Homework 2

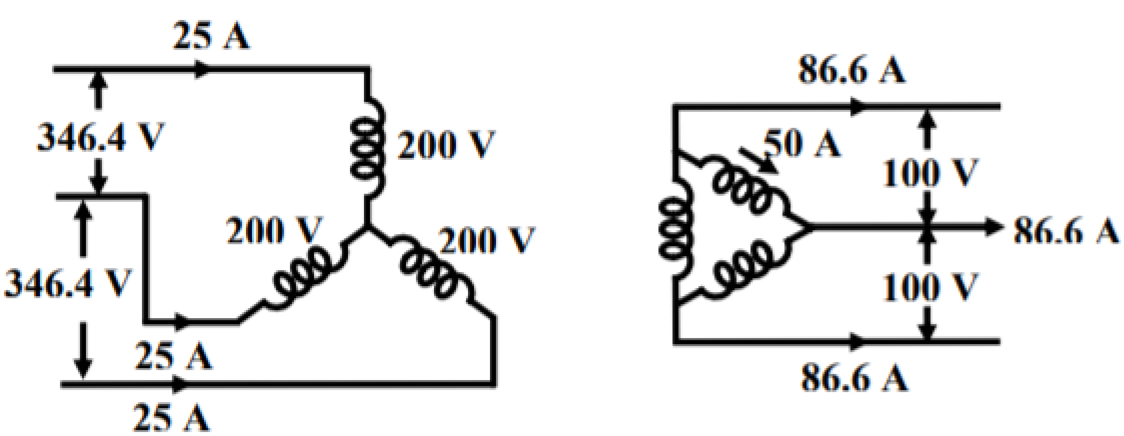
Three single phase ideal transformers, each of rating 5kVA, 200V/400V, 50 Hz are available.

a) The LV sides are connected in star and HV sides are connected in delta. What line to line 3-phase voltage should be applied and what will be the corresponding HV side line to line voltage will be? Also calculate and show the line and phase current magnitudes in both LV & HV sides corresponding to rated condition.

b) The LV sides are connected in delta and HV sides are connected in delta. What line to line 3-phase voltage should be applied and what will be the corresponding HV side line to line voltage will be? Also calculate and show the line and phase current magnitudes in both LV & HV sides corresponding to rated condition.

Solution of (a)

In this case HV sides are connected in star and LV sides are connected in delta as shown in figure 28.5. Thus line to line voltage to be applied to HV side must not exceed $200\sqrt{3} = 346.4V$. This will ensure that rated voltage is applied across each of the HV coil and rated voltage of 100 V is induced in each of the LV coil. Obviously the available line to line voltage on the LV side will be 100 V since the coils on this side are connected in delta.



Now the question is how much line current should be allowed to be supplied by the LV side when balanced 3-phase load is connected across it? The constrain is that we should not allow overloading of any of the coils in terms of current as well. Since rated current of each LV side coil is 50 A and the coils are connected in delta, so the corresponding allowed line current in the LV side will be is $50\sqrt{3} = 86.6A$ (Note: line current = $\sqrt{3}$ phase current in delta connection).

But we know for any individual ideal transformer if LV coil carries a 50 A current, the corresponding HV coil must carry a current of $50/a_{ph} = 25$ A as shown in fig 28.5. Thus HV side line current drawn from the supply must be also 25 A as these coils are connected in star (Note: line current = phase current in star connection).

Now we are in a position to calculate the total kVA handled by the bank of 3-phase transformer. Referring to the LV side the transformers supplies 86.6 A line current at a line to line voltage of 100 V. Therefore, total kVA supplied is equal to $\sqrt{3}\,V_{LL}I_L = \sqrt{3}\times 100\times 86.6\,\text{VA} = 15\,\text{kVA}$. Similarly total kVA drawn from the supply is calculated as $\sqrt{3}\times 346.4\times 25\, mbox\, \text{VA} = 15\,\text{kVA}$. Thus we see the total kVA becomes 3 times the individual kVA rating of the transformers. Since the transformers are assumed to be ideal *Total kVA input* = *Total kVA output*.

Solution of (b)

In this case HV sides are connected in delta and LV sides are connected in star as shown in figure 28.6. Thus line to line voltage to be applied to HV side must not exceed 200V. This will ensure that rated voltage is applied across each of the HV coil and rated voltage of 100 V is induced in each of the LV coils. The available line to line voltage on the LV side will be 100 $\sqrt{3}$ = 173.2 V since coils on this side are connected in star.

Since LV coils are connected in star allowed line current to be delivered is 50 A. So total kVA output is $\sqrt{3}\times 173.2\times 50\,\text{VA} = 15\,\text{kVA}$. In each HV coil current has to be 25 A and the corresponding supply line current is $\sqrt{3}\times 25 = 43.3A$. Total input kVA is $\sqrt{3}\times 200\times 43.3\,\text{VA} = 15\,\text{kVA}$. Distribution of phase and line currents in LV and HV sides are shown in figure 28.6.