

Industrijsko inženjerstvo

Osnovi elektrotehnike

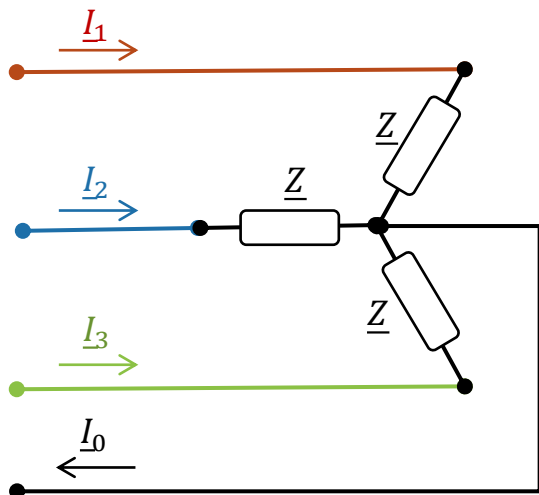
Trofazni sistemi 2

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kabinet 132 NTP

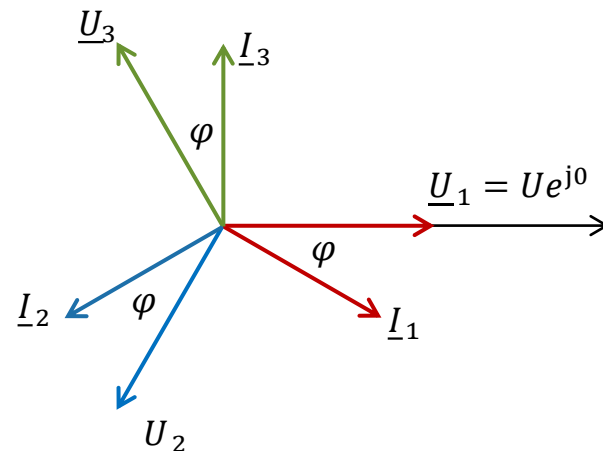
miodragm@uns.ac.rs

Snage u trofaznim sistemima



$$\underline{Z} = Z e^{j\varphi}$$

Fazni napon U



$$\underline{I}_1 = \frac{\underline{U}_1}{\underline{Z}} = \frac{U}{Z} e^{j(\theta_1 - \varphi)}$$

$$\underline{I}_1 = I e^{j\psi_1}$$

$$\underline{I}_2 = \frac{\underline{U}_2}{\underline{Z}} = \frac{U}{Z} e^{j(\theta_2 - \varphi)}$$

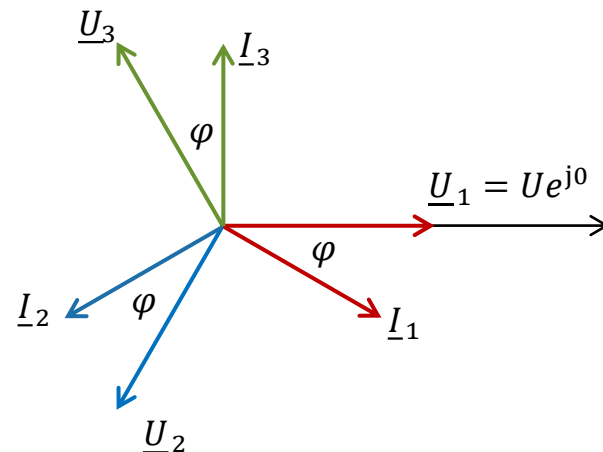
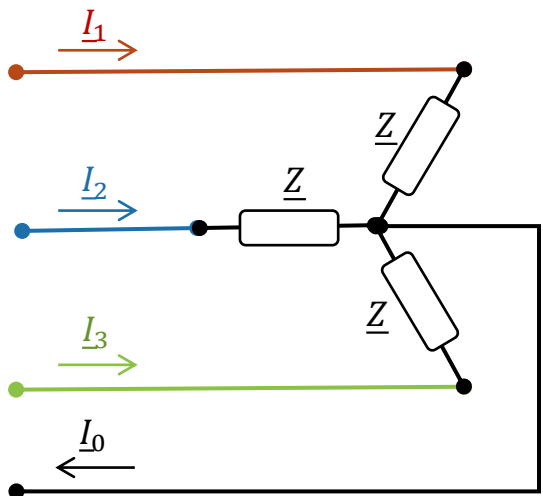
$$\underline{I}_2 = I e^{j\psi_2}$$

