ECE 476 – Power System Analysis Fall 2012
Homework 6

Reading: Chapter 3 of textbook. Please note that the notation of the book is used in this HW. For example, uppercase denotes high voltage side, lower case for low voltage side of transformer.
Due Date: Thursday October 18, 2012

Problem 1. For a bank of three single-phase, two-winding, transformers whose high-voltage terminals are connected to a three-phase, 13.8 kV feeder (line-line), and the low-voltage terminals connected to a three-phase substation load rated 2.1 MVA and 2.3 kV, determine the required voltage, current, and MVA ratings of both windings of *each* transformer, when the high-voltage/low-voltage windings are connected

(a) Wye-Delta.

(b) Delta-Wye.

(c) Wye-Wye.

(d) Delta-Delta.

Problem 2. A three-phase generator rated 300 MVA, 23 kV, is supplying a system load of 240 MVA and 0.9 power factor lagging at 230 kV through a 330 MVA, 23 kV Delta-230 kV Wye step-up transformer with a leakage reactance of 0.11 p.u. Use $\overline{V}_A = 1.0\angle 0^\circ$ as reference.

(a) Neglecting the exciting current and choosing base values at the load of 100 MVA and 230 kV, find the phasor currents I_{A}, I_{B}, and I_{C} supplied to the load in per unit (magnitude and angle).

(b) Draw the per phase equivalent circuit and compute the phasor currents I_{a}, I_{b}, and I_{c}, from the generator in per unit. (Note: Take into account the phase shift of the transformer.)

(c) Find the generator terminal voltage magnitude in kV and the total three-phase real power supplied by generator in MW.

(d) By omitting the transformer phase shift altogether, check to see whether you get the same magnitude of generator terminal voltage and real power delivered by the generator (must show work).

Problem 3. Three single-phase transformers, each rated 10 MVA, 66.4/12.5 kV, 60 Hz, with an equivalent series reactance of 0.1 per unit divided equally between primary and secondary, are connected in a three-phase bank. The high-voltage windings are Wye connected and their terminals are directly connected to a 115 kV three-phase bus. The secondary terminals are all shorted together. Find the current magnitudes entering the high-voltage terminals and leaving the low-voltage terminals if the low-voltage windings are

(a) Wye connected.

(b) Delta connected.

Problem 4. PowerWorld Simulator case Problem 3.60 in textbook duplicates Example 3.13 except that a resistance term of 0.06 per unit has been added to the transformer and 0.05 per unit to the to the transmission line. Since the system is no longer lossless, a field showing the real power losses has also been added to the one-line. With the LTC tap fixed at 1.05, sketch the real power losses as the phase shift angle is varied from -10 to +10 degrees. What value of phase shift minimizes the system real power losses? (Think about why this is the answer.)