SNS COLLEGE OF TECHNOLOGY

(An Autonomous Institution)

COIMBATORE-35

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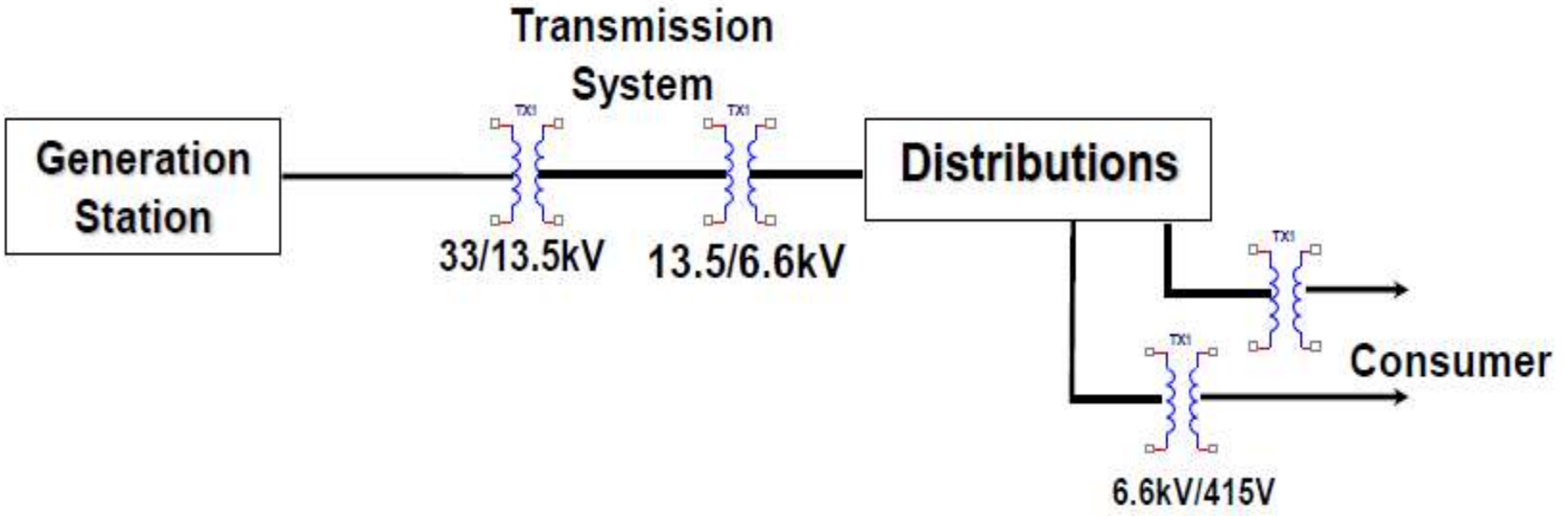
# SINGLE PHASE TRANSFORMER

