Appendix C.
Format for Laboratory Reports

A report is required for all laboratory exercises except Experiment #8. For the first few labs, students must submit individual reports, although for later experiments, a team may only have to submit one report. The report should conform to the outline below. All reports are to be composed using a word processor and neatly printed. A report folder is a nice touch but is not required. USE YOUR SPELLING AND GRAMMAR CHECKERS! <u>Nothing looks more unprofessional than a report full of spelling and grammatical errors</u>. The report should have the following components:

- **A <u>cover sheet</u> which gives the experiment name and number, date, your name, and <u>that of your partner</u>.**
- **The following written sections:**
  1. **Statement of the experiment goal(s). This should be a one- or two-sentence statement that says exactly how you expect to benefit from the laboratory exercise.**
  2. **Diagrams of circuits as mandated in the experiment description.**
  3. **Statements of results for each part of the lab exercise. These should be clearly written summaries of your experimental findings, including data taken (presented in tabular form where requested), calculations, etc., as required. You can use your data sheets to help you re-organize and format this data in the most effective method of presentation for your report.**
  4. **Discussion of results. This should be one or more paragraphs discussing the results described in Section 5 above. It should include a reconciliation of any discrepancies between actual results and expected outcomes.**
  5. **Answers to all questions in the laboratory procedure sheets. Answers should be stated <u>clearly</u> and illustrated by expressions, tables, or diagrams as required.**
  6. **Summary and Conclusions. A summary of your learning experiences and conclusions about the phenomena studied.**
  7. **The filled-out experiment data sheet.**
  8. **The completed worksheet.**
- **Note that each section should start with the identifier “Section X. Title.” The sections do not have to each be on separate pages, but each section break should be at least two lines on a page, and <u>section titles should be a larger, bold type</u>.**

All tabular results should be displayed in an organized manner, using a matrix or chart program such as Excel©. You may hand-draw any required circuit diagrams <u>neatly</u>. Please <u>carefully</u> label all tables, diagrams, or other required information so that it is identified accurately and clearly. <u>Each team will submit a single report</u>. Team members are expected to <u>equally</u> participate in each project. Reports are due in general at the beginning of class two weeks after the lab is assigned. There is no “correct” length for a report, but two or three printed pages, not counting illustrations, should be the <u>minimum</u> amount of text.

An example report follows.

EE 1102
Experiment #X

Computing the Impedance of an Inductor In an AC Circuit as the Frequency is Varied

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October 10, 20--

Experiment #X

Section 1. Experimental Goals: The goal of Experiment #X is to study the behavior of inductive impedance with frequency. A circuit will be built and the current of an inductive circuit will be measured at various frequencies. These measurements will be used to provide data for calculating the impedance of the inductor at the frequencies that were used, and the computed impedances will be graphed versus frequency on a linear graph.

(Comment: Generally, this should be a brief restatement of the goals shown in the experiment goals section, but expand as necessary to show that you understand why you are doing the experiment.)

Section 2. Circuit Diagram for Experiment #X: In Figure 1 below, the circuit that we constructed and used in the experiment is shown. Note that the key circuit elements are a resistor and inductor. The resistance of the inductor is shown as a second resistor in the circuit and labeled appropriately.

