X290994

UNIVERSITY OF NORTH CAROLINA AT CHARLOTTE

Department of Electrical Engineering

Experiment No._______Balanced Three-Phase Networks

INTRODUCTION

Three-phase networks can be connected either in a “Delta” configuration such as in Figure 2 or a “Wye” configuration such asin Figure 4. For balanced loads, Z1 = Z2 = Z3. Also, for a balanced delta-connection and an ABC sequence,

V-phase = V-line (VAB, VBC, VCA)

I-phase = V-phase/Z-phase (IAB, IBC, ICA)

I-line = I-phase (IA, IB, IC)

The line (phase) voltages are 120 electrical degrees apart. So are the line currents and the phase currents. A typical phasor diagram for a delta-connection is shown in Figure 3.

For a balanced wye-connection and an ABC sequence,

V-phase = (V-line/$\sqrt{3}$) $\angle$-30 degrees(VAN, VBN, VCN)

I-phase = V-phase/Z-phase (IAN, IBN, ICN)

I-line = I-phase (IA, IB, IC)

Again, the line (phase) currents are 120 electrical degrees apart as are the line voltages and the phase voltages. A typical phasor diagram for a wye-connection is shown in Figure 5.

Total power for either connection would be,

$$S = 3 \text{ V-phase I*-phase} = P + jQ = \sqrt{P^2 + Q^2}\angle \operatorname{atan}\frac{Q}{P}$$

$$|S| = \sqrt{3}|\text{V-line}||\text{I-line}|$$

$$P = 3\ |\text{V-phase}||\text{I-phase}|\ \cos\angle \text{Vp\&Ip} = |S|\ \cos\angle \text{Vp\&Ip}$$

$$Q = 3\ |\text{V-phase}||\text{I-phase}|\ \sin\angle \text{Vp\&Ip} = |S|\ \sin\angle \text{Vp\&Ip}$$

$$P = 3\ I^2\text{-phase}\ R\text{-phase}$$

$$Q = 3\ I^2\text{-phase}\ X\text{-phase}$$

PRELIMINARY

P-1. Show mathematically and graphically that, IA + IB + IC = 0, for a balanced three-phase network.

P-2. Prove mathematically that the two wattmeters in Figure 1 measures the total real power, P, for a balanced three-phase network.

(INSTRUCTOR'S SIGNATURE______________________________DATE___________)

Suggested Reference

Electrical Engineering Circuits (2nd edition)
Hugh Hildreth Skilling
Chapter 20 – Three Phase Circuits

PROCEDURE

F-1. Connect one of the circuits below AFTER checking with the Instructor

Network No.	Connection	Impedance ($\omega = 377$)
1	Delta	$2000 + RL + j10\omega$
2	Wye	$2000 + RL + j10\omega$
3	Delta	$8000 + RL + j10\omega$
4	Wye	$8000 + RL + j10\omega$
5	Wye	$1000 - j1/(2x10^{-6}\omega)$
6	Wye	$3000 - j1/(2x10^{-6}\omega)$
7	Delta	$1000 - j1/(10^{-6}\omega)$
8	Wye	$1000 - j1/(10^{-6}\omega)$
9	Wye	$3000 - j1/(10^{-6}\omega)$

RL – the resistance of the inductor
ω – frequency in radians/seconds

CAUTION: DO NOT MAKE CHANGES IN THE NETWORK UNLESS THE CIRCUITBREAKER IS OPEN!

The two wattmeters (Power Analyzers) should be connected as shown.

