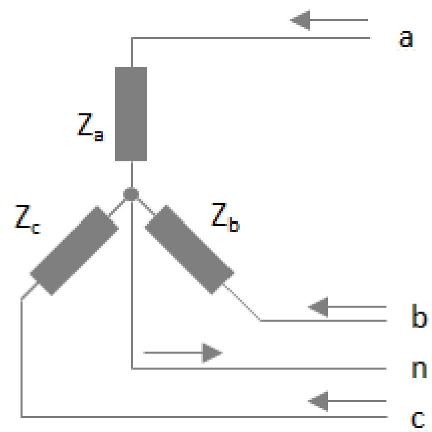
Unbalanced Three-Phase Wye-Connected Load

An unbalanced 3-phase Wye-connected load is connected to a balanced 3-phase four-wire source. The load impedances and line voltage are known.



This application calculates the currents in the system, and the total power drawn by the load.

Impedances and Lined Voltage

$$Z_a := 100 \cdot e^{1\,i \cdot 50.0\,\mathbf{deg}}\,\mathbf{ohm} = (64.279 + 76.604\,i)\,\mathbf{\Omega}$$

$$Z_b := 150 \cdot e^{-1\,i \cdot 140.0\,\mathbf{deg}}\,\mathbf{ohm} = (-114.907 - 96.418\,i)\,\mathbf{\Omega}$$

$$Z_c := 50 \cdot e^{-1\,i \cdot 100.0\,\mathbf{deg}}\,\mathbf{ohm} = (-8.682 - 49.240\,i)\,\mathbf{\Omega}$$

$$V_{ab} := 13.8\,\mathbf{kV}$$

Amplitude and Phase of Voltages

$$V_{an} := \frac{V_{ab}}{\sqrt{3}} = 7.967\,\mathbf{kV}$$

$$V_{bn} := V_{an} \cdot e^{1\,i \cdot 240\,\mathbf{deg}} = (-3.984 - 6.900\,i)\,\mathbf{kV}$$

$V_{cn} := V_{an} \cdot e^{1i \cdot 120\,\mathrm{deg}} = (-3.984 + 6.900i)\ \mathrm{kV}$

$|V_{an}| = 7.967\ \mathrm{kV}$

$|V_{bn}| = 7.967\ \mathrm{kV}$

$|V_{cn}| = 7.967\ \mathrm{kV}$

$\mathrm{argument}(V_{an}) = 0.$

$\mathrm{argument}(V_{bn}) = -2.094$

$\mathrm{argument}(V_{cn}) = 2.094$

Line Currents

$I_a := \frac{V_{an}}{Z_a} = (51.214 - 61.034i)\ \mathrm{A}$

$I_b := \frac{V_{bn}}{Z_b} = (49.913 + 18.167i)\ \mathrm{A}$

$I_c := \frac{V_{cn}}{Z_c} = (-122.068 - 102.427i)\ \mathrm{A}$

$I_n := I_a + I_b + I_c = (-20.942 - 145.295i)\ \mathrm{A}$

$|I_a| = 79.674\ \mathrm{A}$

$|I_b| = 53.116\ \mathrm{A}$

$|I_c| = 159.349\ \mathrm{A}$

$|I_n| = 146.796\ \mathrm{A}$

$\mathrm{argument}(I_a) = -0.873$

$\mathrm{argument}(I_b) = 0.349$

$\mathrm{argument}(I_c) = -2.443$

$\mathrm{argument}(I_n) = -1.714$

Power Delivered by Each Phase

$$P_a := \mathrm{Re}\left(V_{an}\cdot\overline{I_a}\right) = 4.080 \times 10^5\ \mathbf{W}$$

$$P_b := \mathrm{Re}\left(V_{bn}\cdot\overline{I_b}\right) = -3.242 \times 10^5\ \mathbf{W}$$

$$P_c := \mathrm{Re}\left(V_{cn}\cdot\overline{I_c}\right) = -2.205 \times 10^5\ \mathbf{W}$$

Total Power Delivered

$$P := P_a + P_b + P_c = -1.366 \times 10^5\ \mathbf{W}$$