Lab Two
Power Systems Analysis
EECE5682

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Abstract

This laboratory experiment explores three-phase circuit modeling via SimuLink integration into MATLAB. The experiment simulates a provided circuit design and demonstrates the applicability of single-phase equivalence modeling for balanced three-phase circuits.

KEYWORDS: three-phase, modeling, SimuLink, MATLAB, single-phase equivalence, balanced

1 Introduction & Objectives

This experiment begins by integrating the following diagram into MATLAB's SimuLink environment:

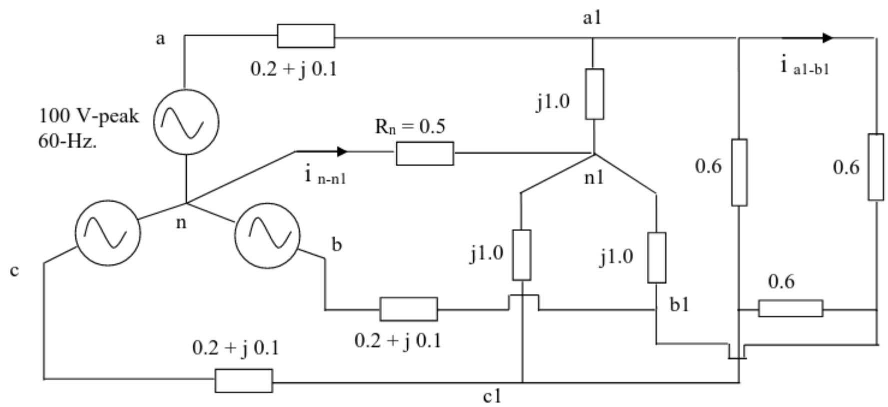

Figure 1: Simulated Circuit

After simulating the circuit, data related to the voltage at various nodes and current through various loops was taken, most importantly nodes a_1 to b_1, and along the neutral line n_1 to n.

2 Results & Analysis

2.1 Original Circuit

The first step of the experiment is to plot the waveforms of $V_{a_1 \to b_1}$, $I_{a_1 \to b_1}$, and $I_{n \to n_1}$. The result is shown in Figure 2 below:

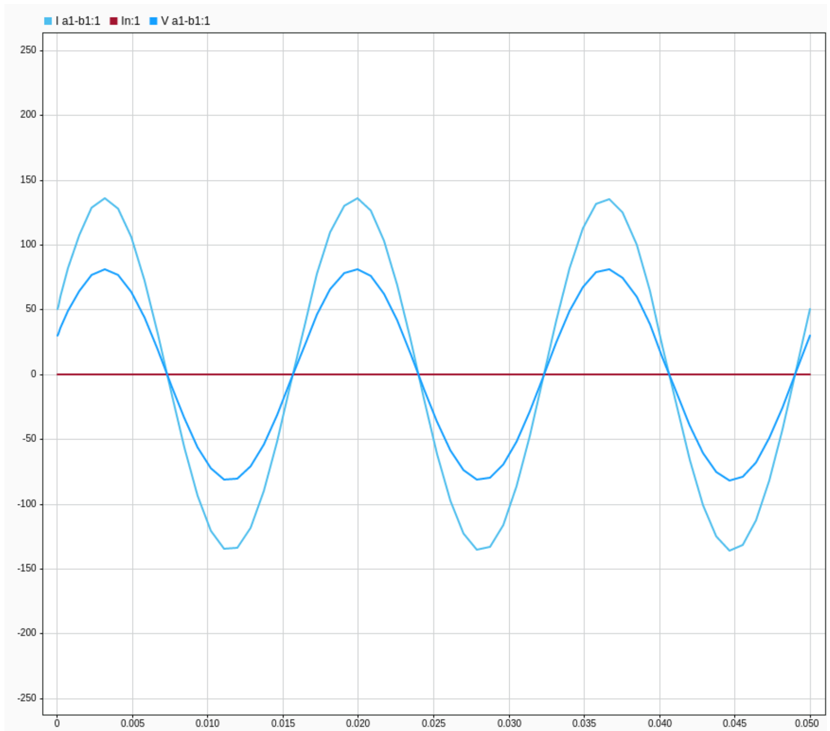

Figure 2: Waveforms for Part (a)