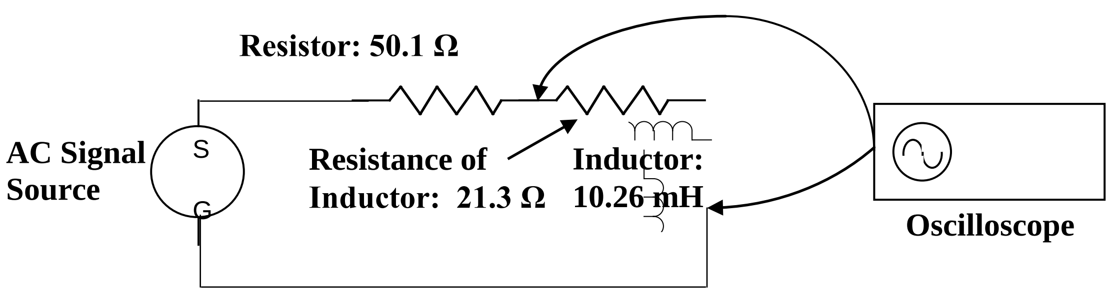
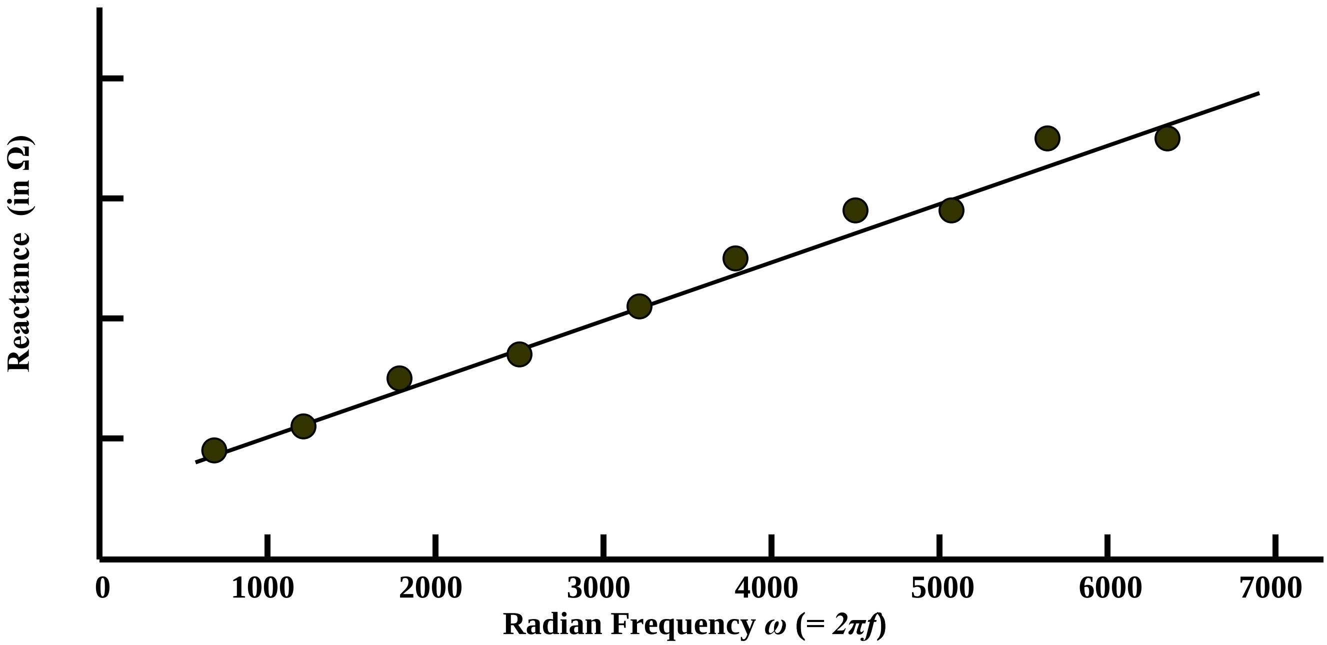


Figure 1. Circuit for Examining Inductor Impedance Versus Frequency.

The oscilloscope is shown checking the voltage on the inductor. However, to measure the current, the oscilloscope probe was set across the 51 Ω resistor and the voltage was recorded. Current was then calculated as $\boldsymbol{i_{resistor} = v_{resistor}/R}$. The actual measured value of the components is shown.

(The circuit may be hand-drawn, or use a layout program such as LogicWorks©, etc.)

