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Report on

“Creative Assignment on **TRANSFORMER**”

For
INTRODUCTION TO ELECTRICAL ENGINEERING (BESCK204B)

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INTRODUCTION TO TRANSFORMERS

A **transformer** is a static electrical device that transfers electrical energy between two or more circuits through the principle of **electromagnetic induction**. It plays a critical role in the generation, transmission, and distribution of electrical power, allowing voltage levels to be increased (stepped-up) or decreased (stepped-down) efficiently. This makes long-distance power transmission feasible by minimizing power loss due to resistance in transmission lines.

Transformers operate only with **alternating current (AC)**. The basic structure consists of two windings—**primary** and **secondary**—wound on a common magnetic core. When an AC voltage is applied to the primary winding, it creates a time-varying magnetic field in the core. This changing magnetic field induces an electromotive force (EMF) in the secondary winding, according to **Faraday's Law of Electromagnetic Induction**. The amount of voltage induced depends on the **turns ratio** of the windings:

Transformers are classified based on various criteria such as **function (power or distribution transformers)**, **construction (core or shell type)**, and **number of phases (single-phase or three-phase)**. Modern power systems heavily depend on transformers at every stage: from generating stations to distribution substations and finally to consumer-level step-down units.

Their efficiency, reliability, and ability to provide electrical isolation between circuits make transformers indispensable in both large-scale power infrastructure and small electronic devices.

What is a Transformer?

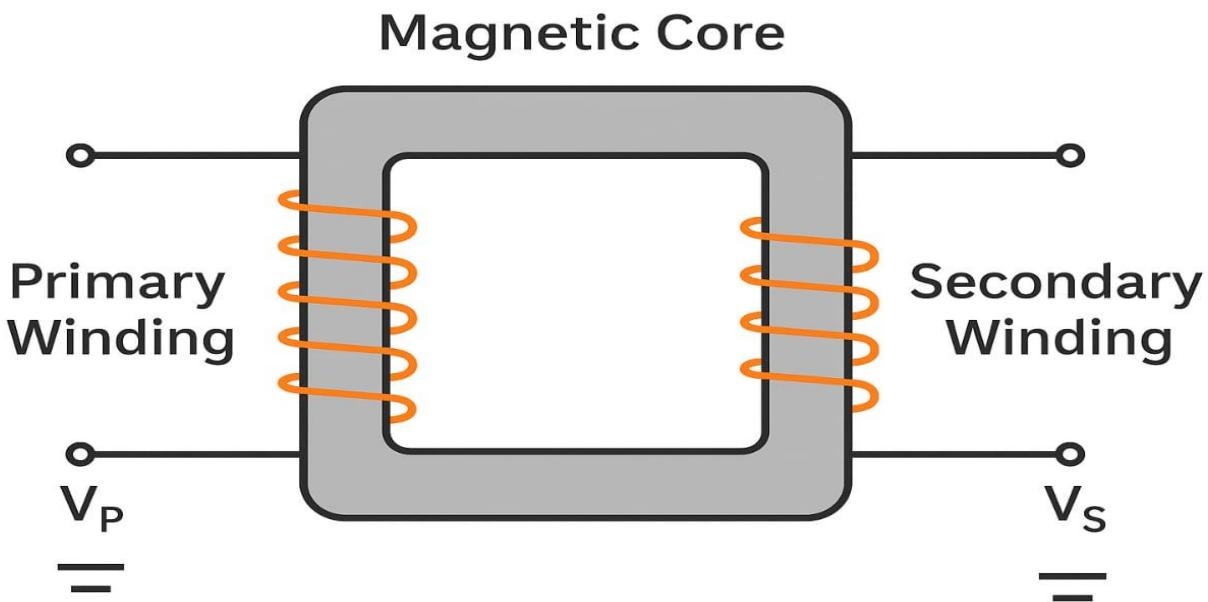
A **transformer** is an electrical device that transfers electrical energy from one circuit to another through **electromagnetic induction**. It is used primarily to change the voltage level — either stepping it up or stepping it down — without changing the frequency.

Basic Principle

Transformers operate on **Faraday's Law of Electromagnetic Induction**, which states that a changing magnetic field in a coil of wire induces a voltage in a nearby coil. A transformer has two main windings:

- **Primary winding:** Connected to the input voltage source.
- **Secondary winding:** Connected to the output load.