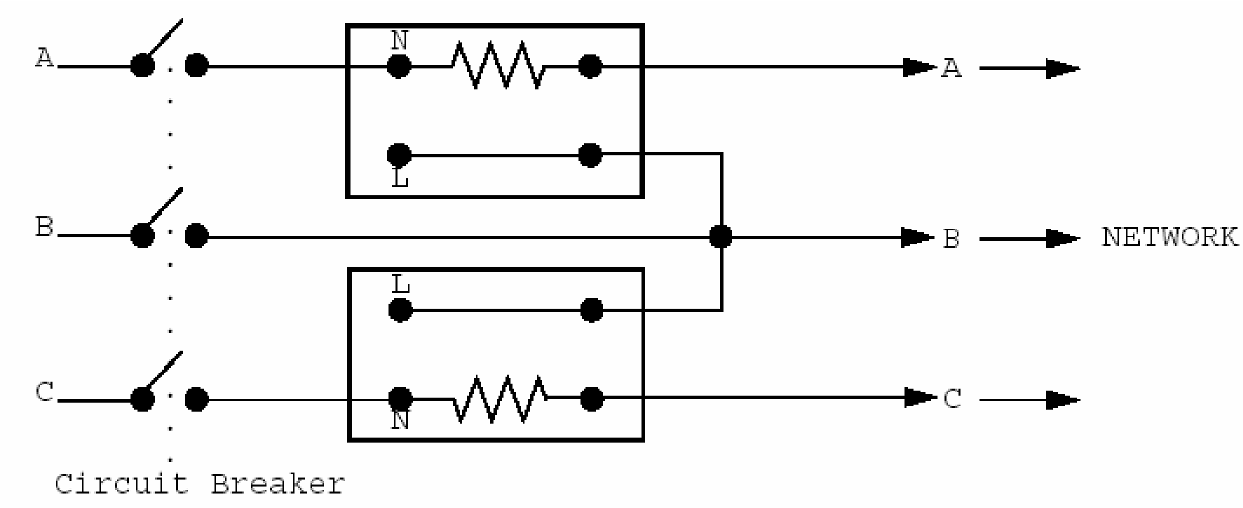

Figure 1.

F-2. Record the two power readings (with sign), the two line voltage readings, and the two line current readings.

F-3. Insert one of the wattmeters (Power Analyzer) into one of the phases. Record the phase voltage, phase current, and phase power readings.

REPORT

R-1. Using data from F-3, verify the per-phase load.

R-2. Calculate the phase voltage, phase current, line current, and total power (S, P, and Q) for the network tested using the given, measured line voltage and the theoretical given load.

R-3. In a table, compare S, P, Q, V-phase, I-phase, V-line, and Iline using the calculations in R-2, the data in F-2, and the data in F-3. Use the load found in R-1 to find S and Q from the data. Be sure the powers are total three-phase powers. Discuss any differences.

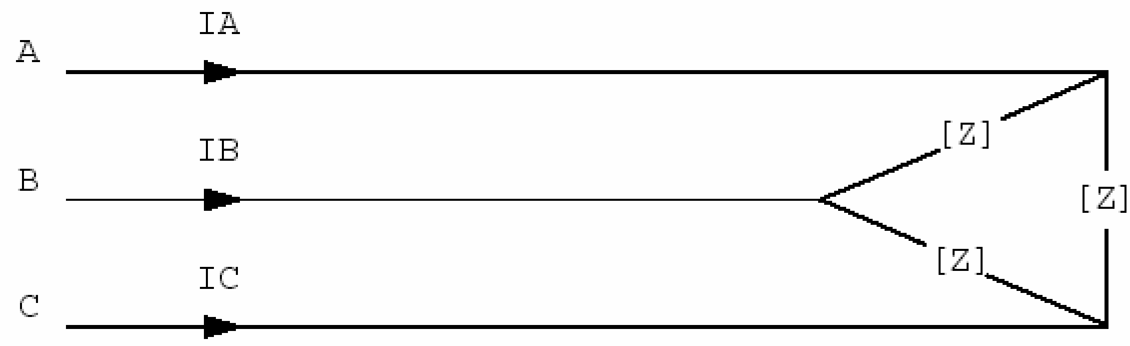

Figure 2.

