SNS COLLEGE OF ENGINEERING

Kurumbapalayam (Po), Coimbatore – 641 107

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE NAME : 23EET101 BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING

I YEAR /I SEMESTER

Unit 1- ELECTRICAL MACHINES

Topic : Construction, Working & Types of Single Phase Transformer

Introduction

- A single-phase transformer is an electrical device that accepts single-phase AC power and outputs single-phase AC.
- This is used in the distribution of power in non-urban areas as the overall demand and costs involved are lower than the 3-phase distribution transformer.
- They are used as a step-down transformer to decrease the home voltage to a suitable value without a change in frequency.
- For this reason, it is commonly used to power electronic appliances at residences.

What is a Single Phase Transformer?

Definition:

- A transformer is a device which converts magnetic energy into electrical energy.
- It consists of two electrical coils called as a primary winding and secondary winding.
- The primary winding of a transformer receives power, while the secondary winding delivers power.
- A magnetic iron circuit called “core” is commonly used to wrap around these coils. Though these two coils are electrically isolated, they are magnetically linked.

- An electric current when passed through the primary of a transformer then a magnetic field is created, which induces a voltage across the secondary of a transformer.

- Based on the type of application, the single-phase transformer is used to either step-up or step-down the voltage at the output.

- This transformer is typically a power transformer with high-efficiency and low losses.

Principle of Single Phase Transformer

- The single-phase transformer works on the principle of Faraday's Law of Electromagnetic Induction.

- Typically, mutual induction between primary and secondary windings is responsible for the transformer operation in an electrical transformer.

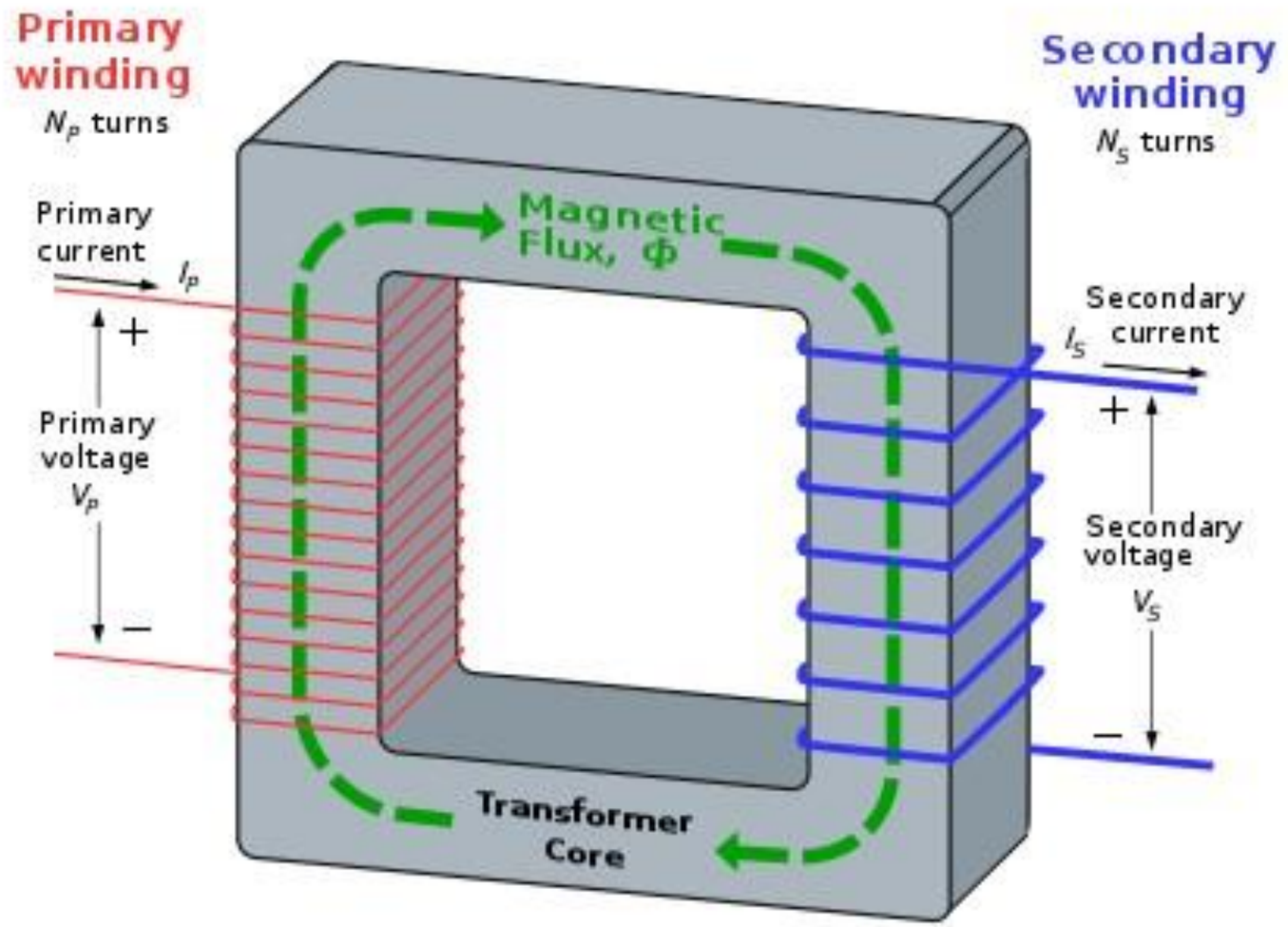
Construction of Single Phase Transformer

