Experiment No.(5)

Three-Phase star delta Transformer Connection and Load Test

1-Objective:

The objective of this experiment is to study the operation of a three-phase transformer bank constructed from three single-phase transformers. The experiment aims to:

1. Observe the phase relationships between primary and secondary windings.
2. Understand the connection types (e.g., Delta–Star or Star–Delta).
3. Measure line and phase voltages and currents on both primary and secondary sides.
4. Analyze the performance of the system under a balanced resistive load.

2-Theory:

A **three-phase transformer** can either be a single three-phase unit or a combination of three single-phase transformers connected together. Each transformer handles one phase of the system. The most common configurations are:

- **Star–Star (Y–Y)** connection
- **Delta–Delta (Δ–Δ)** connection
- **Delta–Star (Δ–Y)** connection
- **Star–Delta (Y–Δ)** connection

In this experiment, three single-phase transformers (T1, T2, and T3) are connected to a three-phase supply. The primary windings are connected to three voltage sources (V1, V2, and V3), each with a phase difference of 120°, representing a balanced three-phase system at 120 V (RMS) per phase and 60 Hz.

The secondary sides are connected to a set of balanced resistive loads (R2–R7) forming a three-phase load network. Each phase carries the same magnitude of current but differs in phase angle by 120°.

The **transformer equation** governing the voltage transformation is:

$$\frac{V_1}{V_2} = \frac{N_1}{N_2}$$

The power transferred through the three-phase system is given by:

where:

$$P = \sqrt{3}\, V_L I_L \cos\phi$$

- **VL = Line voltage**
- **L = Line current**
- **cosϕ = Power factor**

3-Procedure:

1. Connect three single-phase transformers (T1, T2, and T3) as shown in the circuit diagram as shown Fig. 1.
2. Connect the primary sides of the transformers to the three-phase power sources (V1, V2, V3), each providing 120 V at 60 Hz with a phase displacement of 120°.

3. Ensure that the neutral point is properly grounded using low-resistance grounding resistors (R8, R1, and R9).

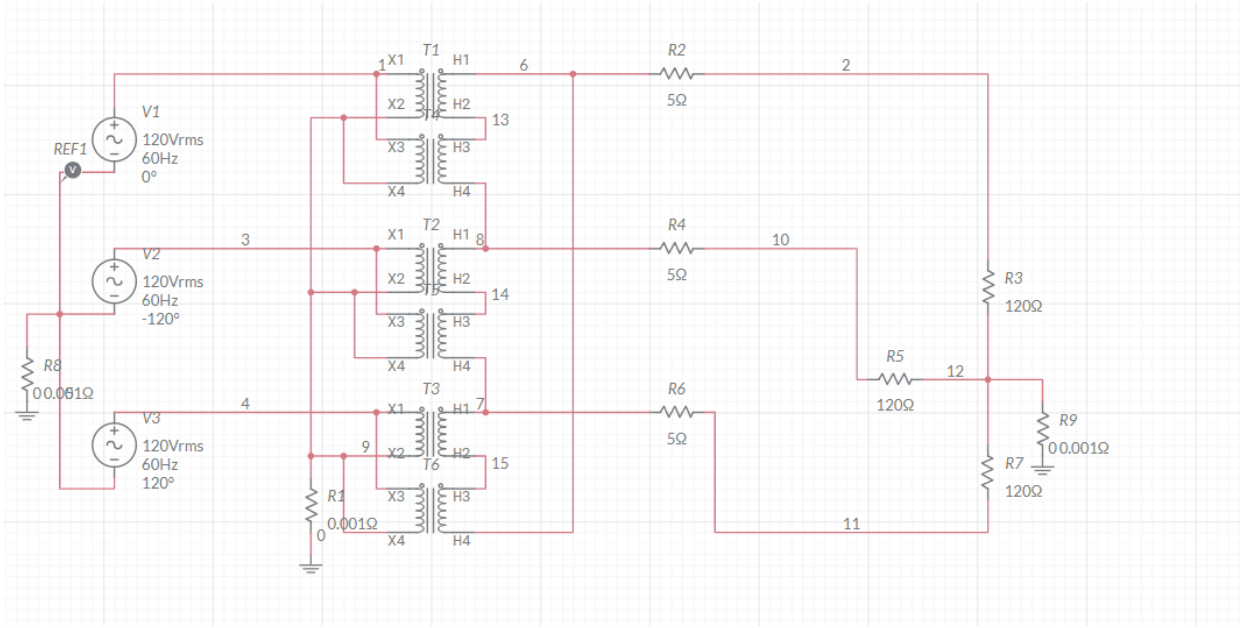

Fig. 1 Three phase stra delta circuit

4- Measurement:

- Measure primary line and phase voltages using a voltmeter.
- Measure secondary voltages across each phase load.
- Use ammeters to record current in each phase on both sides of the transformer.

5-Observation:

- Record values of VL, IL, and calculate the power per phase and total power.
- Verify the relationship between line and phase quantities for the given connection type.

6-Discussion:

1. How does connecting three single-phase transformers create a balanced three-phase transformer system, and what are the benefits of this configuration?

2. What relationship was observed between the primary and secondary voltages, and how does it confirm the transformer turns ratio?
3. How did the balanced resistive load affect the current and power factor in the three-phase system?