

**DEPARTMENT OF
ELECTRONICS AND COMMUNICATION ENGINEERING
College of Engineering and Technology, SRM IST.**

MINI PROJECT REPORT

EVEN Semester 2023-24

Lab Code & Title : 21ECC101J – Electronic Systems and PCB Design

Year & Semester : I Year, II Semester

Project Title : **Mutual Inductor**

Lab Supervisor : DR. Sanjay Kumar Sahu

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Reg. No & Name →	Alan Jaba	Aditya Komath	Asima Shaik
Mark split up ↓	(RA231100401367)	(RA231100401370)	(RA231100401388)
Novelty of the project (5 marks)			
Understanding Level (10 marks)			
Contribution (5 Marks)			
Report writing (5 Marks)			
Viva voce (25 Marks)			
Total (50 Marks)			

Date:

Signature of Lab Supervisor

TITLE: The working of a Mutual Inductor/ Transformer

OBJECTIVE :

To construct a working model of a mutual inductor

ABSTRACT :

Mutual inductors, also known as transformers, are essential devices in electrical engineering. They operate on the principle of electromagnetic induction, transferring electrical energy from one circuit to another through a shared magnetic field. Transformers facilitate voltage transformation, stepping up or stepping down AC voltages as required for efficient power transmission and distribution. They are crucial in various applications, from power generation and distribution to electronic devices. Understanding their principles is key to optimizing performance and ensuring reliable electrical systems.

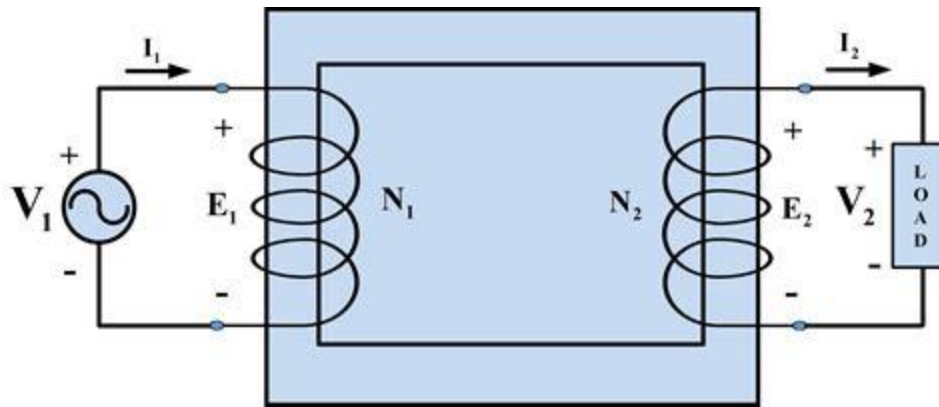
INTRODUCTION :

Mutual inductors are indispensable components in electrical engineering. These devices harness the phenomenon of electromagnetic induction to transfer electrical energy between circuits. At their core, mutual inductors consist of two or more coils of wire wound around a shared ferromagnetic core. When an alternating current flows through one coil, it generates a changing magnetic field in the core, inducing a voltage in the other coil through electromagnetic induction. This enables the conversion of voltage levels, facilitating efficient power distribution, voltage regulation, and isolation in electrical systems.

HARDWARE REQUIREMENT/DESCRIPTION :

Breadboards, resistors, bulb-led, copper wire coils, voltage source, connecting wires to establish connections between the components

CIRCUIT DIAGRAM & DESCRIPTION :



A transformer circuit incorporating coils and resistors typically involves a primary coil connected to an AC voltage source, a secondary coil, and load resistors connected across the secondary coil. Here's a description of such a circuit:

1. **Primary Coil:** The primary coil consists of a certain number of turns of insulated wire wound around one side of the transformer core. It is connected to an alternating current (AC) voltage source, which could be the power grid or an AC generator.
2. **Transformer Core:** The primary and secondary coils are wound around a common ferromagnetic core. This core serves to concentrate the magnetic flux generated by the coils, enhancing the efficiency of energy transfer between them.
3. **Secondary Coil:** The secondary coil is wound around the other side of the transformer core. It typically has a different number of turns compared to the primary coil, which determines the voltage transformation ratio of the transformer.
4. **Load Resistors:** Load resistors represent the electrical load connected to the secondary coil.

Procedure to make the circuit on a breadboard:

The two sides of this inductor are built on different breadboards and the breadboard not connected to an AC supply is moved closer and then moved away from the coil. This will induce a change in magnetic flux between the two coils, in turn generating an emf and creating a mutual inductor.

