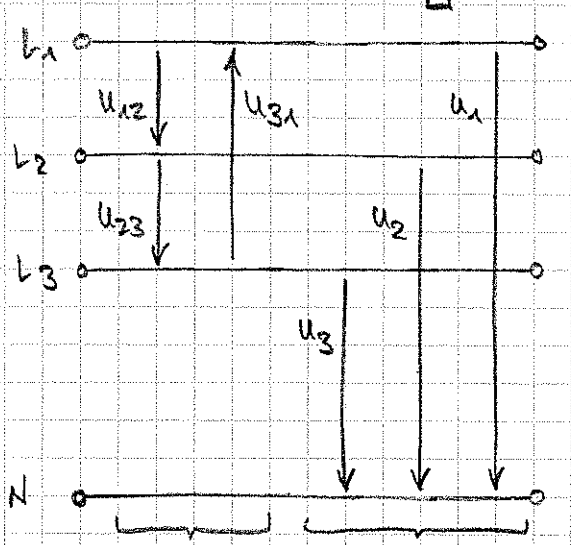
Drehstromnetz:



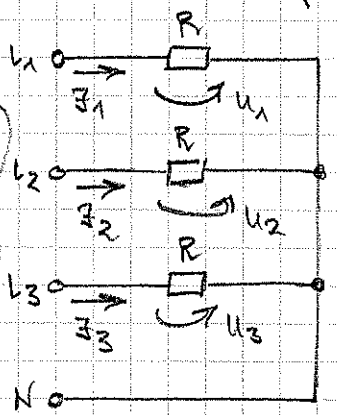

Außenleiterspannungen

$U_L = U_{12} = U_{23} = U_{31} = \sqrt{3}\, U_{St} = 400\,V$

Strangspannungen

$U_{St} = U_1 = U_2 = U_3 = 230\,V$

Sternschaltung




geg: $U_L = 400\,V$

$R = 20\,\Omega$

ges: $I, P$ für $\lambda$ u. $\Delta$

$$P = 3 \cdot U \cdot I$$
$$= 3 \cdot U_{St} \cdot \frac{U_{St}}{R}$$
$$= 3 \cdot \frac{U_{St}^2}{R}$$
$$= 3 \cdot \frac{U_L^2}{\sqrt{3}^2 R}$$

$$P = \frac{U_L^2}{R} = \frac{(400\,V)^2}{20\,\Omega} = \frac{160000\,V^2 A}{20\,V} = 8000\,W$$

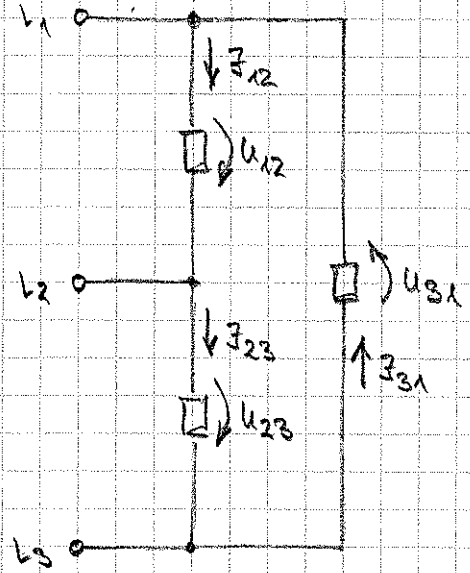
$$I = I_1 = I_2 = I_3 = \frac{U_{St}}{R} = \frac{U_L}{\sqrt{3}R} = \frac{400\,VA}{\sqrt{3}\,20\,V} = \frac{20}{\sqrt{3}}\,A$$

$I_\lambda = 11{,}55\,A$

$P_\lambda = 8\,kW$

Dreieckschaltung

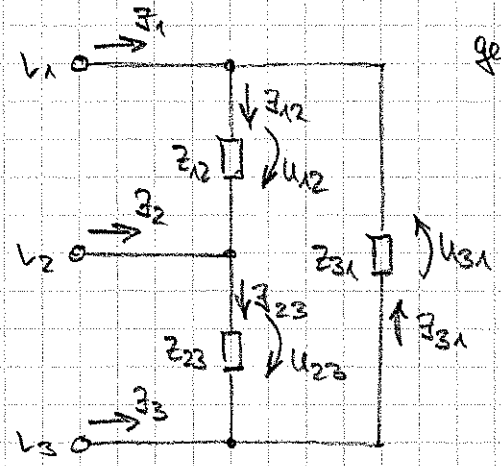
$I = I_{12} = I_{23} = I_{31}$




$$P = 3 \cdot U \cdot I = 3 \cdot U_L \cdot I = 3 \cdot U_L \cdot \frac{U_L}{R}$$
$$P = 3\,\frac{U_L^2}{R} = 3 \cdot \frac{(400\,V)^2}{R}$$
$$P = \frac{3 \cdot 160000\,V^2 A}{20\,V} = 24000\,W$$

