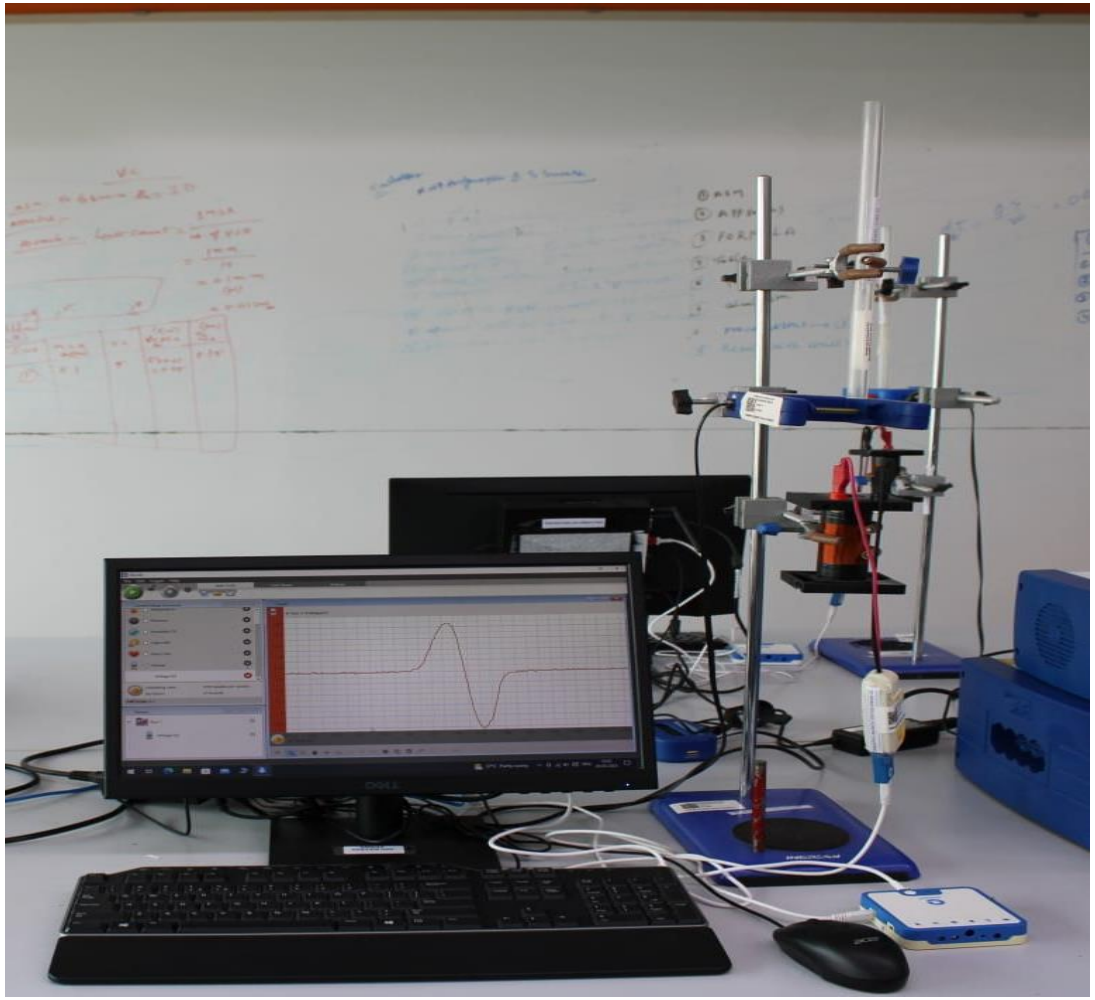
Faraday's law



Prepared by:
Mr. Soumyaditya Das and Dr. Pankaj Bhalla

Department of Physics
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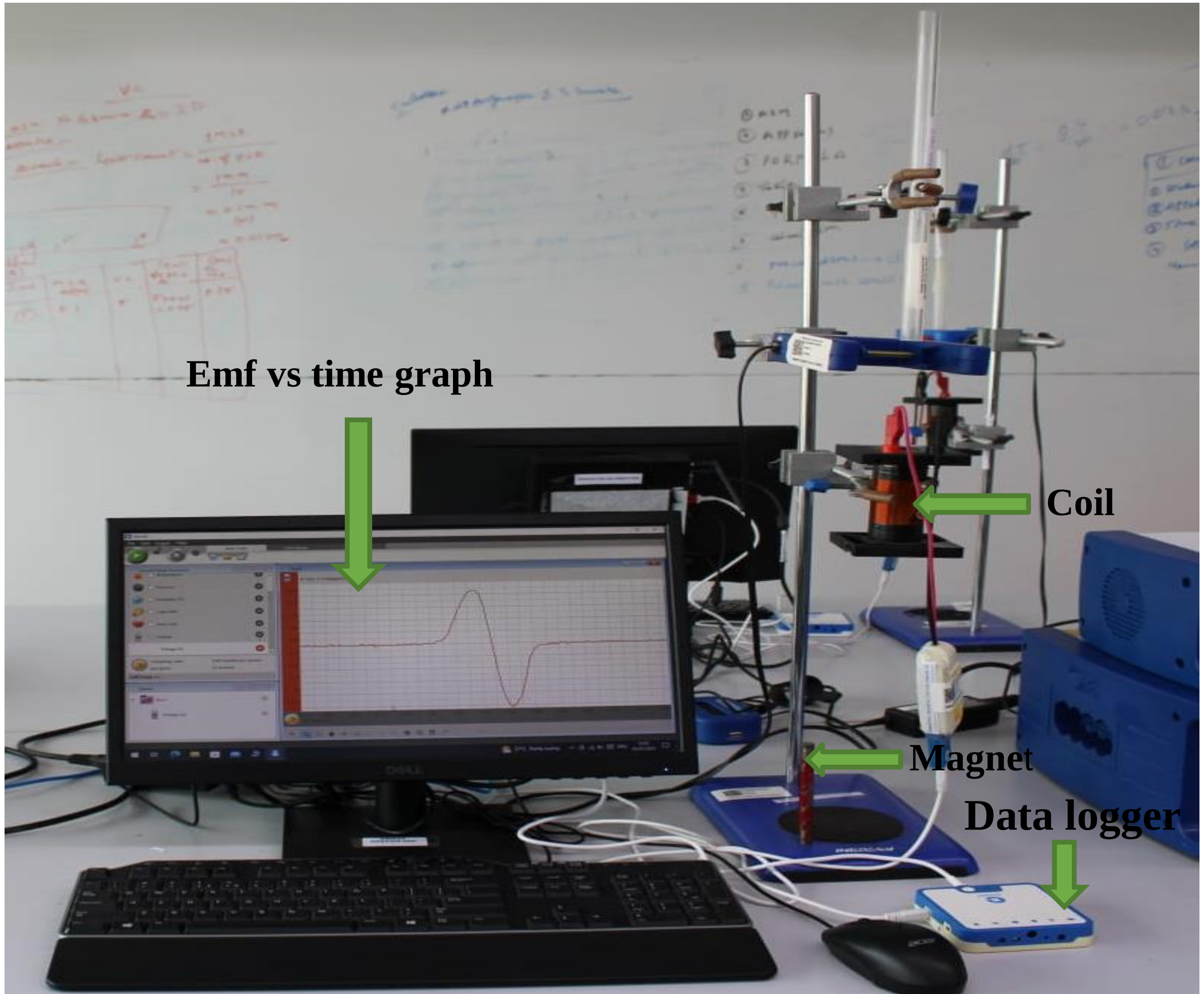
Aim: To calculate the magnetic flux induced by a falling magnet using Faraday's law

Apparatus: Data logger, voltage sensor, boss head, coil [Number of turns N= 700, Length of the coil L = 125MM, Diameter of the coil =32MM], cylindrical magnet, photo gate.