$$\underline{I}_3 = \frac{\underline{U}_3}{\underline{Z}} = \frac{U}{Z} e^{j(\theta_3 - \varphi)}$$

$$\underline{I}_3 = I e^{j\psi_3}$$

$$\underline{I}_0 = \underline{I}_1 + \underline{I}_2 + \underline{I}_3 = 0$$

Snage u trofaznim sistemima



$$\underline{S}_1 = \underline{U}_1 \underline{I}_1^* = U e^{j\theta_1} (I e^{j(\theta_1 - \varphi)})^* = UI e^{j\varphi}$$

$$\underline{S}_2 = \underline{U}_2 \underline{I}_2^* = U e^{j\theta_2} (I e^{j(\theta_2 - \varphi)})^* = UI e^{j\varphi}$$

$$\underline{S}_3 = \underline{U}_3 \underline{I}_3^* = U e^{j\theta_3} (I e^{j(\theta_3 - \varphi)})^* = UI e^{j\varphi}$$

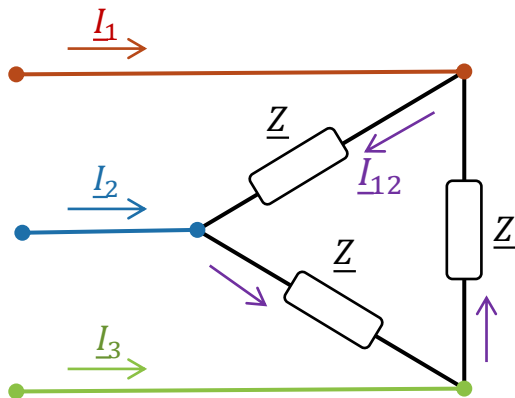
$$\underline{S}_1 = \underline{S}_2 = \underline{S}_3$$

$$\underline{S}_{3F_Y} = \underline{S}_1 + \underline{S}_2 + \underline{S}_3 = 3UI e^{j\varphi}$$

U, I – fazni napon i fazna struja

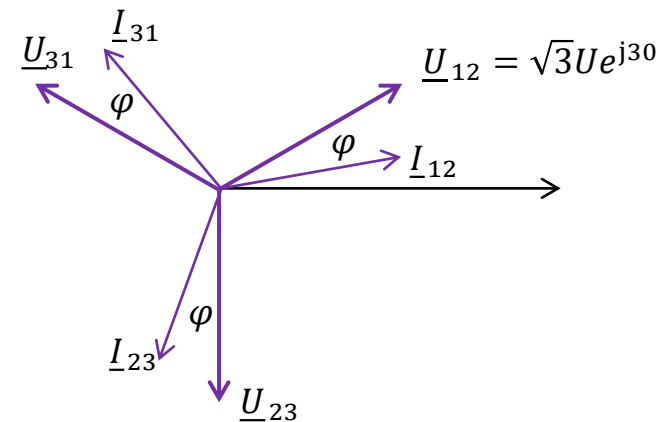
$$\underline{S}_{3FY} = 3 \frac{U^2}{Z} e^{j\varphi}$$

Snage u trofaznim sistemima



Fazni napon $\underline{U}$

$$\underline{Z} = Z e^{j\varphi}$$



$$\underline{I}_{12} = \frac{\underline{U}_{12}}{\underline{Z}} = \frac{\sqrt{3}U}{Z} e^{j(\theta_{12}-\varphi)}$$

$$\underline{I}_{12} = I_p e^{j\psi_{12}}$$

$$\underline{I}_{23} = \frac{\underline{U}_{23}}{\underline{Z}} = \frac{\sqrt{3}U}{Z} e^{j(\theta_{23}-\varphi)}$$

$$I_p = \frac{\sqrt{3}U}{Z}$$

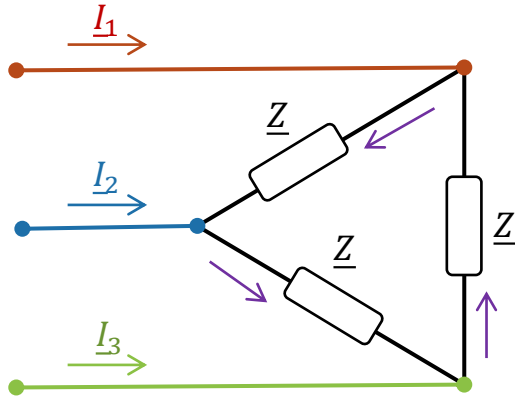
I_p - struja prijemnika

$$\underline{I}_{31} = \frac{\underline{U}_{31}}{\underline{Z}} = \frac{\sqrt{3}U}{Z} e^{j(\theta_{31}-\varphi)}$$

