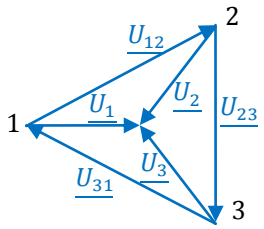
DREHSTROM

Zeigerdiagramm



$$\underline{U}_{12} = \underline{U}_1 - \underline{U}_2$$
$$\underline{U}_{23} = \underline{U}_2 - \underline{U}_3$$
$$\underline{U}_{31} = \underline{U}_3 - \underline{U}_1$$

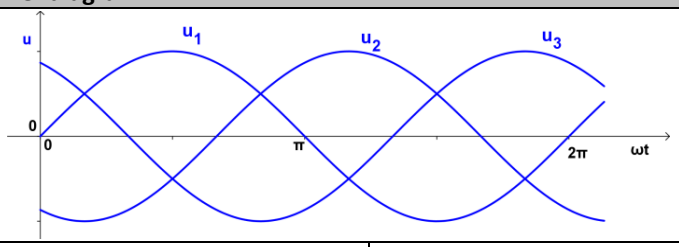
$$\underline{U}_{12} + \underline{U}_{23} + \underline{U}_{31} = 0$$

$$\underline{U}_{12} + \underline{U}_{23} + \underline{U}_{31} \neq 0$$

$$U_1 = U_2 = U_3 = U_{st} = 230V$$
$$U_{12} = U_{23} = U_{31} = U = 400V$$

$$\underline{U}_1 = U_1 * e^{j0}$$
$$\underline{U}_2 = U_2 * e^{j-\frac{2\pi}{3}}$$
$$\underline{U}_3 = U_3 * e^{j\frac{2\pi}{3}}$$

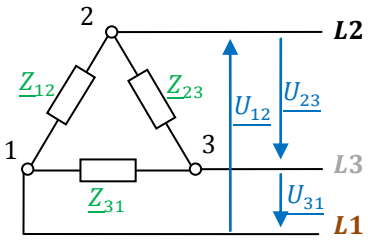
Liniendiagramm



$$u_1 = \hat{u}_1 * \sin(\omega t)$$
$$u_2 = \hat{u}_2 * \sin(\omega t - 120°)$$
$$u_3 = \hat{u}_3 * \sin(\omega t - 240°)$$

$$\hat{u} = 230V * \sqrt{2}$$
$$\omega = 314s^{-1}$$

Dreieckschaltung



N	Knotenpunkt
N	Neutralleiter
$L1, L2, L3$	Aussenleiter
U_1, U_2, U_3	Strangspannungen
U_{St}	Sternspannungen
$U_{12}, U_{23}, U_{31}, U$	Aussenleiter-spannungen

Verkettete Spannung U_L	= Strangspannungen $= U_\Delta = U_{Str}$
Aussenleiterstrom I_L	$= \sqrt{3}$ Strangstrom $= \sqrt{3} * I_\Delta = \sqrt{3} * I_{Str}$

Symmetrische Last

$$\underline{Z}_{12} = \underline{Z}_{23} = \underline{Z}_{31} = \underline{Z} = \frac{1}{\underline{Y}}$$
$$\underline{I}_{12} = \underline{U}_{12} * \underline{Y}$$

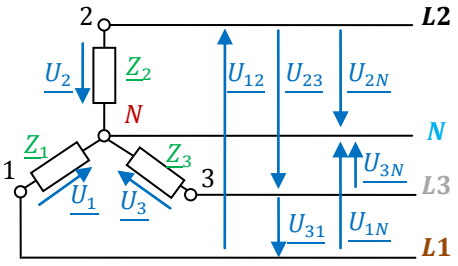
$$I_{12} = I_{23} = I_{31} = I_{Str}$$
$$I_1 = I_2 = I_3 = \sqrt{3} * I_{Str}$$
$$\underline{I}_1 = \underline{I}_{12} - \underline{I}_{31}$$

Unsymmetrische Last

$$\underline{I}_{12} = \underline{U}_{12} * \underline{Y}_{12}$$
$$\underline{I}_{23} = \underline{U}_{23} * \underline{Y}_{23}$$
$$\underline{I}_{31} = \underline{U}_{31} * \underline{Y}_{31}$$

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

Sternschaltung



Verkettete Spannung U_L	$= \sqrt{3}$ Strangspannungen $= \sqrt{3} * U_\curlywedge$
Aussenleiterstrom I_L	= Strangstrom $= I_\curlywedge = I_{Str}$

Mit Neutralleiter

symmetrisch

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

unsymmetrisch

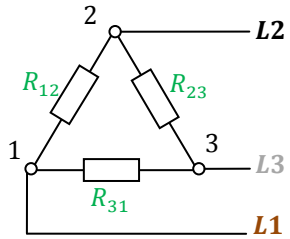
$$\underline{I}_1 = \underline{U}_1 * \underline{Y}_1$$
$$\underline{I}_1 + \underline{I}_2 + \underline{I}_3 = \underline{I}_N$$

Ohne Neutralleiter

$$\underline{I}_N = \underline{I}_1 + \underline{I}_2 + \underline{I}_3 = 0$$
$$\underline{I}_1 = (\underline{U}_1 - \underline{U}_N) * \underline{Y}_1$$

$$\underline{U}_N = \frac{\underline{U}_1 * \underline{Y}_1 + \underline{U}_2 * \underline{Y}_2 + \underline{U}_3 * \underline{Y}_3}{\underline{Y}_1 + \underline{Y}_2 + \underline{Y}_3}$$

Stern in Dreieck



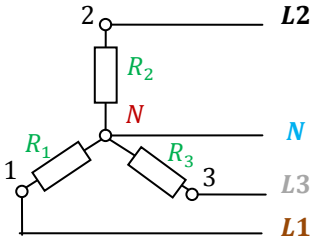
unsymmetrisch

$$R_{12} = R_1 + R_2 + \frac{R_1 R_2}{R_3}$$
$$R_{23} = R_2 + R_3 + \frac{R_2 R_3}{R_1}$$
$$R_{31} = R_3 + R_1 + \frac{R_3 R_1}{R_2}$$

symmetrisch

$$R_{12} = R_{23} = R_{31} = R_\curlywedge$$
$$R_\Delta = 3 * R_\curlywedge$$

Dreieck in Stern



unsymmetrisch

$$R_1 = \frac{R_{12} * R_{31}}{R_{12} + R_{23} + R_{31}}$$
$$R_2 = \frac{R_{23} * R_{12}}{R_{12} + R_{23} + R_{31}}$$
$$R_3 = \frac{R_{31} * R_{23}}{R_{12} + R_{23} + R_{31}}$$

symmetrisch

$$R_{12} = R_{23} = R_{31} = R_\Delta$$
$$R_\curlywedge = \frac{R_\Delta}{3}$$

Leistung im Dreiphasensystem

$$\underline{S} = \sum (P_{Str} + jQ_{Str})$$
$$\underline{S}_{Str} = \underline{U}_{Str} * \underline{I}^*_{Str}$$
$$P_{ges} = \sqrt{3} * U_L * I_L * \cos\varphi$$
$$S_{ges} = \sqrt{3} * U_L * I_L$$
$$Q_{ges} = \sqrt{3} * U_L * I_L * \sin\varphi$$