*Heaven's Light is Our Guide*

# Rajshahi University of Engineering and Technology

## Department of Electrical & Computer Engineering

# Lab Report

**Experiment Name:** Power measurement of 3 phase balanced system with two wattmeter method experiment

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|---|---|
| **Course Code** | ECE 1202 |
| **Course Title** | Circuit and System II Sessional |
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## 3.1 Experiment No: 03

## 3.2 Experiment Name: Power measurement of 3 phase balanced system with two wattmeter method experiment.

## 3.3 Objectives:

- To measure the power in a 3-phase balanced system using the two wattmeter method.
- To calculate total active and reactive power based on the two wattmeter readings.
- To understand the significance of wattmeter readings in star and delta connections.

## 3.4 Theory:

The two wattmeter method is a widely used technique to measure the total power in a 3-phase balanced system. It employs two wattmeters connected to the system to measure power from two phases while the third phase is unmeasured. In this method, the sum of the readings of the two wattmeters gives the total active power, and their difference can be used to calculate reactive power. For a balanced system, the total active power is given by:

$$P_{total} = W_1 + W_2$$

Where:

- $W_1$ is the reading of the first wattmeter.
- $W_2$ is the reading of the second wattmeter.

The calculated power $P_{Calc}$ in a 3-phase system can also be expressed as:

$$P_{Calc} = \sqrt{3} \times V_L \times I_L$$

Where:

- $V_L$ is the line voltage.
- $I_L$ is the line current.

This method is effective for both star and delta connections, and the wattmeter readings will vary based on the power factor of the load. If the power factor is less than 0.5, one of the wattmeters will show a negative reading. This occurs due to the vector relationship between the phase voltages and currents in the system, which changes with the load's power factor. When the load has a leading or lagging power factor, the phase angle between current and voltage causes one wattmeter to register reverse power. This phenomenon is a key feature of the two wattmeter method, as it helps in determining the power factor and nature of the load (inductive or capacitive). The two wattmeter method is particularly advantageous because it doesn't require neutral wires and can measure total power with fewer instruments than other methods.

## 3.5 Required Apparatus:

- VARIAC
- AC source
- Clamp-on meter
- Resistors (as load)
- Two wattmeters
- Multimeter
- Connecting Wires

## 3.6 Circuit Diagram:

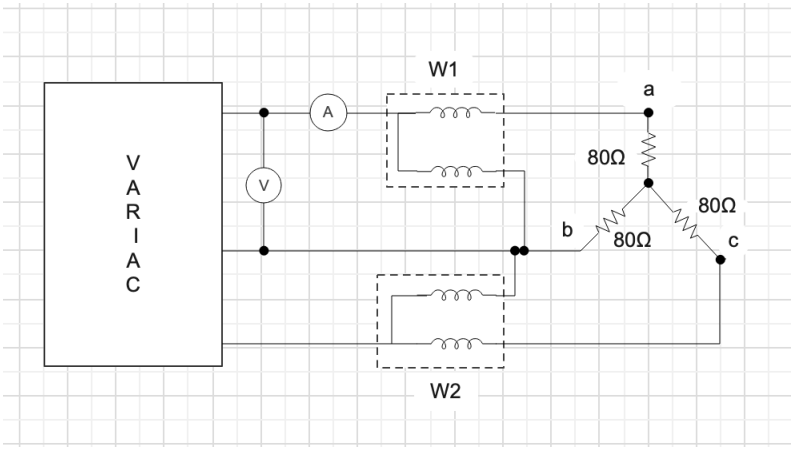


*Figure 3.1: Two wattmeters connected in a 3-phase system*

## 3.7 Data Table:

| Sl No. | $P_1$ | $P_2$ | $P_{(m)} = P_1+P_2$ | $V_L$ | $I_L$ | $P_{(Calc)}=\sqrt{3}\times V_L \times I_L$ | Error(%) |
|---|---|---|---|---|---|---|---|
| 1 | 28 | 24 | 52 | 74.3 | 0.56 | 72.07 | 27.85% |
| 2 | 28 | 26 | 54 | 76.5 | 0.57 | 75.53 | 28.51% |
| 3 | 42 | 43 | 85 | 91.0 | 0.68 | 107.18 | 20.69% |

## Data Table from Lab experiment:

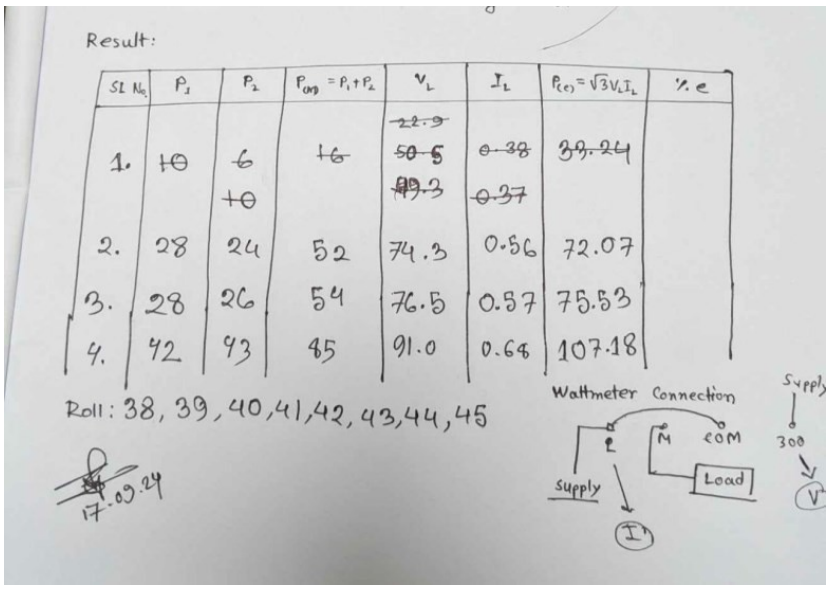


*Figure 3.2: Captured Image*

## 3.8 Result:

The measured power was found to be consistent with the theoretical relationship for a 3-phase balanced system. The total power calculated using the formula:

$$P_{Calc} = \sqrt{3} \times V_L \times I_L$$

which closely matched the sum of the two wattmeter readings. However, some discrepancies were observed, which can be attributed to measurement errors, possible instrument calibration issues, or slight imbalances in the load. The calculated average error in power measurement across different readings was:

$$\%\,Error = \frac{27.85 + 28.51 + 20.69}{3}\%$$

$$= 25.68\%$$

This error could also be a result of inaccuracies in measuring the line voltages and currents during the experiment.

## 3.9 Discussion:

The experiment validated the effectiveness of the two wattmeter method for measuring the total power in a 3-phase balanced system. The total active power was calculated as the sum of the two wattmeter readings, and the reactive power was derived using the difference between the two. The power factor was found to influence the wattmeter readings significantly. For a low power factor, one of the wattmeters provided a negative reading, indicating leading or lagging power. This method proves to be highly useful in industrial settings for analyzing power systems.

## 3.10 Precautions:

- All connections were ensured to be tight and insulated to avoid short circuits.
- Measuring instruments were calibrated to ensure accurate readings.
- Balance in the load was maintained to avoid any system imbalances.
- Wattmeters were handled carefully to prevent damage.

## 3.11 Reference:


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