

The logo of Galgottia University is a circular emblem with three curved, overlapping bands in shades of yellow, blue, and red, resembling a stylized 'G' or a flame. The text 'GALGOTTIA UNIVERSITY' is faintly visible in the background behind the logo.

Three-phase Transformer Construction

Acknowledgement: The materials presented in this lecture has been taken from open source, reference books etc. This can be used only for student welfare and academic purpose.

Recap

- Needs of auto transformer
- Comparison with two winding ordinary transformer
- Electrical power transfer capability of the auto transformer
- Copper saving of the auto transformer
- Advantages and disadvantages
- Applications

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Three-phase Transformer Construction

Lecture-8 Objectives

- Needs of three phase transformer and its types with application
- Magnetic core over view
- Classification
- Merits and demerits

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Three-phase Transformer Construction

Three-phase Transformer

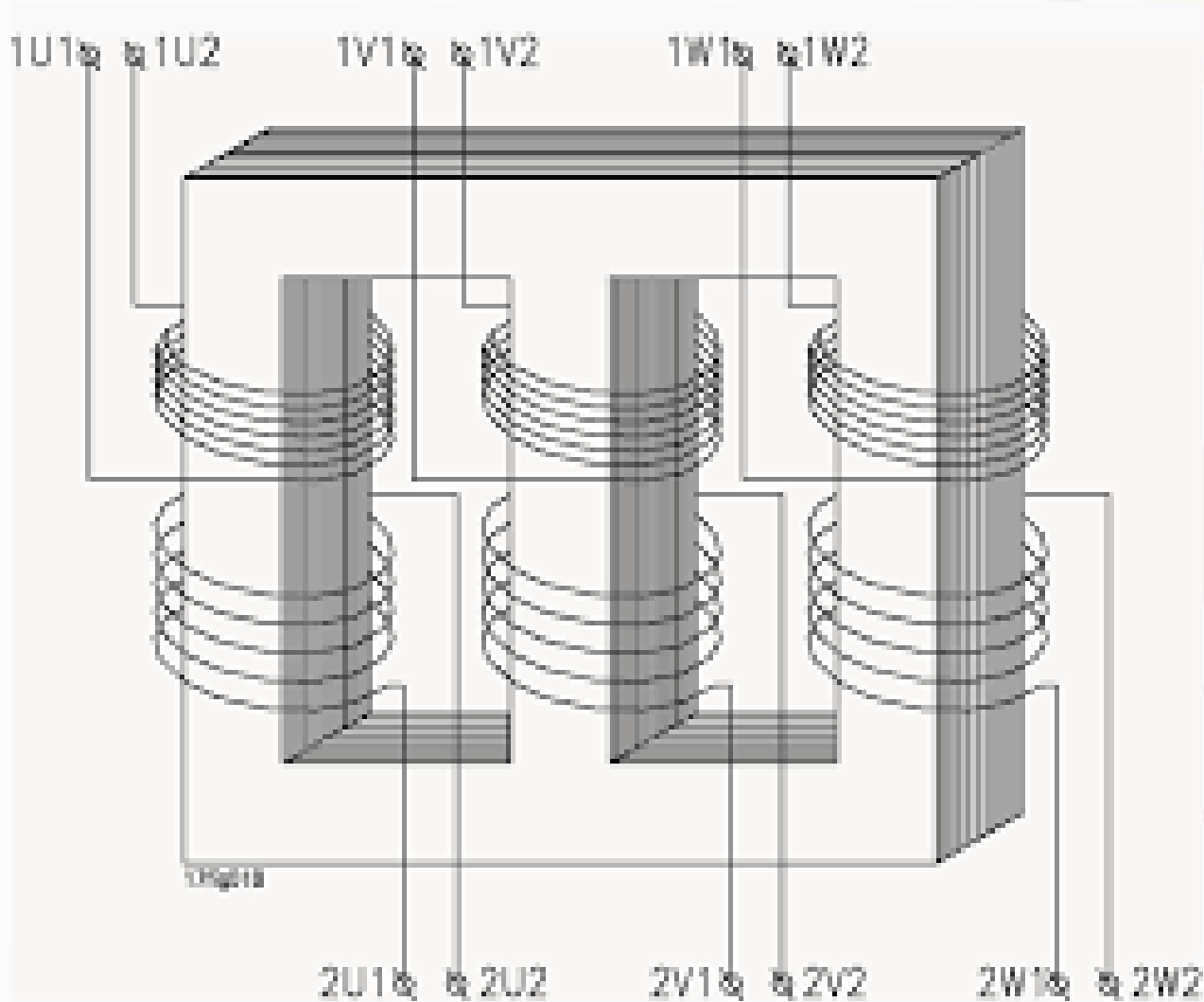
- As known, a single-phase transformer is a device that is capable of transferring electrical energy from one circuit to one or more circuits based on the concept of mutual induction at constant frequency.
- It comprises two coils – a primary and a secondary coil, which helps to transform the energy.
- The primary coil is connected to a single-phase supply, while the secondary is connected to a load.
- Similarly, a three-phase transformer consists of three primary coils and three secondary coils and is represented as 3-phase or 3ϕ .
- A three-phase system can be constructed using three individual identical single-phase transformers, and such a 3-phase transformer is known as the bank of three transformers.

