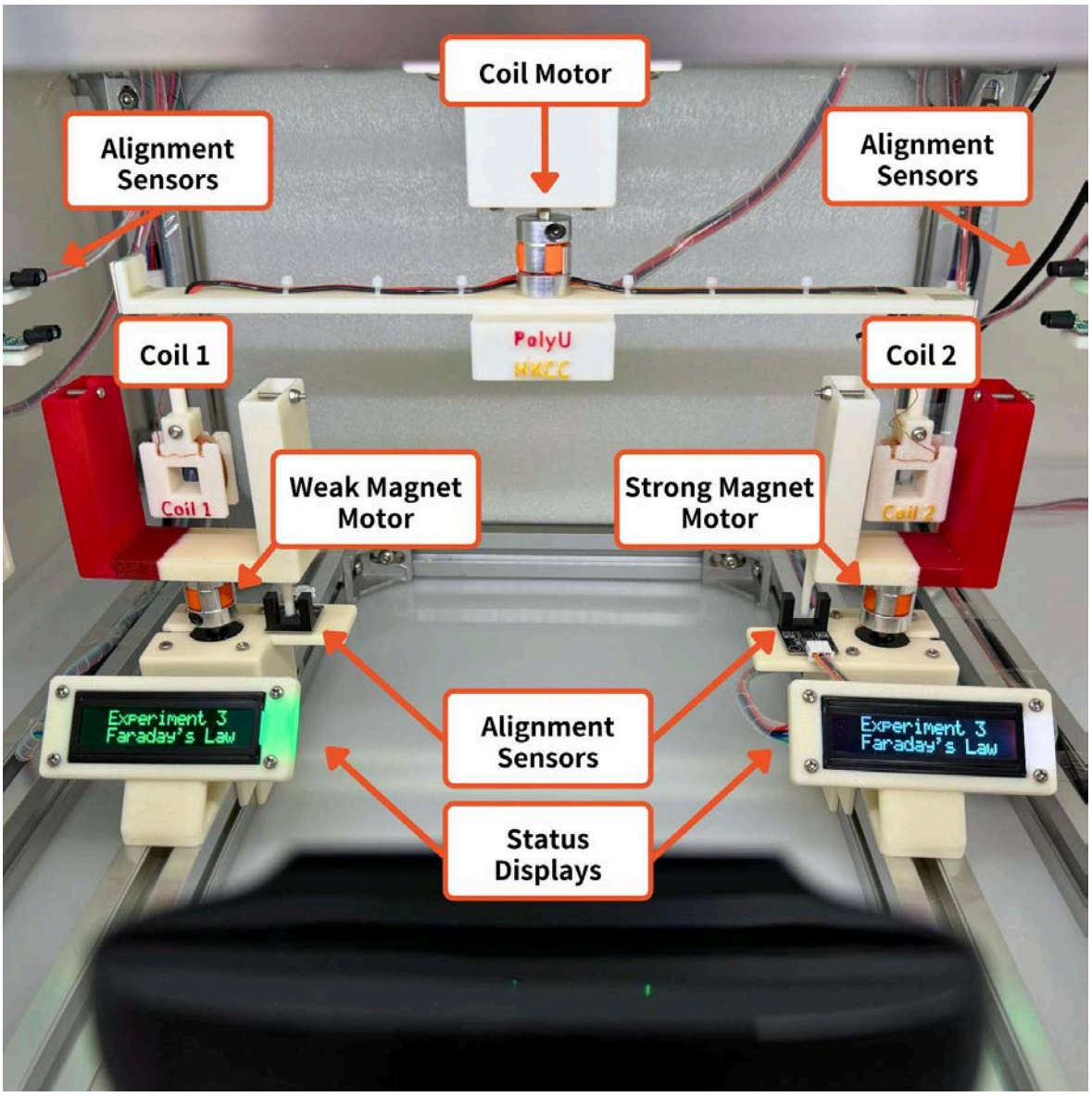
# The Hong Kong Polytechnic University
# College of Professional and Continuing Education
# Hong Kong Community College

## HKCC Remote Laboratory System*
## Electricity Experiment: Faraday's Law of Induction




*HKCC Remote Laboratory is a web-based service to enable remote off-campus access to experimental sets for science and engineering students. The Remote Lab was financially supported by the Quality Enhancement Support Scheme of the Hong Kong Special Administrative Region Government (QESS, HKSAR) and Hong Kong Community College of The Hong Kong Polytechnic University (PolyU HKCC), under the project title, "Development of a Web-based Remote Laboratory for Science and Engineering Education", and project no.: 04/QESS/2021.

## Objective

In this experiment, you will investigate the electromagnetic induction phenomenon by using magnets with different magnetic strengths and number of turns in coils.