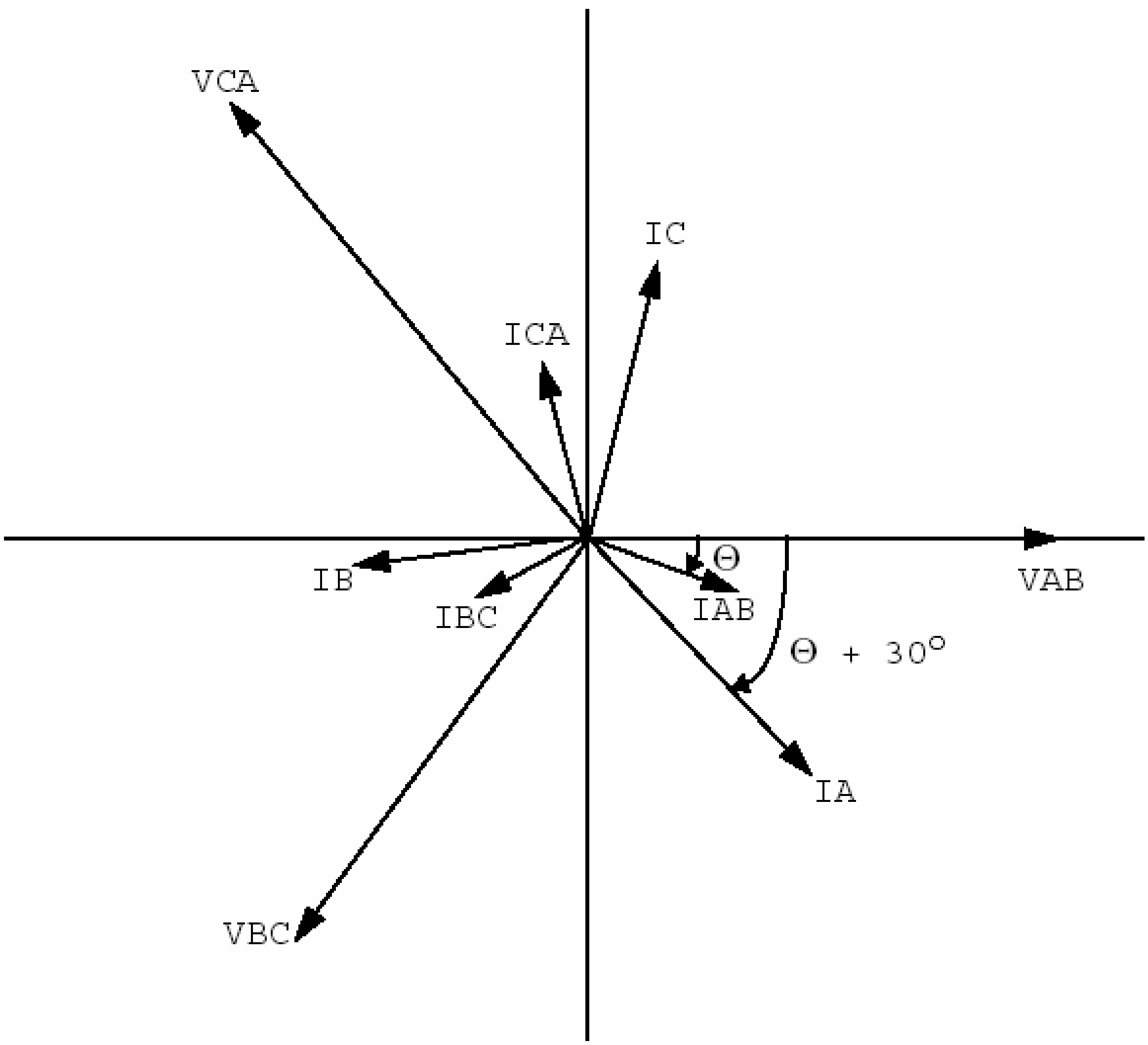

Figure 3.

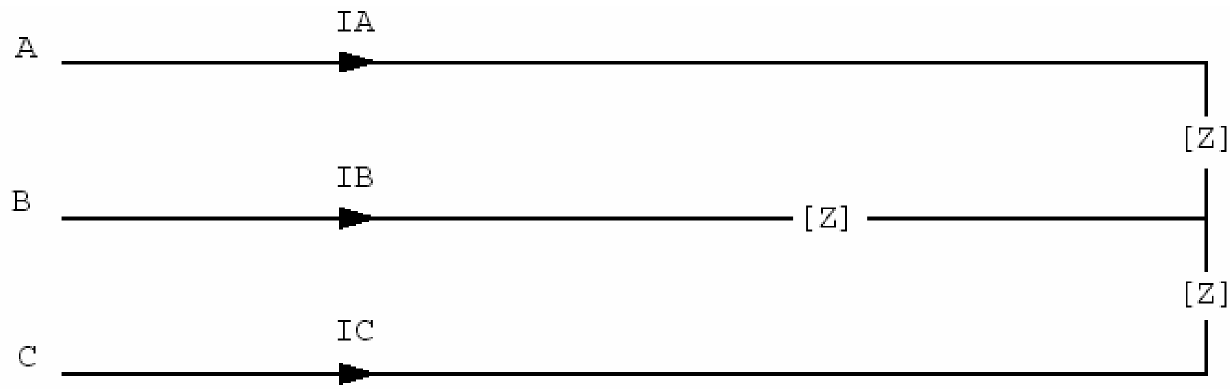

Figure 4.

