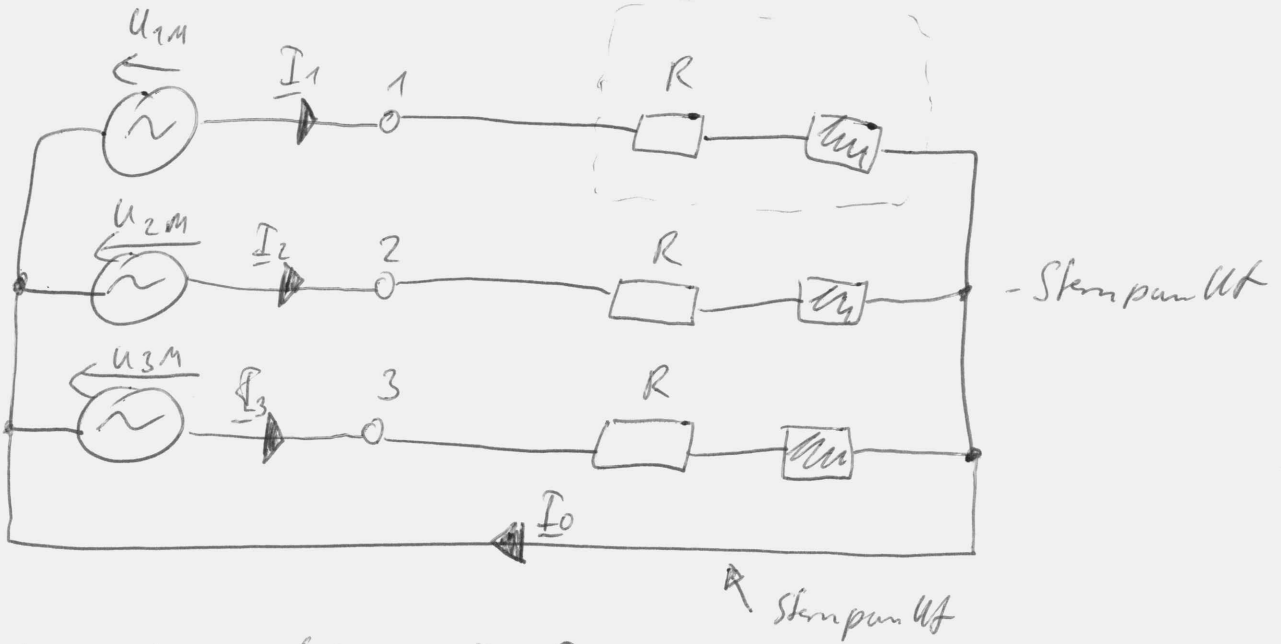
Aufgabe 27



Wegen Symmetrie: $\underline{I}_0 = 0$

$$\underline{I}_1 = \frac{\underline{U}_{1M}}{\underline{Z}} = \frac{\underline{U}}{\underline{Z}}$$

$$\underline{I}_2 = \frac{\underline{U}_{2M}}{\underline{Z}} = \frac{\underline{a}^2 \cdot \underline{U}}{\underline{Z}}$$

$$\underline{I}_3 = \frac{\underline{U}_{3M}}{\underline{Z}} = \frac{\underline{a} \cdot \underline{U}}{\underline{Z}}$$

Knotenregel

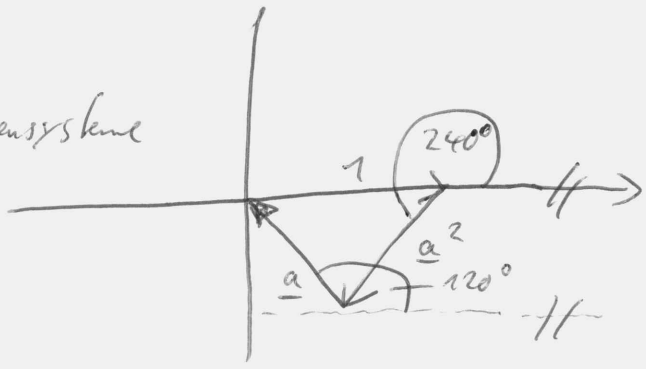
$$\underline{I}_0 = \underline{I}_1 + \underline{I}_2 + \underline{I}_3$$

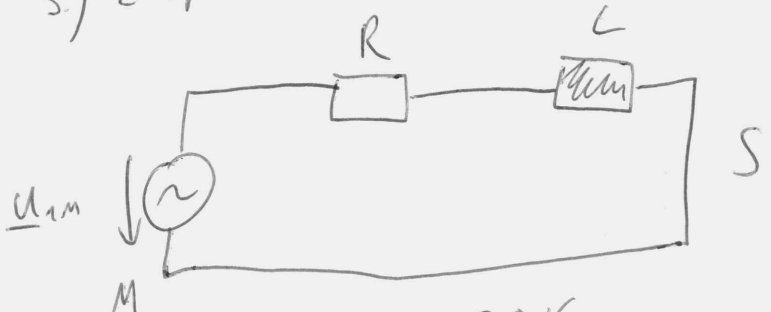
$$= \underbrace{(1 + \underline{a}^2 + \underline{a})}_{0} \cdot \frac{\underline{U}}{\underline{Z}}$$

$$= 0$$

2) Da $\underline{I}_0 = 0$, ändert sich nichts!