Three-phase Transformer Construction

- On the other hand, the three-phase transformer can be built on a single core. The windings of a transformer can be connected in either delta or star (wye) configurations.
- The working of the 3-phase system is similar to a single-phase transformer, and they are normally employed in power generation plants.

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Three-phase Transformer Construction



Three-phase Transformer Construction

A three-phase transformer of a single unit is used widely because it is lighter, cheaper and occupies less space than the bank of three single-phase transformers.

The three-phase transformer construction is of two types:

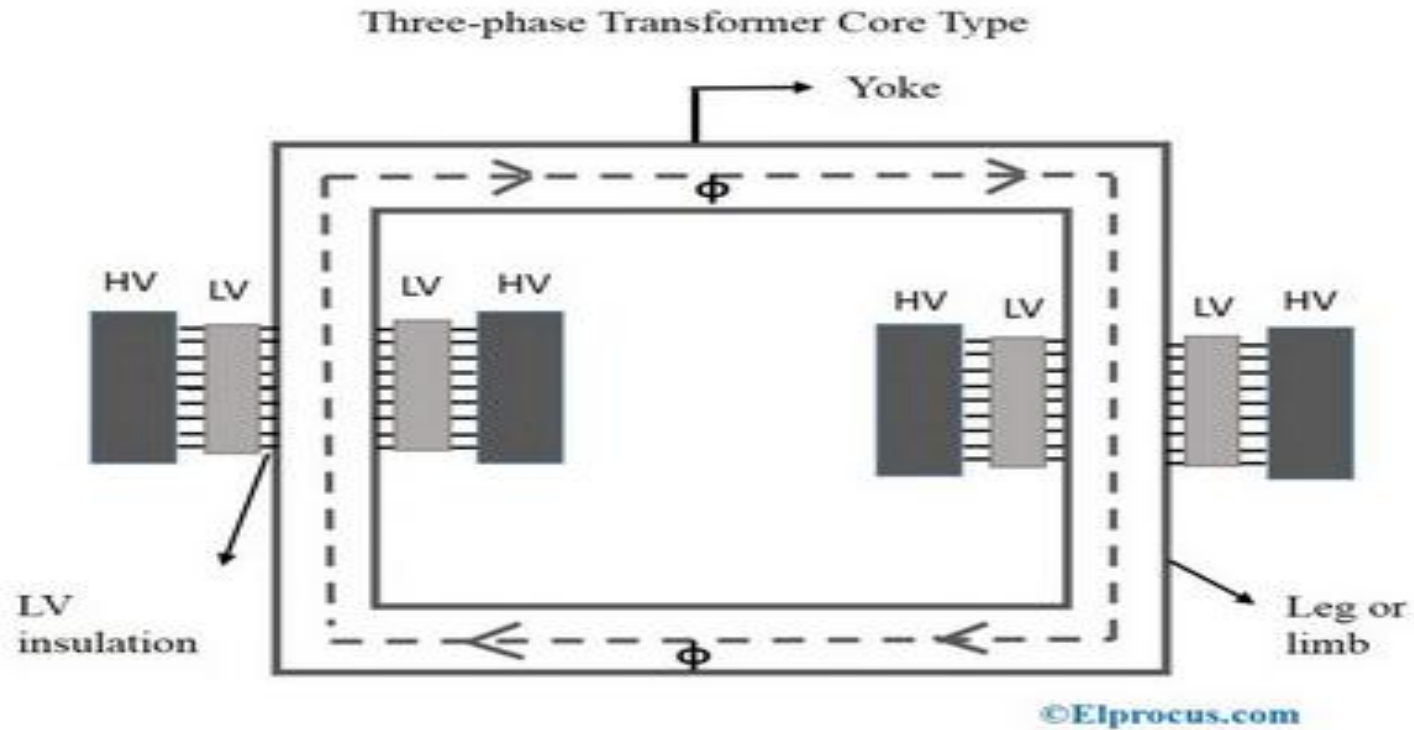
- Core type
- Shell type.

