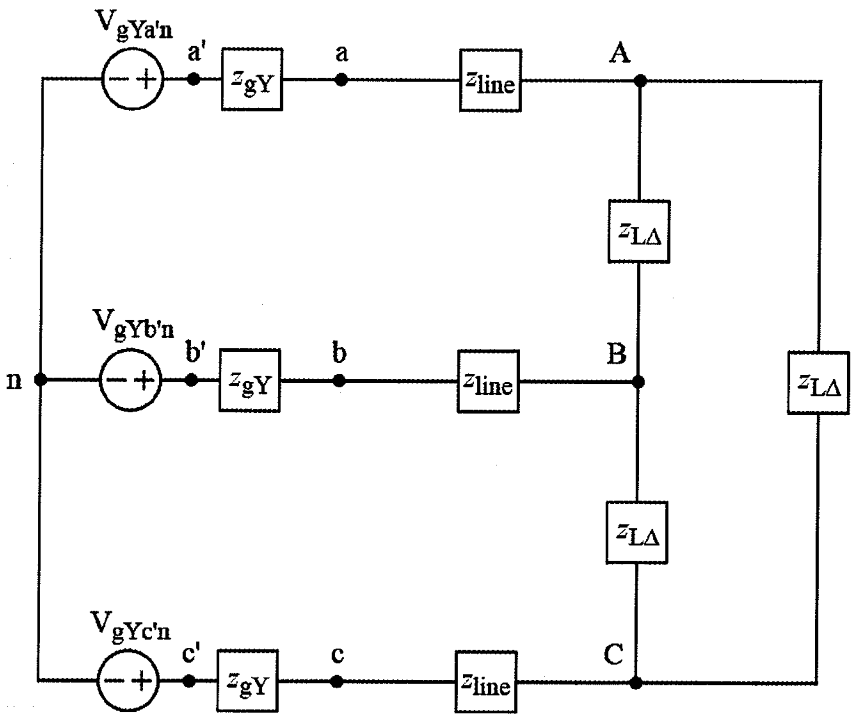
Ex:



$V_{gYa'n} = 172\angle 0°$ V $\qquad z_{gY} = 1 + j3\ \Omega$

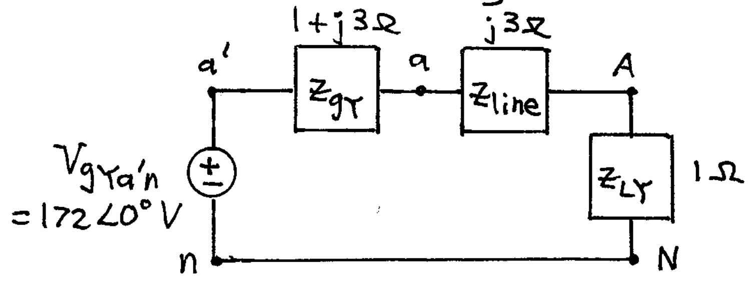
$V_{gYb'n} = 172\angle -120°$ V $\qquad z_{line} = j3\ \Omega$

$V_{gYc'n'} = 172\angle +120°$ V $\qquad z_{L\Delta} = 3\ \Omega$

a) Draw a single-phase equivalent circuit.

b) Calculate the voltage drop $\mathbf{V}_{ca}$ from c to a.

sol'n: a) We convert from this Y-Δ to a Y-Y configuration. We need only divide $Z_{L\Delta}$ by 3: $Z_{LY} = \frac{3\,\Omega}{3} = 1\,\Omega$

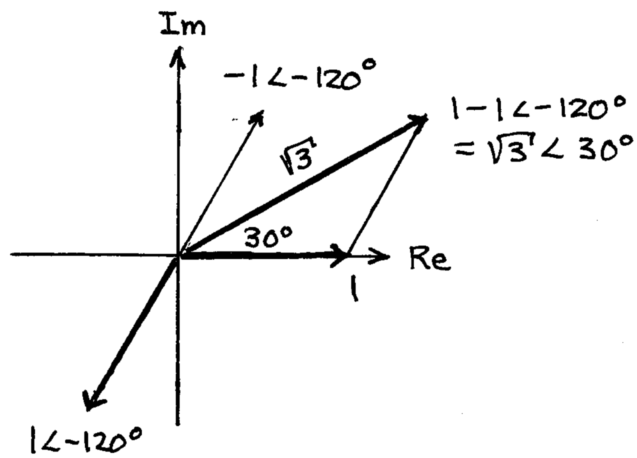


b) $V_{ca} = V_{ab}$ shifted by $+120°$

$V_{ab} = V_{an} - V_{bn}$ and $V_{bn} = V_{an} \cdot 1\angle -120°$

So $V_{ab} = V_{an}(1 - 1\angle -120°)$

We compute $1\angle -120°$ graphically:



$$V_{ab} = V_{an} \cdot \sqrt{3}\angle 30°$$

We use a voltage divider to find V_{an} from the single-phase model, and we observe that $V_{an} = V_{aN}$.

$$V_{aN} = V_{gYa'n} \frac{Z_{line} + Z_{LY}}{Z_{gY} + Z_{line} + Z_{LY}}$$

$$'' = 172\angle 0° V \; \frac{j3 + 1\ \Omega}{1 + j3 + j3 + 1\ \Omega}$$

$$'' = 172\angle 0° V \cdot \frac{1}{2}$$

$$V_{aN} = 86\angle 0° V$$

$$V_{ab} = V_{an} \cdot \sqrt{3} \angle 30^\circ$$

$$\quad \approx 86 \angle 0^\circ \cdot \sqrt{3} \angle 30^\circ \text{ V}$$

$$V_{ab} \doteq 149 \angle 30^\circ \text{ V}$$

$$V_{ca} \doteq V_{ab} \cdot 1 \angle 120^\circ$$

$$\doteq 149 \angle 30^\circ \text{ V} \cdot 1 \angle 120^\circ$$

$$V_{ca} \doteq 149 \angle 150^\circ \text{ V}$$