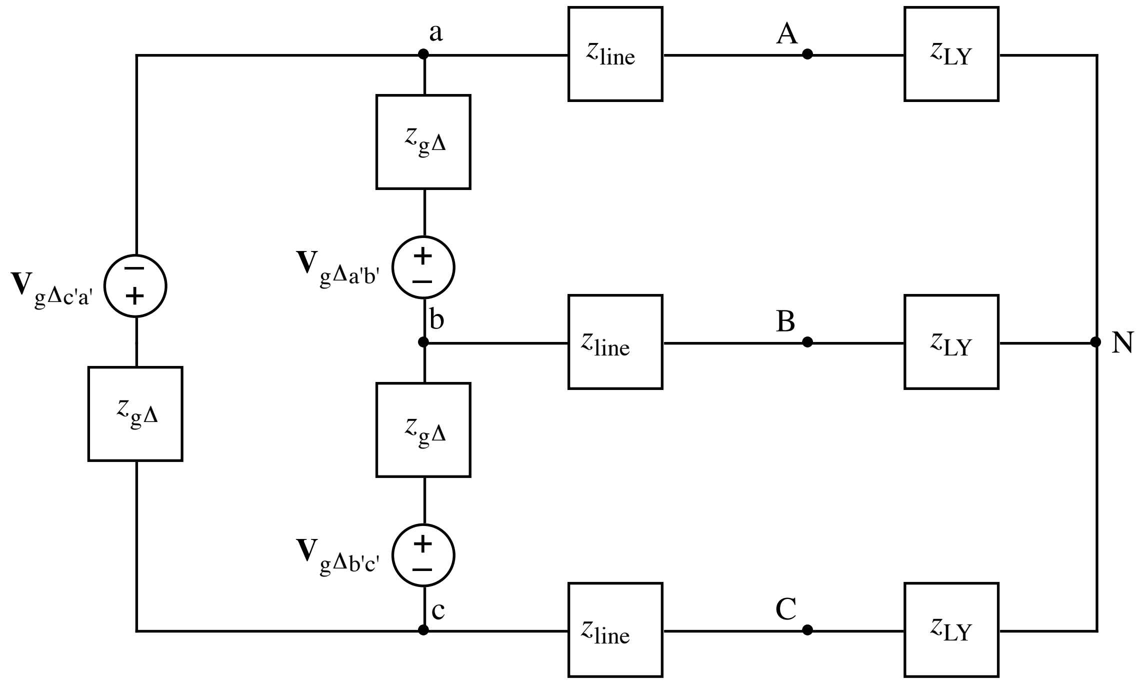
HOMEWORK #7 prob 3 solution

Ex:



$V_{g\Delta a'b'} = 168\angle 0°$ V		$z_{g\Delta} =$	$8.1 + j18.3\ \Omega$
$V_{g\Delta b'c'} = 168\angle{+120°}$ V		$z_{line} =$	$1.4 - j0.5\ \Omega$
$V_{g\Delta c'a'} = 168\angle{-120°}$ V		$z_{LY} =$	$5.6 - j5.6\ \Omega$

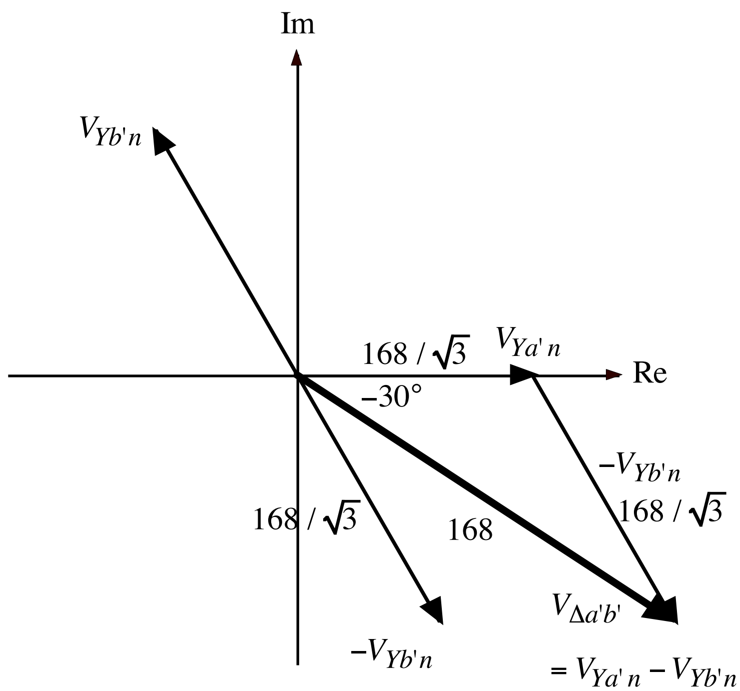
a) Draw the single-phase equivalent circuit.

