Electromagnetic Induction

Purpose

Using "Borderless Lab 365" platform to study the effects of magnet thickness, coil turns and rotation speed on e.m.f. produced.

Theory

- Electromagnetic induction is the production of the electromotive force across the conductor in a changing magnetic field.
- Magnetic field is existed between two pieces of magnet. Magnetic field lines are a visual tool used to represent the magnetic fields. It always runs from North to South.

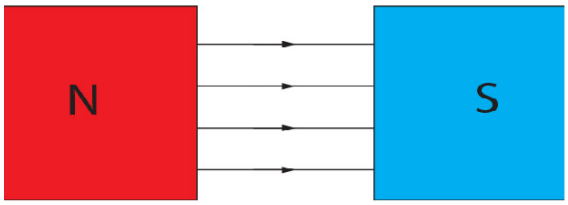
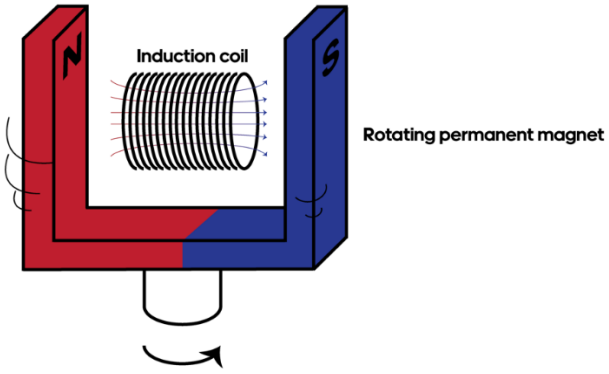


Fig.1

- The wire/coil in the rotating magnet cuts the magnetic field lines. By **Lenz's Law**, an induced e.m.f. and current is produced to oppose the magnetic field change.
- According to **Faraday's law**, the magnitude of the induced e.m.f. depends on the rotation speed of the magnet, the strength of the magnet and the turns of the coil.
- By Faraday's law of induction, we have $\varepsilon = -\frac{d\varphi}{dt}$
- The magnitude of the induced e.m.f. varies with the cutting angle between the coil and the magnetic field lines. For example, the coil cuts no magnetic field lines while the coil parallel to the magnetic field lines. The change of magnetic flux momentarily Zero so induced e.m.f at this position = 0

Apparatus

- "Borderless Lab 365" Platform
- Magnets with three difference thickness: 2mm/ 3mm/ 5mm
- Coil with different turns: 50/ 150/ 200
- Rotation speed with different Hertz: 1Hz/ 2Hz/ 5Hz



Procedure

1. Log in the experiment module "EM induction" on the Borderless Lab 365 platform. https://stem-ap.polyu.edu.hk/remotelab/
2. Choose magnet thickness, coil turns and rotational speed by pressing corresponding button.
3. Press "MEASURE" to record the e.m.f. produced by the coil.
4. Result is shown in the graph, find the peak e.m.f.
5. Download the graph by clicking "Menu" and choose a format (.svg, .png, .csv).
6. Repeat step 2 to 4 under different condition.
7. Press "LOGOUT" at bottom right corner when you complete the experiment.

Data

Thickness: _____ mm

Coil turns: _____

Rotation speed: _____ Hz

Sketch the waveform of the e.m.f. produced by the coil

Period: _____ ms

Max. voltage: _____ mV

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. Find out how the induced e.m.f. is affected if
   a. the coil is moved with a higher speed,
   b. stronger magnets are used,
   c. a coil of more number of turns is used.
2. Write down the energy conversion involved in the experiment.
3. If the coil is an incomplete circuit, is there any induced e.m.f. or induced current in the coil when the magnet rotating?
4. What are the possible errors of the experiment?