Electromagnetic Induction

Purpose

Using "Borderless Lab 365" platform to verify Faraday's Law and Lenz's Law by investigating the induced e.m.f. of a coil in a varying magnetic field generated by a rotating permanent magnet.

Theory

- **Faraday's Law** states that an e.m.f. is induced whenever there is change in magnetic flux across the inductor.
- Magnetic flux is defined as the total magnetic field flowing through a surface. The magnetic flux is defined as $\Delta\Phi = \Delta B \cdot A$.
- Since there are N turns of coils, the total magnetic flux is $N(\Delta\Phi) = N(\Delta B \cdot A)$.
- The induced e.m.f. is given by $-N\frac{\Delta\Phi}{\Delta t} = -N\frac{\Delta B \cdot A}{\Delta t}$, which is the rate of change in the magnetic flux through the surface.
- Note that the negative sign of the equation implies that the direction the induced e.m.f. obeys **Lenz's Law**, i.e. the e.m.f. is induced in the direction such that it opposes the change in magnetic flux. Note: It must be the case in order to obey conservation of energy.
- As the permanent magnet rotates about the induction coil, the induced e.m.f. forms a "sine wave" along with time as the magnetic field changes direction twice per cycle.
- With different numbers of turns of coil, strength of magnet and rotating frequencies of magnet, verify the effect of all these factors on the induced e.m.f.

Apparatus

- "Borderless Lab 365" Platform

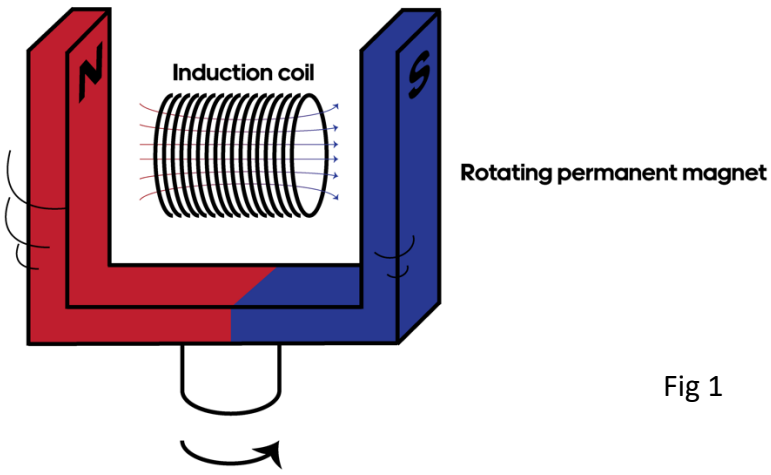

Fig 1

Procedure

1. Log in the experiment module "Visible Spectrum" on the Borderless Lab 365 platform. https://stem-ap.polyu.edu.hk/remotelab/
2. Choose the thickness of magnet, turns of coil and rotating frequency of the magnet on the right-hand side of the panel.
3. Press the "MEASURE" button below and wait for the setup to measure the induced e.m.f. across the coil. The live broadcast of the setup can be observed on the top left corner.
4. The result is shown in the graph below the live stream. Determine the peak e.m.f. by browsing the graph with cursor. Record the data.
5. Repeat the measurement with different combinations of thickness of magnet, turns of coil and rotating frequency of the magnet.

Data

Thickness of magnet = 2mm

	1 Hz	2 Hz	5 Hz
50 Turns	mV	mV	mV
150 Turns	mV	mV	mV
200 Turns	mV	mV	mV

Thickness of magnet = 3mm

	1 Hz	2 Hz	5 Hz
50 Turns	mV	mV	mV
150 Turns	mV	mV	mV
200 Turns	mV	mV	mV

Thickness of magnet = 5mm

	1 Hz	2 Hz	5 Hz
50 Turns	mV	mV	mV
150 Turns	mV	mV	mV
200 Turns	mV	mV	mV

Discussion

1. What is the effect of number of turns of coil on the induced e.m.f.?
2. What is the effect of thickness of magnet on the induced e.m.f.?
3. What are the possible errors of the experiment?