Homework for Week 10/11 lecture material

Three-phase transformers are used everywhere. The simplest type is a "bank" of three single-phase transformers, as discussed in lectures and as explained in §11.4 of your book. If you understand the polarity marks and voltage-current relationships for a simple single-phase ideal transformer, you can easily figure out a 3-phase bank since it is just 3 single-phase transformers – just a bit more "book-keeping" is all.

As explained in lecture, there are 12 different possible connections related to delta-Y and Y-delta. Further, there are 3 variations on delta-delta, and 3 more for wye-wye. Obviously, we cannot hope to memorize every possible connection, but instead focus on a few very basic concepts to understand the engineering design and application.

H10.1 This is a very short problem, just dealing with the voltage relationships from one side to the other. There is this matter of the effective turns ratio (same as voltage ratio) relating the terminal voltages on one side of the transformer bank to the other. To track the voltages on the individual windings of the transformers, the square root of 3 keeps popping up....

H10.2 Do homework problem 11.5. Here, we learn that the max VA capacity of a 3-phase bank is just 3x that of each single-phase transformer. In part b) what they call "the line-line voltage ratio" is the same as a_{eff} discussed in class. Again, keep track of Y vs. delta connections, and the related L-G and L-L voltages.

H10.3 Do homework problem 11.7. Here, we begin to consider RMS line currents flowing into and out of the transformer in order to satisfy a given load. Very similar to Monday's lecture example.

H10.4 Do homework problem 11.10. Similar concepts to 11.7, more practice on a slightly different case to help reinforce the concepts.

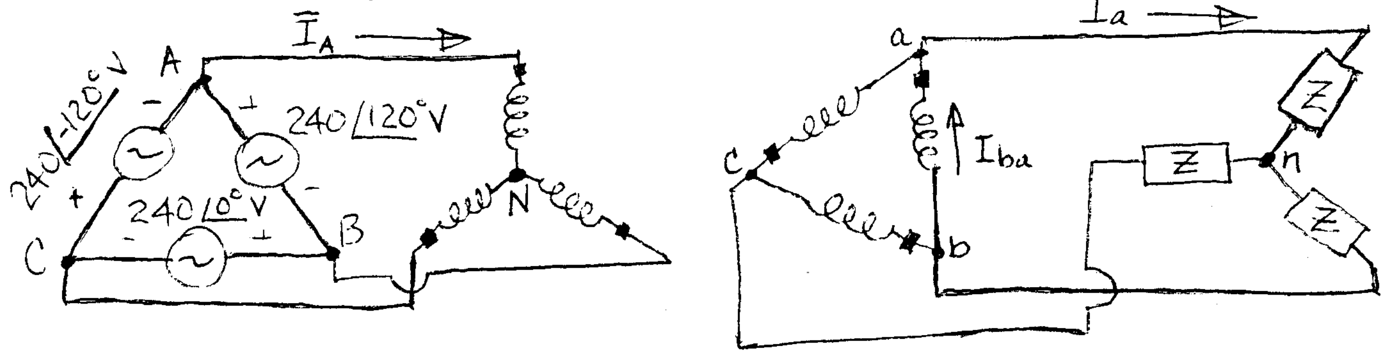
H10.5 Complete the class handout example (will not be collected, but you are responsible for this as a very similar problem could appear on upcoming tests). A copy is attached in case you missed class.

Coming attractions: Induction machines, see Chapter 12. Induction motors are hugely important to us – half of the electrical energy consumed in the US is used by induction motors. More recently, as special type of induction machine – the doubly-fed induction generator – is being used for most new wind generators. Those of you who continue on with EE3221 will learn about how motor drives can be used to optimize the operation of induction motors.

Turns out that induction motors and induction generators have an equivalent circuit that is extremely similar to the transformer. Winding resistance, leakage, magnetizing inductance, core loss resistance show up here too.

3120
Example

A balanced 3ϕ Δ-connected 240V source supplies a balanced 120V Y-connected load through a Y-Δ transformer. Z = 5 + j3Ω in each phase of the load.



a) Determine the following voltage magnitudes:

$V_{LL,PRI}$ = ______________ $V_{LN,PRI}$ = ______________ $V_{LL,SEC}$ = ______________ $V_{LN,SEC}$ = ______________

b) Draw **closed** phasor diagrams of the primary and secondary voltages, orienting all phasors to the nearest 30° angle. Label all phasors (i.e. V_A, V_{AB}, V_a, V_{bc}, etc.)

PRIMARY VOLTAGES **SECONDARY VOLTAGES**

c) Find the phasor values of the following currents: $\mathbf{I}_a$, $\mathbf{I}_{ba}$, and $\mathbf{I}_A$.