EE5223 - Spring 2023 **Assignment 2** Due: 9:00am Jan 24, 2023
Dr. Bruce A. Mork Phasor Relationships, Transformer Connections

Use the Homework Submission sheet as cover sheet for all assignments. This is an individual assignment. Follow instructions! http://www.ece.mtu.edu/faculty/bamork/EE5223/HMWKSUBM.pdf

Attach this homework assignment sheet as cover sheet on your submission. Sign/initial date as required.

Start now and utilize the email discussion forum at ee5223-l@mtu.edu to launch any questions and discussion on the basic concepts needed for each of the questions. Helpful advice: These are "simple" homework problems if you have mastered the basic concepts from EE2111, EE3120 and EE4221 and have them fresh in mind. They are not amenable to a last-minute all-nighter the night before they are due.

Since some of you may not have the required textbook yet, attached is a scanned copy of the problems.

1) Do Prob. 3.1 in your text. Key concepts are passive sign convention and V-I phasor relationships for R, L, C circuit elements. If you are rusty on this, view Pre-req review Video 1 and notes at http://www.ece.mtu.edu/faculty/bamork/ee5200/#PreReq – These concepts are from sophomore circuit analysis and EE3120. This problem was discussed at the end of Lecture 5, you can refer to the video on Canvas.

2) Do Prob. 3.2 in your text. Key concepts are single-phase ideal transformer, polarity markings (Lenz' Law for induced voltages), and three-phase transformer connections. If you are rusty on this, view Pre-req review Videos 5 and 6 and related notes at http://www.ece.mtu.edu/faculty/bamork/ee5200/#PreReq – These concepts are from EE3120 and EE4221.

3) Do Prob. 3.3 in your text. Key concepts are single-phase ideal transformer, polarity markings (Lenz' Law for induced voltages), and three-phase transformer connections. If you are rusty on this, view Pre-req review Videos 5 and 6 and related notes at http://www.ece.mtu.edu/faculty/bamork/ee5200/#PreReq – These concepts are from EE3120 and EE4221.

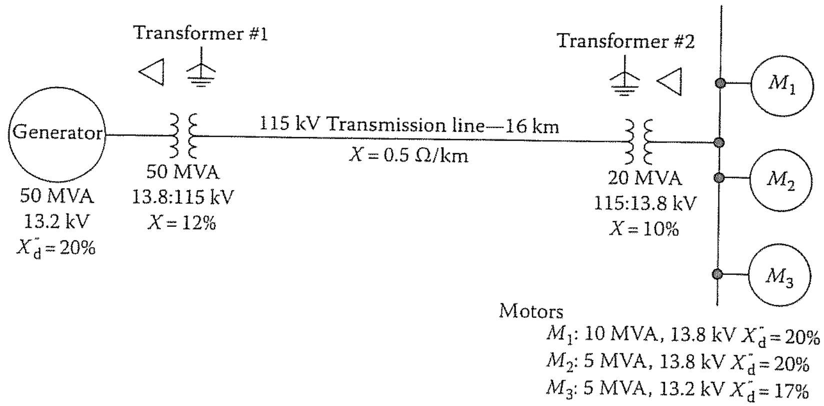

FIGURE P2.5 Single line diagram for Problem 2.5.

2.5 A three-phase generator feeds three large synchronous motors over a 16 km, 115 kV transmission line, through a transformer bank, as shown in Figure P2.5. Draw an equivalent single-line reactance diagram with all reactances indicated in per unit of a 100 MVA, 13.8 or 115 kV base.

2.6 In the system of Problem 2.5, it is desired to maintain the voltage at the motor bus of $1.\angle 0°$ per unit. The three motors are operating at full rating and 90% pf.

a. Determine the voltage required at the generator terminals assuming that there is no voltage regulating taps or similar equipment in this system.

b. What is the voltage required behind the subtransient reactance?

2.7 The percent impedance of a transformer is typically determined by a short-circuit test. In such a test, the secondary of the transformer is shorted and the voltage on the primary is increased until rated current flows in the transformer windings. The applied voltage that produces rated current divided by the rated voltage of the transformer is equal to the per-unit impedance of the transformer.

