Heaven's Light is Our Guide

Rajshahi University of Engineering and Technology

Department of Electrical & Computer Engineering

Lab Report

Experiment Name: Study the relationship between phase and line voltages of wye-connected 3-phase balanced system

Course Code	ECE 1202
Course Title	Circuit and System II Sessional
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INDEX

1.1 Experiment No: 01

1.2 Experiment Name: Study the relationship between phase and line voltages of wye connected 3-phase balanced system.

1.3 Objectives:

- To measure the phase and line voltages in a balanced Wye-connected 3-phase system.
- To confirm the relationship between phase and line voltages in a Wye-connected 3-phase system.
- To measure the phase and line currents in a balanced Wye-connected 3-phase system.

1.4 Theory:

A three-phase system consists of three voltage sources connected to loads by transmission lines, with each source having the same magnitude but differing in phase by 120°. In such systems, the impedance is identical across all three phases, allowing each branch to be analyzed as a single-phase circuit. This simplifies the analysis, making it no more difficult than analyzing a single-phase network. Three-phase systems are typically configured as either Wye (Y) or Delta (Δ), named for their resemblance to the respective shapes. Each configuration has unique electrical characteristics, and the objective of analyzing a three-phase circuit is to determine the relationship between the currents flowing through the transmission lines and loads, as well as the line and phase voltages.

In a Wye-connected 3-phase system, three identical coils (phases) are connected with one end of each coil joined at a common neutral point, forming a "Y" shape. The other ends are connected to the line conductors. The voltage across each coil is known as the phase voltage (V_P), while the voltage between any two lines is the line voltage (V_L).

In a balanced Wye-connected system, the phase voltages are equal in magnitude but have a phase angle difference of 120° between them. The line voltages, on the other hand, are the vector differences of the phase voltages. The relationship between the line voltage and the phase voltage is given by the equation:

$$V_L = \sqrt{3} \times V_P$$

Similarly, the current relationship in a Why system is:

$$I_P = I_L$$

Understanding these relationships is crucial for the design and analysis of three-phase systems, ensuring balanced operation and efficient power delivery.

1.5 Required Apparatus:

- AC source
- Clamp-on meter
- Resistors (three)
- Voltmeter
- Multimeter
- Connecting Wires

1.6 Circuit Diagram:

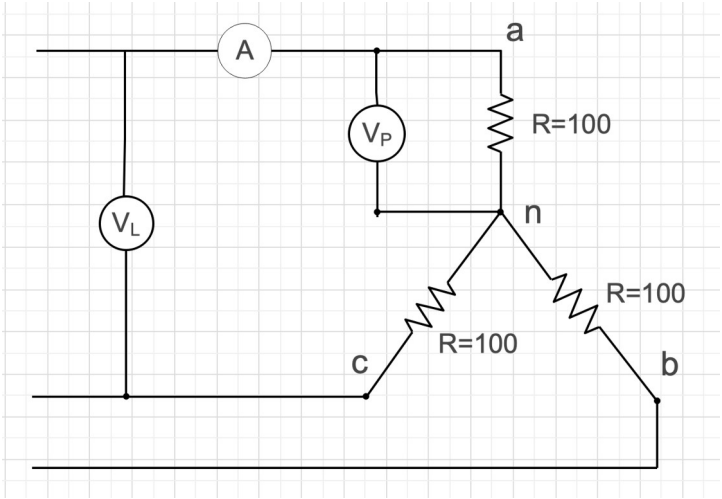

Figure 1.1: Wye-Connected 3 Phase Balanced System

1.7 Data Table:

Sl No.	V_L	$V_{P(m)}$	$V_{p(cal)}$	I_L	I_P	Error(%)
1	39.6	22.6	22.86	0.375	0.388	1.137%
2	41.2	23.2	23.78	0.382	0.378	2.439%
3	40.2	22.9	23.2	0.386	0.389	1.333%

Data Table from Lab experiment:

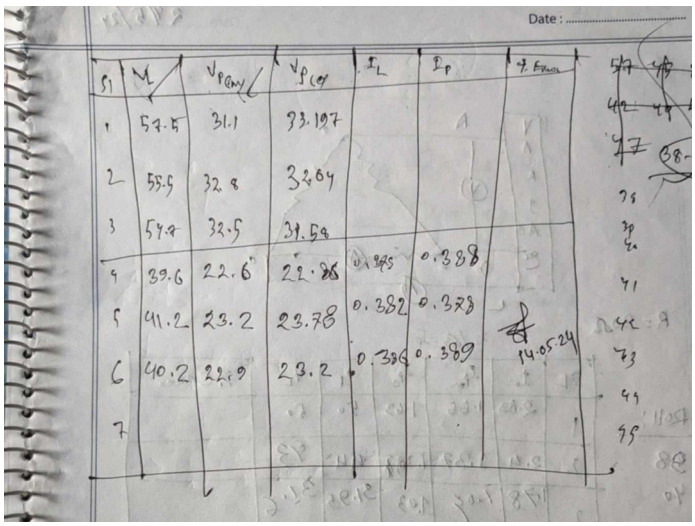

Figure 1.2: Captured Image

1.8 Result:

The measured line voltages are approximately equal to the calculated values based on the phase voltages, confirming the theoretical relationship:

$$V_L = \sqrt{3} \times V_P$$

Some discrepancies can be attributed to measurement errors or slight imbalances in the system. There is a little bit error for measuring the phase voltages. The average error is,

$$\%\,Error = \frac{1.137 + 2.439 + 1.333}{3}\%$$

$$= 1.67\%$$

1.9 Discussion:

This experiment successfully demonstrated the relationship between phase and line voltages in a Wye-connected 3-phase balanced system. The observed line voltages were found to be √3 times the phase voltages, consistent with the theoretical expectations. This relationship is crucial in the analysis and design of three-phase power systems, ensuring balanced operation and efficient power delivery.

1.10 Precautions:

- All connections were ensured to be secure and insulated to prevent short circuits or electric shocks.
- Properly calibrated instruments were used for accurate measurements.
- The load was confirmed to be balanced to maintain system symmetry.

1.11 Reference:

- Charles K. Alexander and Matthew N. O. Sadiku, “Fundamentals of Electric Circuit”, 5th Edition, 1221 Avenue of the Americas, New York
- Wikipedia