Electromagnetic Induction – Open Investigation **PH 221**

In this lab, there will be more emphasis on using the Scientific Method for yourself. You will discuss your findings and logic in a brief report. Before starting, think about how you would go about investigating the system if you had no lab handout or instructor to guide you.

Key elements of any scientific investigation may include:

1. A testable hypothesis: this is an informed guess about how the measurable quantities (Observable Quantities) depend on each other. Specifically, the hypothesis is a testable relationship (e.g. equation, expected dependency, etc.) between quantities that will be set, varied or measured by conducting an experiment.
2. A clearly labeled diagram of any apparatus used or measurement made.
3. Clear definitions of all symbols used in the documents, so that the report makes sense to the reader. It should be clear which variables are being held constant (controls), which are varied by choice (independent variables), and which will be measured from the apparatus (dependent variables).
4. One or more tables of measured data for each investigation, with proper headings, units, etc. and/or
5. One or more graphs showing the data and revealing the relationship between the variables.
6. Analysis based on the quantities extracted from the graphs. For straight-line graphs, the only quantities extracted would be the slope and the intercept found from the best-fit line.
7. A concise (brief and clear) summary report, with an emphasis on logical reasoning. Full sentences with correct spelling, punctuation, and grammar are expected.

Forming a hypothesis for Electromagnetic Induction:

First, note that there are three major things you can vary:

(1) The strength of the magnetic field B

This can be done by combining two iron bar magnets or by creating a magnetic field in a coil using the power supply. Then adjusting the current through the coil would change the magnetic field created by the coil.

(2) The time things are changing

This can be done by varying how quickly you move the iron bar magnets or the coil creating a magnetic field into and out of the coil you measure the current with.

(3) The number of turns of wire in the sensing coil.

This can be done by making use of the three numbered coils of wire. All have the same diameter and are made of the same wire. They differ by how many turns each has.

An additional quantity which can be measured is the current induced by using the galvanometer and/or measuring the emf using the voltage probe with Capstone software.

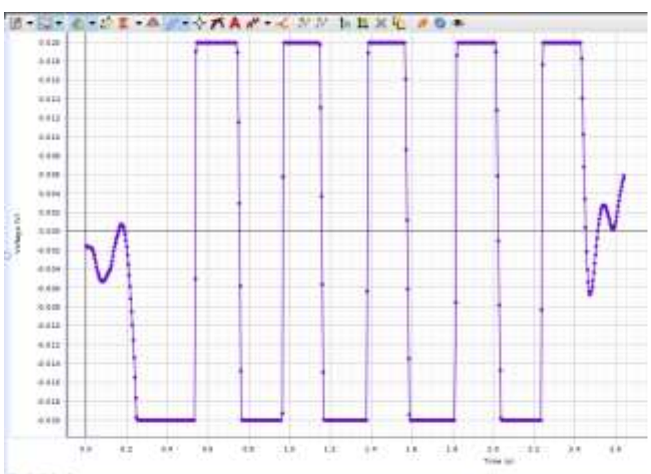
The first three variables (B, t, N) are "Independent" as you can adjust them if you wish to. The current or emf is "Dependent" because it is determined by the other variables in the experiment.

There are two Capstone Files available on the PH 202 Lab Webpage.

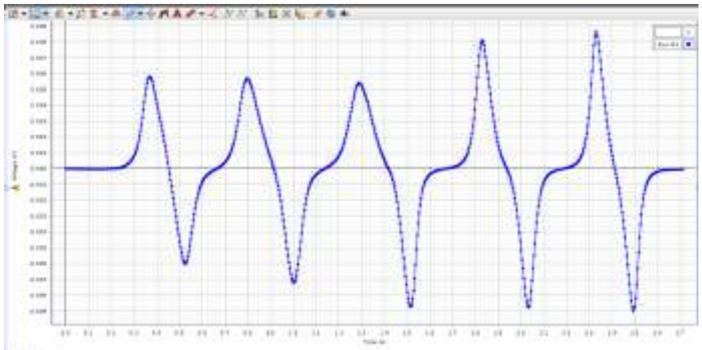
One is <u>EM Induction SCI INQ Low Mag.cap</u>

The other is <u>EM Induction SCI INQ Hi Mag.cap</u>

The Hi Mag one should be used with the three coils that are 10, 20, and 30 loops of wire. It has the sensor set to its highest amplification. The Low Mag one should be used with the two coils you have used previously the Large Square one and the pair of coils with the reddish wire wrapped around them. They use the lowest amplification. Using the Hi Mag one with these two coils will result in signal saturation (the flat spots) which looks like this