These windings are wrapped around a common magnetic core, and no electrical connection exists between them — only magnetic coupling.



The image is a simple, clear diagram of a basic transformer. Here's what it shows:

Labeled Parts:

Magnetic Core (gray): This is the central structure that provides a low-resistance path for magnetic flux. It links the primary and secondary windings magnetically.

Primary Winding (left, orange coil): This coil is connected to the input voltage source (V_P). It produces a magnetic field when current flows through it.

Secondary Winding (right, orange coil): This coil is connected to the output side and generates voltage (V_S) through electromagnetic induction.

Voltage Labels:

- : Voltage applied to the primary winding.
- : Voltage induced in the secondary winding.

Function:

The diagram illustrates how a transformer transfers energy from the primary side to the secondary side without physical connection — only through a shared magnetic field inside the core.

Would you like variations of this diagram, such as for step-up, step-down, or auto transformers?

TYPES OF TRANSFORMERS

1. Step-Up Transformer – Increases the voltage from primary to secondary.
2. Step-Down Transformer – Decreases the voltage from primary to secondary.
3. Power Transformer – Used in transmission networks for high voltages.
4. Distribution Transformer – Used to supply power to end users
5. Isolation Transformer – Provides electrical isolation between two circuits.
6. Auto Transformer – A transformer with a single winding that acts as both primary and secondary

APPLICATIONS

1. Power Transmission and Distribution

- Transformers are used to step up voltage at power generation stations for efficient long-distance transmission, and step down voltage near consumption points for safe usage.

2. Electric Power Supply for Industries

- High-power transformers are used in industries to supply voltage levels suitable for heavy machinery and equipment.

3. Household and Commercial Usage

- Small distribution transformers reduce voltage levels to standard 230V or 110V for safe domestic and office use.

4. Electronic Devices

- Transformers are embedded in chargers, adapters, and power supplies of gadgets to provide required low voltage.

5. Isolation and Protection

- Isolation transformers are used in laboratories and sensitive electronic equipment to prevent electrical noise and ensure safety.

6. Renewable Energy Systems

- In solar and wind energy systems, transformers are used to connect power from variable sources to the main grid.

Advantages and Disadvantages

Advantages:

1. Efficient Power Transmission

- Transformers enable high-voltage transmission over long distances, reducing energy loss due to resistance in the wires.

2. Voltage Conversion

- They can step up or step down voltage levels as needed, making electricity usable for both industrial machinery and household appliances.

3. Electrical Isolation

- Transformers provide safe electrical isolation between circuits, which helps in protecting users and equipment.

4. Improved Safety

- By adjusting voltage levels appropriately, transformers minimize the risk of electrical hazards during distribution.

5. No Moving Parts

- Being static devices, transformers require minimal maintenance and have a long operational life.

6. Wide Range of Applications

- Used in power systems, electronics, renewable energy setups, and various control systems, transformers are highly versatile.

Disadvantages:

1. Works Only with AC

- Transformers cannot operate with direct current (DC); they are limited to alternating current (AC) applications only.

2. Size and Weight

- Power transformers, especially for high-voltage uses, are large and heavy, requiring substantial space and support infrastructure.

3. Initial Cost

- High-quality transformers involve significant manufacturing costs, making the initial investment expensive.

4. Iron and Copper Losses

- Transformers suffer from energy losses due to hysteresis in the core (iron loss) and resistance in the windings (copper loss).

5. Noise Pollution

- Magnetostriction in the core can cause humming noises, especially in large transformers, which may be undesirable in residential areas.

6. Limited Overload Capacity

- Transformers cannot handle excessive overload for long periods; doing so risks overheating and insulation damage.

CONCLUSION

Transformers are essential components in modern electrical systems, enabling the efficient and safe transfer of electrical energy across varying voltage levels. Their ability to step up and step down voltages makes long-distance power transmission practical and cost-effective. With no moving parts, transformers offer high reliability and minimal maintenance, serving a wide range of applications from power grids to household electronics. Despite some limitations—such as energy losses and high initial costs—the advantages significantly outweigh the drawbacks. Understanding the principles, types, and uses of transformers is fundamental for engineers and technicians working in the electrical and power sectors.