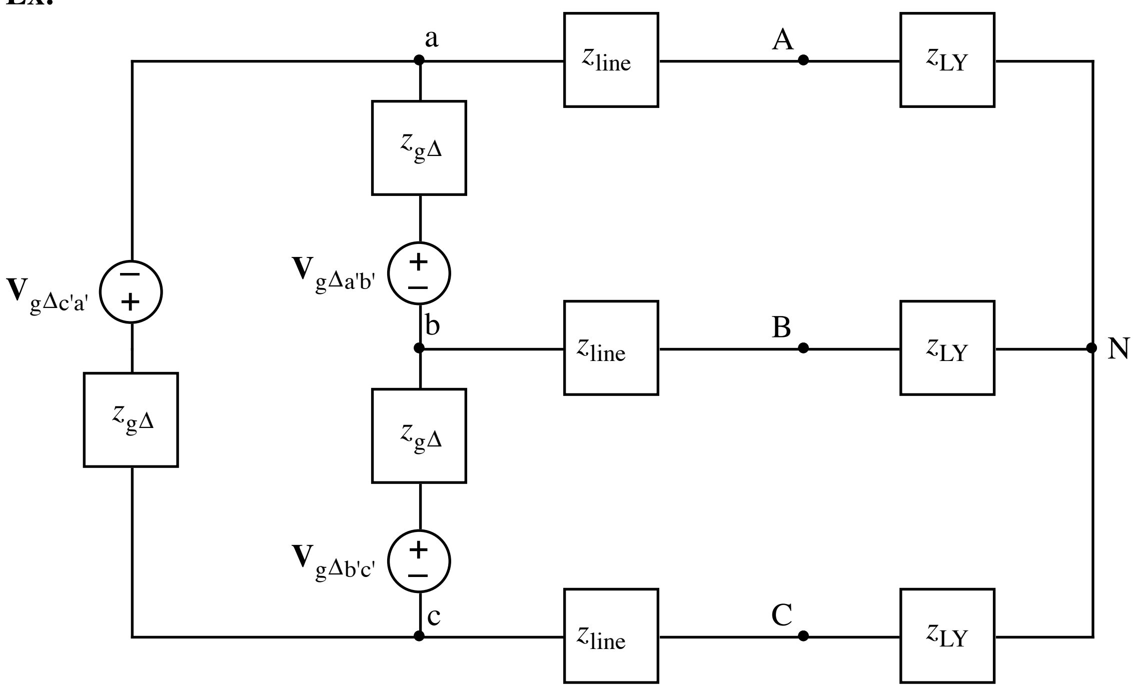
HOMEWORK #8 probs 2 and 3 solution

Ex:



$V_{g\Delta a'b'} = 123\angle 0° \text{ V}$ $\qquad z_{g\Delta} = 0.900 + j18.000\ \Omega$

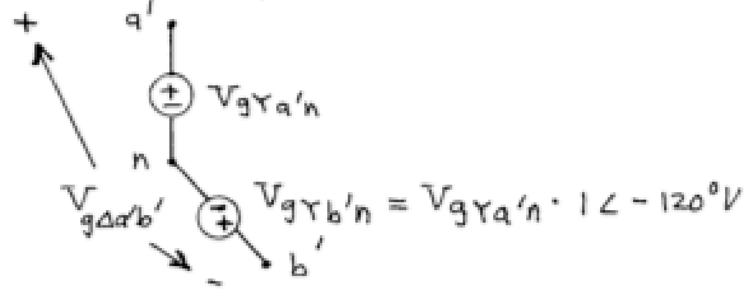
$V_{g\Delta b'c'} = 123\angle -120° \text{ V}$ $\qquad z_{line} = 0.268 + j2.076\ \Omega$

$V_{g\Delta c'a'} = 123\angle +120° \text{ V}$ $\qquad z_{LY} = 0.432 - j1.076\ \Omega$

a) Draw a single-phase equivalent circuit.

b) Calculate the voltage drop $\mathbf{V}_{CN}$ across z_{LY} between C and N.

sol'n: a) We first convert the Δ generator to an equivalent Y generator. We perform the conversion from Y to Δ and then invert the equation (for voltage).



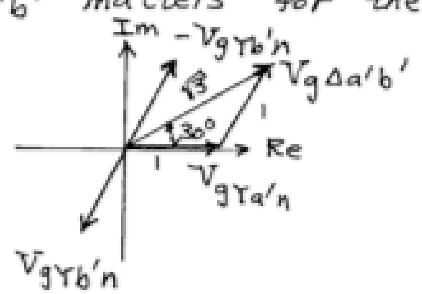
$$V_{g\Delta a'b'} = V_{gYa'n} - V_{gYb'n}$$

or

$$V_{g\Delta a'b'} = V_{gYa'n} - V_{gYa'n} \cdot 1\angle -120° V$$

Using graphical approach, we treat $V_{gYa'n}$ as though it has phase of 0°.

(Only relative phase shift of $V_{gYa'n}$ vs $V_{g\Delta a'b'}$ matters for the eq'n we derive.)



$$V_{g\Delta a'b'} = V_{gYa'n} \cdot \sqrt{3} \angle 30°$$

and

$$V_{gYa'n} = V_{g\Delta a'b'} \cdot \frac{1}{\sqrt{3}} \angle -30°$$

or

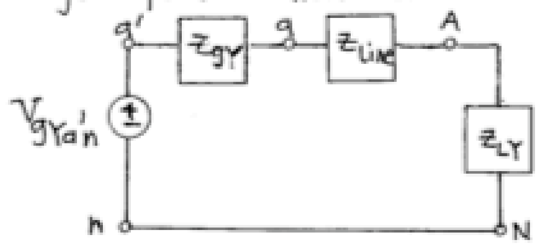
$$V_{gYa'n} = 123\angle 0° \cdot \frac{1}{\sqrt{3}} \angle -30° \text{ V}$$

or

$$V_{gYa'n} \doteq 71.0 \angle -30° \text{ V}$$

For the generator impedance, we divide by 3 to get z_{gY}.

Single-phase model:



$$V_{gYa'n} \doteq 71.0 \angle -30^\circ \text{ V}$$
$$z_{gY} = 0.3 + j6\,\Omega$$
$$z_{line} = 0.268 + j2.076\,\Omega$$
$$z_{LY} = 0.432 - j1.076\,\Omega$$

b) V_{CN} is V_{AN} shifted by $+120^\circ$

$$V_{AN} = V_{gYa'n} \cdot \frac{z_{LY}}{z_{tot}}$$

$$= 71\angle -30^\circ \text{ V} \cdot \frac{0.432 - j1.076\,\Omega}{0.3 + j6 + 0.268 + j2.076 + 0.432 - j1.076\,\Omega}$$

$$= 71\angle -30^\circ \text{V} \cdot \frac{0.432 - j1.076}{1 + j7}$$

$$= 71\angle -30^\circ \text{ V} \cdot \frac{0.432 - j1.076}{1 + j7} \cdot \frac{1 - j7}{1 - j7}$$

$$= 71\angle -30^\circ \text{V} \cdot \frac{-7.1 - j4.1}{50}$$

$$V_{AN} = 71\angle -30^\circ \text{V} \quad \frac{8.2}{50}\angle -150^\circ = -11.6 \text{ V}$$

So $V_{CN} = 11.6 \angle -180^\circ \text{V} \cdot 1\angle 120^\circ = 11.6\angle -60^\circ \text{V}.$