"Heavens Light is Our Guide"

Rajshahi University of Engineering and Technology

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Course title: Circuits & Systems – II Sessional

Report Number: 02

Experiment Name: **Study of the relation between phase current and line current in a delta connected 3 – ϕ balanced system.**

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Experiment 1

1.1 Name of the Experiment: Study of the relation between phase current and line current in a delta connected 3 – ϕ balanced system.

1.2 Theory: In a balanced 3 – ϕ Y - Δ system, phase currents are:

$$I_{ab} = \frac{V_{ab}}{Z_\Delta},\ I_{bc} = \frac{V_{bc}}{Z_\Delta} \text{ and } I_{ca} = \frac{V_{ca}}{Z_\Delta}$$

The line currents can be obtained from applying KCL. So, the line currents will be:

$$I_A = I_{ab} - I_{ca},\ I_B = I_{bc} - I_{ab} \text{ and } I_C = I_{ca} - I_{bc}$$

Since $I_{CA} = I_{AB}\angle -240^\circ$,

$$I_A = I_{ab} - I_{ca} = I_{ab}\,(1 - 1\angle -240^\circ) = I_{ab}\,(1 + 0.5 - j0.866) = I_{ab}\sqrt{3}\angle 30^\circ$$

Now, if we consider the magnitude only, we get the relation between phase and line current as,

$$I_P = \frac{I_L}{\sqrt{3}} \ldots\ \ldots\ \ldots (1)$$

1.3 Required Apparatus:

1. Source
2. VARIAC
3. Voltmeter
4. Ammeter
5. Resistor
6. Multimeter
7. Connecting wires

1.4 Circuit Diagram:

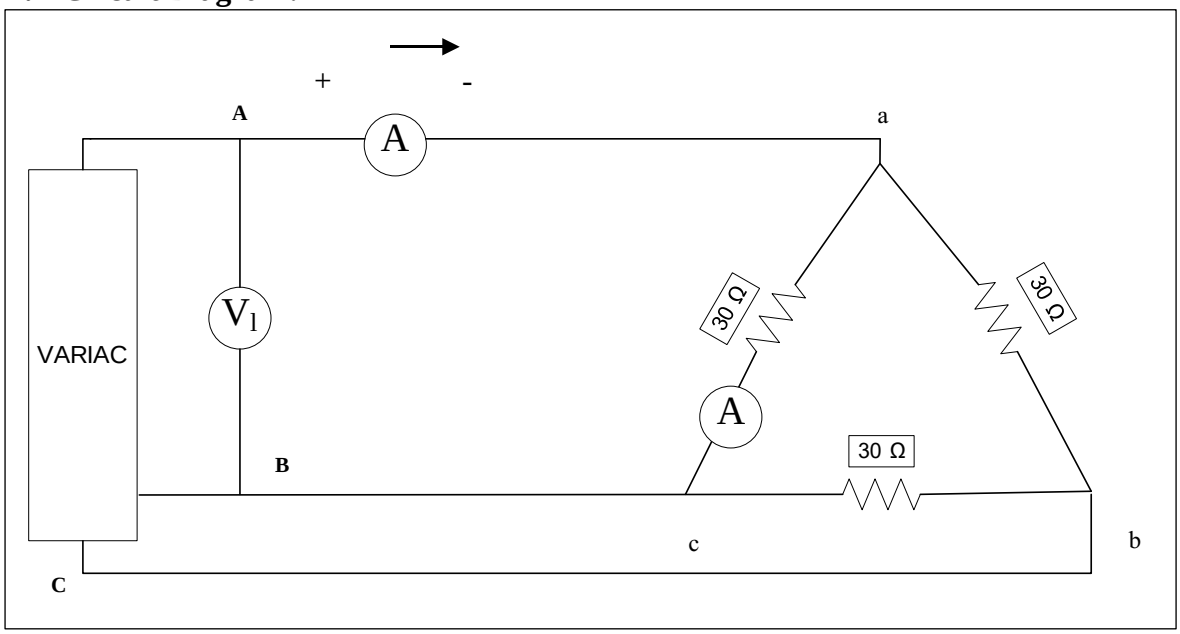

Fig: A balanced 3 – ϕ Y - Δ system

1.5 Calculation:

1. **Reading 1:**

   Line current, I_L = 2.25 A

   Measured phase current, $I_{P(m)}$ = 1.26 A

   Calculated phase current, $I_{P(calc)}$ = 1.29 A

   Error = $\frac{|I_P(calc) - I_P(m)|}{I_P(calc)}$ X 100% = $\frac{|1.29 - 1.26|}{1.29}$ X 100% = 2.32%

2. **Reading 2:**

   Line current, I_L = 0.72 A

   Measured phase current, $I_{P(m)}$ = 0.39 A

   Calculated phase current, $I_{P(calc)}$ = 0.41 A

   Error = $\frac{|I_P(calc) - I_P(m)|}{I_P(calc)}$ X 100% = $\frac{|0.41 - 0.39|}{0.41}$ X 100% = 4.87%

3. **Reading 3:**

   Line current, I_L = 1.28 A

   Measured phase current, $I_{P(m)}$ = 0.7 A

   Calculated phase current, $I_{P(calc)}$ = 0.74 A

   Error = $\frac{|I_P(calc) - I_P(m)|}{I_P(calc)}$ X 100% = $\frac{|0.74 - 0.7|}{0.74}$ X 100% = 5.4%

4. **Reading 4:**

   Line current, I_L = 1.87 A

   Measured phase current, $I_{P(m)}$ = 1.04 A

   Calculated phase current, $I_{P(calc)}$ = 1.08 A

   Error = $\frac{|I_P(calc) - I_P(m)|}{I_P(calc)}$ X 100% = $\frac{|1.08 - 1.04|}{1.08}$ X 100% = 3.7%

5. **Reading 5:**

   Line current, I_L = 2.79 A

   Measured phase current, $I_{P(m)}$ = 1.59 A

   Calculated phase current, $I_{P(calc)}$ = 1.61 A

   Error = $\frac{|I_P(calc) - I_P(m)|}{I_P(calc)}$ X 100% = $\frac{|1.61 - 1.59|}{1.61}$ X 100% = 1.24%

∴ Average error = $\frac{2.32+4.87+5.4+3.7+1.24}{5}$ = 3.506%

1.6 Table for Studying Relation Between Line and Phase Voltage:

Serial No	Line Current, I_L (A)	Measured Phase Current, $I_{P(m)}$ (A)	Calculated Phase Current, $I_{P(calc)}$ (A)	Percentage of Error (%)	Line Voltage, V_L (V)	Phase Voltage, V_P (V)
1	41.47	23.5	24.07	2.32	39.0	38.3
2	34.1	19	19.69	4.87	12.84	12.83
3	55.5	31.4	32.04	5.4	22.15	21.83
4	63.6	35.6	36.72	3.7	32.17	31.6
5	71.7	40.5	41.4	1.24	47.3	47.1

1.7 Result:

Average percentage of error: 3.506%

1.8 Discussion:

Performing the experiment above, we could prove the relation between phase and line current in a 3 – ϕ balanced Y - Δ system. After all the calculations, we figured our error margin was 3.506% which is negligible. This little error margin certifies that, the line current is √3 times that of phase current.

1.9 References:

1. Fundamentals of Electric Circuits by Charles K. Alexander and Mathew N. O. Sadiku.