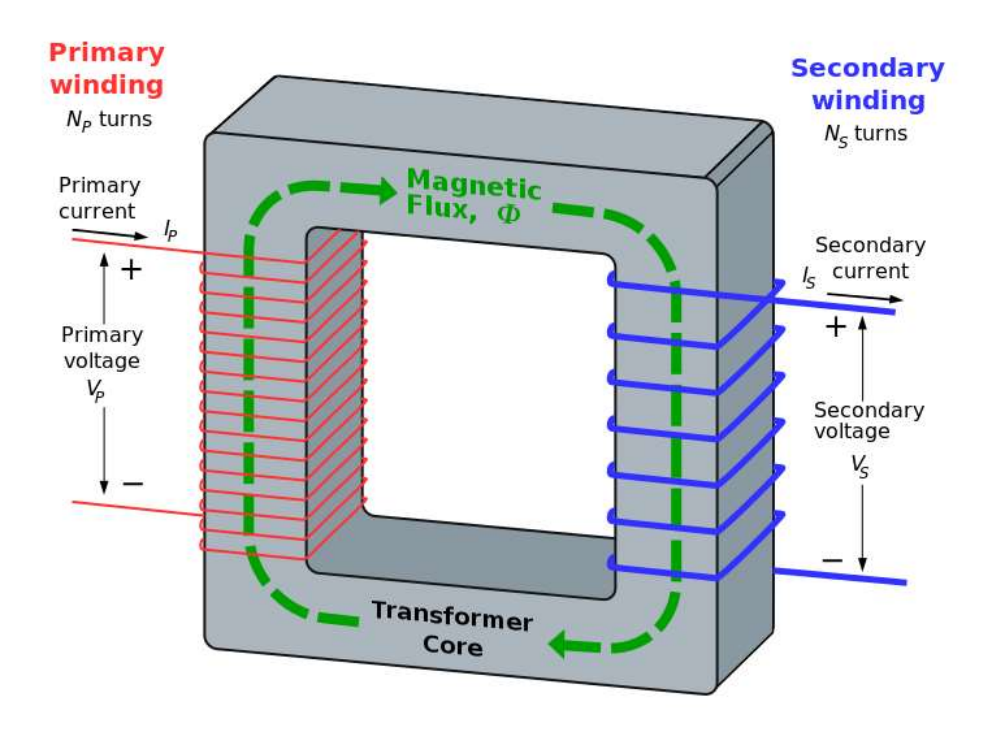
# INTRODUCTION

- The transformer is a static device which is used to transfer electrical energy from one ac circuit to another ac circuit.
- Input to a transformer and output from a transformer both are alternating quantities (AC).
- Electrical energy is generated and transmitted at an extremely high voltages. The voltage is to be then reduced to a lower value for its domestic and industrial use.
- This is done by using a transformer.

- The power transmission system using transformers is shown in figure.
- When the transformer changes the voltage level, it changes the current level also.



# Basic Principle




- The primary winding is connected to the single – phase ac supply, an ac current starts flowing through it.

- The ac primary current produces an alternating flux (Φ) in the core.
- Most of this changing flux gets linked with the secondary winding through the core.
- The varying flux will induce voltage into the secondary winding according to the faraday's laws of electromagnetic induction.
- Voltage level change but frequency i.e. time period remains same.
- There is no electrical contact between the two winding, an electrical energy gets transferred from primary to the secondary.

- A simple transformer consists of two electrical conductors called the primary winding and the secondary winding.
- Energy is coupled between the windings by the time varying magnetic flux that passes through( links) both primary and secondary windings.

- **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 dϕ/dt.
    - **N. dϕ/dt**
- where,
- 'N' is the number of coil turns

The frequency is the same in primary and secondary windings.

- Thus, we can say that the voltage induced is the same in both the windings as the same magnetic flux links both the coils together. Also, the total voltage induced is directly proportional to the number of turns in the coil.
- Let us assume that the primary and secondary windings of the transformer have single turns on each. Assuming no losses, the current flows through the coil to produce magnetic flux and induce voltage of one volt across the secondary.
- Due to AC supply, magnetic flux varies sinusoidally and it is given by,
  - $\phi = \phi_{max}$ **Sin ωt**
- The relationship between the induced emf, E in the coil windings of N turns is given by,
- **E=N (dØ)/dt**
- **$E=N*\omega*\phi_{max}$ cosωtφ**
- **$Emax=N\omega\phi_{max}$**
- **$Erms=N\omega/\sqrt{2}*\phi_{max}=2\pi/\sqrt{2}*f*N*\phi_{max}$**
- **$Erms=4.44\ fN\phi_{max}$**
- Where,
- 'f' is the frequency in Hertz, given by ω/2π.
- 'N' is the number of coil windings
- 'ϕ' is s the amount of flux in Webers
- The above equation is the Transformer EMF Equation. For emf of a primary winding of a transformer E, N will be the number of primary turns (NP), while for the emf, E of a secondary winding of a transformer, the number of turns, N will be (NS).

# Can the transformer operate on DC?

- Answer: **NO**
- The transformer action does not take place with a direct current of constant magnitude.
- Because with a DC primary current, the flux produced in the core is not alternating but it is of constant value.
- As there is no change in the flux linkage with the secondary winding, the induced emf in the secondary is zero.