Section 3. Statements of Results: We took readings of the current in the circuit from 100 Hz to 1KHz, at 100-Hz intervals. The current changed quite a bit as we increased the frequency. The peak-to-peak voltage was set at 10 volts, as required by the experimental procedure. We used the oscilloscope to measure the phase angle of the current and the peak-to-peak voltage on the resistor. Then, we could calculate the impedance of the circuit using the formula $\boldsymbol{Z = V/I}$. The imaginary part of this impedance was the inductor impedance for that frequency. Below is the graph of inductor reactance versus frequency. Since the impedance, according to the formula in the experimental description is $\boldsymbol{Z_L = jX_L}$, then $\boldsymbol{X_L = Z_L/j}$. We calculated $\boldsymbol{Z}$, took the imaginary part, and then divided by $\boldsymbol{j}$ to get the reactance that is plotted.



The straight line is a plot of ωL versus radian frequency, with L equal to the measured value. The ten points are the calculated values based on the current measured.

Our findings show that the value of the reactance, X_L, is very close to the value predicted by the graph of reactance versus radian frequency plotted by using the measured L. This correspondence validates the predicted behavior of inductive reactance and definitely demonstrates that this reactance increases linearly as the frequency of the AC signal increases.

(Make graphs or tables using Excel© or similar tabular/plotting programs.)

Section 4. Discussion of Results: As noted in our summary of the results above, the predicted behavior of inductive reactance (i.e., increasing with increasing frequency) is well demonstrated by the results of our experiment. The formula for X_L, $X_L = \omega L$, predicts the linear increase of inductive reactance with frequency. Our results clearly demonstrate that this behavior is correctly predicted.

Note that all the values of reactance resulting from our measurements do not fall exactly on the plot. This is more than likely because we were using the oscilloscope to make many of our current measurements, taking the data off the oscilloscope screen. Although the oscilloscope is fairly accurate, it is hard to get an exact current reading within more than about 3-4% or so, and therefore there is a little variance in our calculations due to these slight inaccuracies in current. However, the agreement is still very good, and we believe that the frequency-dependence of inductive reactance is well demonstrated.

(It is important to account clearly for discrepancies and to demonstrate that you understand the results.)

Section 5. Answers to Questions:

a. **Are the current readings consistent with an imaginary current component?** Definitely. The calculated impedance has both real and imaginary parts.
b. **What was the hardest part of this experiment?** There were two hard parts: First, remembering to convert frequency to radian frequency (f to ω). Second, learning to convert the peak-to-peak magnitude voltage measurements to the cosine-value instantaneous current expression.
c. **Explain a "power factor" in your own words:** The power factor is the cosine of the phase angle between the AC voltage and current.
d. **Etc.**, etc…….

(Note that each question should begin on a separate line. State the question clearly before answering.)

Section 6. Summary and Conclusions: To summarize our findings, the reactance of an inductor increases linearly with frequency. The reactance is equal to the product of the radian frequency ($2\pi f$) times the inductance value. The predicted behavior of inductive reactance is demonstrated by the calculated values of that reactance over the range of our experimental values, 100 to 1000 Hz. While the values resulting from the measured current do not always fall exactly on the theoretical graph, the values are within our ability to measure current values on the oscilloscope.

(The summary should definitely state whether the aim of the exercise was met. It may be two or more paragraphs if necessary.)

Sections 7 & 8. (Include filled-out data sheet and pre-lab worksheet here.)

Final Notes: Make sure that your report has sufficient text to clearly explain the experiment, your activities, the results, and your conclusions in the proper detail. While the general format instructions (the first page of Appendix C) suggests two or three pages of text, many students attempt to get by with MUCH less. <u>Laboratory teaching assistants are instructed to deduct points if they feel that the written report is too brief to properly cover the material</u>. MAKE SURE THAT YOU SAY ENOUGH TO MAKE A CLEAR REPORT – IT IS SOMETHING THAT YOU WILL BE DOING AS AN ENGINEER FOR MANY YEARS TO COME!