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Three-phase Transformer Construction

1. Core Type Construction

In this type of construction, there are three cores and two yokes. Each core has both primary and secondary windings wounded spirally as shown in the figure.



Core Type Transformer

Three-phase Transformer Construction

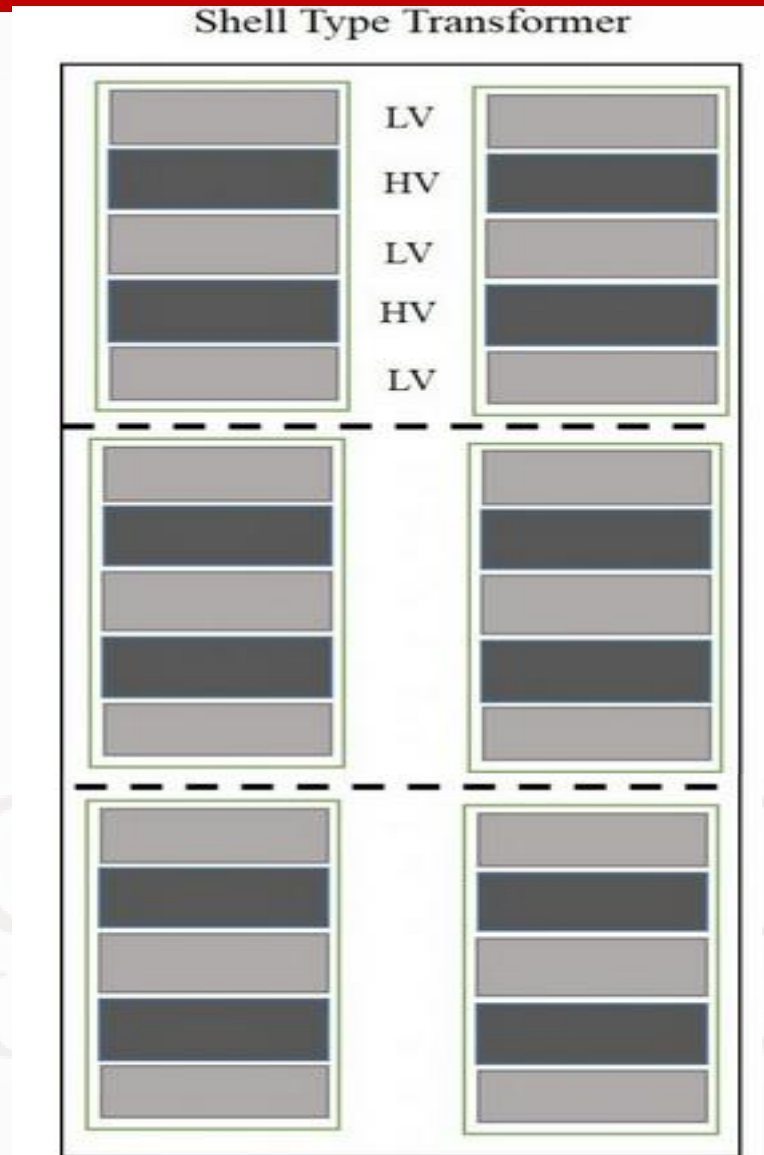
- Each leg of the core carries high voltage as well as low voltage windings.
- The core is laminated to minimize eddy current losses on core and yoke.
- As it is easier to laminate low voltage (LV) winding than the high voltage (HV) winding.
- The LV windings are positioned near the core with appropriate insulation and oil ducts in between them whereas, the HV windings are placed above the LV windings with appropriate insulation and oil ducts between them.