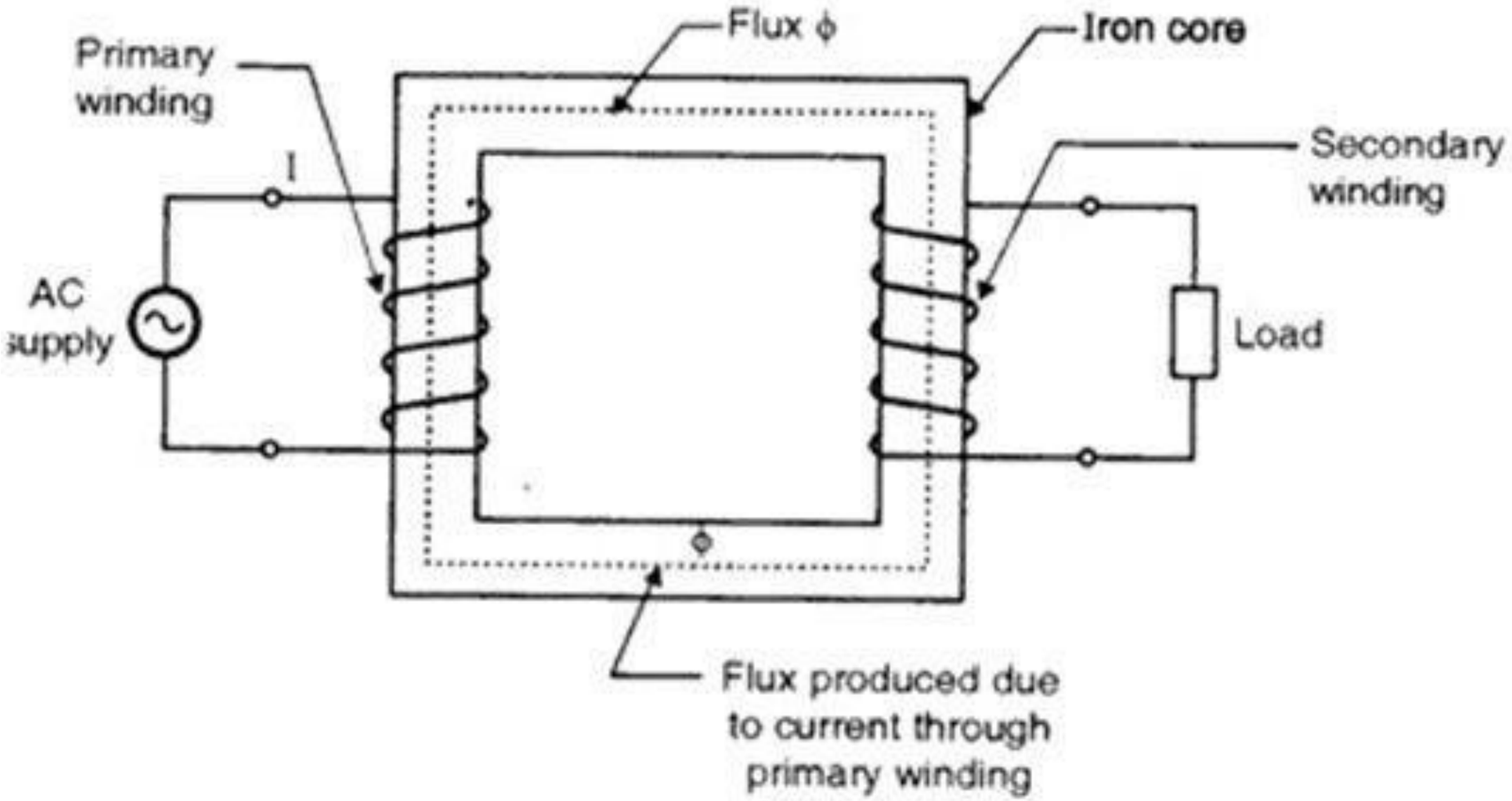
- A simple single-phase transformer has each winding being wound cylindrically on a soft iron limb separately to provide a necessary magnetic circuit, which is commonly referred to as “transformer core”.
- It offers a path for the flow of the magnetic field to induce voltage between two windings.
- The two windings are not close enough to have an efficient magnetic coupling.
- Thus, converging and increasing the magnetic circuit near the coils can enhance the magnetic coupling between primary and secondary windings.
- Thin steel laminations shall be employed to prevent power losses from the core.
- Based on how the windings are wound around the central steel laminated core, the transformer construction is divided into two types (i) Core (ii) Shell

Working of Single Phase Transformer

- A transformer is a static device that transfers electric power in one circuit to another circuit of the same frequency.
- It consists of primary and secondary windings.
- This transformer operates on the principle of mutual inductance.
- When the primary of a transformer is connected to an AC supply, the current flows in the coil and the magnetic field build-up.
- This condition is known as mutual inductance and the flow of current is as per the Faraday's Law of electromagnetic induction.
- As the current increases from zero to its maximum value, the magnetic field strengthens and is given by $d\phi/dt$.