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

SOL'N: a) To determine the single-phase equivalent, we must convert the circuit to a Y-Y configuration. Here, the source is a delta configuration. To convert the delta impedance in the generator to a Y impedance, we divide the impedance by three:

$$z_{gY} = \frac{z_{g\Delta}}{3} = \frac{8.1 + j18.3\ \Omega}{3} = 2.7 + 6.1\ \Omega$$

To convert the delta voltage source to a Y voltage source, we use a phasor diagram. We perform the calculation in the Y to delta direction, however, as the delta to Y calculation is less tractable. The diagram shows the calculation:



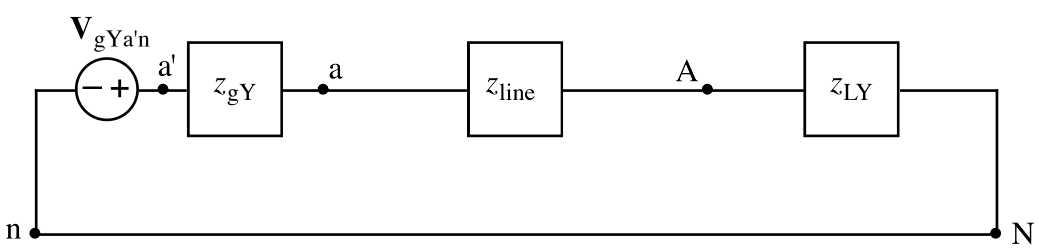
From the diagram, we have the following relationship between the delta and Y voltages:

$$V_{\Delta a'b'} = V_{Ya'n} - V_{Yb'n} = V_{Ya'n}\sqrt{3}\angle -30° = 168\angle 0° \text{ V}$$

Solving for $V_{Ya'n}$, we have the following result:

$$V_{Ya'n} = \frac{V_{\Delta a'b'}}{\sqrt{3}\angle -30°} = \frac{168\angle 0°}{\sqrt{3}\angle -30°} \approx 97\angle 30° \text{ V}$$

We have the single-phase equivalent shown below:



$V_{gYa'n} \approx 97\angle 30°$ V $\quad z_{gY} = 2.7 + j6.1\ \Omega$

$z_{line} = 1.4 - j0.5\ \Omega \quad z_{LY} = 5.6 - j5.6\ \Omega$

b) To find V_{AB}, we can find V_{AN} and use the relationship for generator voltages from (a) applied to the load side of the circuit. In other words, the relationship between quantities is the same on the load side as on the generator side. Thus, the following equation applies:

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

To find V_{AN}, we use the single-phase circuit and the voltage divider formula:

$$V_{AN} = 97\angle 30° \text{ V} \frac{5.6 - j5.6 \ \Omega}{2.7 + j6.1 + 1.4 - j0.5 + 5.6 - j5.6 \ \Omega}$$

or

$$V_{AN} = 97\angle 30° \text{ V} \frac{5.6 - j5.6 \ \Omega}{9.7 \ \Omega} = 10\angle 30° \text{ V} \cdot 5.6(1 - j)$$

or

$$V_{AN} = 10\angle 30° \text{ V} \cdot 5.6\sqrt{2}\angle -45° = 56\sqrt{2}\angle -15° \text{ V}$$

Using our equation above, we find V_{AB}:

$$V_{AB} = V_{AN}\sqrt{3}\angle -30° = 56\sqrt{2}\angle -15° \text{ V} \cdot \sqrt{3}\angle -30°$$

or

$$V_{AB} = V_{AN}\sqrt{3}\angle -30° = 56\sqrt{2}\angle -15° \text{ V} \cdot \sqrt{3}\angle -30°$$

or

$$V_{AB} = V_{AN}\sqrt{3}\angle -30° = 56\sqrt{6}\angle -45° \text{ V} \approx 137\angle -45° \text{ V}$$