8.2: Activities

Equipment

- component board
- multimeter
- power supply
- Pasco Box, voltage probe leads, and laptop
- wires

The General Idea

We are looking to study the exponential decay of the current in an LR circuit. To accomplish this, we need to design a circuit that gets current flowing through an inductor connected to a resistor, and then allow it to run down. This is tricky, because to get the current flowing we need a battery (power supply), but when the decay begins, the battery can no longer be present.

The circuit diagram in the Background Material shows us exactly how we can accomplish this: We create two parallel branches from the battery, one where current is flowing through the inductor, and one where current is flowing through a resistor. If we then suddenly open the switch to the battery, taking it out of the circuit (in our case, this requires unceremoniously yanking a lead out of the power supply), then there is current present in the inductor when it is alone with a resistor in a circuit.

What we will be measuring is the time-dependent voltage drop across the inductor, the exponential behavior of which will mimic that of the current flowing through it. The ultimate "problem" we are asked to solve is to determine the inductance of the inductor from voltage-vs-time data. Given that we know (or can look-up) the role that inductance and resistance play in the time evolution of the decaying current, an appropriate best-fit line for the data (as well as a direct measurement of the resistance with an ohmmeter) will give us what we seek.

Here are some of the details you will need to know for the procedure:

- See the Background Material page for a picture of where the inductor and resistor are located on the component board.
- You have a multimeter with which you can measure the resistance of the inductor, and check the 220Ω indicated resistance for the resistor.
- The voltage sensors should be connected to the Pasco box in port A, and the software on the laptop that should be running is "Inductance."
- After you get the circuit connected and start the current flowing for a short time, you can assume that there is a steady current through the inductor. All you need to do then is:
  - start the recording of data in the software
  - quickly pull one of the leads out of the power supply (*Note: The software is written to automatically stop recording after one second, so you need to disconnect the power supply pretty soon after you start recording.*)
  - check to see if the data is fairly "clean" (you will have to blow-up the graph to look at its features better), and if it is not, go ahead and run it again
- If you have trouble getting a graph to come out without wild jumps (especially during the exponential decay), ask your TA for assistance.
- The graph is created from data points that are plotted, and while it should certainly *look* like an exponentially decaying function, you will need to use the actual data to create a best-fit line and extract the information you need.

Some Things to Think About

There are a few details that need to be incorporated into and some things to look out for in what is otherwise a very straightforward procedure.

- The inductor has an internal resistance that needs to be accounted for – you have a multimeter at your disposal for this.
- You should check to see if the minimum and maximum voltages encountered are what you would expect them to be. The flat line before the switch is opened is easy enough to check, but the sharp peak poses a little physics puzzle for you to solve.
- The simplest approach for analyzing the data from the decaying voltage is something you have done many times in past labs (with the exception of the first two steps):
  - magnify the screen until you can distinguish the data points

- use the  tool to extract the voltage values of 8 to 10 data points (It's probably a good idea to just choose the data points at regular intervals)
- construct a table of raw data, adding a column for some calculated values that you expect to demonstrate a linear relationship
- plot the expected linear function in the usual graphing calculator
- run the linear regression to get the slope
- extract the value you are looking for from the result

- Be sure to include (at a minimum) a screen capture of your Pasco data, the data table you constructed, the best fit line and their results, and of course your analysis discussion, in your lab report.

Lab Report

Craft a lab report for these activities and analysis, making sure to include every contributing group member's name on the front page. You are ***strongly encouraged*** to refer back to the Read Me as you do this, to make sure that you are not leaving out anything important. You should also feel free to get feedback from your lab TA whenever you find that your group requires clarification or is at an impasse.

Every member of the group must upload a separate digital copy of the report to their lab assignment in Canvas *prior to leaving the lab classroom*. These reports are not to be written outside the lab setting.