Three-phase Transformer Construction

2. Shell Type Transformer

- The three-phase shell type transformer is generally constructed by stacking three individual single-phase transformers.
- Three phases of a shell-type transformer are independent than the core-type transformer, while each phase has an individual magnetic circuit.
- These magnetic circuits are parallel to each other and flux induced by each winding is in phase.
- Shell type transformer is highly preferred as the voltage waveforms are less distorted.

Three-phase Transformer Construction

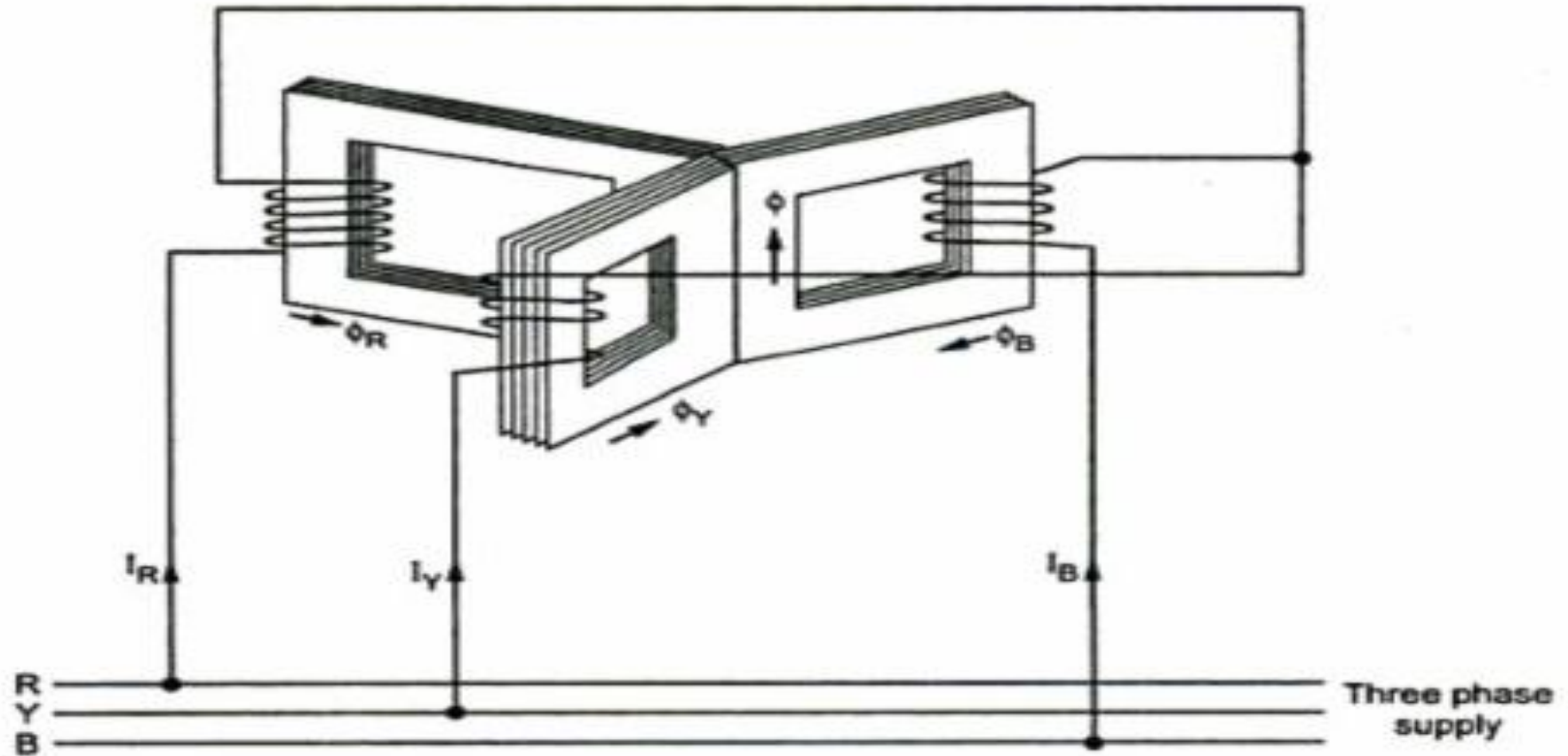


Three-phase Transformer Construction

Working of Three-Phase Transformers

- The figure below shows the three-phase transformer, wherein three cores are placed at 120° from each other.