$P_\Delta = 24\,kW$

$$I = \frac{U_L}{R} = \frac{400\,V\,A}{20\,V} \Rightarrow I_\Delta = 20\,A$$




gegeben: $\underline{Z}_{12} = -j|X_C|$  $R = |X_C| = X_L = 100\,\Omega$

$\underline{Z}_{23} = R$  $U_L = 400\,V$

$\underline{Z}_{31} = R + jX_L$

gesucht: $\underline{Z}_L = \{\underline{Z}_1, \underline{Z}_2, \underline{Z}_3\}$ mit $\varphi_{12} = 0$

+ Zeigerdiagramm

$$\underline{I}_{12} = \frac{\underline{U}_{12}}{\underline{Z}_{12}} = -\frac{\underline{U}_{12}}{j|X_C|} = -\frac{400V\exp(0)}{100\Omega\exp(j\frac{\pi}{2})} = -4A\exp(-j\tfrac{\pi}{2}) = \underline{4A\exp(j\tfrac{\pi}{2}) = 4Aj}$$

$$\underline{I}_{23} = \frac{\underline{U}_{23}}{\underline{Z}_{23}} = \frac{\underline{U}_{23}}{R} = \frac{400V\exp(-j\frac{2\pi}{3})}{100\Omega} = \underline{4A\exp(-j\tfrac{2\pi}{3})}$$

$$= 4A\left(\cos(-\tfrac{2\pi}{3}) + j\sin(-\tfrac{2\pi}{3})\right)$$

$$= \underline{-2A - 3{,}464A\,j}$$

$$\underline{I}_{31} = \frac{\underline{U}_{31}}{\underline{Z}_{31}} = \frac{\underline{U}_{31}}{R + jX_L} = \frac{400V\exp(j\frac{2\pi}{3})}{100\Omega\,(1+j)} = \frac{400V\exp(j\frac{2\pi}{3})}{100\cdot\sqrt{2}\,\Omega\exp(j\frac{\pi}{4})} = \frac{4}{\sqrt{2}}A\exp\left(j\left(\tfrac{2}{3}\pi - \tfrac{\pi}{4}\right)\right)$$

($1+j$: $45°$)

$$= \frac{4}{\sqrt{2}}A\exp\left(j\frac{5}{12}\pi\right) = \frac{4}{\sqrt{2}}A\left(\cos\left(\frac{5}{12}\pi\right) + j\sin\left(\frac{5}{12}\pi\right)\right) = 0{,}732A + 2{,}732A\,j$$

($\frac{5}{12}\pi$: $2{,}83$ / $75°$)

$$\underline{I}_1 = \underline{I}_{12} - \underline{I}_{31} = -0{,}732A + j(4 - 2{,}732)A = \underline{(-0{,}732 + j\,1{,}268)A} = \underline{1{,}464A\cdot\exp(j\tfrac{2}{3}\pi)}$$

$$\underline{I}_2 = \underline{I}_{23} - \underline{I}_{12} = -2A + j(-3{,}464 - 4)A = \underline{(-2 - j\,7{,}464)A}$$

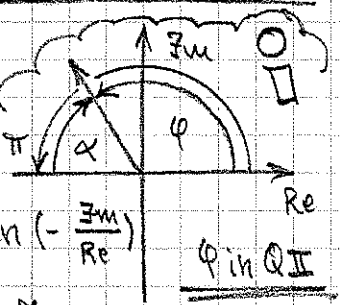
$$= \underline{7{,}73A\exp(j\tfrac{7}{12}\pi) = 7{,}73A\exp(-j\,105°)}$$

$$\underline{I}_3 = \underline{I}_{31} - \underline{I}_{23} = 0{,}732A + 2A + j(2{,}732 + 3{,}464)A$$

