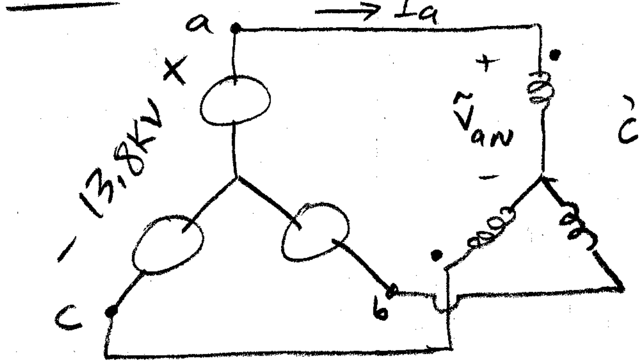
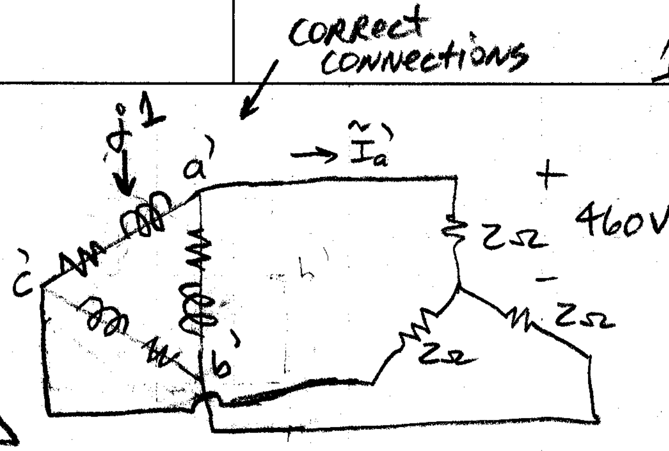
5.12





Individual 10:1 transformers with $Z = j1\Omega$ (problem doesn't say, but I'm assuming this is in the 797V winding.

Over here, $\hat{V}_{ab} = 13.8\text{KV}\angle 0$,

so $\hat{V}_{aN} = \dfrac{\hat{V}_{ab}}{\sqrt{3}}\angle -30° = 7.97\angle -30°\ \text{KV}$

ANSI standard dictates that the connections are made so that $\underset{\text{LOW side}}{\tilde{V}_{AN}}$ lags $\underset{\text{HIGH SIDE}}{\hat{V}_{AN}}$ by $30°$

If $\underset{\text{HIGH SIDE}}{\tilde{V}_{aN}} = 7.97\angle -30°$, then $\underset{\text{LOW SIDE}}{\tilde{V}_{ab}} = \underset{\text{HIGH SIDE}}{\tilde{V}_{aN}} \cdot \left(\frac{1}{10}\right) = 0.797\angle -30°\ \text{KV}$

Thus, using ANSI, $\underset{\text{LOW SIDE}}{\tilde{V}_{aN}} = \underset{\text{LOW SIDE}}{\tilde{V}_{ab}} \cdot \underbrace{\left(\frac{1}{\sqrt{3}}\angle -30°\right)}_{\text{effect of changing l-l to l-N.}}$

Thus, $\underset{\text{LOW SIDE}}{\tilde{V}_{aN}} = (0.797\angle -30)\left(\frac{1}{\sqrt{3}}\angle -30\right) = 460\angle -60°\ V_{RMS}$

Putting the $j1\Omega$ in wye give $j\frac{1}{3}$, so $\tilde{I}_a' = \dfrac{460\angle -60}{j\frac{1}{3} + Z} = 227\angle -69.5\ A$

So, $I_{ab}' = \tilde{I}_a'\left(\frac{1\angle 30}{\sqrt{3}}\right) = 131\angle -39.5A$

$\tilde{I}_a = (131\angle -39.5)\left(\frac{1}{10}\right) = 13.1\angle -39.5$

So, the equivalent load impedance on the high side is $\dfrac{7970\angle -30}{13.1\angle -39.5} = 608\angle 9.5\Omega$

5.12, cont

The best way to approach this problem is to reflect the load Z using the line-to-line turns ratio, ignoring all phase shift (because $\tilde{V}$ & $\tilde{I}$ shift the same)

$$Z_{\substack{HIGH\\SIDE}} = Z_{\substack{LOW\\SIDE}} \cdot \underbrace{\left[\frac{13800}{7970/10}\right]^2}_{\text{line-to-line turns ratio.}} = \left(2+\frac{j}{3}\right)(300) = 600+j100$$
$$= 608\angle 9.5^\circ$$

The line-to-neutral turns ratio gives the same results

$$\left(2+\frac{j}{3}\right)\underbrace{\left(\frac{7970}{\frac{7970}{10}\cdot\frac{1}{\sqrt{3}}}\right)^2}_{300} \qquad \text{(same as above)}$$