3) Einphasiges ESB gilt für symm. Dreiphasensysteme



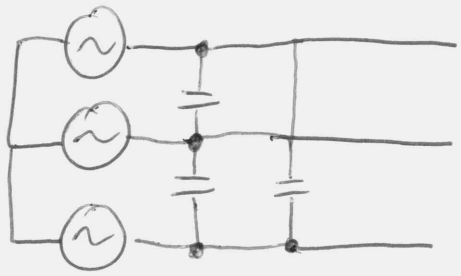


$$\underline{I}_1 = \frac{\underline{U}_{1M}}{R + j\omega L} = \frac{230\,V}{20\,\Omega + j\,2\pi 50\,Hz \cdot 31{,}83\,mH} = 9{,}2\,A - j\,4{,}6\,A$$

$$S = 3 \cdot \underline{U}_{1M} \cdot \underline{I}_1^* = 3 \cdot \{230\,V \cdot (9{,}2\,A - j\,4{,}6\,A)^* = 3 \cdot 230\,V\,(9{,}2\,A + j\,4{,}6\,A)$$

$$= 6{,}348\,kW + j\,3{,}174\,kVAr \quad (\text{Wirkleistung } P + (\text{Blindleistung } Q)$$

4.) $\Rightarrow$ Blindleistungskompensation



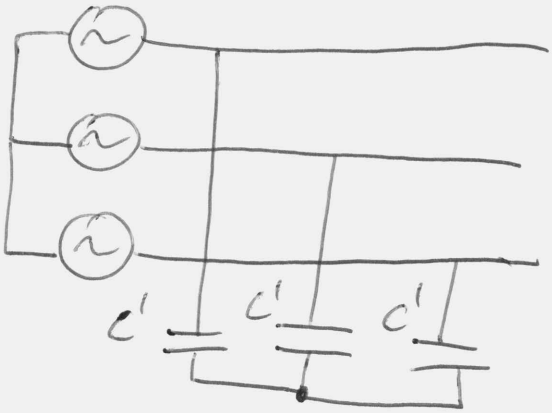
$\Delta \rightarrow Y$

$\underline{Z} \rightarrow \frac{1}{3}\underline{Z}$

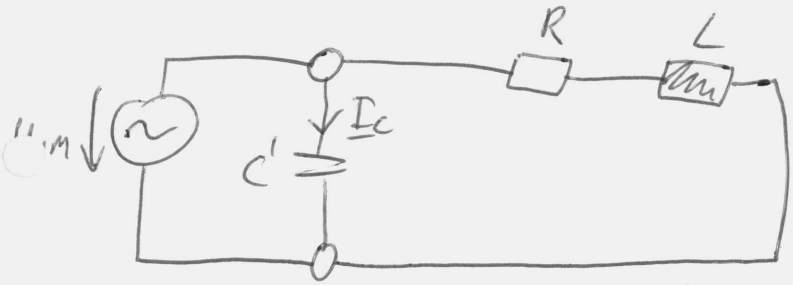
$\frac{1}{j\omega C} \rightarrow \frac{1}{3}\frac{1}{j\omega C}$

$C \rightarrow 3C = C'$

$(L \rightarrow \frac{1}{3}L)$



$\Rightarrow$ 1 phasiges ESB



Blindleistung, die von C' aufgenommen werden muss:

$$Q_C = -Q_L$$

$$= 3 \cdot \mathrm{Im}\left\{ \underline{U}_{1m} \cdot \underline{I}_C^* \right\} = 3 \cdot \mathrm{Im}\left\{ \frac{\underline{U}_{1m} \cdot (\underline{U}_{1m})^*}{\left(\frac{1}{j\omega C'}\right)^*} \right\}$$

$$= -3 \cdot U^2 \cdot \omega \cdot 3 \cdot C \overset{!}{=} -Q_L$$

$$\Leftrightarrow C = \frac{Q_L}{9\,U^2 \cdot \omega} = \frac{3{,}174\ \mathrm{kVAr}}{9 \cdot (230\mathrm{V})^2 \cdot 2\pi \cdot 50\mathrm{Hz}}$$