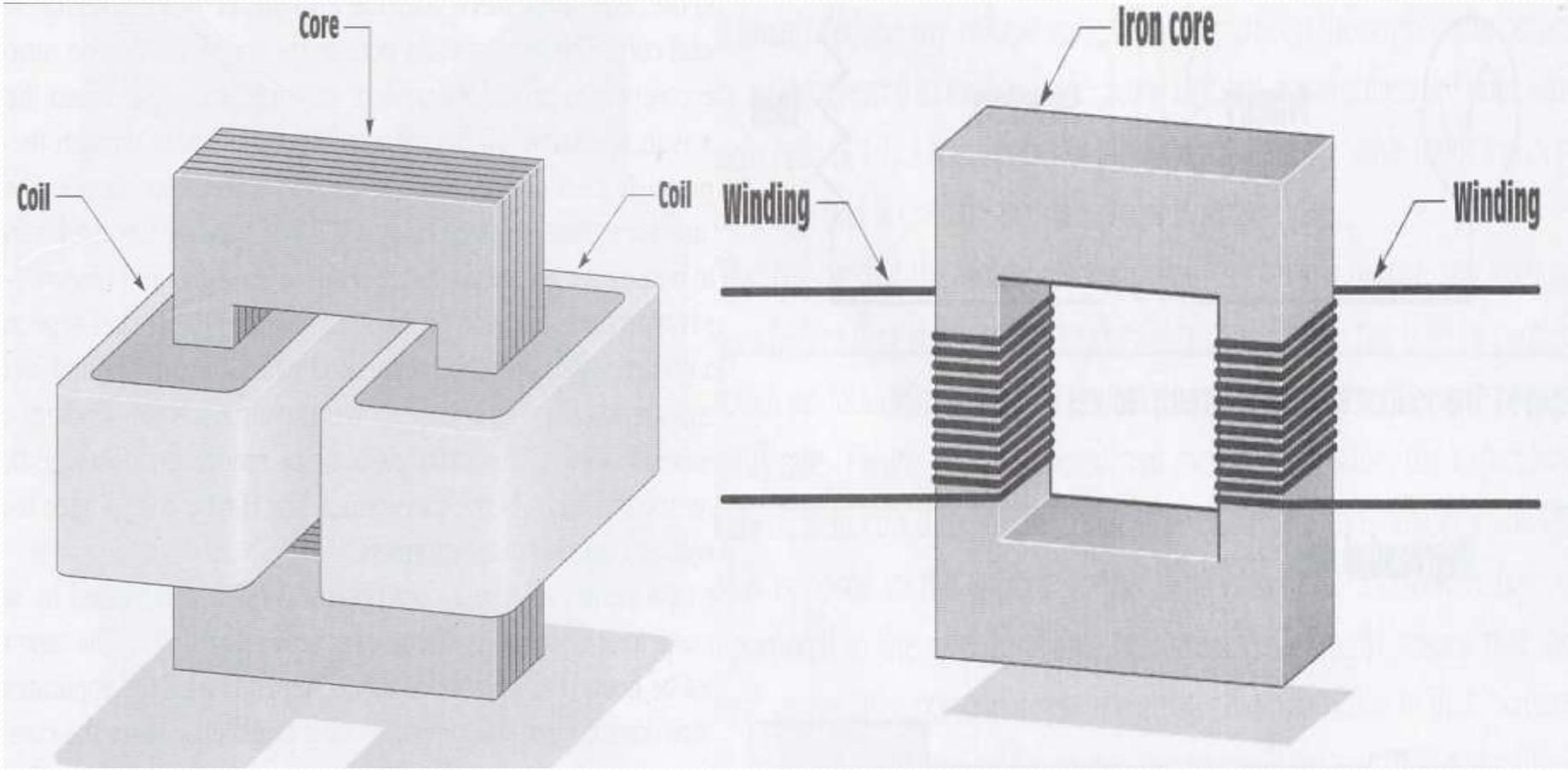
- If DC is applied to the primary then there is a possibility of transformer core saturation.
- If core saturates the primary will draw excessively large current. Therefore application of DC should be avoided.

