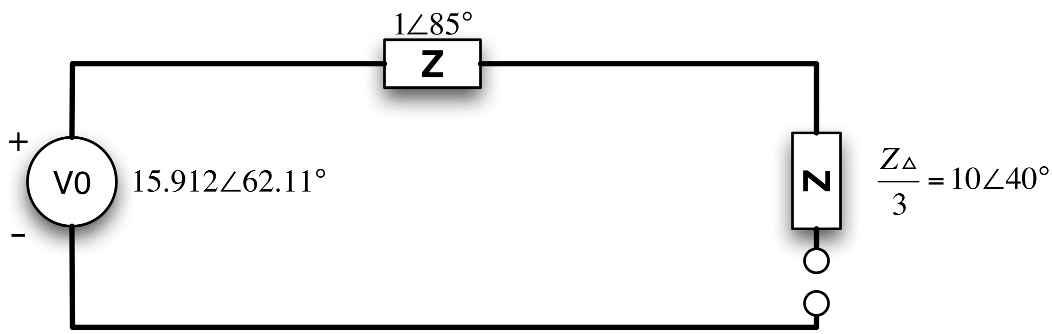
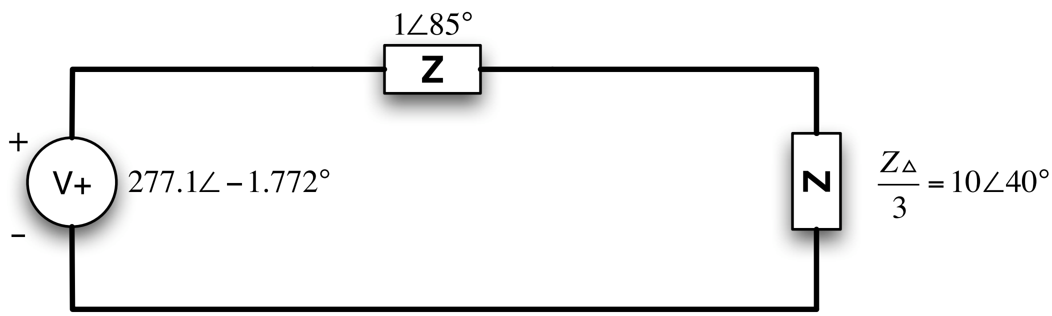
Using symmetrical voltage components to find symmetrical line currents.

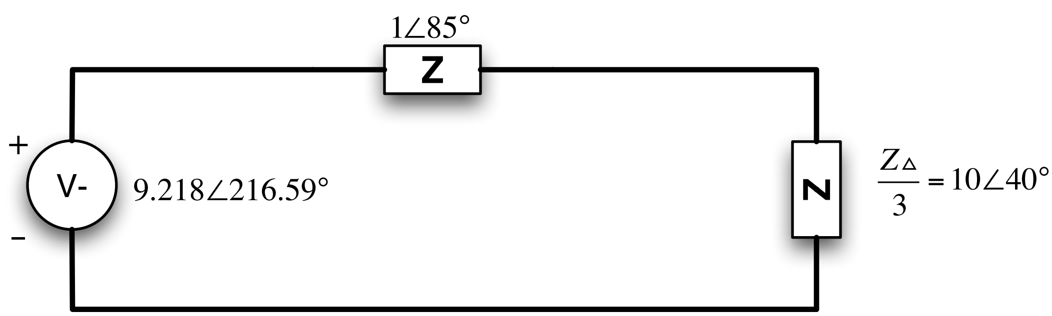
The most common mistake with this method was to have a closed path in the zero sequence circuit.
Using KCL and the definition of zero sequence components we have the following

$$\left.\begin{aligned} I_a &= I_{ab} - I_{ca} \\ I_b &= I_{bc} - I_{ab} \\ I_c &= I_{ca} - I_{bc} \end{aligned}\right\} \rightarrow I_a + I_b + I_c = 0 \ \ and \ \ I_a^0 = \frac{1}{3}(I_a + I_b + I_c)$$

