

Practical No. 6: Connect three phase Delta connected balanced load and verify the relationship between line voltage and phase voltage, line current and phase current.

I Practical Significance:

In practice, large power application like Transformer, Transmission line etc. use three phase systems. In a three phase circuit loads can be connected in balanced star and delta mode. Practical will help the students to acquire necessary skills.

II Industry/Employer Expected Outcome(s)

Three-phase power is commonly used in factories and manufacturing plants to power large equipment such as compressors, pumps, conveyors, and motors, often use three-phase power to run large fans and pumps. It is necessary to formulate voltage and current relations for system parameters for testing, calculations and interpretations.

III Course Level Learning Outcome(s)

Analyze A.C. circuits for single phase and polyphase supply.

IV Laboratory Learning Outcome(s)

LLO 1 Connect Delta connected three phase load.

LLO 2 Verify relationship between line and phase quantities.

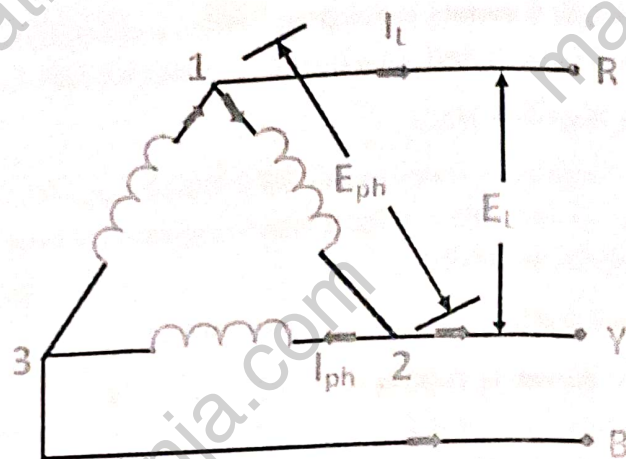
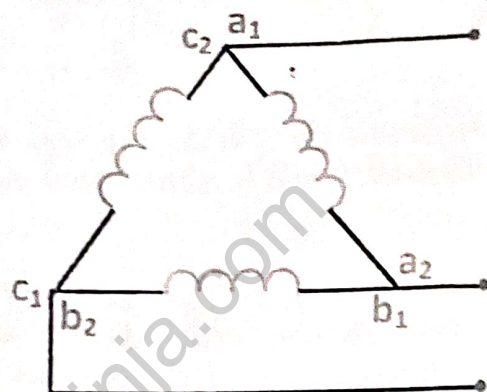
V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

The delta in a three-phase system is formed by connecting one end of the winding to the starting end of other winding and the connections are continued to form a closed loop. The star in the three-phase system is formed by connecting one end of all three impedances are connected together.

In Delta (Δ) or Mesh connection, the finished terminal of one winding is connected to start terminal of the other phase and so on which gives a closed circuit. The three-line conductors are run from the three junctions of the mesh called **Line Conductors**.



To obtain the **delta connections**, a_2 is connected with b_1 , b_2 is connected with c_1 and c_2 is connected with a_1 as shown in the above figure. The three conductors R, Y and B are running from the three junctions known as **Line Conductors**.

The current flowing through each phase is called **Phase Current (I_{ph})**, and the current flowing through each line conductor is called **Line Current (I_L)**.

The voltage across each phase is called **Phase Voltage (E_{ph})**, and the voltage across two line conductors is called **Line Voltage (E_L)**.

Relation between Phase Voltage and Line Voltage in Delta Connection

$$E_{RY} = E_{YB} = E_{BR} = E_L$$

In delta connection, line voltage is equal to phase voltage.

Relation between Phase Current and Line Current in Delta Connection

In delta connection line current is root three times of phase current.

