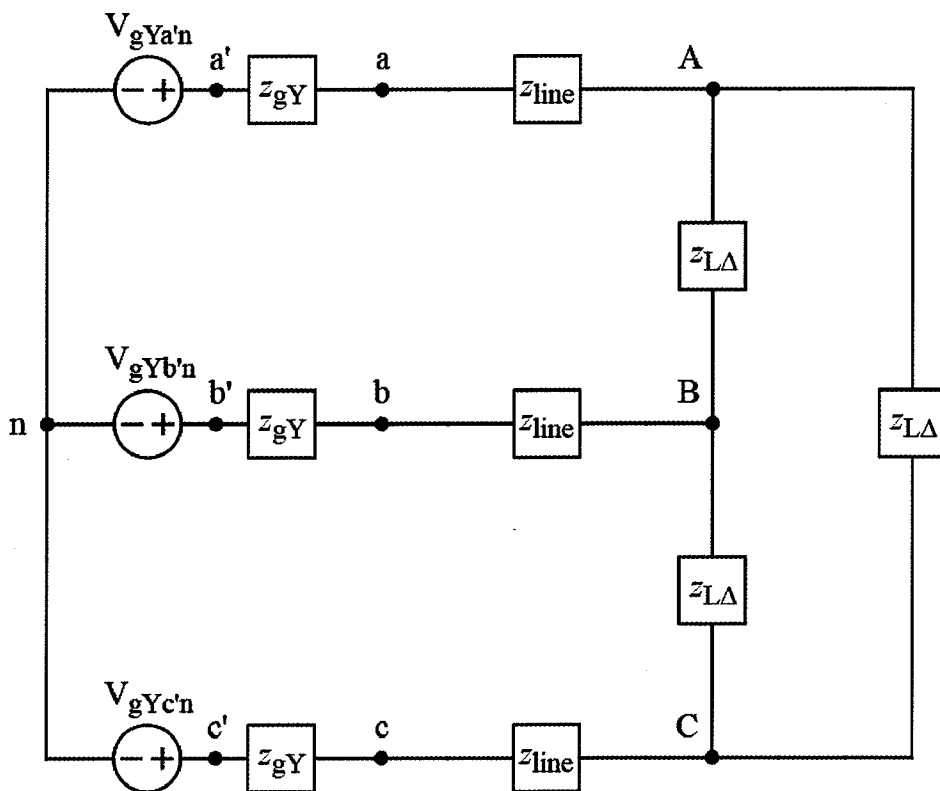


Ex:



$$V_{gYa'b'} = 2930 \angle 0^\circ \text{ V} \quad z_{gY} = j4 \Omega$$

$$V_{gYb'c'} = 2930 \angle +120^\circ \text{ V} \quad z_{line} = j2 \Omega$$

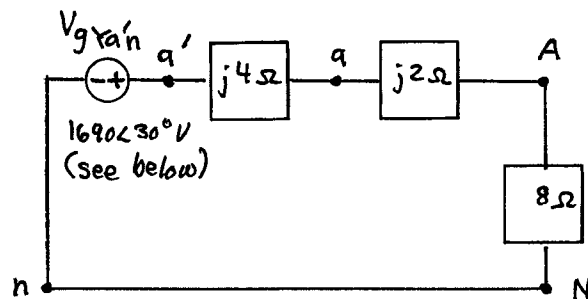
$$V_{gYc'a'} = 2930 \angle -120^\circ \text{ V} \quad z_{L\Delta} = 24 \Omega$$

- Draw the single-phase equivalent circuit.
- Calculate V_{BC} .
- Calculate I_{AB} .
- Write a numerical time-domain expression for $v_{BC}(t)$.

sol'n: a) We convert the load to a Y config. This will yield a Y-Y configuration from which we obtain a single-phase model.

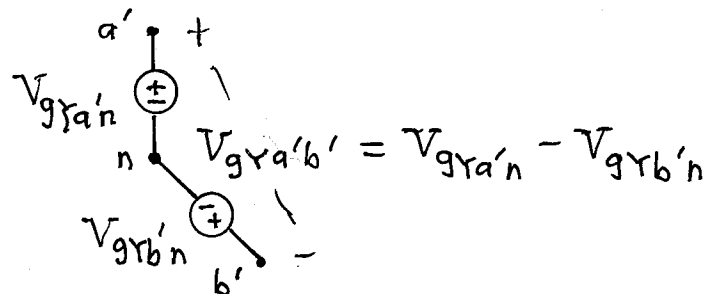
$$z_{LY} = z_{L\Delta} / 3 = 24 \Omega / 3 = 8 \Omega$$

For the single-phase model, we add a wire connecting the neutrals n and N . Since current in the wire connecting the neutrals is zero, the added wire has no effect on voltages and currents. We then argue that the neutral wire has three independent circuits in parallel across it, namely the three phases. Our single-phase model is the "A" phase.