$$\therefore I_a^0 = 0$$







$$I_a^0 = 0 \ A$$

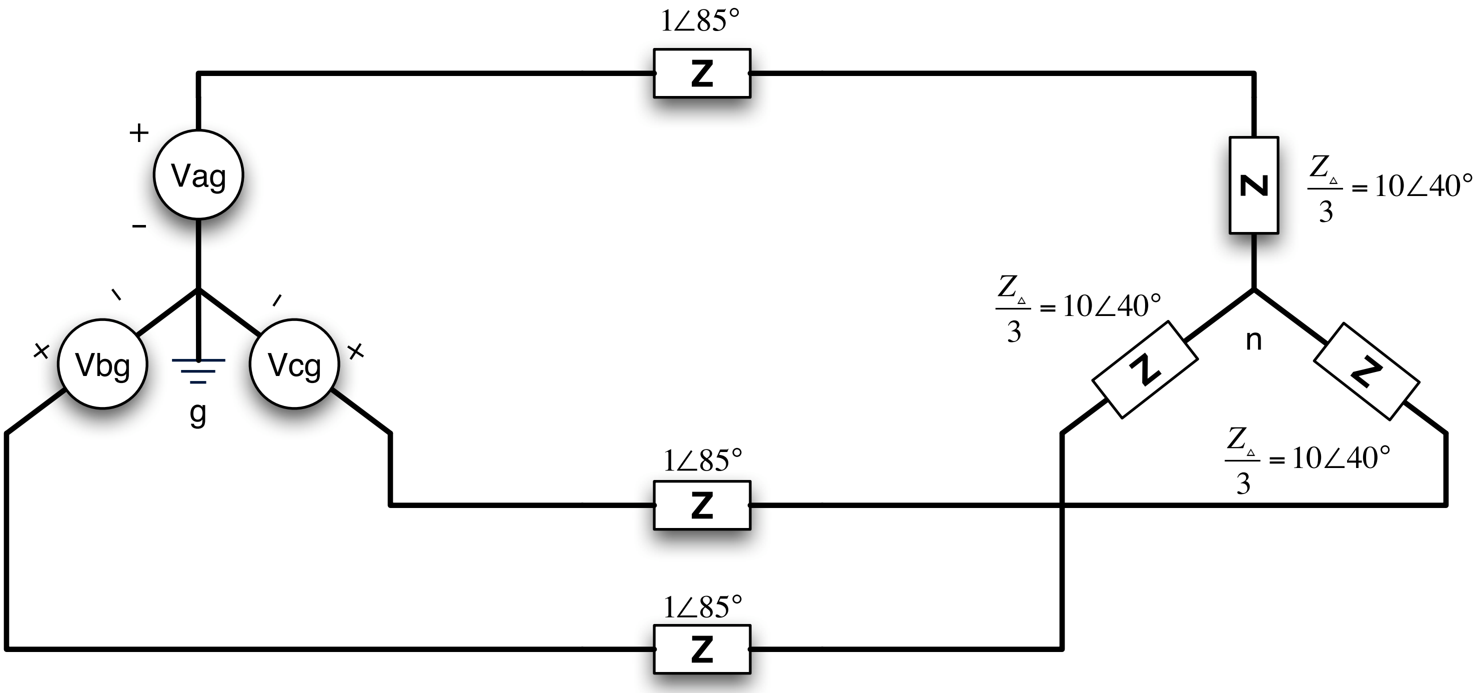
$$I_a^+ = \frac{V_a^+}{Z_{line} + \frac{Z_\Delta}{3}} = \frac{277.1\angle -1.722°}{10.73\angle 43.78°} = 25.82\angle -45.55° \ A$$

$$I_a^- = \frac{V_a^-}{Z_{line} + \frac{Z_\Delta}{3}} = \frac{9.218\angle 216.59°}{10.73\angle 43.78°} = 0.8591\angle 172.81° \ A$$

$$\begin{bmatrix} I_a \\ I_b \\ I_c \end{bmatrix} = [A] \begin{bmatrix} I_a^0 \\ I_a^+ \\ I_a^- \end{bmatrix} = \begin{bmatrix} 25.15\angle -46.76° \\ 25.71\angle 196.34° \\ 26.62\angle 73.77° \end{bmatrix}$$

Using line voltages to find line currents by converting load to WYE

The most common mistake with this method was to ground the wye from the converted delta.



