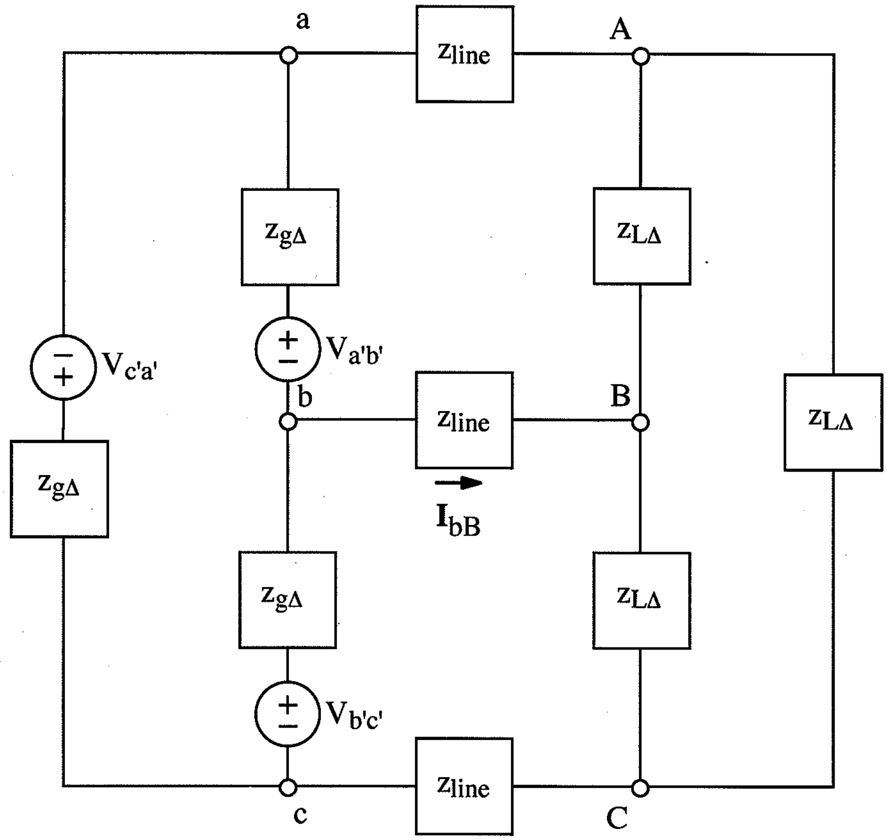
Ex:



$V_{a'b'} = 142\angle 0°$ V $\quad z_{g\Delta} = 24 + j33\ \Omega$

$V_{b'c'} = 142\angle{-120°}$ V $\quad z_{line} = j28\ \Omega$

$V_{c'a'} = 142\angle 120°$ V $\quad z_{L\Delta} = 3 + j3\ \Omega$

Find the numerical value of the current, $\mathbf{I}_{bB}$.

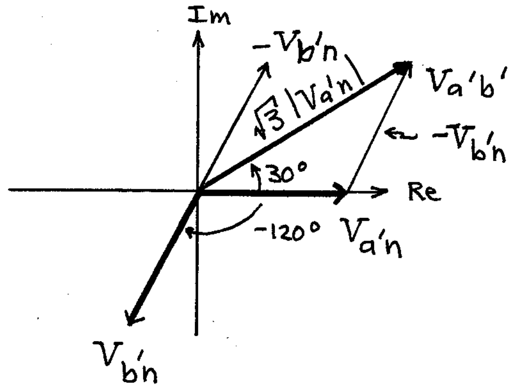
sol'n: We find $\mathbb{I}_{bB}$ by converting the Δ-Δ circuit to a Y-Y configuration, finding the current $\mathbb{I}_{aA}$, and shifting the phase by $-120°$.