$$\underline{I}_1 = I e^{j\psi_1}$$

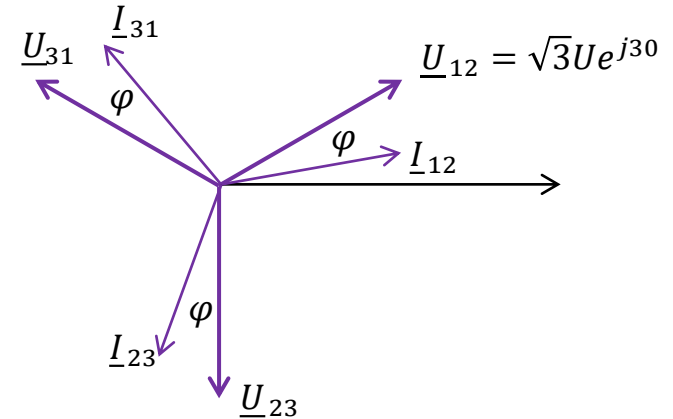
I - fazna struja

Snage u trofaznim sistemima



$$\underline{Z} = Z e^{j\varphi}$$

$$I_p = \frac{\sqrt{3}U}{Z}$$



$$\underline{S}_{12} = \underline{U}_{12} \cdot \underline{I}_{12}^* = \sqrt{3}U e^{j\theta_{12}} (I_p e^{j(\theta_{12}-\varphi)})^* = \sqrt{3}U I_p e^{j\varphi}$$

$$\underline{S}_{12} = \sqrt{3}U \frac{\sqrt{3}U}{Z} e^{j\varphi} = 3U I e^{j\varphi}$$

$$\underline{S}_{23} = \underline{U}_{23} \cdot \underline{I}_{23}^* = \sqrt{3}U e^{j\theta_{23}} (I_p e^{j(\theta_{23}-\varphi)})^* = 3U I e^{j\varphi}$$

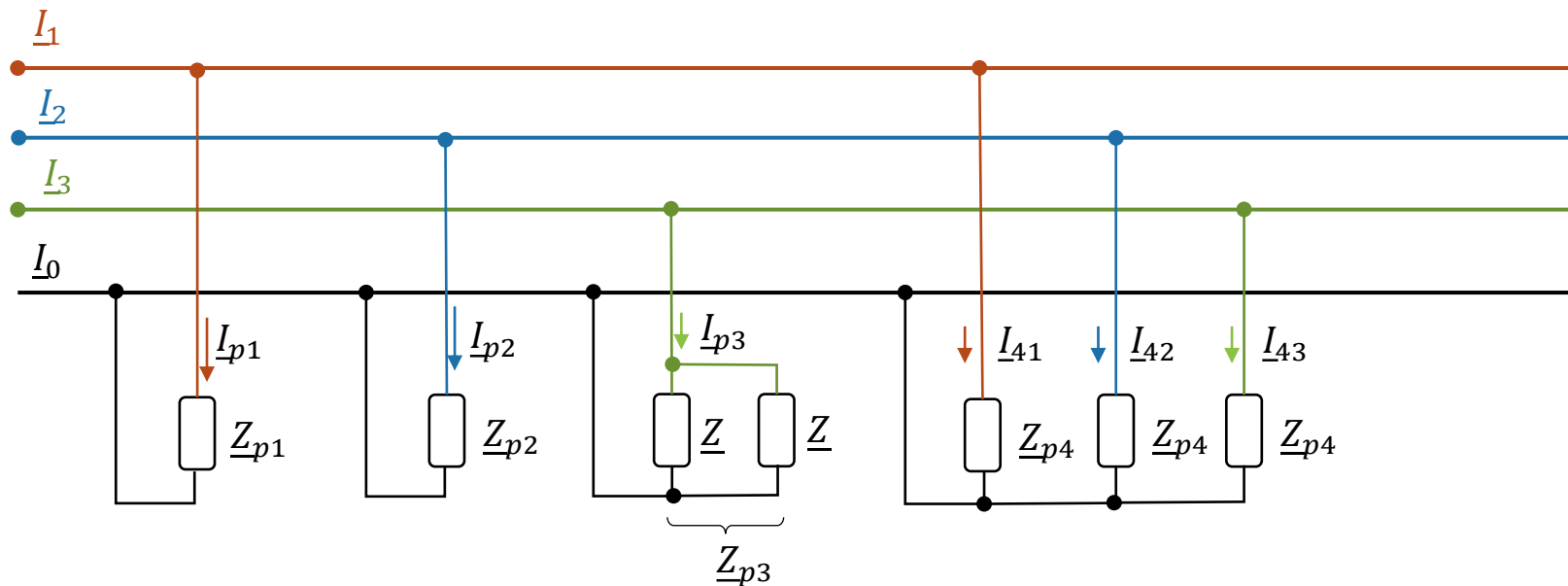
$$\underline{S}_{31} = \underline{U}_{31} \cdot \underline{I}_{31}^* = \sqrt{3}U e^{j\theta_{31}} (I_p e^{j(\theta_{31}-\varphi)})^* = 3U I e^{j\varphi}$$