PCB DESIGN RULES :

- 1) Clearance and Spacing: Maintain proper distances between traces, pads, and components to prevent short circuits and ensure manufacturability.
- 2) Trace Width and Thickness: Determine appropriate trace dimensions based on current carrying capacity and impedance requirements. Via Placement: Strategically place vias to facilitate signal routing and avoid interference with component mounting areas.
- 3) Component Placement: Arrange components for optimal signal integrity, thermal management, and ease of assembly and testing.
- 4) Silkscreen and Reference Designators: Clearly label components and features on the silkscreen layer for easy identification.
- 5) Power Distribution: Design robust power distribution networks with dedicated planes or wide traces to minimize voltage drop.
- 6) Ground Plane: Include a solid ground plane for low-impedance signal return paths and EMI reduction.
- 7) Signal Integrity: Address signal integrity issues by adhering to controlled impedance routing and minimizing trace lengths.
- 8) Design for Manufacturability (DFM): Consider manufacturing constraints to ensure reliable and cost-effective production.
- 9) Design for Testing (DFT): Incorporate test points and access features to facilitate testing and debugging during assembly.

Adhering to these rules ensures a functional, reliable, and manufacturable PCB design while minimizing the risk of errors and production challenges.

DESIGN CONSTRAINTS :

- 1) Size and Form Factor: PCB dimensions must fit within designated space constraints, dictated by enclosure or mounting requirements.
- 2) Component Compatibility: The layout must accommodate specified components in terms of package sizes, pin configurations, and mounting constraints.
- 3) Electrical Specifications: Ensure the design meets voltage, current, impedance, and signal integrity requirements as per project specifications.
- 4) Environmental Considerations: Account for factors like temperature, humidity, and vibration to maintain performance and reliability in varying conditions.
- 5) Regulatory Compliance: Adhere to relevant industry standards, safety regulations, and certification requirements applicable to the intended application.
- 6) Cost and Manufacturing: Optimize design for cost-effectiveness while considering manufacturing processes, assembly techniques, and component availability.

RESULT AND DISCUSSION:

Result:

The working principle involves Faraday's law of electromagnetic induction, which states that a changing magnetic field induces an electromotive force (EMF) in a nearby conductor. Here's how it works:

1. Primary Coil: When an alternating current (AC) flows through the primary coil, it creates a changing magnetic field around it. This changing magnetic field induces an alternating voltage (AC) in the secondary coil according to Faraday's law.
2. Magnetic Core: The magnetic core serves to concentrate the magnetic field generated by the primary coil. It ensures efficient transfer of energy from the primary coil to the

secondary coil.

3. Secondary Coil: The alternating voltage induced in the secondary coil can be transformed to a different voltage level depending on the ratio of the number of turns in the

primary and secondary coils. If the secondary coil has more turns than the primary coil, the output voltage will be greater than the input voltage (step-up transformer). Conversely, if the secondary coil has fewer turns than the primary coil, the output voltage will be less than the input voltage (step-down transformer).

4. Isolation and Transmission: Mutual inductors provide electrical isolation between the primary and secondary circuits while allowing energy transfer. This isolation is crucial in applications where safety and protection against electric shock are required. Overall, mutual inductors are fundamental components in electrical systems for voltage transformation, impedance matching, and isolation, playing a vital role in various applications such as power distribution, electrical appliances, and electronic devices.

Discussion:

Transformers and mutual inductors are indispensable components in electrical engineering, facilitating efficient energy transfer and voltage transformation. They play a pivotal role in power distribution, enabling the transmission of electricity over long distances while maintaining voltage stability. Beyond power grids, transformers are integral to various industries, from manufacturing and transportation to telecommunications and renewable energy. They provide voltage regulation, electrical isolation, and compatibility between different electrical systems, ensuring optimal performance and safety. In everyday life, transformers power electronic devices, charge batteries, and support essential infrastructure. Their importance lies in enabling the reliable and efficient distribution of electrical energy, driving technological advancements and global connectivity.

CONCLUSION :

In conclusion, transformers and mutual inductors stand as foundational pillars in modern electrical engineering, serving a multitude of critical functions across diverse industries. From facilitating efficient power distribution and voltage regulation in electrical grids to powering everyday electronic devices, their significance is undeniable. These components not only ensure the reliable transmission of electrical energy but also contribute to energy conservation and sustainability efforts. As technology continues to evolve, the role of transformers and mutual inductors remains essential, driving innovation, enabling connectivity, and powering the infrastructure of our interconnected world. Their versatile applications and enduring importance underscore their status as indispensable elements of the modern technological landscape.

REFERENCES :

<https://ieeexplore.ieee.org>

<https://www.allaboutcircuits.com/>