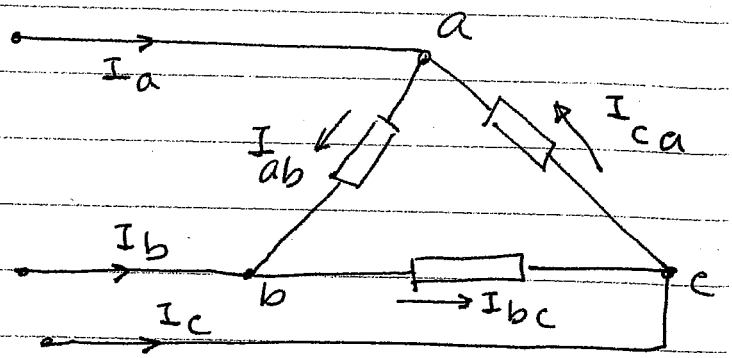
Example 6 [Prob 8-9 / Glover]

Assume the phasi currents of the Δ-connected load below are:

$I_{ab} = 10 \angle 0°$,

$I_{bc} = 20 \angle -90°$,

$I_{ca} = 15 \angle 90°$.



a) Calculate the sequence components of Δ-connected load: $I_{\Delta 0}, I_{\Delta 1}, I_{\Delta 2}$.

b) Find the line currents: I_a, I_b, I_c.

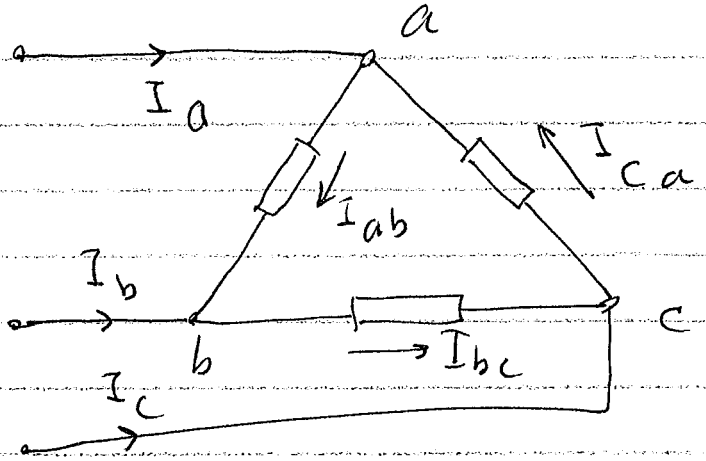
c) Find the sequence components of the line current: I_{L0}, I_{L1}, I_{L2}.

d) Verify the following general rule:

$$\begin{cases} I_{L0} = 0 \\ I_{L1} = \sqrt{3}\, I_{\Delta 1}\, e^{-j30^\circ} \\ I_{L2} = \sqrt{3}\, I_{\Delta 2}\, e^{+j30^\circ} \end{cases}$$

Solution [Example 6]

$$\begin{cases} I_{ab} = 10\angle 0 \\ I_{bc} = 20\angle -90 \\ I_{ca} = 15\angle 90 \end{cases}$$



a) Sequence components of Δ-load current.

$$\begin{bmatrix} I_{\Delta 0} \\ I_{\Delta 1} \\ I_{\Delta 2} \end{bmatrix} = \begin{bmatrix} A^{-1} \end{bmatrix} \begin{bmatrix} I_{ab} \\ I_{bc} \\ I_{ca} \end{bmatrix} = \cdots$$

b) The line currents are:

$$\begin{cases} I_a = I_{ab} - I_{ca} = 10\angle 0 - 15\angle 90 = 10 - j15 \\ I_b = I_{bc} - I_{ab} = 20\angle -90 - 10\angle 0 = -(10 + j15) \\ I_c = I_{ca} - I_{bc} = 15\angle 90 - 20\angle -90 = +j35 \end{cases}$$

c)

$$\begin{bmatrix} I_{L0} \\ I_{L1} \\ I_{L2} \end{bmatrix} = \begin{bmatrix} A^{-1} \end{bmatrix} \begin{bmatrix} I_a \\ I_b \\ I_c \end{bmatrix} = \cdots = \begin{bmatrix} 0 \\ 23.32\angle -26.4 \\ 11.81\angle 203 \end{bmatrix}$$

d)

- Let: $I_{ab0} = I_{\Delta 0}$; we have just 0-sequence current in Δ-load.

then:

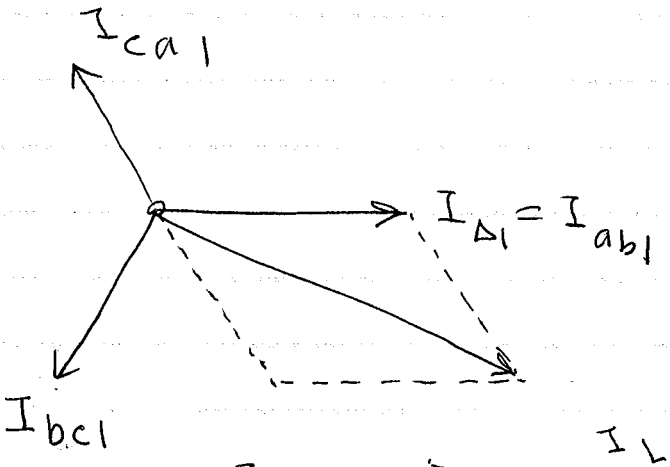
$$I_{bc0} = I_{ca0} = I_{ab0} = I_{\Delta 0}$$

Now,

$$I_{a0} \triangleq I_{L0} = I_{ab0} - I_{ca0} = I_{\Delta 0} - I_{\Delta 0} = 0;$$

proven.

- Let $I_{ab1} = I_{\Delta 1}$ as shown in this diagram.

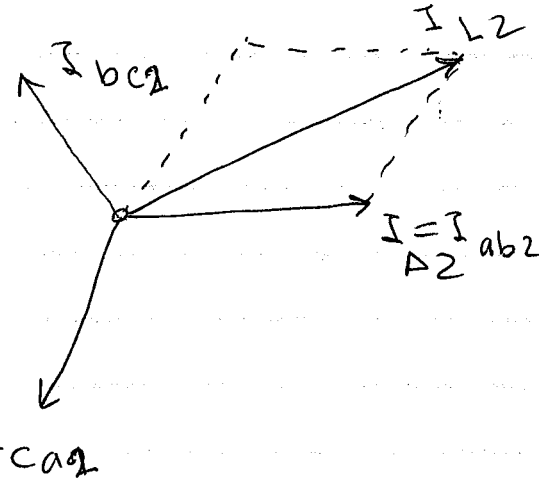


Now, find

$$I_{L1} = I_{a1} = I_{ab1} - I_{ca1}$$

$$= \sqrt{3}\, I_{\Delta 1} e^{-j30}$$

- Let $I_{ab2} = I_{\Delta 2}$ as shown and find:



$$I_{L2} = I_{a2} = I_{ab2} - I_{ca2}$$

$$= \sqrt{3}\, I_{\Delta 2} e^{+j30}$$