MATHEMATICAL QUESTIONS

Question 1

For the circuit of Fig. 1, find both the phase and line currents, and the phase and line voltages throughout the circuit. Then, calculate the total power dissipated in the load.

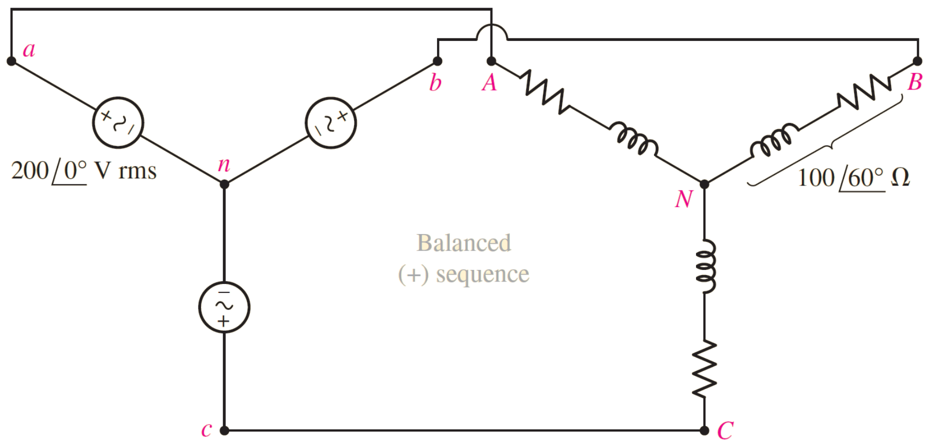

Figure 1: A balanced three-phase three-wire Y-Y connected system.

Question 2

The balanced load in Fig. 2 is fed by a balanced three-phase system having $V_{ab} = 230\underline{/0^\circ}$ V rms and positive phase sequence. Find the reading of each wattmeter and the total power drawn by the load.

Question 2 continued on next page. . .

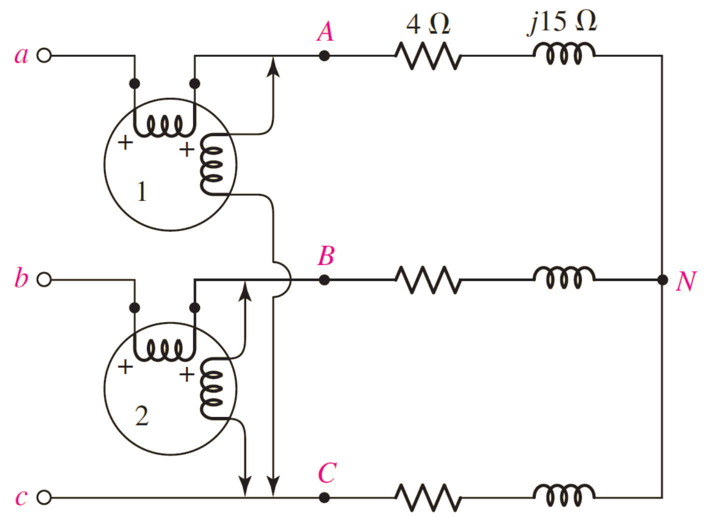

Figure 2: A balanced three-phase system connected to a balanced three-phase load, the power of which is being measured using the two-wattmeter technique.

Question 3

For the balanced three-phase system shown in 3, it is determined that 100 W is lost in each wire. If the phase voltage of the source is 400 V, and the load draws 12 kW at a lagging PF of 0.83, determine the wire resistance R_W.