$$\underline{S}_{12} = \underline{S}_{23} = \underline{S}_{31}$$

$$\underline{S}_{3F\Delta} = \underline{S}_{12} + \underline{S}_{23} + \underline{S}_{31} = 9U I e^{j\varphi}$$

$$\underline{S}_{3F\Delta} = 3\underline{S}_{3FY}$$

Određivanje struja i snaga prijemnika



$$I_{p1} = \frac{\underline{U}_1}{\underline{Z}_{p1}}$$

$$I_{p2} = \frac{\underline{U}_2}{\underline{Z}_{p2}}$$

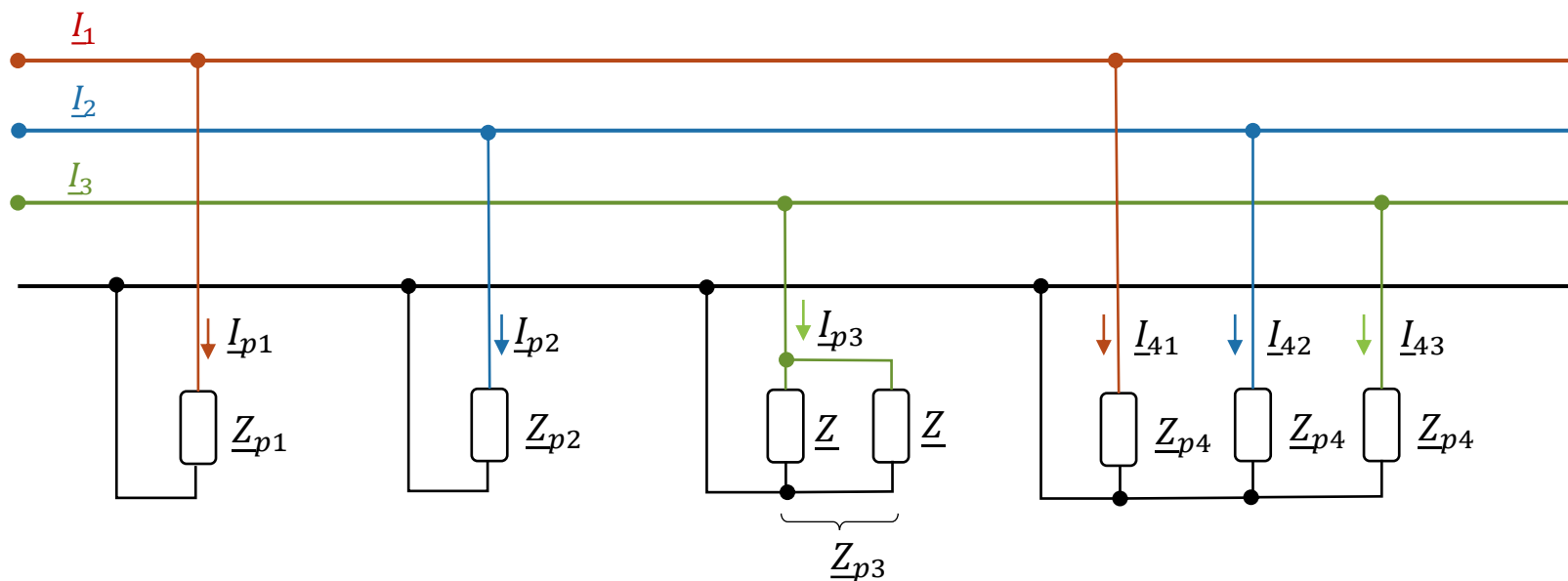
$$I_{p3} = \frac{\underline{U}_3}{\underline{Z}_{p3}}$$