To convert from z_Δ to z_Y, (both for the generator and load), we divide z by 3:

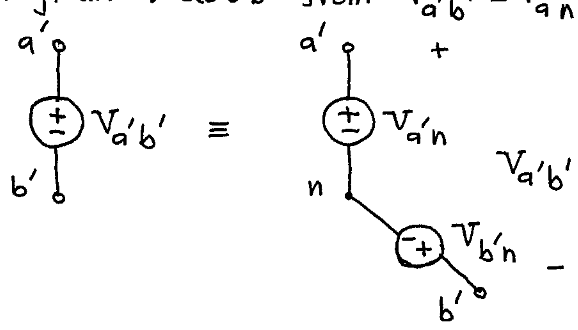
$$z_{gY} = \frac{z_{g\Delta}}{3} = \frac{24 + j33\,\Omega}{3} = 8 + j11\,\Omega$$

$$z_{LY} = \frac{z_{L\Delta}}{3} = \frac{3 + j3}{3}\,\Omega = 1 + j\,\Omega$$

To find the Y-equivalent voltage source value, we consider the case of z's $= 0$.



Note: The diagram follows from $V_{a'b'} = V_{a'n} - V_{b'n}$:



From the phasor diagram, we have the following relationship between $V_{a'b'}$ and $V_{a'n}$ and $V_{b'n}$:

$$V_{a'b'} = V_{a'n} - V_{b'n}$$

$$V_{a'b'} = V_{a'n} \cdot \sqrt{3}\angle 30°$$

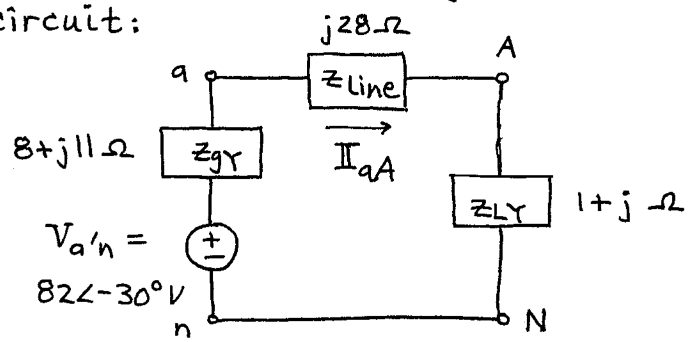
Inverting the eqn for $V_{a'b'}$ yields an expression for $V_{a'n}$:

$$V_{a'n} = V_{a'b'} \frac{1}{\sqrt{3}} \angle -30°$$

$$= 142\angle 0° \text{ V} \cdot \frac{1}{\sqrt{3}} \angle -30°$$

$$V_{a'n} \doteq 82 \angle -30° \text{ V}$$

We now draw the single-phase equivalent circuit:



Line current I_{aA} is the same in the original circuit and the single-phase equivalent since it is outside the generator and load.

We now calculate I_{aA}:

$$I_{aA} = \frac{V_{a'n}}{z_{gY} + z_{line} + z_{LY}}$$

$$= \frac{82\angle -30° \text{ V}}{8 + j11\ \Omega + j28\ \Omega + 1 + j\ \Omega}$$

$$= \frac{82\angle -30° \text{ V}}{9 + j40}$$

$$\mathbb{I}_{aA} = \frac{82\angle -30^\circ \text{V}}{41\angle 77.3^\circ \Omega} \doteq 2\angle -107.3^\circ \text{A}$$

Since $V_{b'c'}$ is phase-shifted by $-120°$ from $V_{a'b'}$, we phase-shift $\mathbb{I}_{aA}$ by $-120°$ to obtain $\mathbb{I}_{bB}$:

$$\mathbb{I}_{bB} = \mathbb{I}_{aA} \cdot 1\angle -120^\circ$$

$$= 2\angle -107.3^\circ \text{A} \cdot 1\angle -120^\circ$$

$$\mathbb{I}_{bB} = 2\angle -227.3^\circ \text{A}$$

$$\text{or } \mathbb{I}_{bB} = 2\angle 132.7^\circ \text{A}$$

$$\text{or } \mathbb{I}_{bB} = -1.36 + j1.47 \text{ A}$$