Using KCL at node n

$$I_a + I_b + I_c = 0 \;\Rightarrow\; \frac{V_{ag} - V_{ng}}{Z_{line} + Z_{load}} + \frac{V_{bg} - V_{ng}}{Z_{line} + Z_{load}} + \frac{V_{cg} - V_{ng}}{Z_{line} + Z_{load}} = 0$$

$$\frac{277\angle 0^\circ - V_{ng}}{1\angle 85^\circ + 10\angle 40^\circ} + \frac{260\angle -120^\circ - V_{ng}}{1\angle 85^\circ + 10\angle 40^\circ} + \frac{295\angle 115^\circ - V_{ng}}{1\angle 85^\circ + 10\angle 40^\circ} = 0$$

$$\frac{47.73\angle 62.11^\circ - 3V_{ng}}{10.73\angle 43.77^\circ} = 0$$

$$V_{ng} = 15.91\angle 62.11^\circ$$

$$I_a = \frac{277\angle 0^\circ - 15.91\angle 62.11^\circ}{10.73\angle 43.77^\circ} = 25.15\angle -46.76^\circ$$

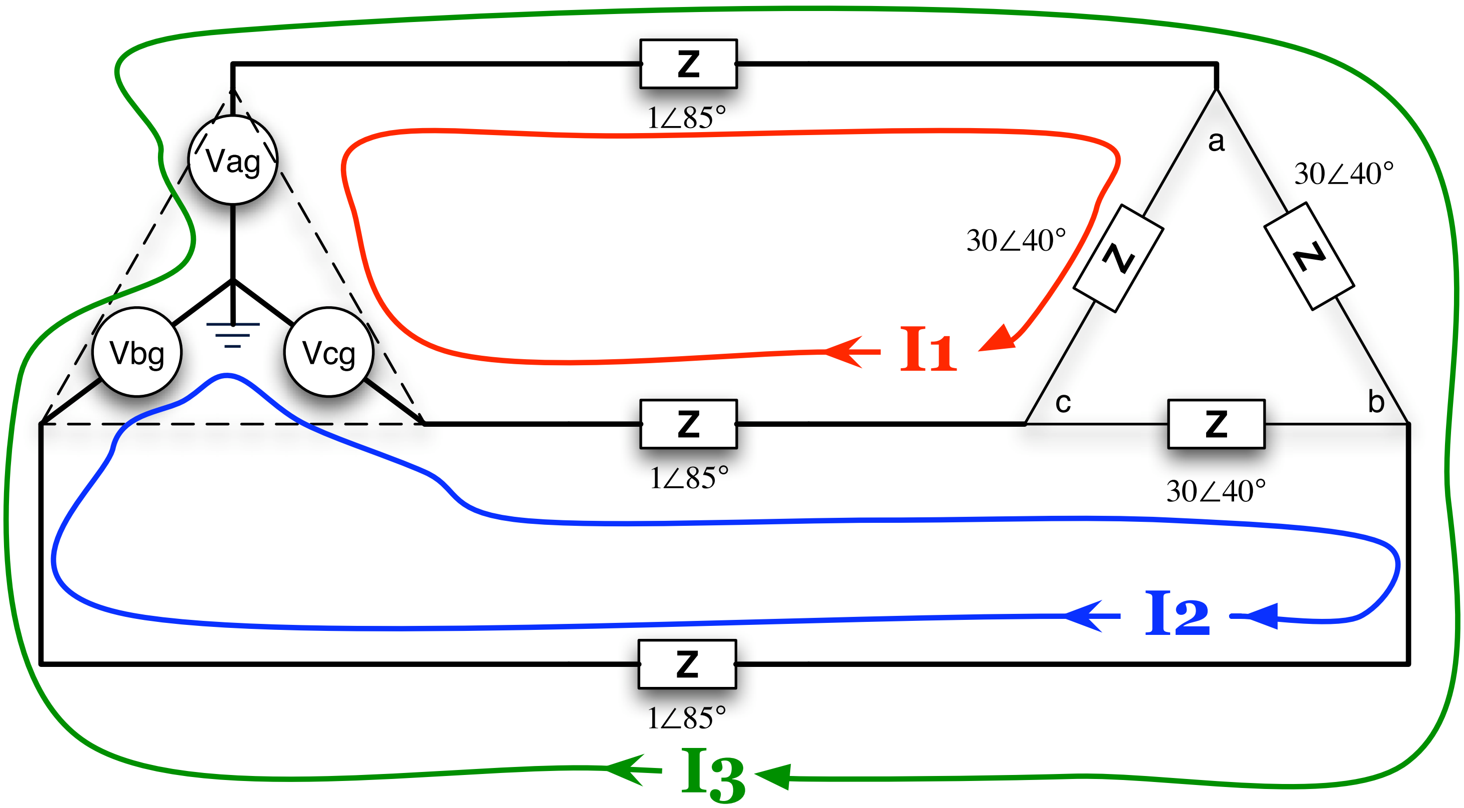
$$I_b = \frac{260\angle -120^\circ - 15.91\angle 62.11^\circ}{10.73\angle 43.77^\circ} = 25.71\angle 196.34^\circ$$