- **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.
- As seen in the figure above, 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

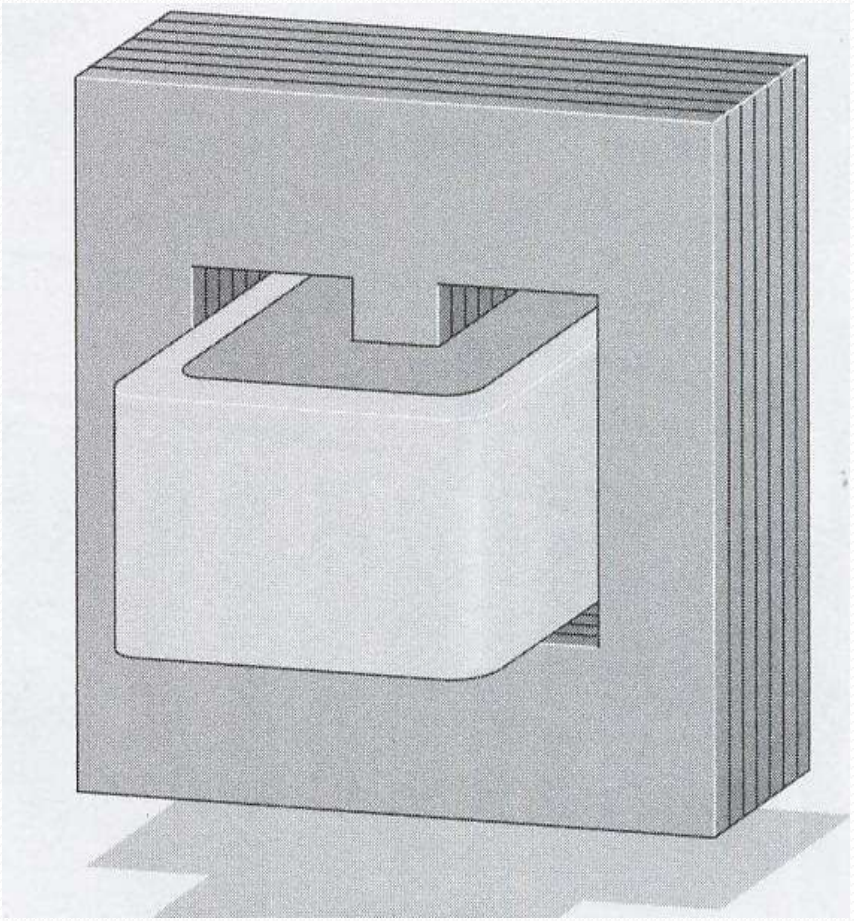
# Transformer Types

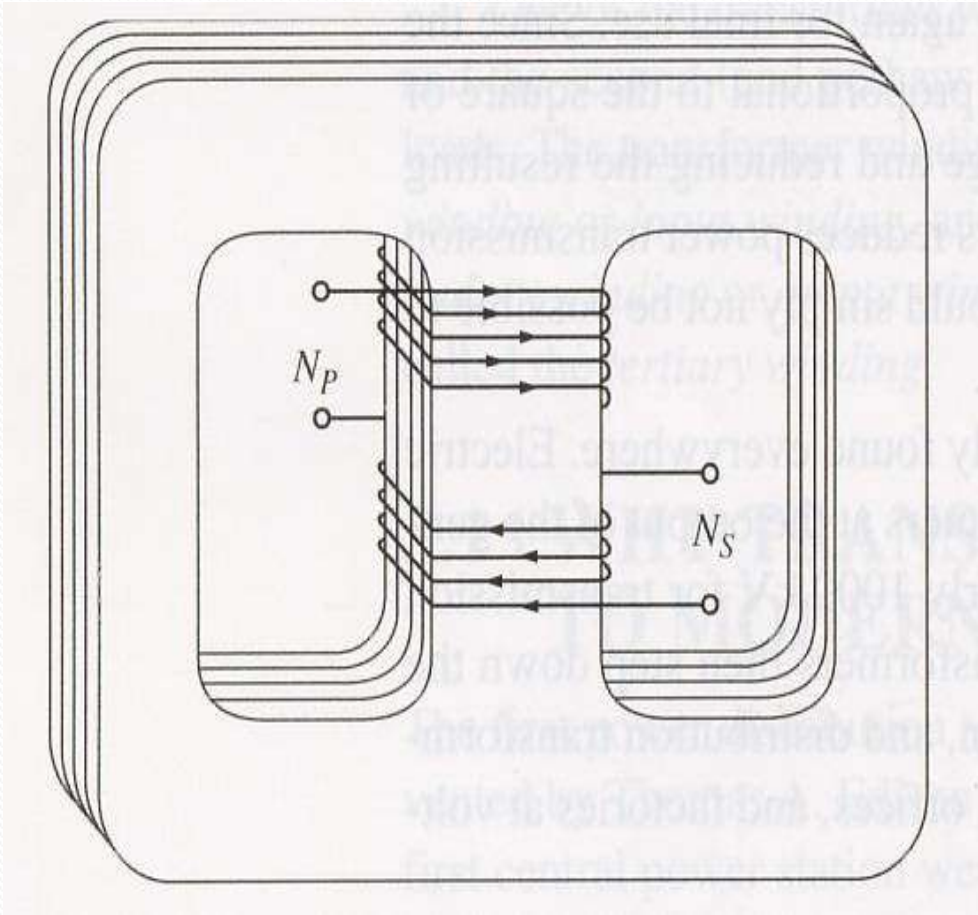
- The transformer are of different types depending on the arrangement of the core and the winding as follows.
- Core Type
- Shell Type
- Berry Type
- The magnetic core is a stack of thin silicon-steel laminations about 0.35 mm thick for 50 Hz transformer. In order to reduce the eddy current losses, these laminations are insulated from one another by thin layers of varnish.