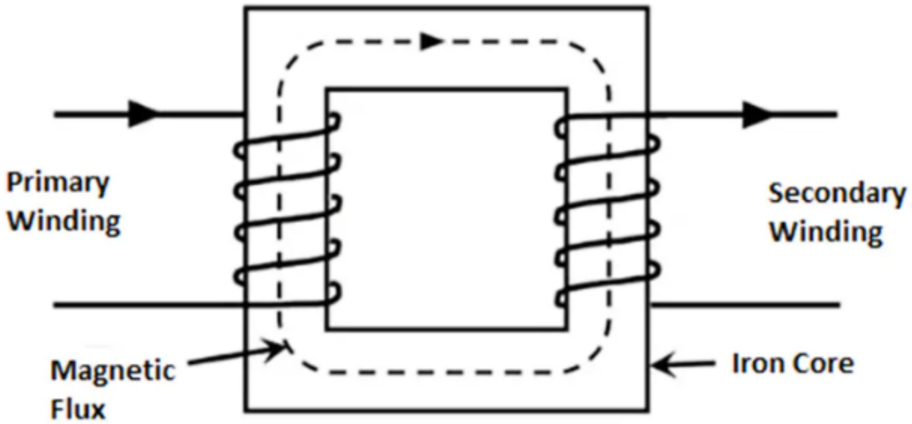
- This electromagnet forms the magnetic lines of force and expands outward from the coil forming a path of magnetic flux.
- The turns of both windings get linked by this magnetic flux.
- The strength of a magnetic field generated in the core depends on the number of turns in the winding and the amount of current.
- The magnetic flux and current are directly proportional to each other.
- As the magnetic lines of flux flow around the core, it passes through the secondary winding, inducing voltage across it.


Primary winding
N_p turns
Secondary winding
N_S turns
Primary current
I_p
Magnetic Flux, Φ
Secondary current
I_S
+
Primary voltage
V_p
−
+
Secondary voltage
V_S
−
Transformer Core


Primary winding
Flux ϕ
Iron core
Secondary winding
I
AC supply
Load
Flux produced due to current through primary winding

Core-type Transformer

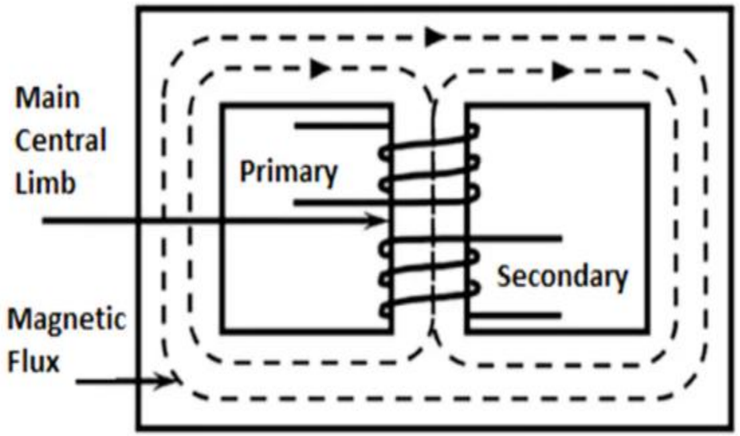
- In this type of construction, only half of the windings are wound cylindrically around each leg of a transformer to enhance magnetic coupling.
- This type of construction ensures that magnetic lines of force flow across both the windings simultaneously.
- The main disadvantage of the core-type transformer is the leakage flux that occurs due to the flow of a small proportion of magnetic lines of force outside the core.



Core Type Transformer

Shell-type Transformer

- In this type of transformer construction, the primary and secondary windings are positioned cylindrically on the center limb resulting in twice the cross-sectional area than the outer limbs.
- There are two closed magnetic paths in this type of construction and the outer limb has the magnetic flux $\phi/2$ flowing.
- Shell type transformer overcomes leakage flux, reduces core losses and increases efficiency.



Shell Type Transformer

Applications

- The applications of a single-phase transformer are mentioned below.
- To step-down long-distance signals to support both residential and light-commercial electronic devices
- In television sets for voltage regulation
- To step-up power in home inverters
- To supply power to non-urban areas
- To isolate two circuits electrically as primary and secondary are placed far from each other

Assessment

1. **A transformer transforms ?**

(A) voltage
(B) current
(C) current and voltage
(D) power.

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Thank You