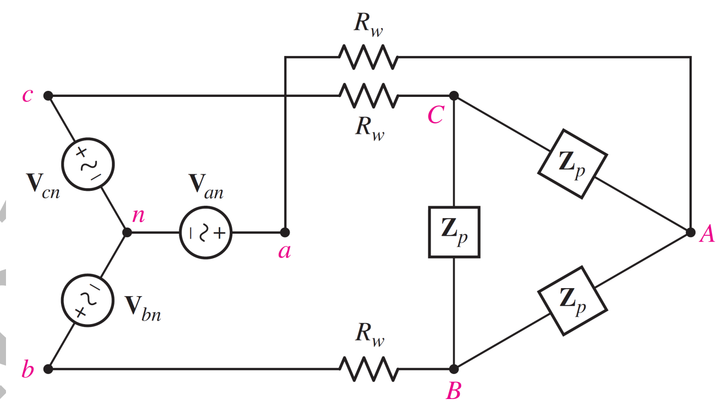

Figure 3: A balanced three-phase three-wire Y-Δ connected system.

Question 4 continued on next page...

Question 4

For the circuit of Fig. 4, find line currents including the current of the null line. Assume that $(V_{a'n}, V_{b'n}, V_{c'n}) = 1000(1, 1\angle -120°, 1\angle 120°)$ **V rms,** $Z_{ga} = Z_{gb} = Z_{gc} = 2 + j8$**,** $Z_{la} = Z_{lb} = Z_{lc} = Z_{ln} = 1 + j2$**,** $Z_{LA} = 19 + j18$**,** $Z_{LB} = 49 - j2$**, and** $Z_{LC} = 29 + j50\ \Omega$**. Repeat the calculations for the negative phase sequence** $(V_{a'n}, V_{b'n}, V_{c'n}) = 1000(1, 1\angle 120°, 1\angle -120°)$ **V rms.**

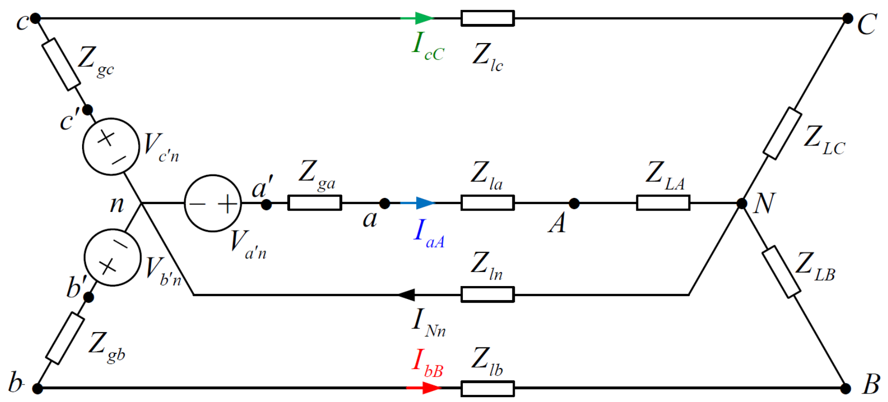

Figure 4: An imbalanced three-phase four-wire Y-Y connected system.

Question 5

For the circuit of Fig. 5, find the phase and line currents, the phase and line voltages, the apparent, real, and reactive powers generated by the three-phase source, and the apparent, real, and reactive powers absorbed by the three-phase load.

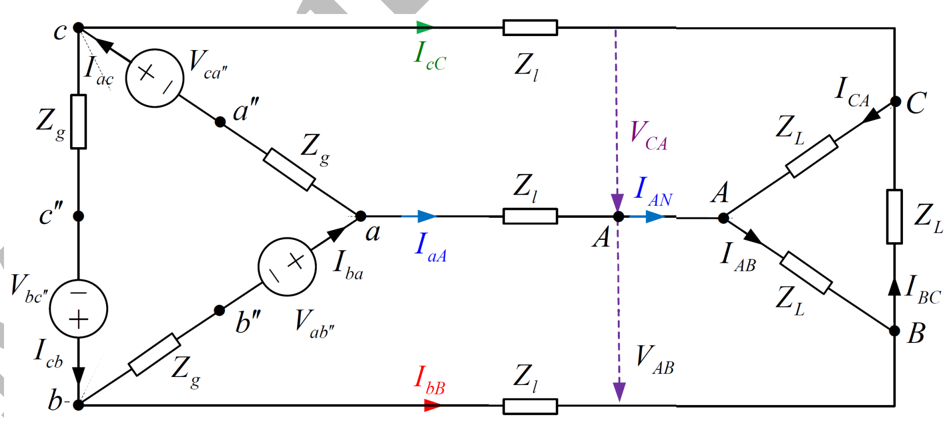

Figure 5: A balanced three-phase three-wire Δ-Δ connected system.

