A Practical Model of the Mutual Induction Effect for Student Learning and Application

Prof P S Thakare[1], Ms Srushti P Bochare[2], Ms Pooja Santosh Raut[3], Mr Ajay Kailas Deshmukh[4]
[1,2,3,4] *Padma shri Dr V B Kolte College of Engineering malkapur*

***Abstract*—This paper presents a simplified and practical model of the mutual induction effect tailored for student understanding and academic use. The model demonstrates the fundamental principles of mutual induction using basic circuit components and mathematical relationships, allowing students to explore the physical phenomena and its engineering relevance. This approach bridges theoretical knowledge with hands-on experimentation, providing a valuable educational tool.**

I. INTRODUCTION

Mutual induction is a core concept in electromagnetism, critical to the operation of transformers, inductive sensors, and wireless power transfer systems. Despite its importance, many students struggle to grasp the concept due to abstract explanations and limited experimental resources. This paper introduces a model that simplifies the concept while maintaining scientific integrity, making it accessible to students.

II. THEORETICAL BACKGROUND

Mutual induction occurs when a changing current in one coil induces an electromotive force (EMF) in another nearby coil through a shared magnetic field. According to Faraday's Law of Induction:
Where:

- : Induced electromotive force (EMF)
- : Mutual inductance (Henries)
- : Rate of change of current in the primary coil

III. PROPOSED MODEL

The model comprises two coils placed in proximity, with the primary coil connected to a function generator and the secondary coil connected to an oscilloscope. By varying the frequency and amplitude of the primary current, students can observe the corresponding induced voltage in the secondary coil.

Components Used

- Two copper coils (400 P1 and 200 turn P2)
- LED
- PN Junction Diode
- Auto transformer

Fig 1.1 actual model view with red light on

IV. SIMULATION AND RESULTS

A simulation using Multisim/Proteus confirmed the expected behavior of mutual induction. Increasing the frequency of the input signal led to a proportional increase in the induced EMF, validating the theoretical relationship. The results showed clear voltage peaks in the secondary coil when the primary coil current changed rapidly.

V. EDUCATIONAL APPLICATION

This model allows students to:

- Visualize magnetic field interactions
- Measure induced EMF

- Understand the impact of coil distance and orientation
- Explore real-world applications in transformers and wireless charging

VI. CONCLUSION

The mutual induction model presented here provides an accessible and practical approach for students to study electromagnetic induction. Its simplicity and effectiveness make it a valuable addition to physics and electrical engineering curricula.

REFERENCES

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