PHYSICS INVESTIGATORY PROJECT

ARMY PUBLIC SCHOOL
AMBALA CANTT.

CLASS – XII
SESSION 2024-25

Topic: The Factors upon which
Self-Inductance is Dependent.

Submitted by:

Submitted to:

CERTIFICATE

This is to certify that this bonafide project work in the subject of Physics has been done by

of Class XII in the academic session 2024-25 and submitted to AISSCE Practical Examination conducted by CBSE at Army Public School, Ambala Cantt, on

Internal Examiner:

External Examiner:

Introduction

Inductance is the process in which an emf is induced by a changing magnetic flux. Mutual inductance is the effect of Faraday's law of induction for one device upon another, such as the primary coil in transmitting energy
to the secondary in a transformer.

In addition to this, the magnetic field can also affect the current in the original circuit that produced the field. This phenomenon is known as *self-inductance,* and it finds applications in a wide variety of fields.

Aim

To study the factors upon which self inductance of a coil depends by observing its effect on a bulb placed in series with it, within an A.C. circuit, Source being of adjustable frequency.

Apparatus

A coil with a large number of turns, A.C. Source, 6V bulb, ammeter, soft iron rod, key/switches, connecting wires.

Theory

Self-Inductance is a property of a coil due to which it opposes the change in current through it. The self-inductance of a long solenoid is given by the equation: $L = \mu_0\mu_r N^2 A/l$

Here, μ_0 is the permeability in free space, μ_r is the relative magnetic permeability of the magnetic material; N, A and *l* are the Number of turns, Area of cross-section and length of the solenoid, respectively.

The self-inductance of a coil depends on three factors:

1. The number of turns, $L \alpha N^2$
2. Geometry of the coil, $L \alpha A$, $L \alpha (1/l)$
3. Nature of the core material, $L \alpha \mu$

When an indicator is connected in series with a resistance with variable frequency source, the current that flows through the bulb is:

$I_{rms} = E_{rms}/Z$

Where $Z = (R^2 + \omega^2)^{1/2}$, the impedance of the A.C. circuit; Where R is the resistance offered by the bulb, L is the coil's self-inductance and
$\omega = 2\pi f$, the angular frequency of the A.C. source.

Circuit Diagram

Procedure

1. Make all connections as shown in diagram.

2. Turn on the A.C. supply, adjust current with the rheostat.

3. Note the current in the A.C. ammeter, check the bulb's brightness; Then put the soft iron core inside the inductor and note the current and brightness again; Both decrease.

4. Turn the supply off and lower the source frequency.

5. Turn on the supply once more and adjust the current in the circuit at same constant voltage 10V with the rheostat. Note the current in the ammeter and bulb's brightness; Both will increase.

6. Re-insert the iron in the coil's core and note the current and brightness; Both should decrease again.

7. Repeat steps 4, 5 and 6 a few more times and note their readings.

Observations

Result

1. The current in the circuit decreases on inserting the iron rod in the core of coil at constant frequency of applied voltage along with the brightness of the bulb.

2. The current in the circuit increases when the applied voltage frequency is decreased, along with the bulb's brightness.

Precautions

1. The coil should have a large number of turns.
2. Current should be passed for a small time to avoid changes in results due to the heating effect of current.

Sources of Error

1. The resistance of the circuit may increase due to heating effect.
2. There can be eddy currents created in the soft iron core.

Applications

The phenomenon of self-inductance has a wide variety of applications and use-cases in electric circuits, as well as in semiconductor-based electronic circuits, appliances and machinery; including but not limited to

Relays – These are electromagnetic switches that open/close circuits electromechanically or electronically. A larger current is controlled via the use of a smaller current. This device makes use of self-induction.

Environmental Sensors – The effect of self-inductance can be used to detect metallic objects that interact with a magnetic field; Useful in metal detectors, proximity sensors etc.

Transformers – It transfers electricity from one circuit to another. A varying current in any of its coils produces a varying magnetic flux in its core, inducing a varying EMF across other coils wound around the core. Thus electricity is transfered between coils without an actual material connection between them.

From this and many other use cases, it is quite evident that self-induction is extremely important, with no shortage of practical usage cases.