# Core Type Transformer



# Shell Type Transformer

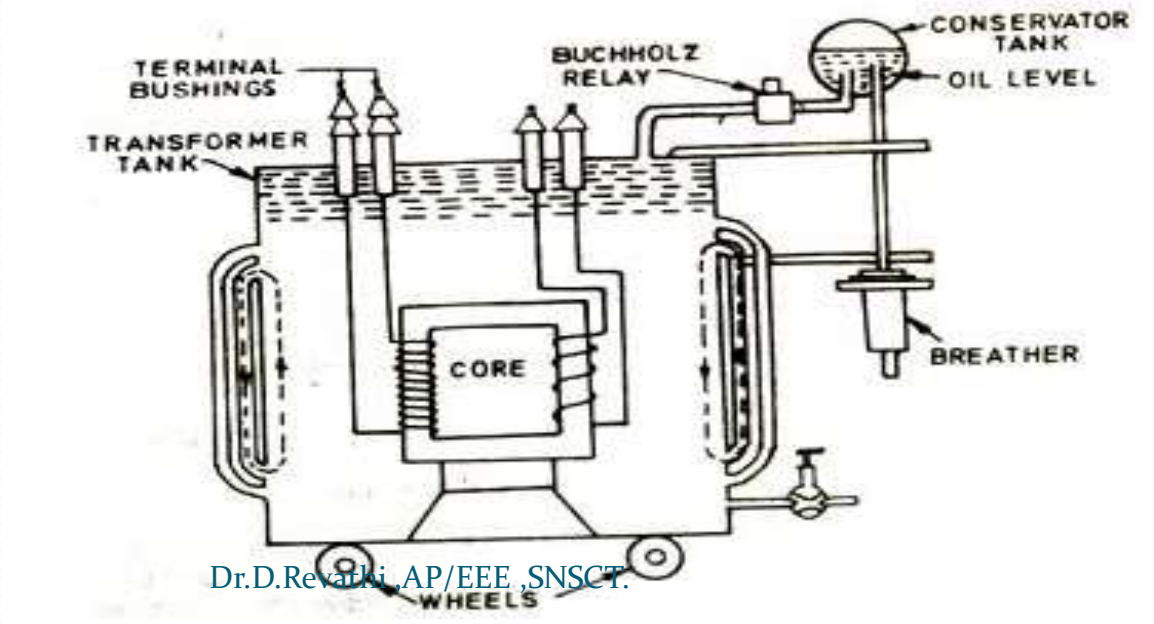




| Sr. No | Core Type Transformer | Shell Type Transformer |
|---|---|---|
| 1. | The core has only one window. | The core has two windows. |
| 2. | Winding encircles the core. | Core encircles the windings. |
| 3. | Cylindrical windings are used. | Sandwich type windings are used. |
| 4. | Easy to repair. | It is not so easy to repair. |
| 5. | Better cooling since more surface is exposed to the atmosphere. | Cooling is not very effective. |

# Construction of Transformer

- The Most important parts of a transformer are the windings (coils) and the core.
- Some other parts such as suitable tank, conservator, bushings, breather, explosion vent etc. are also used along with the core and windings.



# Applications

- Step – up and Step – down Voltage
- Measurement of current in single and three phase system
- Measurement of voltage in single and three phase system
- Measurement of power
- Measurement of Energy

# Thank You