- This figure is simplified to show only primary windings and their connection to the three-phase power supply.
- As soon as the three-phase supply is excited, the currents I_R , I_Y , and I_B are carried by the primary windings and thus inducing the fluxes ϕ_R , ϕ_Y , and ϕ_B individually in each core.
- The center leg will carry the sum of all the fluxes, and the center leg combined all the legs of a core.

- For instance, if the sum of the currents $I_R + I_Y + I_B$ is zero in a three-phase system, then the sum of all the three fluxes also becomes zero, resulting in the center leg carrying no flux.
- Therefore, removing the center leg makes no difference for other transformer conditions.



Working of Three Phase Transformer

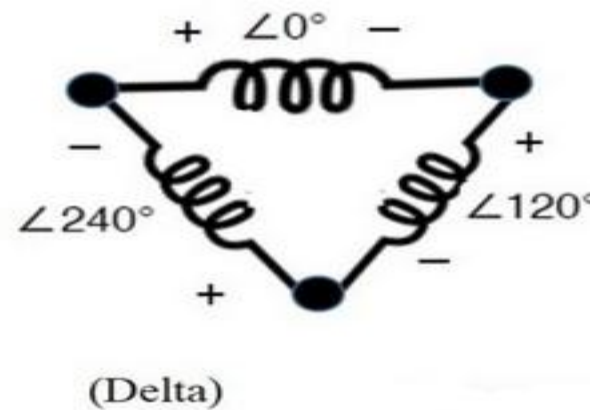
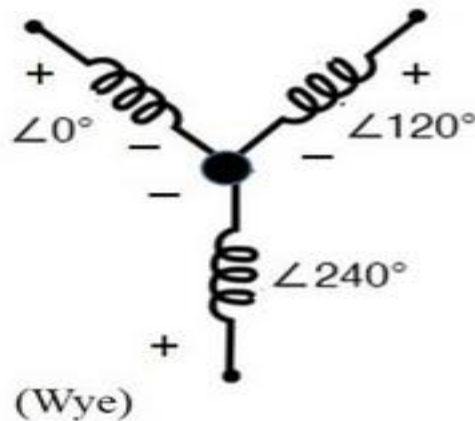
Three-phase Transformer Construction

