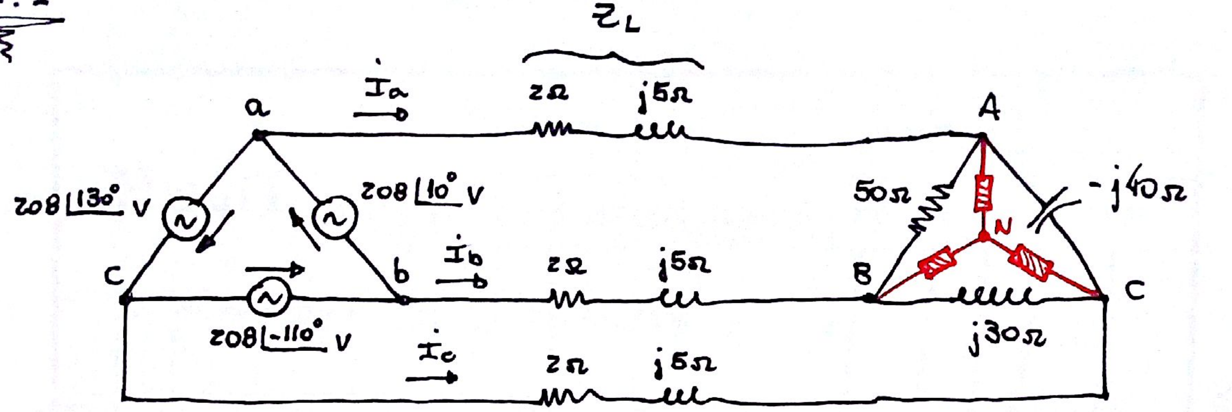
Ex. 1

Calcular as correntes de linha ($\dot{I}_a$, $\dot{I}_b$ e $\dot{I}_c$) para o circuito abaixo.



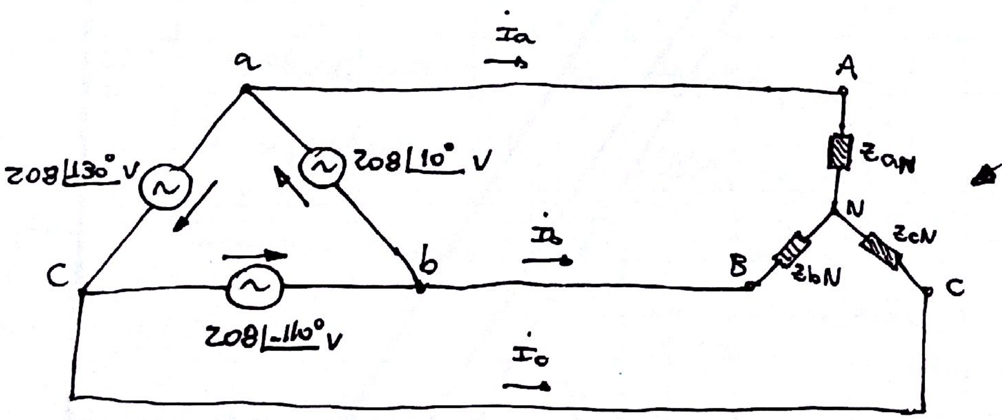
Solução (transformação da carga p/ estrela):

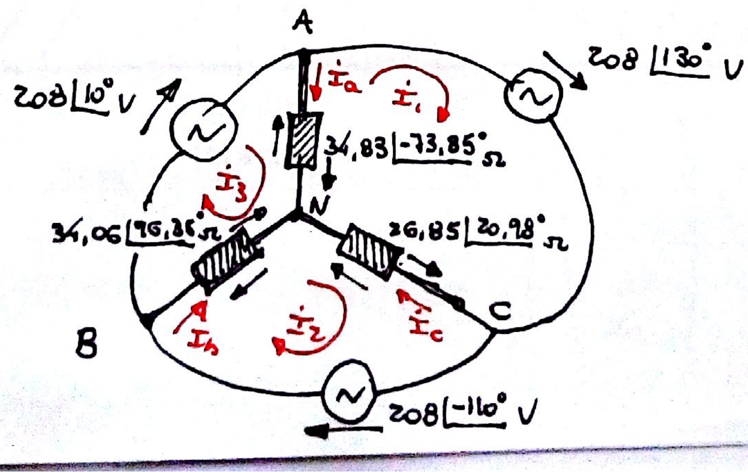
$$Z_{AN} = \frac{Z_{AB} \times Z_{AC}}{Z_{AB} + Z_{BC} + Z_{AC}} = \frac{50 \times (-j40)}{50 + j30 - j40} \Rightarrow Z_{AN} = 39{,}22\angle -78{,}69^\circ\ \Omega \xrightarrow{+Z_L} \boxed{34{,}83\angle -73{,}85^\circ\ \Omega}$$