$$= 21{,}22\,\mu\mathrm{F}$$

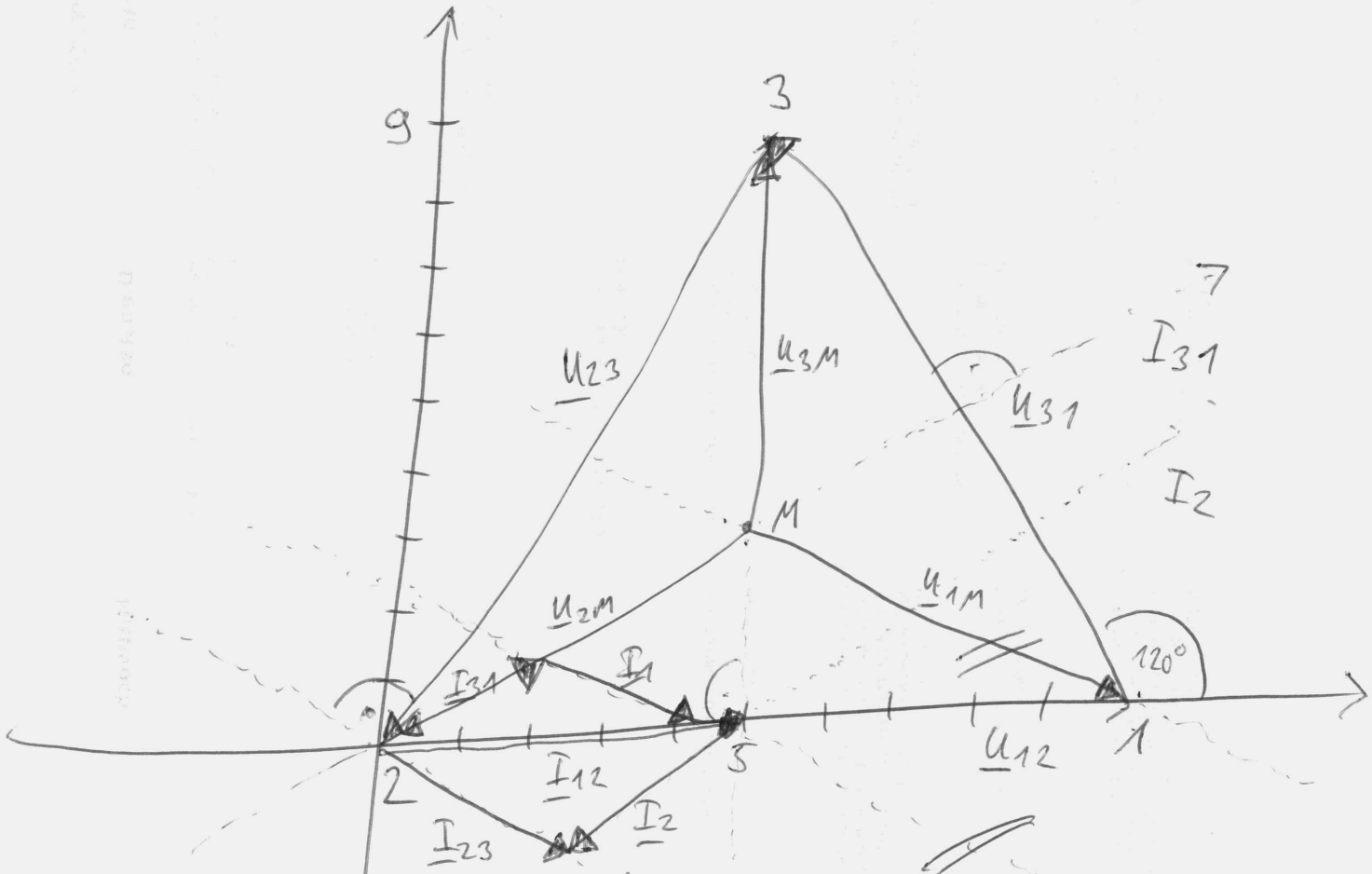
Aufgabe 28

(4)

Unsymmetrische Last im Dreieck

1 cm ≙ 50 V

1 cm ≙ 2 A



Knotengleichung:

ablesen:

$2{,}9\ \text{cm} \hat{=} \underline{I}_{31} = 5{,}8\,\text{A}\, e^{j30°}$

$u \hat{=} \underline{I}_{23} = 5{,}8\,\text{A}\, e^{-j30°}$

$\underline{I}_{12} = \underline{I}_{31} + \underline{I}_1$

$\underline{I}_{31} \perp \underline{U}_{31}$, nacheilender Strom

(Spule: U vor I)

