ECE 476 – Power System Analysis Fall 2017
Homework 5

Reading: Chapter 3.
Due Date: Tuesday October 10, 2017

Problem 1. The following data are obtained when open-circuit and short-circuit tests are performed on a single-phase, 50-kVA, 2400/240-volt, 60-Hz distribution transformer

- **Measurement on low-voltage side with high-voltage winding open.**
  Voltage: 240 V. Current: 5.97 A. Power: 213 W.
- **Measurements on high-voltage side with low-voltage winding shorted.**
  Voltage: 60 V. Current: 20.8 A. Power: 750 W.

(a) Neglecting the series impedance, determine the exciting admittance referred to the high-voltage side.
(b) Neglecting the exciting admittance, determine the equivalent series impedance referred to the high-voltage side.
(c) Assuming equal series impedances for the primary and referred secondary, obtain an equivalent T-circuit referred to the high-voltage side.

Problem 2. A single-phase 50-kVA, 2400/240-volt, 60-Hz distribution transformer is used as a step-down transformer at the load end of a 2400volt feeder whose series impedance is (1.0 + j2.0) Ω. The equivalent series impedance of the transformer is (1.0 + j2.5) Ω referred to the high-voltage (primary) side. The transformer is delivering rated load at 0.8 power factor lagging and at rated secondary voltage. Neglecting the transformer exciting current, determine:
(a) The voltage at the transformer primary terminals.
(b) The voltage at the sending end of the feeder.
(c) The real and reactive power delivered to the sending end of the feeder.

Problem 3. 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

1. Wye-Delta.
2. Delta-Wye.
3. Wye-Wye.
4. Delta-Delta.

Problem 4. 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 $\overline{V}_A = 1.0\angle 0°$ as reference.

1. 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).
2. 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.)
3. Find the generator terminal voltage magnitude in kV and the total three-phase real power supplied by generator in MW.
4. 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).