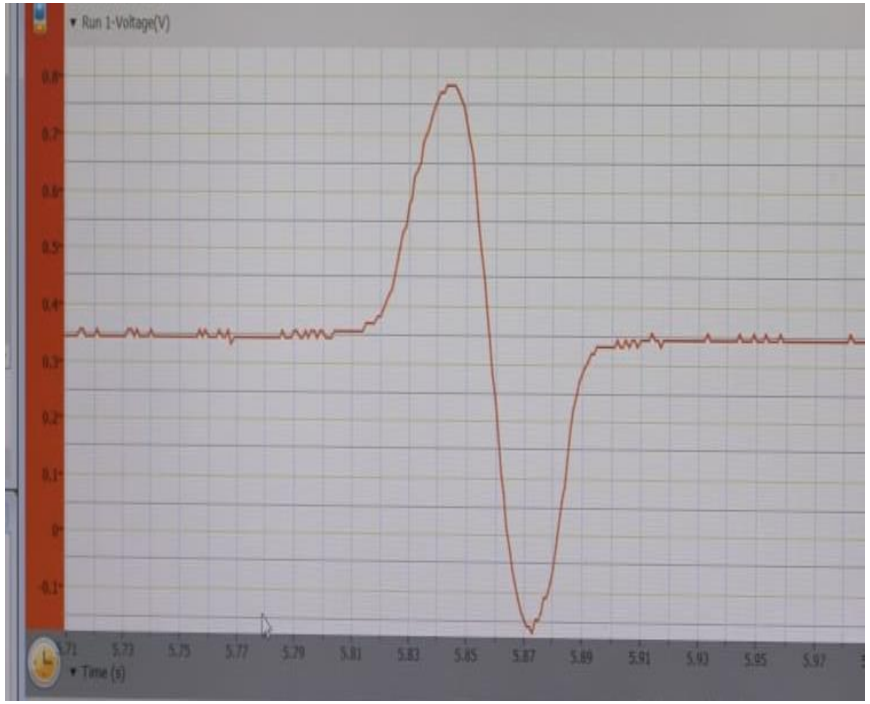


Working formula:

$$\varepsilon = -N\frac{d\phi}{dt}$$

$$\frac{d\phi}{dt} = -\frac{\varepsilon}{N} \rightarrow \phi = -\frac{1}{N}\int \varepsilon\, dt \rightarrow \phi = -\frac{1}{N} \times A$$

Where A is the area under emf vs. time graph which can be calculated using the software provided for the experiment. The area is the arithmetic sum of two areas corresponding to positive and negative peaks (just add two numerical values by neglecting the negative sign for negative peak).



Emf vs time graph

Procedure:

1. Open Milab software. Turn off the data logger indicator to activate the software.
2. Run it.
3. Drop the magnet through the coil within the time set for data recording.
4. Measure area from the emf vs time graph.
5. Calculate flux.

Calculation: Area under the positive peak = $\boldsymbol{A_1}$, Area under the negative peak = $\boldsymbol{A_2}$

Total area , $\mathbf{A} = \boldsymbol{A_1} + \boldsymbol{A_2}$

Magnetic flux , $\boldsymbol{\phi} = -\frac{\mathbf{1}}{\boldsymbol{N}} \times \boldsymbol{A}$ (Wb in S.I unit)

Result: The magnetic flux linked with the coil is =…… Wb

Precautions:

1. Data logger indicator should be in off mode
2. Don’t touch the voltage sensor while doing the experiment.
3. Catch the magnet properly after you pass through the coil.

VIVA QUESTIONS

1. What is Faraday's law of electromagnetic induction?

Whenever there is a change in the magnetic flux ***(φ)*** linked with a coil, an emf is induced.

The induced emf, $E = -N\frac{d\Phi}{dt}$, Where N is the number of turns

2. What is Lenz's law?

When an emf is induced according to Faraday's law, the polarity (direction) of that induced emf is such that it opposes the cause of its production.

3. What is the relation between magnetic flux, φ and magnetic induction, *B*?

If φ is the total flux of magnetic field lines through a unit cross sectional area of the material.

Magnetic induction $= B =$ Magnetic flux/Area $= \varphi/A$

4. How the induced emf changes with the velocity of the magnet?

The greater the speed, the greater the magnitude of the emf, and the emf is zero when there is no motion.

5. Write down the differential and integral form of Faraday's law?

$\oint_l \vec{E}.\overrightarrow{dl} = -\int_s \frac{\partial \vec{B}}{\partial t}.\overrightarrow{ds}$ (integral form)

$\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$(differential form)

6. Explain how magnetic flux can be zero when the magnetic field is not zero?

The magnetic flux is generated when a change in the magnitude and direction of the magnetic field occurs. If the magnetic field is parallel to the place of the area that is exposed, then the magnetic flux generated is zero when the magnetic field is not zero.

7. Why the negative peak for emf vs time curve is longer than the corresponding positive peak ?

The magnet move fastly when it moves out than when it moves into the coil.

8. What are the applications of Faraday's law of induction in daily life?

Electrical generators, transformers etc.