$$I_{41} = \frac{\underline{U}_1}{\underline{Z}_{p4}} = I e^{j\psi_1}$$

$$I_{42} = I e^{j(\psi_1 - 120)}$$

$$I_{43} = I e^{j(\psi_1 - 240)}$$

Određivanje struja i snaga prijemnika



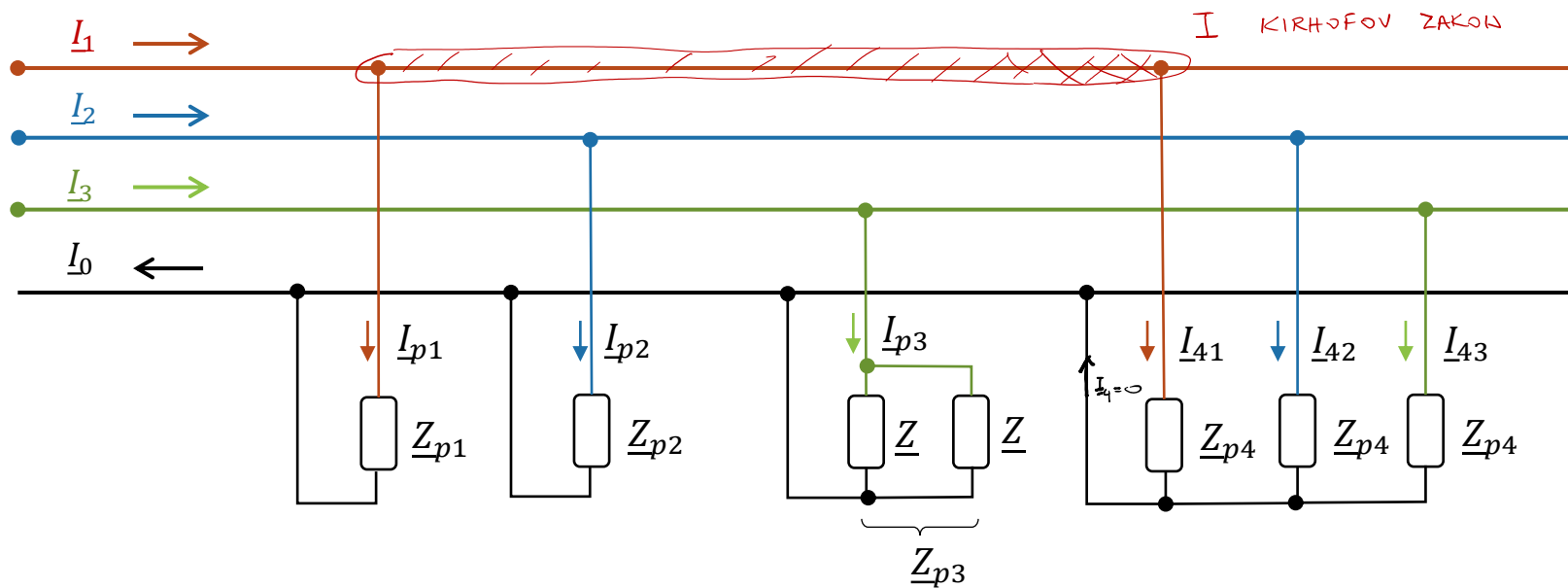
$$S_{p1} = \underline{U}_1 (I_{p1})^*$$

$$S_{p2} = \underline{U}_2 (I_{p2})^*$$

$$S_{p3} = \underline{U}_3 (I_{p3})^*$$

$$S_{p4} = 3 \underline{U}_1 (I_{41})^*$$

Određivanje faznih struja i snaga po fazi



$$\underline{I}_1 = \underline{I}_{p1} + \underline{I}_{41}$$

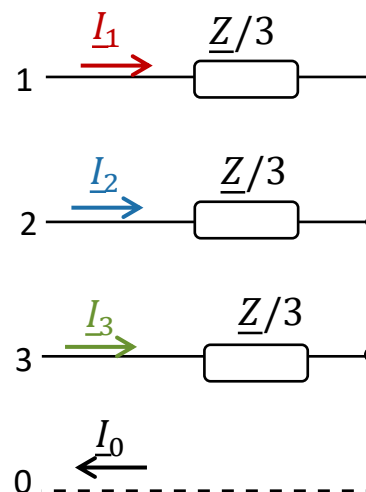
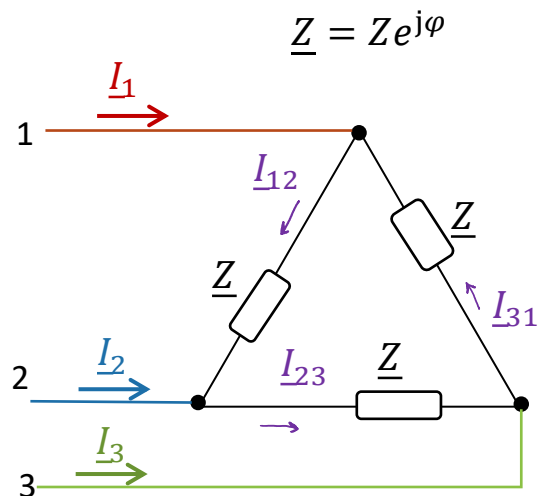
$$\underline{I}_2 = \underline{I}_{p2} + \underline{I}_{42}$$

$$\underline{I}_3 = \underline{I}_{p3} + \underline{I}_{43}$$

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

$$\underline{S}_1 = \underline{U}_1(\underline{I}_1)^* \quad \underline{S}_2 = \underline{U}_2(\underline{I}_2)^* \quad \underline{S}_3 = \underline{U}_3(\underline{I}_3)^*$$

Transformacija iz trougla u zvezdu



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

