

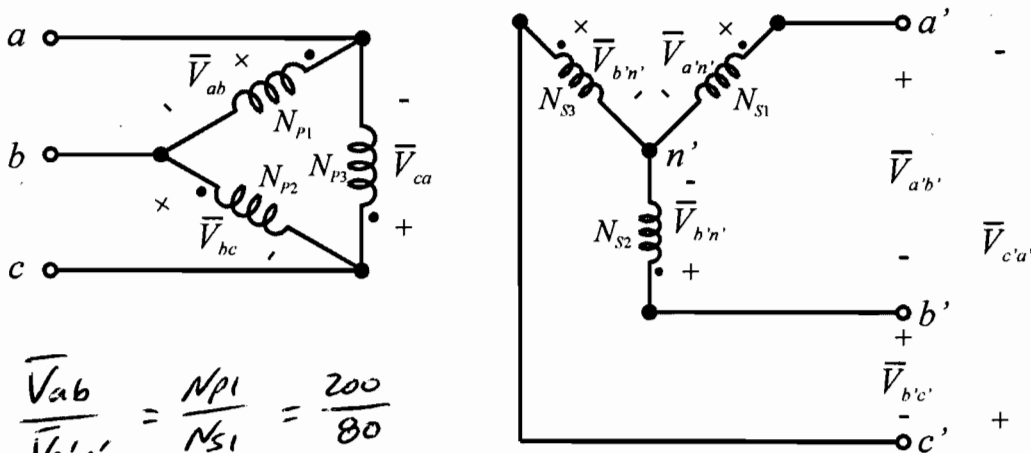
EE 330/330L Energy Systems (Spring 2012) Quiz #4

Name Key A

Instructions: Closed book. Place answers in indicated spaces & show all work for credit.

Helpful equations- $\frac{\bar{V}_P}{\bar{V}_S} = \frac{N_P}{N_S} = a$, $\frac{\bar{I}_P}{\bar{I}_S} = \frac{N_S}{N_P} = \frac{1}{a}$, $P = \sqrt{3}V_{LL}I_L \cos\theta$, $Q = \sqrt{3}V_{LL}I_L \sin\theta$

For the Δ -Y transformer shown, the primary phase voltages are $\bar{V}_{ab} = 240 \angle 30^\circ \text{ V}_{\text{rms}}$, $\bar{V}_{bc} = 240 \angle 150^\circ \text{ V}_{\text{rms}}$, and $\bar{V}_{ca} = 240 \angle -90^\circ \text{ V}_{\text{rms}}$. Find the secondary line-to-line voltages $\bar{V}_{a'b'}$, $\bar{V}_{b'c'}$, & $\bar{V}_{c'a'}$ and secondary phase voltages $\bar{V}_{a'n'}$, $\bar{V}_{b'n'}$, & $\bar{V}_{c'n'}$. Assume ideal transformers and $N_{P1} = N_{P2} = N_{P3} = 200$ and $N_{S1} = N_{S2} = N_{S3} = 80$.



$$\text{coil \#1} \quad \frac{\bar{V}_{ab}}{\bar{V}_{a'n'}} = \frac{N_{P1}}{N_{S1}} = \frac{200}{80}$$

$$\hookrightarrow \bar{V}_{a'n'} = \frac{80}{200} \bar{V}_{ab} = 0.4 (240 \angle 30^\circ) = 96 \angle 30^\circ \text{ V}_{\text{rms}}$$

$$\text{coil \#2} \quad \bar{V}_{b'n'} = \frac{80}{200} \bar{V}_{bc} = 0.4 (240 \angle 150^\circ) = 96 \angle 150^\circ \text{ V}_{\text{rms}}$$

$$\text{coil \#3} \quad \bar{V}_{c'n'} = \frac{80}{200} \bar{V}_{ca} = 0.4 (240 \angle -90^\circ) = 96 \angle -90^\circ \text{ V}_{\text{rms}}$$

$$\text{By KVL: } \bar{V}_{a'b'} = \bar{V}_{a'n'} - \bar{V}_{b'n'} = 96 \angle 30^\circ - 96 \angle 150^\circ = 166.3 \angle 0^\circ \text{ V}_{\text{rms}}$$

$$\bar{V}_{b'c'} = \bar{V}_{b'n'} - \bar{V}_{c'n'} = 96 \angle 150^\circ - 96 \angle -90^\circ = 166.3 \angle 120^\circ \text{ V}_{\text{rms}}$$

$$\bar{V}_{c'a'} = \bar{V}_{c'n'} - \bar{V}_{a'n'} = 96 \angle -90^\circ - 96 \angle 30^\circ = 166.3 \angle -120^\circ \text{ V}_{\text{rms}}$$

$$\bar{V}_{a'b'} = 166.3 \angle 0^\circ \text{ V}_{\text{rms}} \quad \bar{V}_{b'c'} = 166.3 \angle 120^\circ \text{ V}_{\text{rms}} \quad \bar{V}_{c'a'} = 166.3 \angle -120^\circ \text{ V}_{\text{rms}}$$

$$\bar{V}_{a'n'} = 96 \angle 30^\circ \text{ V}_{\text{rms}} \quad \bar{V}_{b'n'} = 96 \angle 150^\circ \text{ V}_{\text{rms}} \quad \bar{V}_{c'n'} = 96 \angle -90^\circ \text{ V}_{\text{rms}}$$