

MUTUAL INDUCTION

Summer Internship
at
Centre for Indian Knowledge System



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Table of Contents

- Introduction
- Theoretical Background
- Application in Engineering
- Experimental Setup and Methodology
- Results and Analysis
- Discussion
- Conclusion
- Reference

Introduction

Mutual inductance, the working principle of numerous electrical devices, is a property of a conductor or a coil in the circuit. It is defined as the property of a conductor of a coil or conductor that opposes the change in current or voltage in another coil placed close to it.

Application in Engineering

Mutual induction is widely used in engineering for:

- ❑ **Transformers:** These devices use mutual induction to change the voltage levels in electrical circuits, enabling efficient transmission and distribution of electrical power.
- ❑ **Inductive Coupling:** Used in wireless power transfer systems, such as inductive chargers for smartphones and other devices.
- ❑ **Inductive Sensors:** Used in proximity sensors and non-contact switches where detecting the presence of metal objects is required.
- ❑ **Communication:** Inductive coupling is also used in some types of communication systems, such as RFID (Radio Frequency Identification) tags.

In all these applications, mutual induction allows for efficient and safe transfer of electrical energy and signals without direct electrical contact between components.

Experimental Setup

An experimental setup to demonstrate mutual induction typically involves:

- ❑ **Two Coils:** Use two coils of wire, preferably with a significant number of turns, placed close to each other.
- ❑ **Power Source:** Connect one coil to a DC (direct current) power source. The changing current in this coil will create a changing magnetic field.
- ❑ **Induced Voltage Measurement:** Connect the second coil to a LED. As the magnetic field from the first coil changes, it induces a voltage in the second coil.
- ❑ **Observation:** Observe the LED glowing, which will show voltage fluctuations corresponding to changes in the current flowing through the first coil.

This setup demonstrates how a changing current in one coil induces a voltage in the other coil due to mutual induction. It's a fundamental experiment showcasing the principles used in transformers and other devices that rely on mutual induction.

Methodology

The methodology of mutual induction involves:

- ❑ **Setup of Coils:** Place two coils of wire close to each other.
- ❑ **Apply Changing Current:** Pass an direct current (DC) through one coil (primary coil).
- ❑ **Observation:** Measure the voltage induced in the second coil (secondary coil) using a multimeter.
- ❑ **Analysis:** Note how the induced voltage in the secondary coil changes with the frequency and magnitude of the current in the primary coil.

This method demonstrates how a changing magnetic field generated by one coil induces a voltage in another coil nearby, illustrating the principle of mutual induction.

Results

The results of mutual induction typically include:

- 1.Voltage Induction:** When a direct current flows through one coil (primary coil), it generates a changing magnetic field.
- 2.Induced Voltage:** This changing magnetic field induces a voltage in a nearby coil (secondary coil) without direct electrical connection.
- 3.Proportional Relationship:** The induced voltage in the secondary coil depends on factors like the number of turns in the coils and the rate of change of current in the primary coil.

These results demonstrate how mutual induction enables the transfer of electrical energy between coils and is fundamental to the operation of transformers and many other electrical devices.

Analysis

Mutual induction analysis involves understanding:

- ❑ **Cause:** A changing current in one coil creates a changing magnetic field.
- ❑ **Effect:** This changing magnetic field induces a voltage in a nearby coil.
- ❑ **Factors:** The induced voltage depends on factors like the number of turns in the coils, the frequency of the alternating current, and the distance between the coils.
- ❑ **Applications:** Mutual induction is used in transformers, inductive sensors, wireless power transfer, and communication technologies like RFID.
- ❑ **Importance:** It allows for efficient transmission of electrical energy and signals without physical contact, enabling various technological advancements in power distribution and electronics.

This analysis highlights how mutual induction plays a crucial role in modern engineering applications.

Discussion

Mutual induction is a fundamental principle in electromagnetism where a changing magnetic field generated by one coil induces a voltage in a nearby coil. This phenomenon forms the basis for transformers, which are crucial in electricity distribution and voltage regulation. It also enables technologies like wireless charging and inductive sensors, where energy or signals are transferred without direct electrical contact. Understanding mutual induction has paved the way for innovations in power transmission, communication, and sensor technology, making it indispensable in modern engineering and everyday.

Conclusion

In conclusion, mutual induction is a vital concept in electromagnetism that underpins the functionality of transformers, wireless charging systems, and various sensors. It demonstrates how a changing magnetic field in one coil induces a voltage in a nearby coil, enabling efficient energy transfer without physical contact. This principle is essential in modern engineering for electricity distribution, communication technologies, and many other applications where reliable and efficient electrical transfer is required.

Beyond power transmission, mutual induction drives innovations like wireless charging technologies for smartphones and electric vehicles, as well as inductive sensors used in automation and security systems. Its versatility underscores its importance in advancing modern engineering solutions, ensuring efficient and reliable operation across various industrial and consumer applications.