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

$$\underline{I}_1 = \frac{\underline{U}_1}{\underline{Z}/3} = \frac{3Ue^{j\theta_1}}{Ze^{j\varphi}} = Ie^{j\psi_1}$$

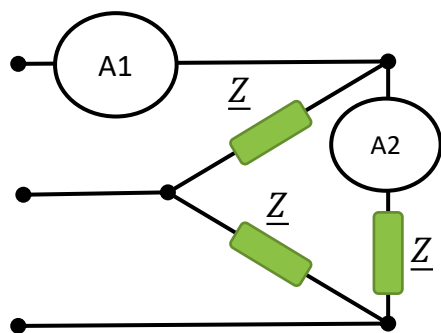
$$\underline{I}_2 = Ie^{j(\psi_1 - 120^\circ)}$$

$$\underline{I}_3 = Ie^{j(\psi_1 - 240^\circ)}$$

$$\underline{I}_0 = 0$$

Primer

Odrediti pokazavanje ampermetara ako je fazni napon $U = 230V$ a impedansa prijemnika $\underline{Z} = (40 + j30)\Omega$.



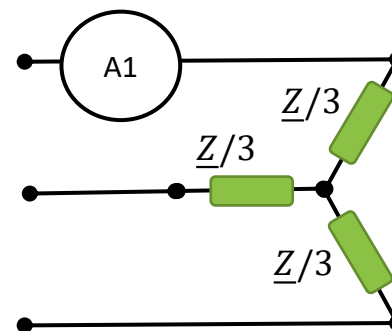
$$I_{A1} = |\underline{I}_1|$$

$$I_{A2} = |\underline{I}_{31}|$$

$$\underline{I}_{31} = \frac{\underline{U}_{31}}{\underline{Z}} = \frac{\sqrt{3}U}{Z} e^{j(\theta_{31} - \varphi)} = I_p e^{j\psi_{31}}$$

$$Z = \sqrt{40^2 + 30^2} = 50\Omega$$

$$I_p = \frac{\sqrt{3}U}{Z} = 8A \quad I_{A2} = I_p \quad I_{A1} = \sqrt{3}I_p = 13,8A$$



$$\underline{I}_1 = \frac{\underline{U}_1}{\underline{Z}/3} = \frac{U}{Z/3} e^{j(\theta_1 - \varphi)} = I e^{j\psi_1}$$

$$I = \frac{3U}{Z} = 13,8A$$

$$I_{A1} = I = 13,8A$$