A short-circuit test on a 150 kVA, 7200–240 V transformer provides the following results:

Primary voltage at 20.8 primary amperes = 208.8 V

a. Determine the %Z of the transformer.

b. Calculate the ohmic impedance of the transformer in primary and secondary terms.

c. How much current would flow in the transformer if its secondary would become shorted during normal operating conditions? (Consider source impedance to be zero.)

CHAPTER 3

3.1 Four boxes represent an AC generator, reactor, resistor, and capacitor and are connected to a source bus XY as shown in Figure P3.1. From the circuit and phasor diagrams, identify each box.

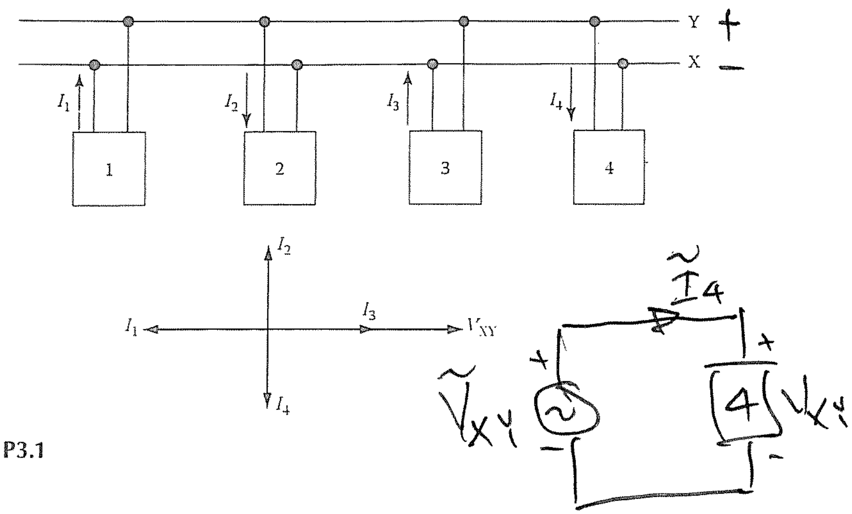

FIGURE P3.1

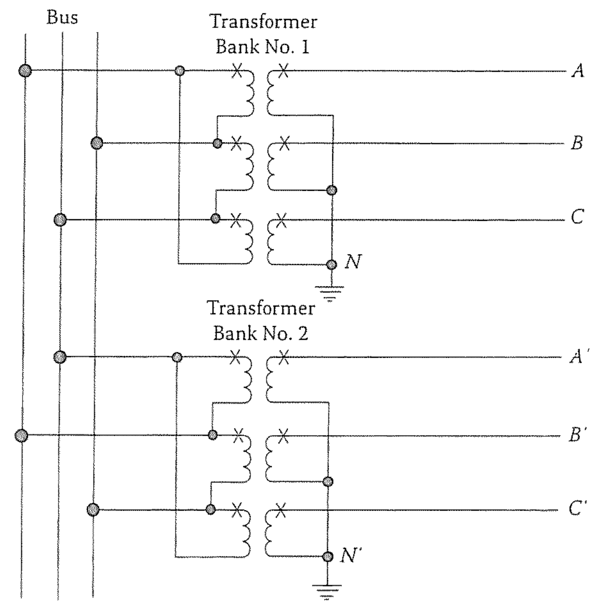

FIGURE P3.2

3.2 Two transformer banks are connected to a common bus as shown in Figure P3.2. What are the phase relations between the voltages V_{AN} and $V_{A'N'}$, V_{BN} and $V_{B'N'}$, and V_{CN} and $V_{C'N'}$?

3.3 Reconnect transformer bank 2 of Problem 3.2 with the left windings in wye instead of delta and the right windings in delta instead of wye so that V_{AN} and $V_{A'N'}$ are in phase, V_i and $V_{B'N'}$ are in phase, and V_{CN} and $V_{C'N'}$ are in phase.

3.4 The power transformer connections shown in Figure P3.3 are nonstandard and quite unusual with today's standardization. However, this connection provides