Here, we see the waveforms. Note that the neutral line has no current, as would be expected for a balanced circuit. From here, we construct a single phase equivalent circuit using Phase a. The circuit becomes:

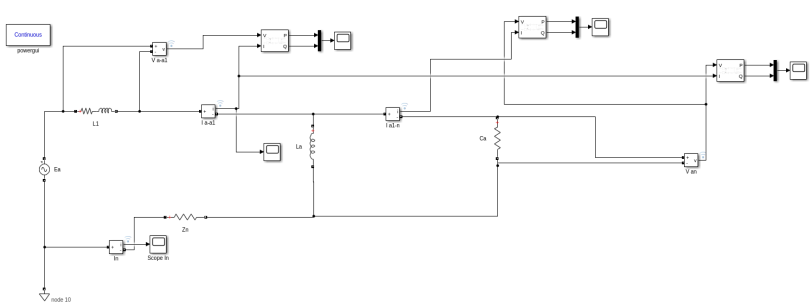

Figure 3: Single Phase Equivalent Circuit (Phase a)

Note that for the equivalent circuit, $C_a = .2[\Omega]$ instead of the original .6, since the configuration was in delta instead of 'Y' form.

2.2 Modified Circuit

Using the circuit to simulate, we may obtain the equivalent waveforms for $V_{a_1 \to b_1}$ and $I_{a_1 \to b_1}$:

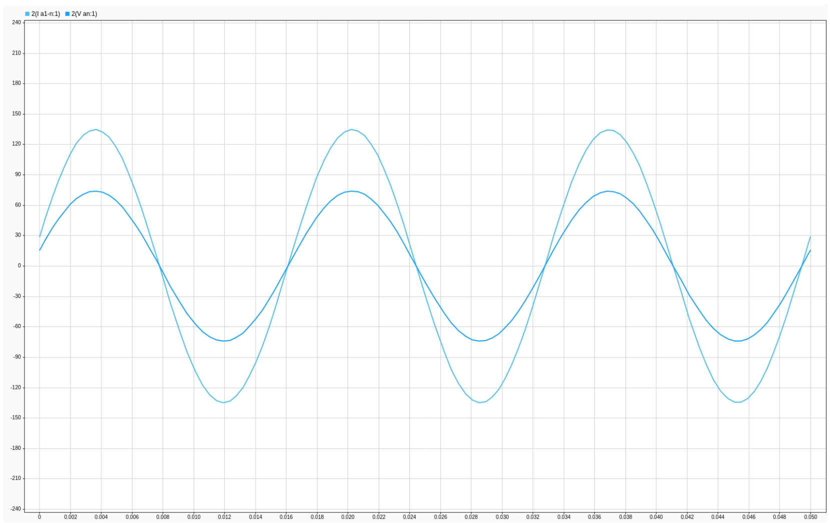

Figure 4: Waveforms Plotted Using Single-Phase Equivalent

Note that, as expected, the waveforms are equivalent to those shown in Figure 2

2.3 Changing the Neutral Line Impedance

From here, we return to the original three-phase circuit, but now we modify the parameters. First, we change the neutral line impedance from $R_n = .5[\Omega]$ to $R_n = 50[\Omega]$. Plotting the same waveforms, we get:

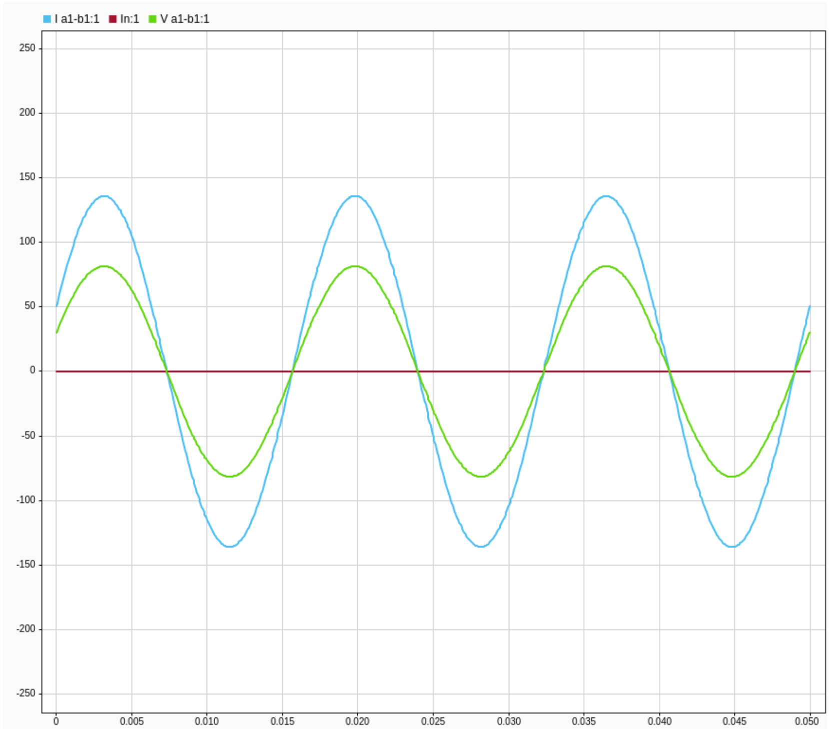

Figure 5: Waveforms with Changed Neutral Line Impedance

Once again, we see no change, as expected. This is because the neutral line still experiences no current flow, as the circuit remains balanced.

2.4 Unbalancing the Circuit

We now change the impedance from a_1 to n_1 by a factor of ten. This results in the following waveforms:

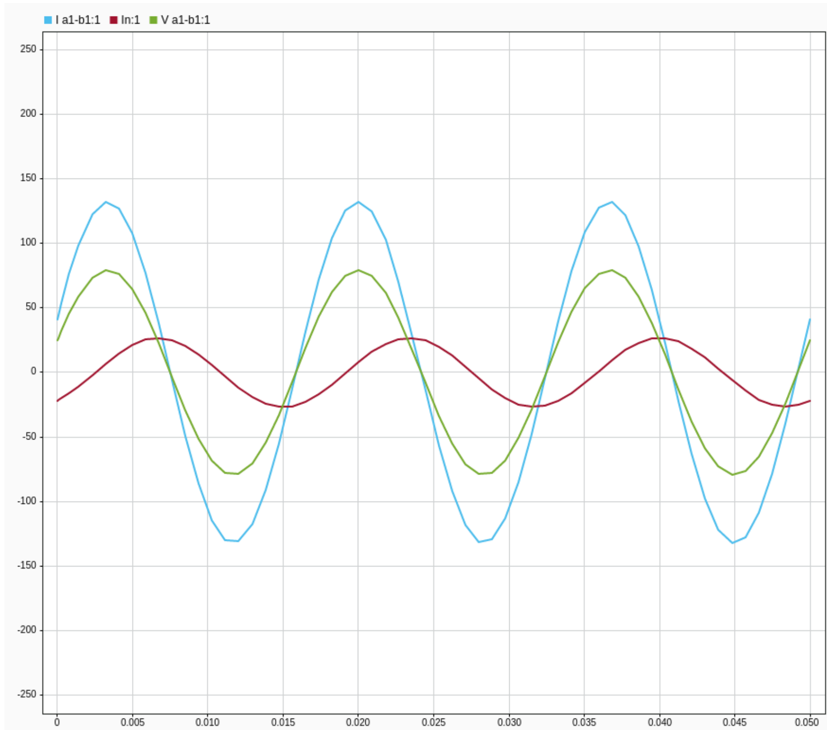

Figure 6: Waveforms for the Now-Unbalanced Circuit

We may notice with this waveform that, although the line-to-line difference remains the same, there is now a line-to-neutral difference. This causes current to flow through the neutral line, which can be seen by the red line.

3 Conclusion

Throughout this experiment, we verified several important concepts related to three-phase circuits. Namely, we confirmed that, for balanced three-phase circuits, a single-phase equivalent may be used to analyze each phase more easily. Additionally, we confirmed that current flows through the neutral line only in the unbalanced case.