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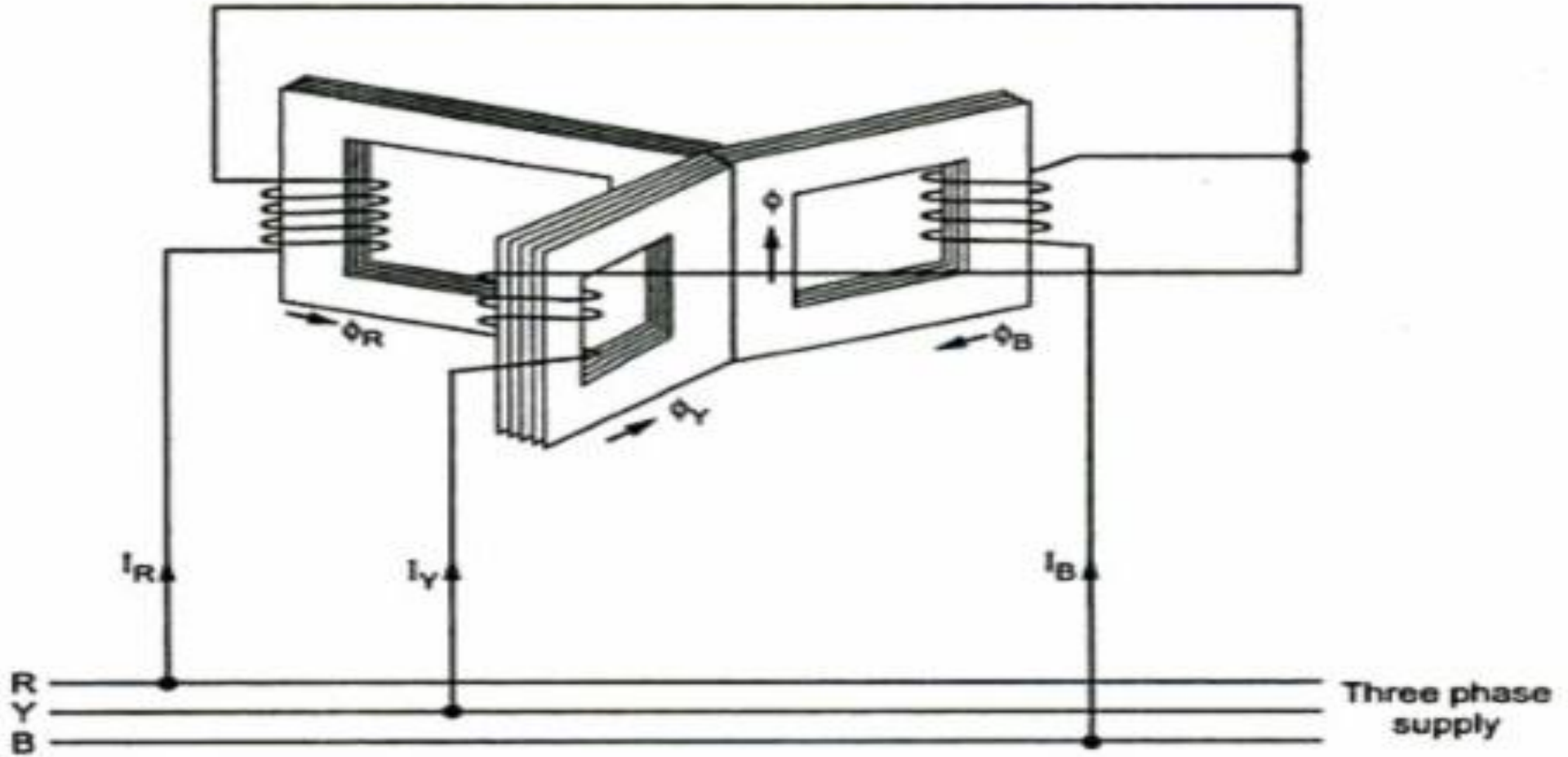
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Three-Phase Transformer Connections

Primary Winding Configuration	Secondary Winding Configuration
Star (Wey)	Star (Wey)
Star (Wey)	Delta
Delta	Star (Wey)
Delta	Delta



Three-phase Transformer Construction



Working of Three Phase Transformer

Three-phase Transformer Construction

The advantages and disadvantages of a three-phase transformer are discussed below.

- Needs less space to install and it is easier to install
- Less weight and reduced size
- Higher efficiency
- Low cost
- Transportation cost is low

Disadvantages of a three-phase transformer

- The entire unit shuts down in case of fault or loss occurs in any one unit of a transformer as a common core is shared by all three units.
- Repair costs are higher
- Cost of spare units are high

Three-phase Transformer Construction

Summary

- Needs of three phase transformer and its types with application
- Magnetic core over view
- Classification
- Merits and demerits

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