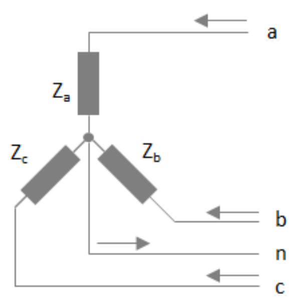
Unbalanced Three-Phase Wye-Connected Load

Introduction

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.

Parameters

restart :
with(*Units*[*Simple*]) :
interface(*imaginaryunit* = *j*) :

$$Z_a := 100 \cdot e^{j \cdot 50.0\ \mathrm{deg}}\ \mathrm{ohm} :$$

$$Z_b := 150 \cdot e^{-j \cdot 140.0\ \mathrm{deg}}\ \mathrm{ohm} :$$

$$Z_c := 50 \cdot e^{-j \cdot 100.0\ \mathrm{deg}}\ \mathrm{ohm} :$$

$$V_{ab} := 13.8\ \mathrm{kV} :$$

Amplitude and Phase of Voltages

$$V_{an} := \frac{V_{ab}}{\sqrt{3.0}} \cdot e^{j \cdot 0\ \mathrm{deg}} = 7.97\ \mathrm{kV}$$

$$V_{bn} := V_{an} \cdot e^{j \cdot 240.0\ \mathrm{deg}} = (-3.98 - 6.90\,j)\ \mathrm{kV}$$

$$V_{cn} := V_{an} \cdot e^{j \cdot 120.0\ \mathrm{deg}} = (-3.98 + 6.90\,j)\ \mathrm{kV}$$

Amplitude and phase angles

$|V_{an}| = 7.97\ \text{kV}$

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

$|V_{bn}| = 7.97\ \text{kV}$

$\text{argument}(V_{bn}) = -2.09$

$|V_{cn}| = 7.97\ \text{kV}$

$\text{argument}(V_{cn}) = 2.09$

Line Currents

$$I_a := \frac{V_{an}}{Z_a} = (51.21 - 61.03j)\ \text{A}$$

$|I_a| = 79.67\ \text{A}$

$\text{argument}(I_a) = -0.87$

$$I_b := \frac{V_{bn}}{Z_b} = (49.91 + 18.17j)\ \text{A}$$

$|I_b| = 53.12\ \text{A}$

$\text{argument}(I_b) = 0.35$

$$I_c := \frac{V_{cn}}{Z_c} = (-122.07 - 102.43j)\ \text{A}$$

$|I_c| = 159.35\ \text{A}$

$\text{argument}(I_c) = -2.44$

$$I_n := I_a + I_b + I_c = (-20.94 - 145.29j)\ \text{A}$$

$|I_n| = 146.80\ \text{A}$

$\text{argument}(I_n) = -1.71$

Power Delivered by Each Phase

$$P_a := \text{Re}\left(V_{an} \cdot \overline{I_a}\right) = 4.08 \times 10^5\ \text{W}$$

$$P_b := \text{Re}\left(V_{bn} \cdot \overline{I_b}\right) = -3.24 \times 10^2\ \text{kW}$$

$$P_c := \text{Re}\left(V_{cn} \cdot \overline{I_c}\right) = -2.20 \times 10^2\ \text{kW}$$

Total power delivered

$$P := P_a + P_b + P_c = -1.37 \times 10^2\ \text{kW}$$