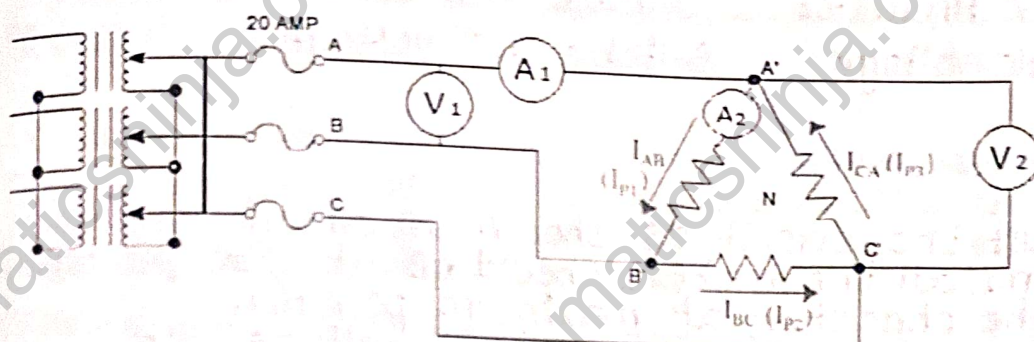
$$\text{Line Current} = \sqrt{3} \times \text{Phase Current}$$

$$I_L = \sqrt{3} I_{ph}$$

In a Delta Connection, the Line and Phase Voltages are same and hence, more insulation is required for individual phases. Usually, Star Connection is used in both transmission and distribution networks (with either single phase supply or three – phase. Delta Connection is generally used in distribution networks).

Three Phase balanced network are used in the power industry for the reason of economy and performance. Three phase generators and motors run smoothly, with no torque pulsation, unlike single phase machine. In addition balanced three phase system may be operated as three or four wire systems, which much less copper needed for the power delivered as compared with three single phase systems.

VII Actual Circuit diagram used in laboratory with equipment Specifications:



VIII Required Resources/apparatus/equipment with specification:

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Three Phase Variac	Suitable Three phase variac	1 No.
2	Three Phase load	Suitable range	1 No.
3	A.C. Ammeter	Suitable A.C. ammeter	2 No.
4	A.C. voltmeter	Suitable A.C. Voltmeter	2 No.

IX Precautions to be followed:

1. Avoid loose connections.
2. Don't touch wire with wet hands.
3. Ensure the output voltage of the Autotransformer should be zero.

X Procedure

1. Connect the circuit as shown in circuit diagram.
2. Confirm all the meters should be at zero position.
3. Set the rheostat at maximum position.
5. Set the autotransformer output voltage zero.
6. Switch ON the supply.
7. Record the reading of ammeters, voltmeters.
8. Take different readings at different input voltages.

XI Required Resources/apparatus/equipment with specification:

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Three Phase Variac	Suitable Three phase Variac	1 No
2	Three Phase load	Suitable range	1 No
3	Ac Ammeter	Suitable A.C ammeter	02 No
4	Ac voltage	Suitable AC voltage	02 No

XII Actual Procedure Followed:

1. Connect the circuit as shown in circuit diagram.
2. Confirm all the meters should be at zero position.
3. Set the rheostat at maximum position.
4. Set the autotransformer output voltage zero.
5. Switch on the supply.
6. Record the reading of ammeter, voltage.
7. Take different readings at different input voltage.

XIII Observation and Calculation table:

Sr. No.	Line Voltage (volts)	Phase Voltage (volts)	Line current (amp)	Phase Current (amp)	Ratio V_L/V_{ph}	Ratio I_L/I_{ph}
1	400	230	10	5	1.73	2
2	380	220	9.5	4.8	1.73	1.98
3	360	208	9	4.5	1.73	2
4	340	196	8.5	4.3	1.73	1.98

XIV Result(s)

The experimental result verify the theoretical relationship in a three-phase connected balanced load.

XV Interpretation of results

The phase voltage equal the line voltage $V_L = \sqrt{3} \cdot V_\phi$.

XVI Conclusion and recommendation

The experiment confirms the relationship between line voltage and phase voltage and between line current and phase current in a delta-connected system.

XVII Practical related questions (Provide space for answers)

1. Define balanced load and unbalanced load.
2. State the application of Delta connection.
3. What are the advantage of three phase system over single phase system?
4. Compare Star and delta connection.

1] • Balanced Load :- A three phase load is balanced if all three phase have equal impedance and consume equal power.
• Unbalanced load :- A three phase load is unbalanced if impedances differ between phase, resulting in equal power consumption.

2] • Used in three-phase motors and generators.
• common in power transmission systems for efficient power transfer.
• Suitable for system requiring high starting torque.

3] • Higher efficiency for power transmission and distribution.
• Deliver more power with the same current.
• Smoother and more reliable operation of three-phase motors.
• Reduced conductor material for the same load.