SOFTWARE QUESTIONS

Question 6

Each phase of a three-phase induction motor can be modeled with the circuit of Fig. 6. In fact, in each phase, the equivalent load impedance of

$$Z_p = R_1 + jX_1 + \frac{1}{\frac{1}{R_c} + \frac{1}{jX_M} + \frac{1}{jX_2 + R_2/s}}$$

is seen, where the slit s determines the relative difference of the rotor and synchronous speeds. Use the PSIM simulation tool to compare the current and power of three-phase induction motors for Δ and Y connections, as shown in Fig. 7. Assume that $R_1 = 0.641\ \Omega$, $X_1 = 1.106\ \Omega$, $R_2 = 0.332\ \Omega$, $X_2 = 0.464\ \Omega$, $X_M = 26.3\ \Omega$, $R_C = 1\ M\Omega$, and $s = 0.022$. Also assume that the source has a Y connection with a phase voltage of 220 V rms. You might plot current and power curves versus time for Δ and Y connections in the motor to facilitate the comparison.

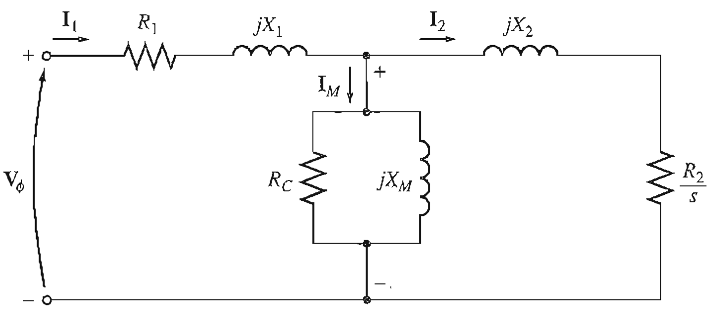

Figure 6: Per-phase equivalent circuit of an induction motor.

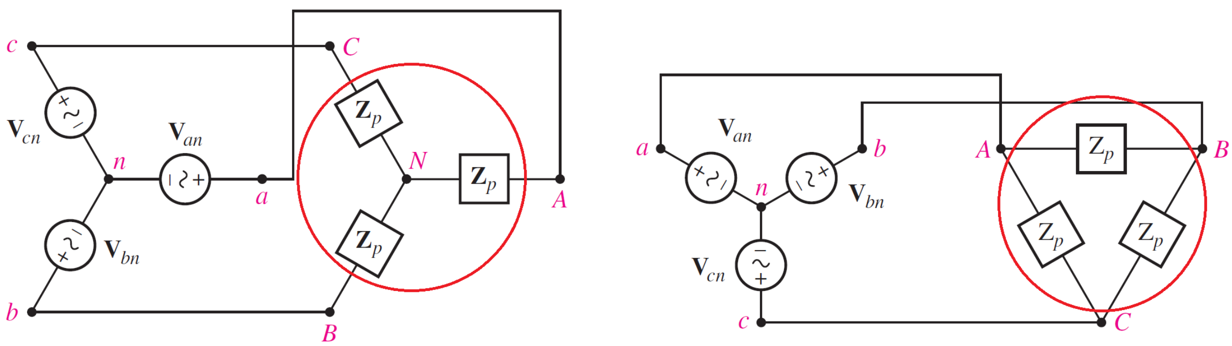

Figure 7: A three-phase induction motor in Y and Δ connections.

BONUS QUESTIONS

Question 7

Return your answers by filling the LaTeX template of the assignment.