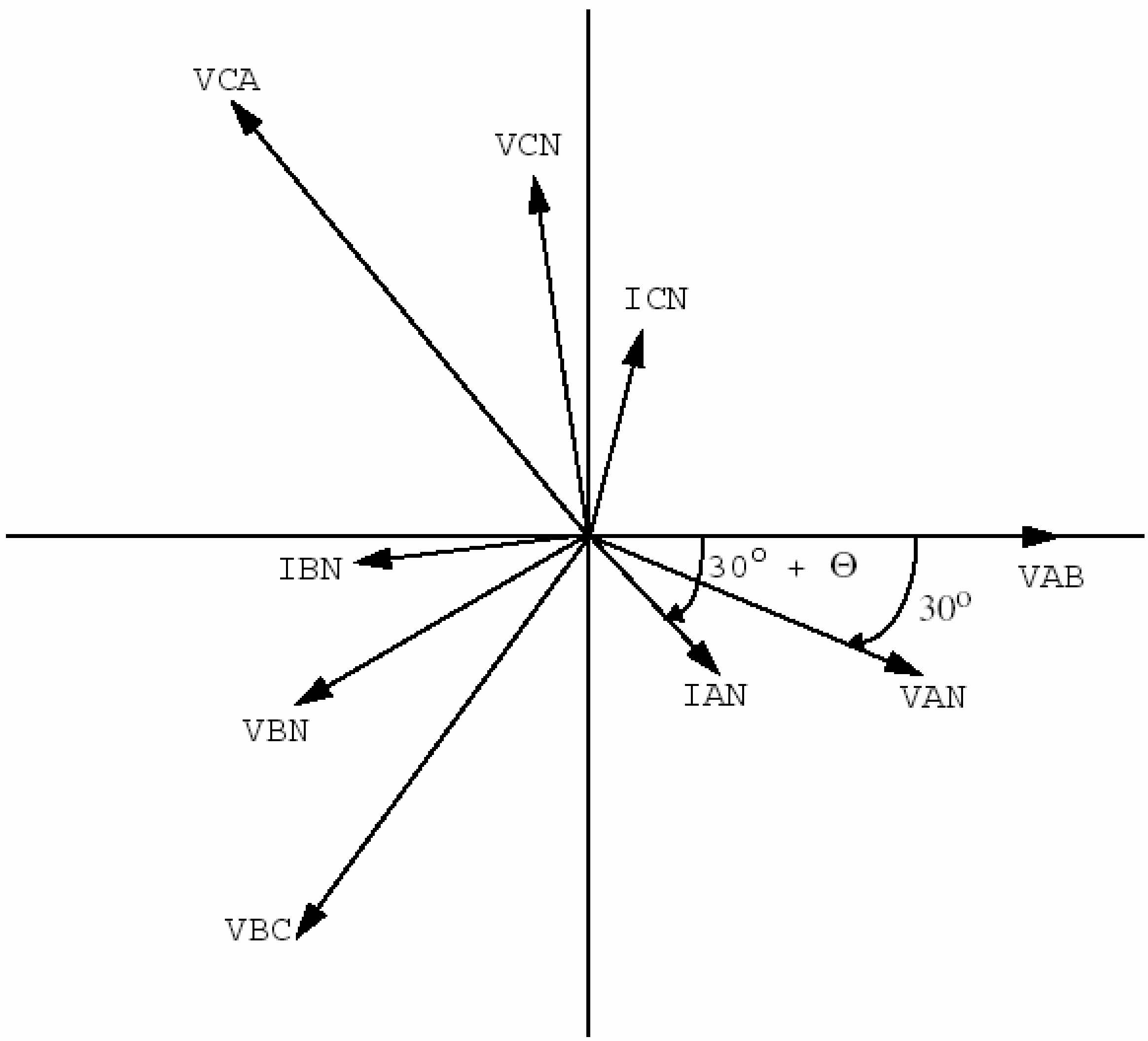

Figure 5.