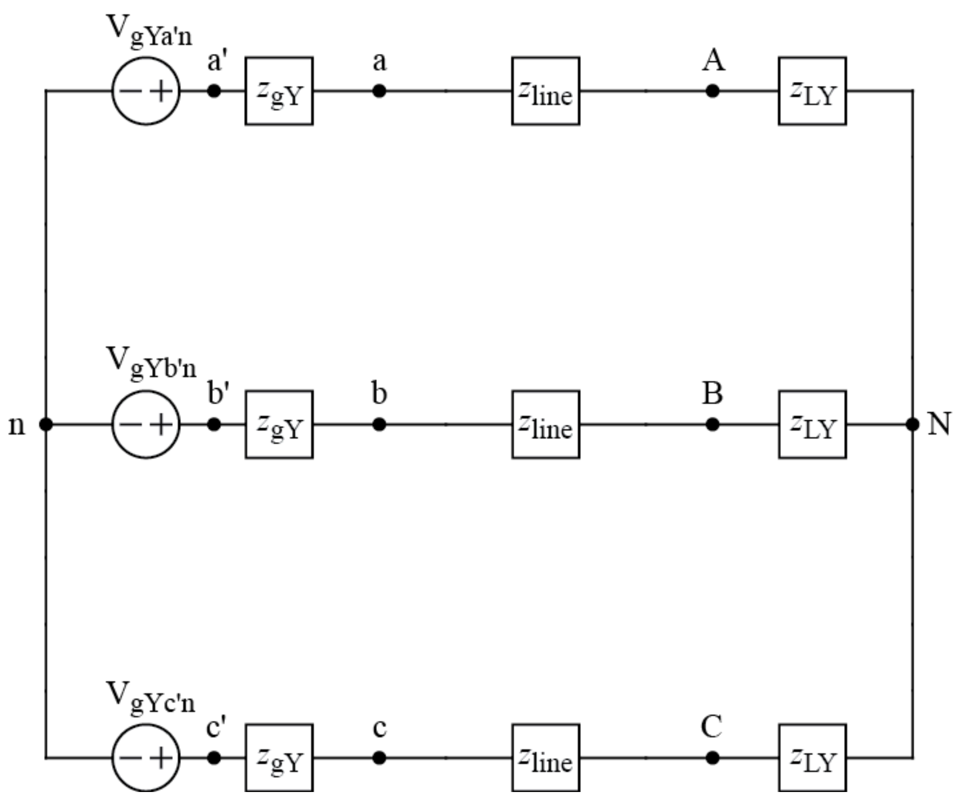
HOMEWORK #7 prob 3 solution

Ex:



$V_{gYa'n} = 120\angle 0°$ V $\quad z_{gY} = j0.3\ \Omega$

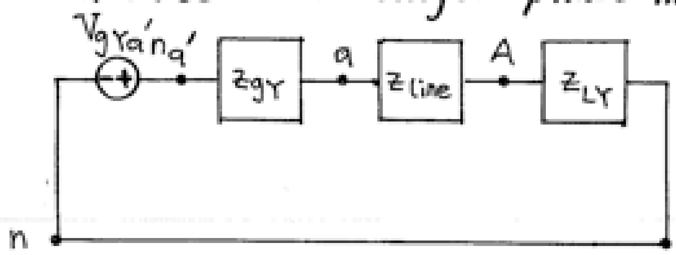
$V_{gYb'n} = 120\angle{+120°}$ V $\quad z_{line} = j0.6\ \Omega$

$V_{gYc'n} = 120\angle{-120°}$ V $\quad z_{LY} = 3 - j0.1\ \Omega$

a) Draw the single-phase equivalent circuit.

b) Calculate $\mathbf{V}_{aA}$.

sol'n: a) This 3-phase circuit is already in a Y-Y configuration. Thus, the single phase model is obtained by adding a wire from n to N, (which has no effect on the circuit since the voltages and currents in a 3-phase circuit sum to zero). Then we use the added wire and the components in the a-phase to create the single-phase model.



$V_{gYa'n} = 120\angle 0° \text{ V}$ $\quad z_{gY} = j0.3\ \Omega$

$z_{line} = j0.6\ \Omega$

$z_{LY} = 3 - j0.1\ \Omega$

b) V_{aA} in the original circuit is outside of the generator and the load. Therefore V_{aA} is the same in the original circuit and in the single-phase model.

In the single-phase model, V_{aA} is given by a voltage-divider:

$$V_{aA} = V_{gYa'n} \cdot \frac{z_{line}}{z_{gY} + z_{line} + z_{LY}}$$

$$= \frac{120\angle 0° \text{ V} \cdot j0.6}{j0.3 + j0.6 + 3 - j0.1\ \Omega}$$

$$V_{aA} = 120\angle 0^\circ \text{ V} \cdot \frac{0.6\angle 90^\circ}{3 + j0.8}$$

$$= 120\angle 0^\circ \text{ V} \cdot \frac{0.6\angle 90^\circ}{3.1\angle 14.9^\circ}$$

$$= \frac{120(0.6)}{3.1} \text{ V}\angle 0^\circ + 90^\circ - 14.9^\circ$$

$$V_{aA} = 23.2\angle 75.1^\circ \text{ V}$$