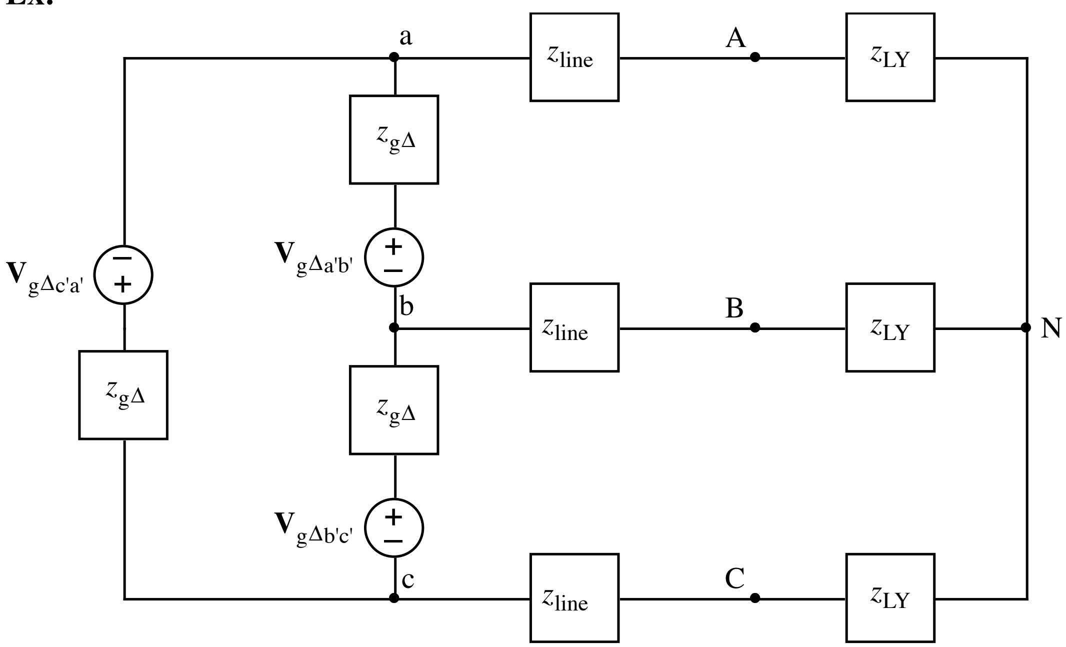
HOMEWORK #8 probs 2 and 3 solution

Ex:



$V_{g\Delta a'b'} = 168\angle 0°$ V $\qquad z_{g\Delta} = 0.90 + j1.62\ \Omega$

$V_{g\Delta b'c'} = 168\angle{+120°}$ V $\qquad z_{line} = 0.51 + j4.92\ \Omega$

$V_{g\Delta c'a'} = 168\angle{-120°}$ V $\qquad z_{LY} = 7.92 - j1.58\ \Omega$

a) Draw a single-phase equivalent circuit.

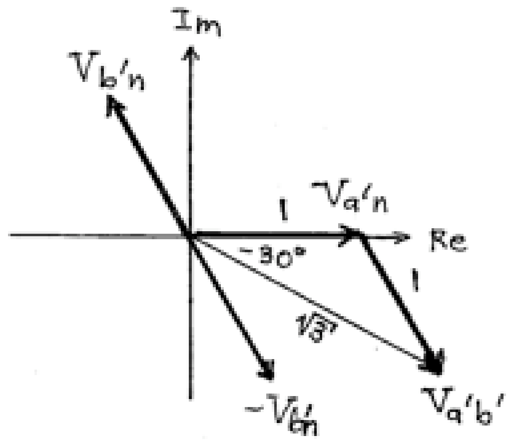
b) Calculate the voltage drop $\mathbf{V}_{BC}$ from B to C.

sol'n: a) We convert to a Y-Y configuration.

$$z_{gY} = \frac{z_{g\Delta}}{3} = \frac{0.90 + j1.62}{3} = 0.3 + j0.54\ \Omega$$

To convert the voltage source, we use a phasor diagram and observe that the voltage from a to b in the Y-Y configuration is as follows:

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



From the diagram, we have the following:

$$V_{a'b'} = V_{a'n}\sqrt{3}\angle -30^\circ$$

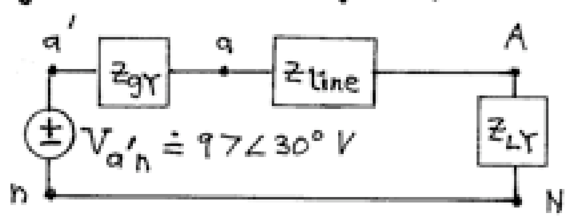
Inverting this eq'n, i.e., multiplying by $\frac{1}{\sqrt{3}}\angle 30^\circ$, yields the eq'n we seek:

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

$$'' \quad = 168\angle 0^\circ V \cdot \frac{1}{\sqrt{3}}\angle 30^\circ$$

$$V_{a'n} \doteq 97\angle 30^\circ\ V$$

The other components of the 3-phase system are unchanged in the Y-Y configuration. Single-phase model:



$Z_{gY} = 0.3 + j0.54\ \Omega$

$Z_{line} = 0.51 + j4.92\ \Omega$

$Z_{LY} = 7.92 - j1.58\ \Omega$

b) Given the phase shifts in the original diagram, we have that

$$V_{BC} = V_{AB} \cdot 1\angle 120°$$

We find V_{AB} from V_{AN} using the same relationship equation found earlier for $V_{a'b'}$ and $V_{a'n}$:

$$V_{AB} = V_{AN} \sqrt{3} \angle -30°$$

We use a V-divider eq'n to find V_{AN}:

$$V_{AN} = V_{a'n} \cdot \frac{Z_{LY}}{Z_{gY} + Z_{line} + Z_{LY}}$$

$$\doteq \frac{97\angle 30° \text{ V} \cdot 7.92 - j1.58\ \Omega}{0.3 + j0.54 + 0.51 + j4.92 + 7.92 - j1.58\ \Omega}$$

$$\doteq 97\angle 30° \text{ V} \ \frac{7.92 - j1.58}{8.73 + j3.88}$$

$$\doteq 82 \angle 30° - 35.2° \text{ V}$$

$$V_{AN} \doteq 82 \angle -5.2° \text{ V}$$

Now we substitute into earlier eq'ns:

$$V_{AB} = V_{AN} \sqrt{3} \angle -30°$$

$$\doteq 82\angle -5.2° \text{ V} \sqrt{3} \angle -30°$$

$$\doteq 142 \angle -35.2° \text{ V}$$

and

$$V_{BC} \doteq 142 \angle -35.2° + 120° \text{ V} = 142 \angle 84.8° \text{ V}$$