## Theory

Faraday's law of induction describes the magnitude of the electromotive force (emf), or voltage, induced in a conductor under changing magnetic field. This phenomenon is known as electromagnetic induction. Figure 1 shows a conducing coil connected to an ammeter, i.e. a closed circuit. Initially, there is no current in the circuit. However, if we move a bar magnet toward the coil, the ammeter registers a current in the coil. The current disappears when the magnet stops. If we then move the magnet away, a current again is observed on the ammeter, but now in the opposite direction. The direction of this induced current in the coil is determined by Lenz's law: The magnetic field due to this induced current opposes the change in magnetic flux through the coil.

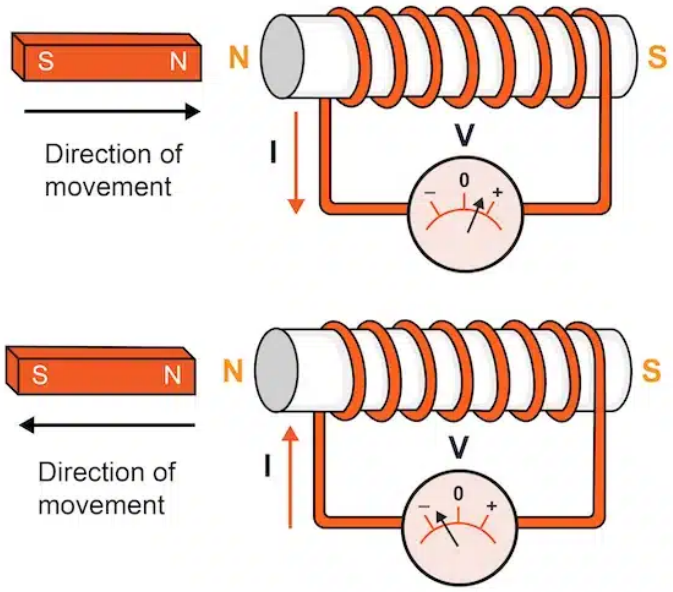



Figure 1. An induced current is observed in the ammeter when the magnet is either moving towards or away from the coli. (https://samtechlabs.com/faraday-law-apparatus/)

According to the Faradays' law, a changing magnetic flux, $\Phi_B$, through a coil (with $N$ turns) induced an emf will be

$$E_{induced} = -N\frac{d\Phi_B}{dt},$$

where $\Phi_B = \int \vec{B} \cdot d\vec{A} = BA\cos\theta$, if both $\vec{B}$ (magnetic field through the coil) and $A$ (area enclosed by the coil) are constant (as in this experiment). Then, the Faraday's law can be written as

$$E_{induced} = -NBA\frac{d\cos\theta}{dt} = -NBA\frac{d\cos\theta}{d\theta}\frac{d\theta}{dt} = NBA\omega\sin\theta$$

## Procedure

1. Select a coil (coil 1 or coil 2) with different number of turns and magnetic field strength (strong or weak) under the "Controls" tab. Then, click "Start" button to begin the experiment.