$\underline{I}_1 \parallel \underline{U}_{1M}$

$\underline{I}_{23} = \underline{I}_{12} + \underline{I}_2$

$\underline{I}_{23} \perp \underline{U}_{23}$, voreilender Strom

$\underline{I}_2 \parallel \underline{U}_{2M}$

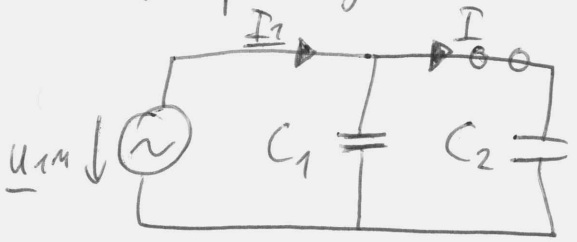
Aufgabe 29

1.) S geschlossen: $C_1 \parallel C_2$

$$\Rightarrow C_1 \parallel C_2 = C_1 + C_2 = \frac{2}{3}C + \frac{1}{3}C = C$$

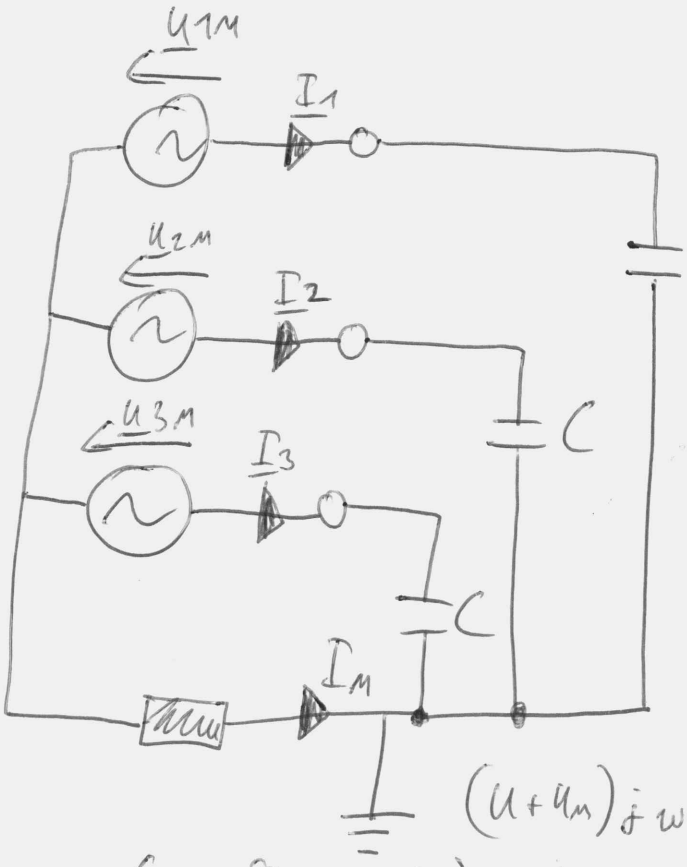
$\Rightarrow$ Symmetrie liegt vor

1-phasiges ESB:



$$\underline{I}_x = j\omega C_2 \cdot \underline{u}_{1m} = j\omega\frac{C}{3} \cdot \underline{u}$$

2.)



Knotengleichung:

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

$$\left(\underline{u}_{1m} + \underline{u}_m\right) j\omega \underbrace{C_1}_{=\frac{2}{3}C} + \left(\underline{u}_{2m} + \underline{u}_m\right) j\omega C$$

$$+ \left(\underline{u}_{3m} + \underline{u}_m\right) j\omega C + \frac{\underline{u}_m}{j\omega L} = 0$$

mit $\underline{a} = e^{j120°}$ und den gegebenen Spannungen folgt:

$$\left(\underline{u} + \underline{u}_m\right) j\omega\frac{2}{3}C + \left(\underline{u}\underline{a}^2 + \underline{u}_m\right) j\omega C + \left(\underline{u}\underline{a} + \underline{u}_m\right) j\omega C + \frac{\underline{u}_m}{j\omega L} = 0$$

$$\Leftrightarrow \underline{u}_m\left(j\omega\frac{8}{3}C + \frac{1}{j\omega L}\right) = -j\omega L\underline{u}\cdot\underbrace{\left(\frac{2}{3} + \underline{a}^2 + \underline{a}\right)}$$

$$\frac{2}{3} + \underline{a}^2 + \underline{a} = -\frac{1}{3} + 1 + \underline{a}^2 + \underline{a} = -\frac{1}{3}$$

$$\Rightarrow \underline{u}_m = -\frac{\frac{1}{3}\omega^2 LC \cdot \underline{u}}{1 - \omega^2\frac{8}{3}LC} = -\underline{u}\frac{\omega^2 LC}{3\left(1 - \omega^2\frac{8}{3}LC\right)}$$

3.) $u_M \to \infty$?

$\Rightarrow$ Nenner $\to 0$

$\Rightarrow 3\left(1 - \omega^2 \frac{8}{3} LC\right) \stackrel{!}{=} 0$

$\Leftrightarrow 3 = 8\omega^2 LC$

$\Leftrightarrow \omega = \sqrt{\frac{3}{8LC}}$