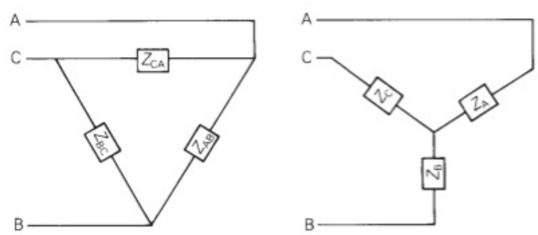
impedance $Z_L = (0.8 + j0.6)\ \Omega$ per line. (a) Calculate the line-to-line voltage at the load terminals. (b) Repeat part (a) when a Δ-connected capacitor bank with reactance $(-j60)\ \Omega$ per phase is connected in parallel with the load.

2.47 Two three-phase generators supply a three-phase load through separate three-phase lines. The load absorbs 30 kW at 0.8 power factor lagging. The line impedance is $(1.4 + j1.6)\ \Omega$ per phase between generator G_1 and the load, and $(0.8 + j1)\ \Omega$ per phase between generator G_2 and the load. If generator G_1 supplies 15 kW at 0.8 power factor lagging, with a terminal voltage of 460 V line-to-line, determine (a) the voltage at the load terminals, (b) the voltage at the terminals of generator G_2, and (c) the real and reactive power supplied by generator G_2. Assume balanced operation.

2.48 Two balanced Y-connected loads in parallel, one drawing 15 kW at 0.6 power factor lagging and the other drawing 10 kVA at 0.8 power factor leading, are supplied by a balanced, three-phase, 480-volt source. (a) Draw the power triangle for each load and for the combined load. (b) Determine the power factor of the combined load and state whether lagging or leading. (c) Determine the magnitude of the line current from the source. (d) Δ-connected capacitors are now installed in parallel with the combined load. What value of capacitive reactance is needed in each leg of the A to make the source power factor unity? Give your answer in Ω. (e) Compute the magnitude of the current in each capacitor and the line current from the source.

2.49 Figure 2.33 gives the general Δ-Y transformation. (a) Show that the general transformation reduces to that given in Figure 2.16 for a balanced three-phase load. (b) Determine the impedances of the equivalent Y for the following Δ impedances: $Z_{AB} = j10$, $Z_{BC} = j20$, and $Z_{CA} = -j25\ \Omega$.



$$Z_{AB} = \frac{Z_A Z_B + Z_B Z_C + Z_C Z_A}{Z_C} \qquad Z_A = \frac{Z_{AB} Z_{CA}}{Z_{AB} + Z_{BC} + Z_{CA}}$$

$$Z_{BC} = \frac{Z_A Z_B + Z_B Z_C + Z_C Z_A}{Z_A} \qquad Z_B = \frac{Z_{AB} Z_{BC}}{Z_{AB} + Z_{BC} + Z_{CA}}$$

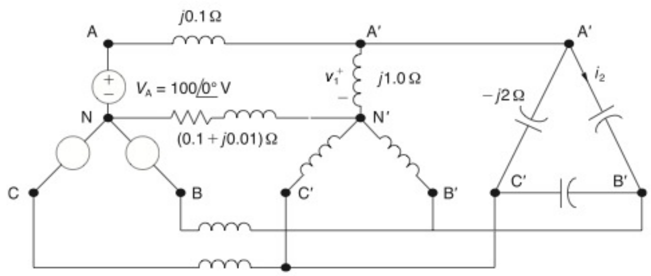
$$Z_{CA} = \frac{Z_A Z_B + Z_B Z_C + Z_C Z_A}{Z_B} \qquad Z_C = \frac{Z_{CA} Z_{BC}}{Z_{AB} + Z_{BC} + Z_{CA}}$$

FIGURE 2.33
General Δ-Y transformation

2.50 Consider the balanced three-phase system shown in Figure 2.34. Determine $v_1(t)$ and $i_2(t)$. Assume positive phase sequence.

FIGURE 2.34

Circuit for Problem 2.50



2.51 A three-phase line with an impedance of (0.2 + j1.0) Ω /phase feeds three balanced three-phase loads connected in parallel.

Load 1: Absorbs a total of 150 kW and 120 kvar.

Load 2: Delta connected with an impedance of (150 − j48) Ω /phase.

Load 3: 120 kVA at 0.6 PF leading.

If the line-to-neutral voltage at the load end of the line is 2000 v (rms), determine the magnitude of the line-to-line voltage at the source end of the line.

2.52 A balanced three-phase load is connected to a 4.16-kV, three-phase, four-wire, grounded-wye dedicated distribution feeder. The load can be modeled by an impedance of Z_L = (4.7 + j9) Ω /phase, wye-connected. The impedance of the phase conductors is (0.3 + j1) Ω. Determine the following by using the phase A to neutral voltage as a reference and assume positive phase sequence:
(a) Line currents for phases A, B, and C.
(b) Line-to-neutral voltages for all three phases at the load.
(c) Apparent, active, and reactive power dissipated per phase, and for all three phases in the load.
(d) Active power losses per phase and for all three phases in the phase conductors.

CASE STUDY QUESTIONS

a. What is a microgrid?

b. What are the benefits of microgrids?

c. What are the two primary goals of the U.S. Department of Energy's Smart Grid Research & Development Program?

d. Can smart grids defer transmission and distribution investments? If so, how?

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