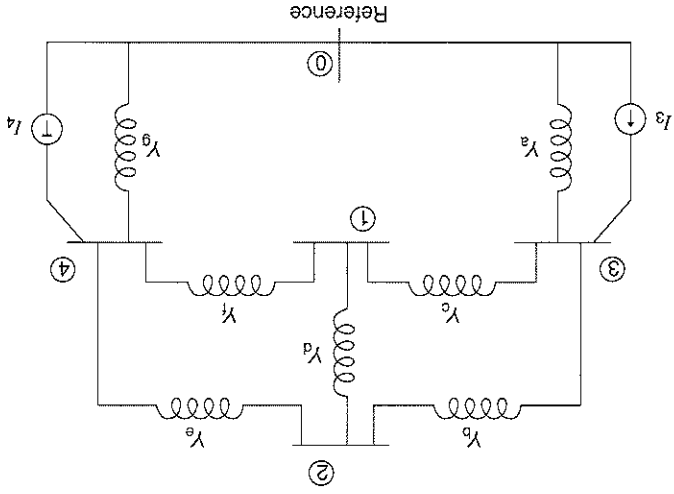


FIGURE 2.26
Circuit diagram for
Problem 2.31



SECTIONS 2.5 AND 2.6

2.32 A balanced three-phase 208-V source supplies a balanced three-phase load. If the line current I_A is measured to be 10 A and is in phase with the line-to-line voltage V_{BC} , find the per-phase load impedance if the load is (a) Y-connected, (b) Δ -connected.

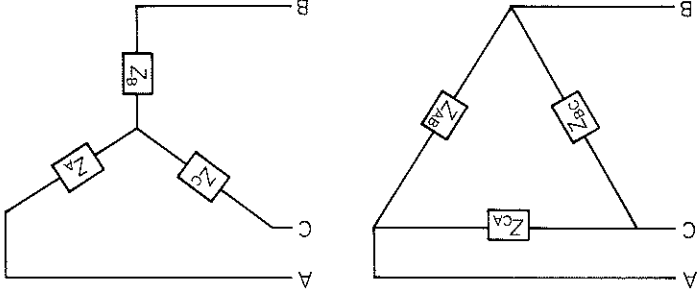
2.33 A three-phase 25-kVA, 208-V, 60-Hz alternator, operating under balanced steady-state conditions, supplies a line current of 20 A per phase at a 0.8 lagging power factor and at rated voltage. Determine the power triangle for this operating condition.

2.34 A balanced Δ -connected impedance load with $(12 + j9) \Omega$ per phase is supplied by a balanced three-phase 60-Hz, 208-V source. (a) Calculate the line current, the total real and reactive power absorbed by the load, the load power factor, and the apparent load power. (b) Sketch a phasor diagram showing the line currents, the line-to-line source voltages, and the Δ -load currents. Assume positive sequence and use V_{ab} as the reference.

2.35 A three-phase line, which has an impedance of $(2 + j4) \Omega$ per phase, feeds two balanced three-phase loads that are connected in parallel. One of the loads is Y-connected with an impedance of $(30 + j40) \Omega$ per phase, and the other is Δ -connected with an impedance of $(60 - j45) \Omega$ per phase. The line is energized at the sending end from a 60-Hz, three-phase, balanced source of $120\sqrt{3}$ V (rms, line-to-line). Determine (a) the current, real power, and reactive power delivered by the sending-end source; (b) the line-to-line voltage at the load; (c) the current per phase in each load; and (d) the total three-phase real and reactive powers absorbed by each load and by the line. Check that the total three-phase complex power delivered by the source equals the total three-phase power absorbed by the line and loads.

2.36 Two balanced three-phase loads that are connected in parallel are fed by a three-phase line having a series impedance of $(0.4 + j2.7) \Omega$ per phase. One of the loads absorbs 560 kVA at 0.707 power factor lagging, and the other 132 kW at unity power factor. The line-to-line voltage at the load end of the line is $2200\sqrt{3}$ V. Compute (a) the line-to-line voltage at the source end of the line, (b) the total real and reactive power losses in the three-phase line, and (c) the total three-phase complex power delivered at the sending end of the line. Check that the total three-phase complex power delivered by the source equals the total three-phase power absorbed by the line and loads.

FIGURE 2.27
General Δ -Y
transformation



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

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

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

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

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

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

2.41

Figure 2.27 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 $Z_{CA} = -j25 \Omega$.

2.40

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 Δ 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.

2.39

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 G1 and the load, and $(0.8 + j1) \Omega$ per phase between generator G2 and the load. If generator G1 supplies 15 kW at 0.8

2.38

power factor lagging, determine (a) the power factor lagging, with a terminal voltage of 460 V line-to-line, (b) the voltage at the load terminals, (c) the real and reactive power supplied by generator G2, and (d) the real and reactive power supplied by generator G1. Assume balanced operation.

2.37

Two balanced Y-connected loads, one drawing 10 kW at 0.8 power factor lagging and the other 15 kW at 0.9 power factor leading, are connected in parallel and supplied by a balanced three-phase Y-connected, 480-V source. (a) Determine the source current through an ammeter, what will the ammeter read? (b) If the load neutrals are connected to the source neutral by a zero-ohm neutral wire, three identical impedances $Z_A = 20/\sqrt{60} \Omega$ are connected in Δ to a balanced three-phase 480-V source by three identical line conductors with 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 $(-j20) \Omega$ per phase is connected in parallel with the load.