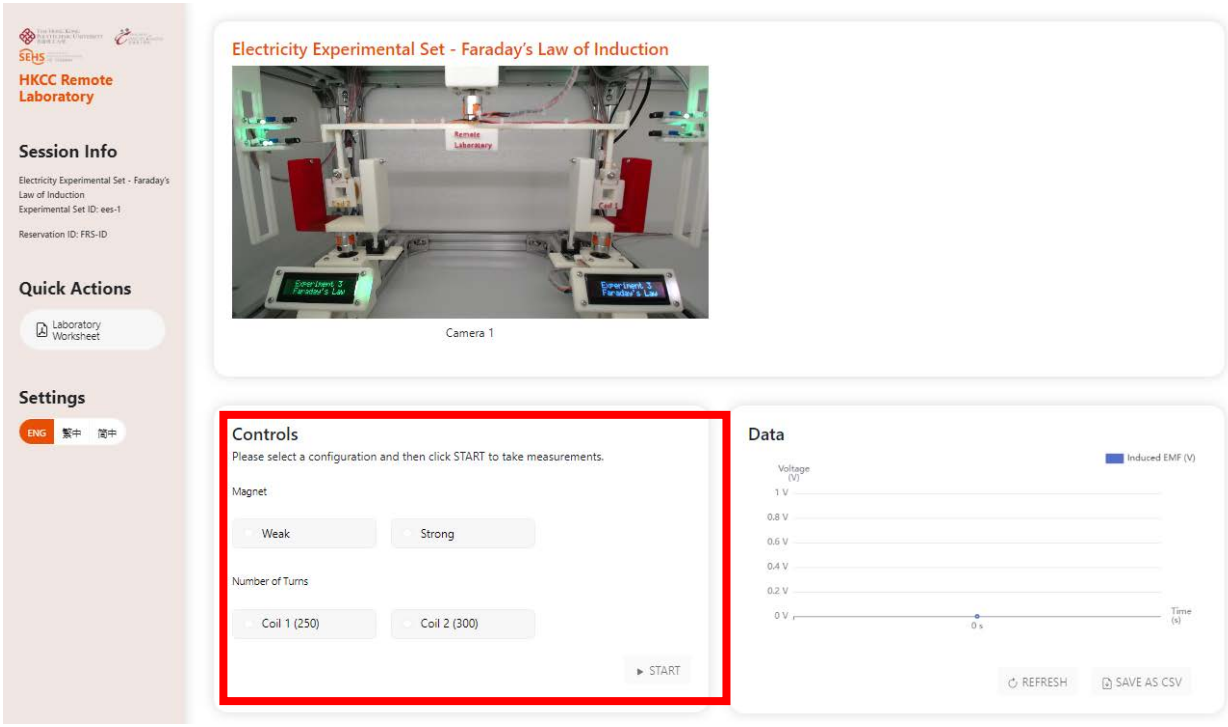



Figure 2. Select a coil and magnetic field strength for starting the experiment.

2. The LCD display panel indicates your selected magnetic as shown in Figure 3 below.

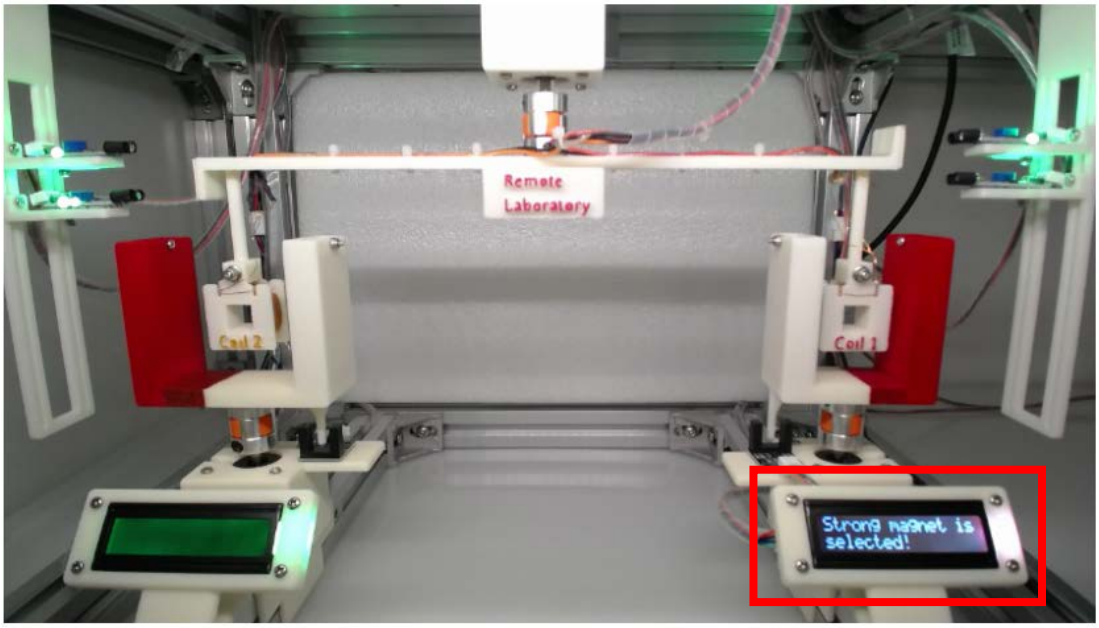



Figure 3. A strong magnet is selected.