$$Z_{BN} = \frac{Z_{AB} \times Z_{BC}}{Z_{AB} + Z_{BC} + Z_{AC}} = \frac{50 \times (j30)}{50 + j30 - j40} \Rightarrow Z_{BN} = 29{,}42\angle 101{,}31^\circ\ \Omega \xrightarrow{+Z_L} \boxed{34{,}06\angle 96{,}35^\circ\ \Omega}$$

$$Z_{CN} = \frac{Z_{BC} \times Z_{AC}}{Z_{AB} + Z_{BC} + Z_{AC}} = \frac{j30 \times (-j40)}{50 + j30 - j40} \Rightarrow Z_{CN} = 23{,}53\angle 11{,}31^\circ\ \Omega \xrightarrow{+Z_L} \boxed{26{,}85\angle 20{,}98^\circ\ \Omega}$$

Assim, tem-se:





Malha 1

$$-208\angle 130^\circ + 26{,}85\angle 20{,}98^\circ\,\dot{I}_1 + 34{,}83\angle -73{,}85^\circ\,\dot{I}_1 -$$

$$- 34{,}83\angle -73{,}85^\circ\,\dot{I}_3 - 26{,}85\angle 20{,}98^\circ . \dot{I}_2 = 0$$

$$\text{I} \quad \boxed{(42{,}15\angle -34{,}45^\circ)\,\dot{I}_1 - (26{,}85\angle 20{,}98^\circ)\,\dot{I}_2 - (34{,}83\angle -73{,}85^\circ) . \dot{I}_3 = 208\angle 130^\circ}$$

Malha 2

$$-208\angle -110^\circ + 34{,}06\angle 96{,}36^\circ\,\dot{I}_2 + 26{,}85\angle 20{,}98^\circ . \dot{I}_2 -$$

$$- 26{,}85\angle 20{,}98^\circ . \dot{I}_1 - 34{,}06\angle 96{,}36^\circ . \dot{I}_3 = 0$$

$$\text{II} \quad \boxed{-(26{,}85\angle 20{,}98) . \dot{I}_1 + (48{,}40\angle 63{,}90^\circ)\,\dot{I}_2 - (34{,}06\angle 96{,}36^\circ)\,\dot{I}_3 = 208\angle -110^\circ}$$

Malha 3

$$-208\angle 10^\circ + 34{,}83\angle -73{,}85^\circ\,\dot{I}_3 + 34{,}06\angle 96{,}36^\circ\,\dot{I}_3 -$$

$$- 34{,}83\angle -73{,}85^\circ . \dot{I}_1 - 34{,}06\angle 96{,}36^\circ\,\dot{I}_2 = 0$$

$$\text{III} \quad \boxed{-(34{,}83\angle -73{,}85^\circ)\,\dot{I}_1 - (34{,}06\angle 96{,}36^\circ)\,\dot{I}_2 + (5{,}93\angle 3{,}82^\circ)\,\dot{I}_3 = 208\angle 10^\circ}$$

$$\Downarrow$$

$$\begin{pmatrix} 42{,}15\angle -34{,}45^\circ & -26{,}85\angle 20{,}98^\circ & -34{,}83\angle -73{,}85^\circ \\ -26{,}85\angle 20{,}98^\circ & 48{,}40\angle 63{,}90^\circ & -34{,}06\angle 96{,}36^\circ \\ -34{,}83\angle -73{,}85^\circ & -34{,}06\angle 96{,}36^\circ & 5{,}73\angle 3{,}82^\circ \end{pmatrix} \begin{pmatrix} \dot{I}_1 \\ \dot{I}_2 \\ \dot{I}_3 \end{pmatrix} = \begin{pmatrix} 208\angle 130^\circ \\ 208\angle -110^\circ \\ 208\angle 10^\circ \end{pmatrix}$$

Resolvendo-se o sistema de equações:

$$\dot{I}_1 = 6{,}32\angle{-59{,}76^\circ}\ A$$

$$\dot{I}_2 = 3{,}33\angle{-16{,}35^\circ}\ A$$

$$\dot{I}_3 = 12{,}42\angle{-12{,}83^\circ}\ A$$

Assim:

$$\dot{I}_a = \dot{I}_3 - \dot{I}_1$$

$$\dot{I}_b = \dot{I}_2 - \dot{I}_3$$

$$\dot{I}_c = \dot{I}_1 - I_2$$

$$\Rightarrow$$

$$\boxed{\begin{aligned} \dot{I}_a &= 9{,}33\angle{16{,}84^\circ}\ A \\ \dot{I}_b &= 9{,}10\angle{168{,}46^\circ}\ A \\ \dot{I}_c &= 4{,}52\angle{-90{,}16^\circ}\ A \end{aligned}}$$