$$= \underline{(2{,}732 + j\,6{,}196)A}$$

$$= \underline{6{,}772A\exp(j\,1{,}156)}$$

$$= 6{,}772A\exp(j\,66{,}2°)$$

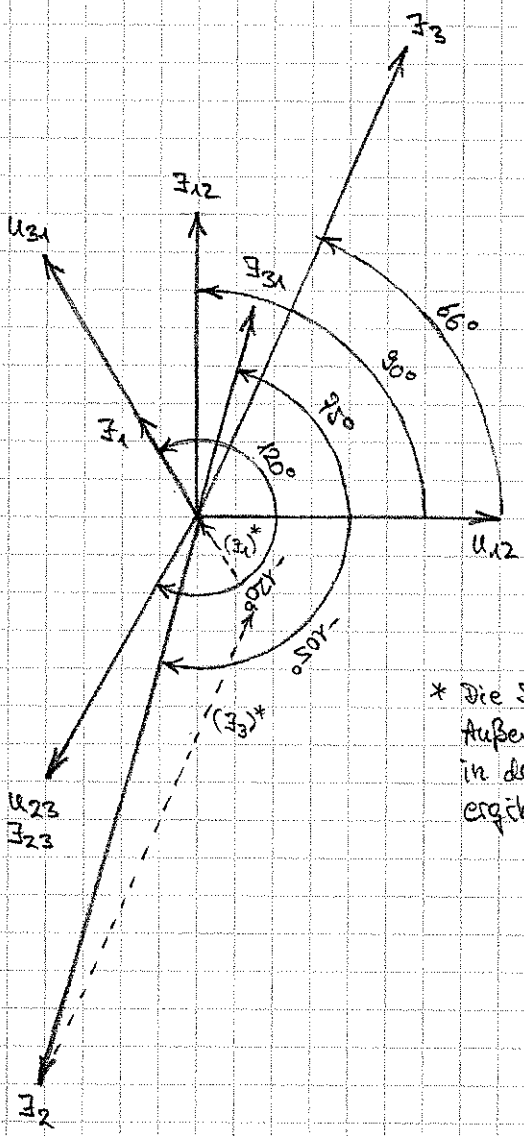



$\alpha = \operatorname{atan}\left(-\frac{Im}{Re}\right)$

$\varphi = \pi - \alpha$

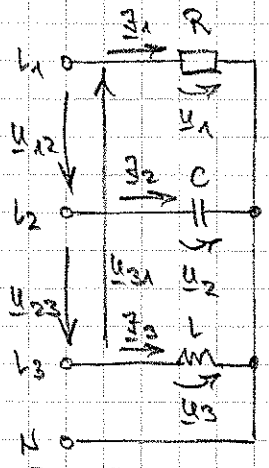
$\varphi = \pi - \operatorname{atan}\left(-\frac{Im}{Re}\right)$

$\varphi$ in QII




* Die Summe des Außenleiterströme in der Dreieckschaltung ergibt Null.

GET (2) Rechenübung (22) Aufgabe (3) Rex B Markus Symmank 27.05.2025




geg: $R = |X_L| = |X_C| = 100\Omega$

$\underline{U}_{12} = \underline{U}_{23} = \underline{U}_{31} = U_L = 400V$

$\underline{U}_1 = \underline{U}_2 = \underline{U}_3 = U_{St} = \frac{U_L}{\sqrt{3}} = \frac{400V}{\sqrt{3}}$

$\underline{Z}_1 = R$

$\underline{Z}_2 = -|X_C|\,j$

$\underline{Z}_3 = |X_L|\,j$

Ansatz: $P_\Sigma = Re\{\underline{S}_\Sigma\} = Re\{\underline{S}_1 + \underline{S}_2 + \underline{S}_3\}$

$Q_2 = Im\{\underline{S}_2\}$

$Q_3 = Im\{\underline{S}_3\}$

$Q_\Sigma = Im\{\underline{S}_\Sigma\} = Im\{\underline{S}_1 + \underline{S}_2 + \underline{S}_3\}$

Fehler im Seminar vom 27.05.2025

Falsch: $\underline{S} = \underline{U} \cdot \underline{I} = \frac{U^2}{\underline{Z}}$

Richtig: $\underline{S} = \underline{U} \cdot \underline{I}^* = \underline{U} \cdot \left(\frac{\underline{U}}{\underline{Z}}\right)^* = \frac{\underline{U} \cdot \underline{U}^*}{\underline{Z}^*} = \frac{|\underline{U}|^2}{\underline{Z}^*}$

Da Strom geht konjugiert komplex in die Leistung ein!

$$\underline{S}_1 = \frac{|\underline{U}_1|^2}{\underline{Z}_1^*} = \frac{U_{St}^2}{R} = \frac{400^2 V^2}{3 \cdot 100\Omega} = 533{,}3\,\Omega$$

$$\underline{S}_2 = \frac{|\underline{U}_2|^2}{\underline{Z}_2^*} = \frac{U_{St}^2}{(|X_C| \exp(-j\frac{\pi}{2}))^*} = \frac{U_{St}^2}{|X_C| \exp(j\frac{\pi}{2})} = \frac{U_{St}^2}{|X_C|} \exp(-j\tfrac{\pi}{2}) = -533{,}3\,\Omega\, j$$

$$Q_2 = Im\{\underline{S}_2\} = -533{,}3\,\Omega$$

$$\underline{S}_3 = \frac{|\underline{U}_3|^2}{\underline{Z}_3^*} = \frac{U_{St}^2}{|X_L| \exp(-j\frac{\pi}{2})} = \frac{U_{St}^2}{|X_L|} \exp(j\tfrac{\pi}{2}) = 533{,}3\,\Omega\, j$$

$$Q_3 = Im\{\underline{S}_3\} = 533{,}3\,\Omega$$

$$\underline{S}_\Sigma = \underline{S}_1 + \underline{S}_2 + \underline{S}_3 = 533{,}3\,\Omega\,(1 - j + j) = 533{,}3\,\Omega$$

$$P_\Sigma = Re\{\underline{S}_\Sigma\} = 533{,}3\,\Omega$$

$$Q_\Sigma = Im\{\underline{S}_\Sigma\} = 0$$