3. The induced emf (or voltage) will be plotted in the "Data" tab as shown in Figure 4.

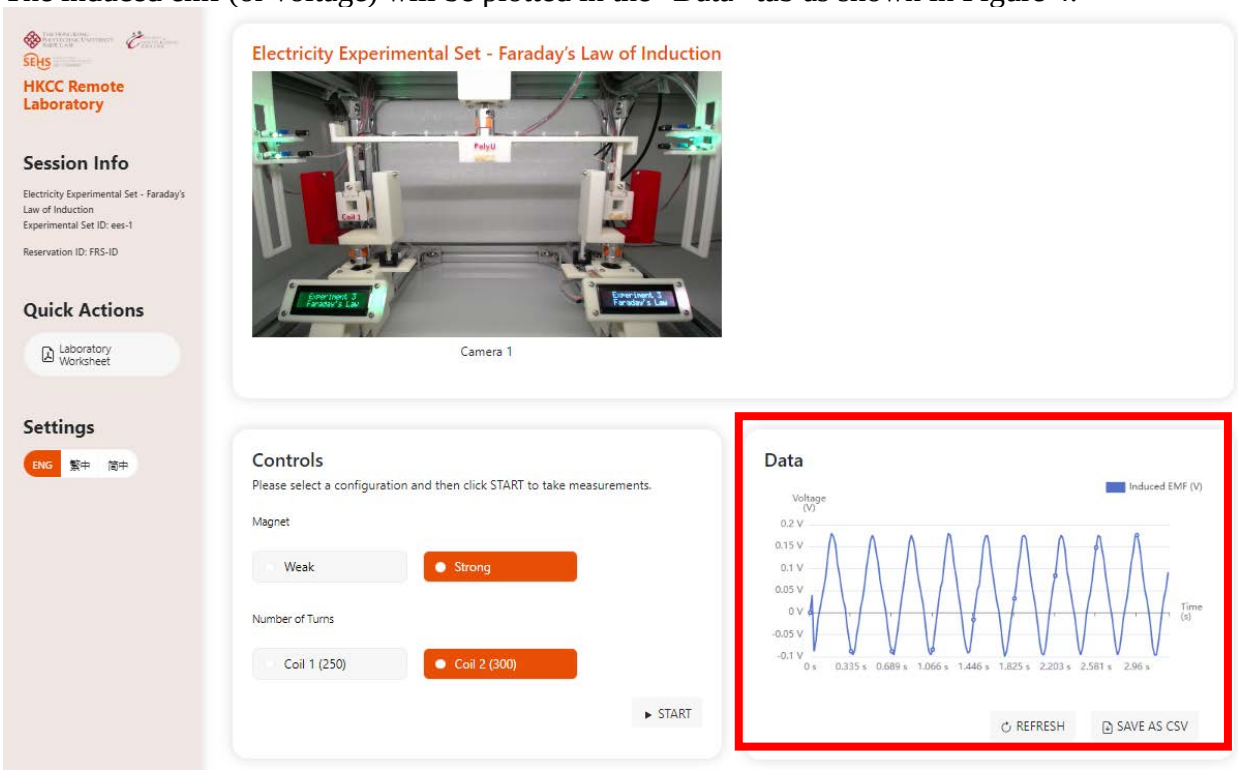



Figure 4. The experimental result.

4. The result can be downloaded in .CSV format for further analysis (Figure 4). Record your selected parameters in the "**Data**" section below.

5. You may start a new trial of the experiment with same or other settings.

## Data

6. Find the period of the induced emf for each combination in the table below.

| **Period (in seconds)** | Magnetic Field Strength | |
|---|---|---|
| | Weak | Strong |
| Coil 1 (250 turns) | s | s |
| Coil 2 (300 turns) | s | s |

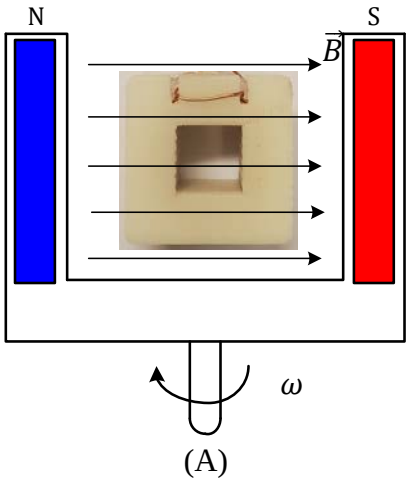
7. Identify the maximum induced emf ($V_{max}$) for each combination in the table below.

| **Induced emf ($V_{max}$)** | Magnetic Field Strength | |
|---|---|---|
| | Weak | Strong |
| Coil 1 (250 turns) | V | V |
| Coil 2 (300 turns) | V | V |

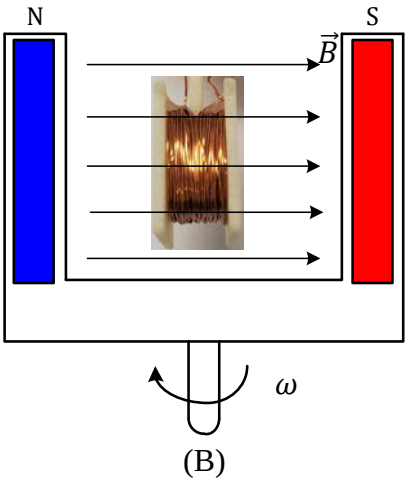
## Analysis and Discussion

8. How the induced emf be affected if different coils and magnetic field strength are selected?

9. Which one of the following orientations of the coil will generate maximum induced emf ? Why?




(A)




(B)

Explanation:

End of Laboratory Worksheet