We need to calculate $V_{g_{a'n}}$ from the $V_{g_{a'b'}}$ value given in the problem.

Consider how $V_{g_{a'b'}}$ is related to $V_{g_{a'n}}$ and $V_{g_{b'n}}$.

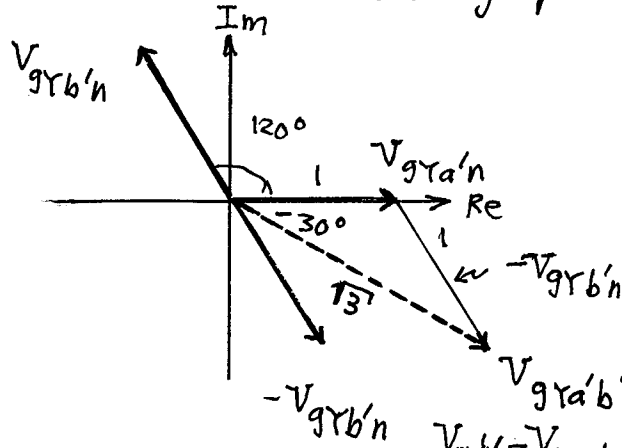


Since $V_{g_{b'n}}$ is the phase after $V_{g_{a'n}}$, it is the same as $V_{g_{a'n}}$ but $+120^\circ$ phase.

$$\text{So } V_{gYb'n} = V_{gYa'n} \cdot 1 \angle 120^\circ$$

$$V_{gYa'b'} = V_{gYa'n} (1 - 1 \angle 120^\circ)$$

We calculate $1 - 1 \angle 120^\circ$ graphically.



$$\text{We have } V_{gYa'b'} = V_{gYa'n} \cdot \sqrt{3} \angle -30^\circ$$

$$\text{So } V_{gYa'n} = \frac{2930 \angle 0^\circ \text{ V}}{\sqrt{3} \angle -30^\circ}$$

$$V_{gYa'n} = 1690 \angle 30^\circ \text{ V}$$

b) We have $V_{BC} = V_{AB} \cdot 1 \angle 120^\circ$.

$$\text{We find } V_{AB} = V_{AN} - V_{BN} = V_{AN} \sqrt{3} \angle -30^\circ$$

(The diagram for this calculation will be the same as the diagram above.)

We use the single-phase model to calculate V_{AN} .

$$V_{AN} = 1690 \angle 30^\circ \text{ V} \cdot \frac{8 \Omega}{8 \Omega + j2 \Omega + j4 \Omega} \quad \leftarrow \begin{array}{l} \text{V-divider} \\ z_{\text{Tot}} \end{array}$$

$$= 1690 \angle 30^\circ \text{ V} \cdot \frac{8 \Omega}{10 \angle 37^\circ \Omega} \quad \leftarrow \begin{array}{l} \text{polar form} \\ \text{of } z_{\text{Tot}} \end{array}$$

$$V_{AN} \doteq 169(8) \angle (30^\circ - 37^\circ) \text{ V}$$

$$V_{AN} \doteq 1352 \angle -7^\circ \text{ V}$$

$$\text{So } V_{AB} \doteq 1352 \angle -7^\circ \text{ V} \cdot \sqrt{3} \angle -30^\circ$$

$$V_{AB} \doteq 2342 \angle -37^\circ \text{ V}$$

$$\text{So } V_{BC} \doteq V_{AB} \cdot 1 \angle 120^\circ = 2342 \angle -37^\circ \text{ V} \cdot 1 \angle 120^\circ$$

$$V_{BC} \doteq 2342 \angle 83^\circ \text{ V}$$

c) We use z_{LY} to find I_{AB} .

$$I_{AB} = \frac{V_{AB}}{Z_{LO}} \doteq \frac{2342 \angle -37^\circ \text{ V}}{24 \Omega}$$

$$I_{AB} \doteq 98 \angle -37^\circ \text{ A}$$

d) We have $V_{BC} \doteq 2342 \angle 83^\circ \text{ V}$. So we just take the inverse phasor.

$$v_{BC}(t) = 2342 \cos(\omega t + 83^\circ) \text{ V}$$

(We don't know the frequency, so we use ω .)