# Power Systems Lab

## Experiment 4

Laboratory Report

**Syed Alisamar Husain, 17BEE012**
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**Department of Electrical Engineering**
Jamia Millia Islamia, New Delhi

# Experiment 4

## 1 Objective

To write a MATLAB program to determine line currents to a Y-connected load by mesh analysis and by using symmetrical components.

**Let the given problem be as follows:**

*A balanced three phase voltage is applied to a Y-connected load with ungrounded neutral. The three phase load consists of three mutually-coupled reactances.*

1. *Determine the line currents by mesh analysis.*
2. *Determine the line currents by using symmetrical components.*

## 2 Theoretical Background

Shown below is a 3-phase supply connected to a Y-connected load.

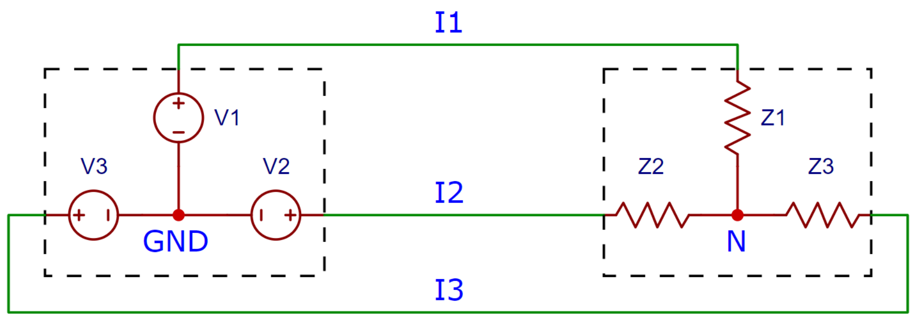


Figure 1: Y-connected load with ungrounded neutral.

## 2.1 Sequence Components

A set of three balanced voltages (phasors) $V_a, V_b, V_c$ is charactertzed by equal magnitudes and interphase differences of 120 deg. The set is said to have a phase sequence *abc* (positive sequence) if $V_b$ lags $V_a$ by 120 deg and $V_c$ lags $V_b$ by 120 deg.

The three phasors can then be expressed in terms of the reference phasor $V_a$ as

$$
\begin{aligned}
V_a &= V_a \\
V_b &= \alpha^2 V_a \\
V_c &= \alpha V_a
\end{aligned}
$$

where the complex number operator $\alpha$ is defined as $\alpha = e^{j120\,\mathrm{deg}}$. The same applies to voltages or currents.

If the phase sequence is *acb* (negative sequence), then

$$
\begin{aligned}
V_a &= V_a \\
V_b &= \alpha V_a \\
V_c &= \alpha^2 V_a
\end{aligned}
$$

Thus a set of balanced phasors is fully characterized by its reference phasor (say $V_a$) and its phase sequence (positive or negative).

Consider now a set of three voltages (phasors) $V_a, V_b, V_c$ which in general may be unbalanced. According to **Fortesque's theorem** the *three phasors can be described as the sum of positive, negative and zero sequence phasors.*

$$
\begin{aligned}
V_a &= V_a^1 + V_a^2 + V_a^0 \\
V_b &= V_b^1 + V_b^2 + V_b^0 \\
V_c &= V_c^1 + V_c^2 + V_c^0
\end{aligned}
$$

The three phasor sequences (positive, negative and zero) are called the **symmetrical components** of the original phasors. These equations can be expressed in the matrix form

$$
\begin{bmatrix} V_a \\ V_b \\ V_c \end{bmatrix} = \begin{bmatrix} 1 & 1 & 1 \\ 1 & \alpha^2 & \alpha \\ 1 & \alpha & \alpha^2 \end{bmatrix} \begin{bmatrix} V_a^0 \\ V_b^1 \\ V_c^2 \end{bmatrix}
$$

$$
\mathbf{V_p} = \mathbf{A V_s}
$$

To find the sequence components, we can invert the equation

$$
\mathbf{V_s} = \mathbf{A^{-1} V_p}
$$

$$
\text{where } \mathbf{A^{-1}} = \frac{1}{3} \begin{bmatrix} 1 & \alpha & \alpha^2 \\ 1 & \alpha^2 & \alpha \\ 1 & 1 & 1 \end{bmatrix}
$$

# 3 Implementation

# 4 Observations

Figure 2: Result in MATLAB

The result of the above program with the given parameters is shown in figure 2.

# 5 Result