, \quad \underline{I}_3 = \frac{\underline{U}_{3N}}{\underline{Z}_3}$$

$$\underline{S} = \underline{S}_1 + \underline{S}_2 + \underline{S}_3$$

2.4 Asymmetrisch belastete Sternschaltung (Dreileiter)

$$\underline{U}_{KN} = (\underline{Z}_1 \| \underline{Z}_2 \| \underline{Z}_3) \cdot \left(\frac{\underline{U}_{1N}}{\underline{Z}_1} + \frac{\underline{U}_{2N}}{\underline{Z}_2} + \frac{\underline{U}_{3N}}{\underline{Z}_3} \right)$$

$$\underline{S} = \underline{S}_1 + \underline{S}_2 + \underline{S}_3$$

2.5 Asymmetrisch belastete Dreiecksschaltung

$$\underline{I}_{12} = \frac{\underline{U}_{12}}{\underline{Z}_{12}}, \quad \underline{I}_{23} = \frac{\underline{U}_{23}}{\underline{Z}_{23}}, \quad \underline{I}_{31} = \frac{\underline{U}_{31}}{\underline{Z}_{31}}$$

$$\underline{S} = \underline{S}_1 + \underline{S}_2 + \underline{S}_3$$