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 currents of a delta-connected 3-phase balanced system

Course Code	ECE 1202
Course Title	Circuit and System II Sessional
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2.1 Experiment No: 02

2.2 Experiment Name: Study the relationship between phase and line currents of a delta connected 3-phase balanced system.

2.3 Objectives:

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

2.4 Theory:

In a Delta-connected 3-phase system, the three-phase coils or windings are connected in a closed loop, forming a triangular shape resembling the Greek letter delta (Δ). In this configuration, each phase winding is directly connected between two line conductors, resulting in the system's unique electrical characteristics. One key characteristic of a Delta connection is that the line voltage is equal to the phase voltage, meaning the voltage across each phase winding is the same as the voltage between any two line conductors. However, the relationship between the line current and the phase current is different.

Phase Current (I_P): This is the current flowing through each individual phase winding.

Line Current (I_L): This is the current flowing in each line conductor connected to the external supply.

In a balanced Delta-connected system, the line currents are equal in magnitude but differ by 120° in phase angle. And the phase currents are also equal in magnitude and are related to the line currents by a factor of 3.

The relationship between the line current (I_L) and the phase current (I_P) is expressed as:

$$I_L = \sqrt{3} \times I_P$$

$$\text{And,} \quad V_P = V_L$$

This relationship arises because the line current is the vector sum of the currents in two phases connected to that line, making the line current 3 times larger than the phase current. This principle is essential when calculating currents and voltages in Delta-connected systems.

Understanding these relationships is crucial for analyzing and designing Delta-connected 3-phase systems, particularly in industrial power distribution, where high currents are typically required. The accurate calculation of these currents and voltages ensures efficient and balanced system operation.

2.5 Required Apparatus:

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

2.6 Circuit Diagram:

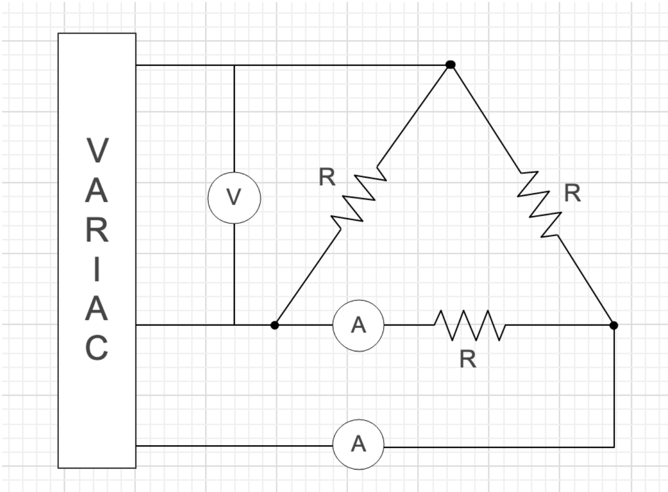
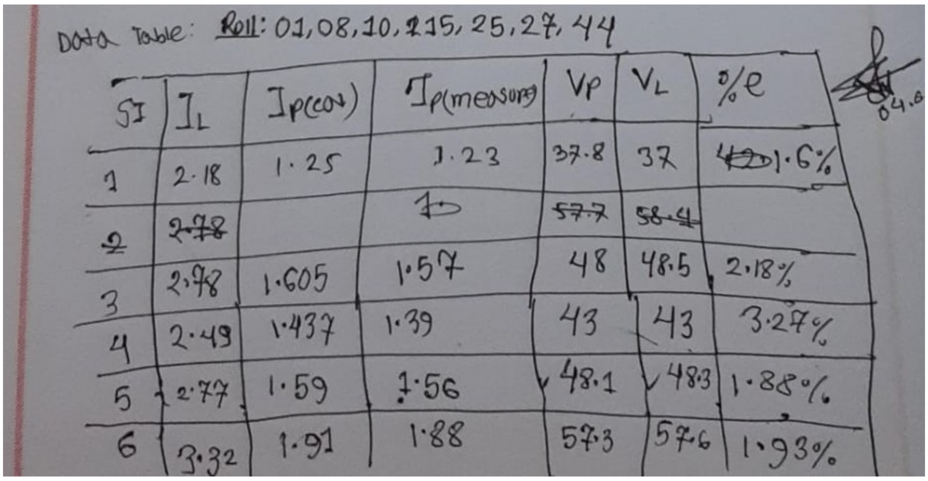


Figure 2.1: Delta Connected 3-phase balanced system

2.7 Data Table:

Sl No.	I_L	$I_{P(cal)}$	$I_{p(measure)}$	V_P	V_L	Error(%)
1	2.18	1.25	1.23	37.8	37	1.6%
2	2.78	1.605	1.57	48	48.5	2.18%
3	2.49	1.437	1.39	43	43	3.27%
4	2.77	1.59	1.56	48.1	48.3	1.88%
5	3.32	1.91	1.88	57.3	57.6	1.93%

Data Table from Lab experiment:



Data Table: Roll: 01,08,10,215,25,27,44

Sl	I_L	Ip(cal)	Ip(measure)	Vp	V_L	%e
1	2.18	1.25	1.23	37.8	37	~~420~~ 1.6%
2	~~2.78~~		~~1.5~~	~~57.7~~	~~58.4~~	
3	2.78	1.605	1.57	48	48.5	2.18%
4	2.49	1.437	1.39	43	43	3.27%
5	2.77	1.59	1.56	48.1	48.3	1.88%
6	3.32	1.91	1.88	57.3	57.6	1.93%

Figure 2.2: Captured Image

2.8 Result:

The measured line currents were found to be approximately 3 times the phase currents, consistent with the theoretical relationship.

$$I_L = \sqrt{3} \text{ x } I_P$$

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,

$$\% \, Error = \frac{1.6 + 2.18 + 3.27 + 1.88 + 1.93}{5} \%$$

$$= 2.17\%$$

2.9 Discussion:

The experiment successfully demonstrated the relationship between phase and line currents in a Delta-connected 3-phase balanced system. The observed line currents closely matched the theoretical values, confirming that in a Delta connection, the line current is 3 times the phase current. This verification highlights the importance of understanding vector relationships in three-phase systems, which is essential for designing and maintaining balanced power systems. Additionally, the accurate correlation between theoretical and measured values reinforces the reliability of using Delta connections in industrial applications where efficient current management is critical.

2.10 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.

2.11 Reference:

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