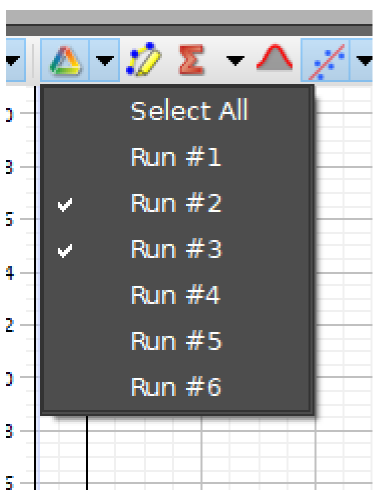


When you run either of these set up Capstone files, you will see this show up

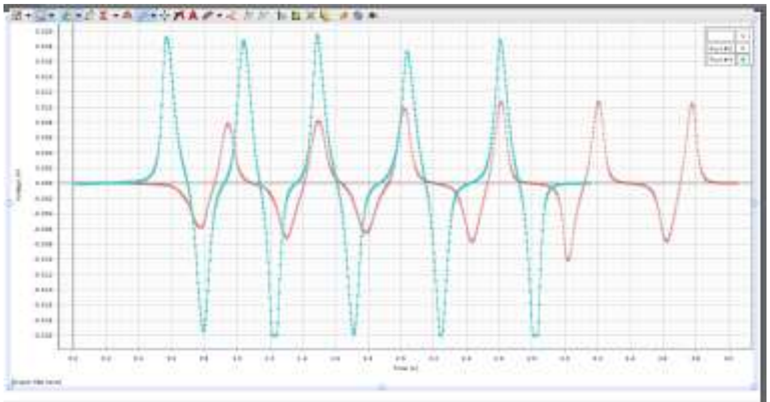


When you begin to collect new data, this will disappear and the new data will show. However, if you do not delete runs you can view two or more runs at the same time which can be useful for comparison. At the top of the graph window find the button

Pressing the down triangle and the runs appear and you can select which ones you wish to see such as



This shows



The horizontal axis is time in seconds, you could make use of this to find either speed or some other time related quantity. The vertical axis is voltage which is of course the EMF induced in the coils.

Cover Page for PH 221 Science Inquiry Lab **Name:** ______________

Partner(s): ______________

Instructions:

This cover page should be the first page, with your report attached after that. Each person must write their own report, which must be word processed.

Use the section headings: **1. Question, 2. Method, 3. Analysis, and 4. Discussion.** Your work will also be assessed based on critical thinking skills:

Evidence: Base your conclusions on the experimental evidence you found.

Integration: Combine information from different parts of the experiment logically.

Evaluation: Draw rational conclusions based on your experiment.

Grading Rubric: (Leave this for your instructor to fill in)

1. Question.

State the hypothesis equations you are investigating. Discuss the quantities in the equations which are the independent variables, which are the dependent variables? A clear, labelled diagram is a good idea. Based on the hypothesis equations, explain what quantities will go on the axes for each graph, and how you will identify which hypothesis best fits the data. Provide enough detail so that someone not familiar with the experiment can understand what you are interested in finding out. Write a clear paragraph, in full sentences.

______________ (5pts)

2. Method

Method. Discuss details of each measurement in the experiment. Mention anything that needs particular care. Discuss how many significant digits can be justified for each measurement. The measurements you took are the evidence upon which you draw your conclusions. Provide a critical discussion of how reliable they are.

______________ (5pts)

3. Analysis

Show the table with your measured quantities, and write a brief explanation of what is included in each column. Show the graphs you have made to test your hypotheses. For each, discuss whether the experimental data follows a linear trend, and thus whether it is consistent with the hypothesis. If this is the case, extract the values of the constants and report them clearly. Make sure quality standards are met for tables and graphs. Correct use of units and significant figures is expected. Refer to the handout from the first graphing lab to review details of how graphs are used to find experimental results. Integrate the information you found from your tables, graphs, and calculations to form a logical sequence.

______________ (5pts)

4. Discussion

Discuss whether your data is consistent with, or in conflict with, your original hypothesis equations. Give quantitative conclusions. Justify your claims by referencing the evidence you found in the experiment. Evaluate your results critically. This should include a discussion of weaknesses in your experiment and how you might change things in future.

______________ (5pts)