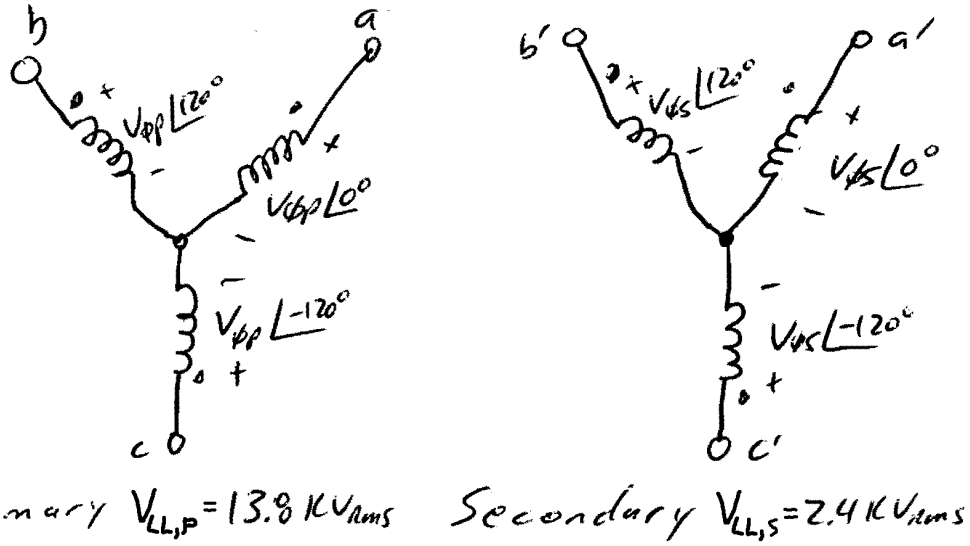
3–9 A three-phase transformer bank is to handle 400 kVA and have a 34.5/13.8-kV voltage ratio. Find the rating of each individual transformer in the bank (high voltage, low voltage, turns ratio, and apparent power) if the transformer bank is connected to *(a)* Y–Y, *(b)* Y–Δ, *(c)* Δ–Y, *(d)* Δ–Δ.

➢ modified so apparent power is 360 kVA & voltages are 13.8/2.4 kV_{rms}. Tabulate answers.

a)



Primary $V_{LL,P} = 13.8\ kV_{rms}$ Secondary $V_{LL,S} = 2.4\ kV_{rms}$

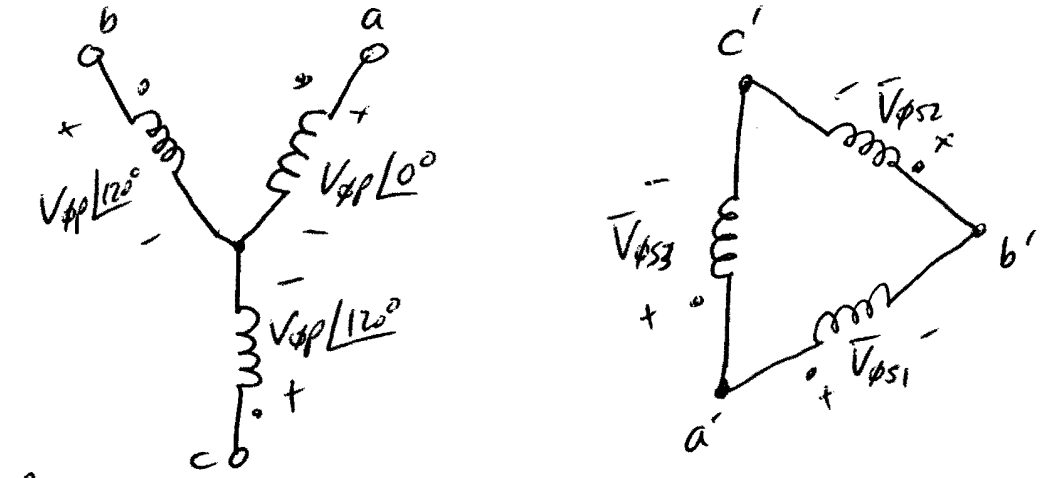
Per (2-11), $V_{LL} = \sqrt{3}\ V_\phi$ for Y-connection. So,

$V_{\phi,P} = 13.8/\sqrt{3} \Rightarrow \underline{V_{\phi,P} = 7.9674\ kV_{rms}}$ and $V_{\phi,S} = 2.4/\sqrt{3} \Rightarrow \underline{V_{\phi,S} = 1.3856\ kV_{rms}}$

The turns ratio is (3-5) $a = V_{\phi,P}/V_{\phi,S} = 7.9674/1.3856 \Rightarrow \underline{a = 5.75}$.

The apparent power per phase is $S_\phi = S_{tot}/3 = 360/3 \Rightarrow \underline{S_\phi = 120\ kVA}$.

b)