$$I_c = \frac{295\angle 115^\circ - 15.91\angle 62.11^\circ}{10.73\angle 43.77^\circ} = 26.62\angle 73.77^\circ$$

$$\begin{bmatrix} I_a^0 \\ I_a^+ \\ I_a^- \end{bmatrix} = A^{-1} \begin{bmatrix} I_a \\ I_b \\ I_c \end{bmatrix} = \begin{bmatrix} 0 \\ 25.82\angle -45.55^\circ \\ 0.859\angle 172.81^\circ \end{bmatrix}$$

Using line voltages to find line currents with delta load

By KCL at the delta, Ia+Ib+Ic = 0, so we can say no current will flow through the wye ground. The source can be converted to a delta or left as a wye, the equations are the same as we add 2 phases together in each mesh. The load sequence is labeled as such to allow for easier mesh construction.



Mesh 1: $(1\angle 85° + 30\angle 40° + 1\angle 85°)I_1 - (1\angle 85°)I_2 + (1\angle 85°)I_3 = 277\angle 0° - 295\angle 115°$

Mesh 2: $-(1\angle 85°)I_1 + (1\angle 85° + 30\angle 40° + 1\angle 85°)I_2 + (1\angle 85°)I_3 = 295\angle 115° - 260\angle -120°$

Mesh 3: $(1\angle 85°)I_1 + (1\angle 85°)I_2 + (1\angle 85° + 30\angle 40° + 1\angle 85°)I_3 = 277\angle 0° - 260\angle -120°$

$I_1 = 14.989\angle -77.43°$

$I_2 = 15.30\angle 45.60°$

$I_3 = 14.45\angle -14.83°$

⇒

$I_a = I_1 + I_3 = 25.15\angle -46.76°$

$I_b = -I_2 - I_3 = 25.71\angle 196.34°$

$I_c = I_2 - I_1 = 26.62\angle 73.77°$

⇒

$$\begin{bmatrix} I_a^0 \\ I_a^+ \\ I_a^- \end{bmatrix} = A^{-1} \begin{bmatrix} I_a \\ I_b \\ I_c \end{bmatrix} = \begin{bmatrix} 0 \\ 25.82\angle -45.55° \\ 0.859\angle 172.81° \end{bmatrix}$$