Primary $V_{LL,P} = 13.8\ kV_{rms}$ Secondary $V_{LL,S} = 2.4\ kV_{rms}$

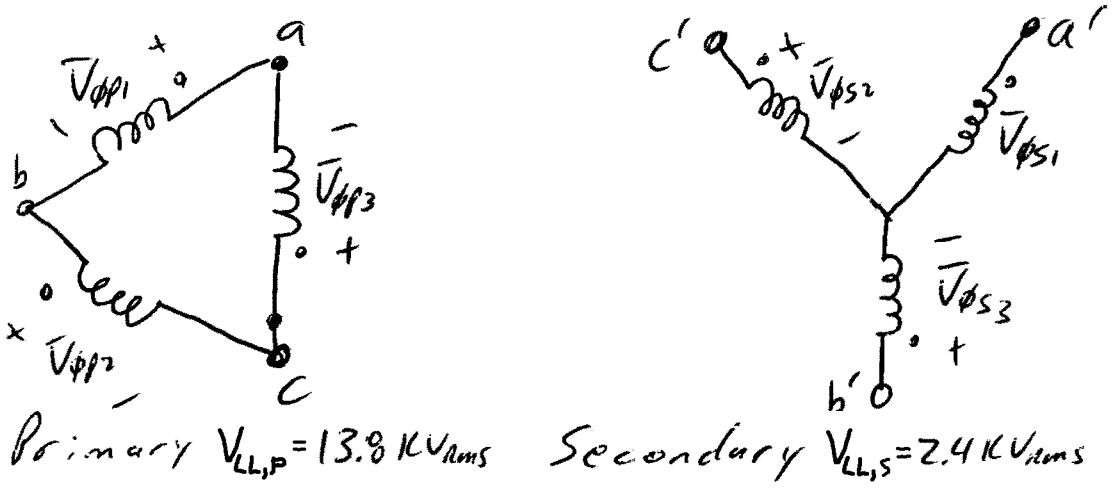
Per (2-11), $V_{LL} = \sqrt{3}\ V_\phi$ for Y-connection. So, $V_{\phi,P} = 13.8 / \sqrt{3}$ $\Rightarrow$ $\underline{V_{\phi,P} = 7.9674\ \text{kV}_{\text{rms}}}$.

Per (2-14), $V_{LL} = V_\phi$ for Δ-connection. So, $\Rightarrow$ $\underline{V_{\phi,S} = 2.4\ \text{kV}_{\text{rms}}}$

The turns ratio is (3-5) $a = V_{\phi,P} / V_{\phi,S} = 7.9674 / 2.4$ $\Rightarrow \underline{a = 3.3198}$.

The apparent power per phase is $S_\phi = S_{\text{tot}} / 3 = 360 / 3$ $\Rightarrow \underline{S_\phi = 120\ \text{kVA}}$.

c)



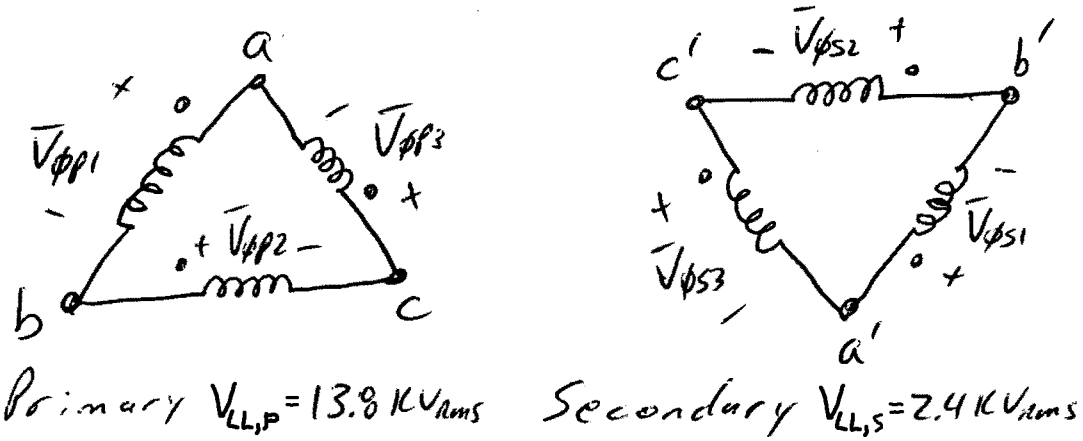
Per (2-14), $V_{LL} = V_\phi$ for Δ-connection. So, $\Rightarrow$ $\underline{V_{\phi,P} = 13.8\ \text{kV}_{\text{rms}}}$

Per (2-11), $V_{LL} = \sqrt{3}\ V_\phi$ for Y-connection. So, $V_{\phi,S} = 2.4 / \sqrt{3}$ $\Rightarrow$ $\underline{V_{\phi,P} = 1.38564\ \text{kV}_{\text{rms}}}$.

The turns ratio is (3-5) $a = V_{\phi,P} / V_{\phi,S} = 13.8 / 1.38564$ $\Rightarrow \underline{a = 9.9593}$.

The apparent power per phase is $S_\phi = S_{\text{tot}} / 3 = 360 / 3$ $\Rightarrow \underline{S_\phi = 120\ \text{kVA}}$.

d)



Per (2-14), $V_{LL} = V_{\phi}$ for Δ-connection. So, $\Rightarrow$ $V_{\phi,P} = 13.8\ \text{kV}_{\text{rms}}$ & $V_{\phi,S} = 2.44\ \text{kV}_{\text{rms}}$.

The turns ratio is (3-5) $a = V_{\phi,P} / V_{\phi,S} = 13.8 / 2.4$ $\Rightarrow a = 5.75$.

The apparent power per phase is $S_{\phi} = S_{\text{tot}} / 3 = 360 / 3$ $\Rightarrow S_{\phi} = 120\ \text{kVA}$.

Per- transformer rating summary

3ϕ Transformer Connections	High Voltage (kV_{rms})	Low Voltage (kV_{rms})	Turns ratio *a*	Apparent Power *S* (kVA)
a) Y-Y	7.967	1.386	5.75	120
b) Y-Δ	7.967	2.4	3.32	120
c) Δ-Y	13.8	1.386	9.96	120
d) Δ–Δ	13.8	2.4	5.75	120