APPENDIX A
GUIDELINES FOR PREPARING LABORATORY REPORTS

In the following, general guidelines are given to help the EE 420 laboratory student write well-prepared laboratory reports. A good laboratory report must have the following items:

1- A front page: this page should contain:

- The experiment title and number.
- The student name and ID number.
- The laboratory name and section number.
- Date.
- The name of the laboratory instructor.

Use of fancy fonts and color is strongly discouraged throughout the report.

2- Objectives of the experiment. Do not copy the objectives from the experimental manual, use your *own wording*.

3- A list of equipment used with details, if available.

4- A short introduction. Again, use your own wording to write a short introduction to explain to the reader what he is expected to see in the report. Many students take extreme short cuts when preparing their laboratory reports, by omitting essential items such as a proper introduction.

5- Results and Discussion: This section is the main body of the experimental report. It should contain the figure, tables, explanations, discussion, etc.

6- Diagrams of any experimental setups.

7- Equations if any. Always number the equations and type the equations using an equation editor.

8- Figures and tables if any. Always number the figures and tables. Do not leave a figure or a table without a number. Also, immediately following the *figure number* or *table number*, describe the contents of the figure or table.

Always refer to the figure or table in the body of the report and explain what the figure or table contains.

Always label the vertical and horizontal axes of the figures.

If more than one curve is drawn in the same figure, make sure that these curves are properly labeled.

9- *Always* calculate and *report* the percent error between the experimental data and theory, even if you were not explicitly asked to do so in the experimental manual. Report this error in a table or in the form of graph or both.

Always comment on the percent error. Whether it is low, moderate or high and try to explain any possible reasons when the error is not low.

10- Pay attention to the units used and report them.

11- Summary. Include a summary immediately before the conclusion.

12- Conclusion. Take care not to confuse summary and conclusions and write as many conclusions as you can think of. It is best if you itemize the conclusions.

13- Answers to questions if any. Write the answers to the questions at the very end of the laboratory report, after the conclusion, using a separate page entitled "ANSWERS TO QUESTIONS". Type the questions as well as the answers.

14- Proper language. Take extra care to write the report in proper language using your own words. Poor English gives a poor impression and may cause the laboratory instructor not to understand the full meaning of the idea that you want to convey. This may also result in lowering the grade of your report.

A sample report is shown next. Examine this report and check if the above-mentioned items have been properly implemented. The sample is based on a *hypothetical* experiment. The sample report contains comments in *italic* font to highlight the important points that you should pay attention to when you prepare your report.

KING FAHD UNIVERSITY OF PETROLEUM AND MINERALS

ELECTRICAL ENGINEERING DEAPRTMENT

EE 420

Fiber Optics Communication

Laboratory Report

Experiment #1

Title: Heat Expansion of a Steel Rod

Name: ………………

ID Number: ………….

Section #55

Date of Experiment: ……………………

Submission Date: ………………………

Submitted to: …………………………..

OBJECTIVES:

The main objectives of this experiment are to:

1- Experimentally investigate how the length of a steel rod changes with temperature.
2- Compare theoretical and experimental results.
3- Experimentally measure the thermal expansion coefficient of steel and to compare it wit the established value.

[Notice that the objectives were itemized for clarity].

EQUIPMENT:

1- A steel rod, approximately 1m long.
2- A ruler.
3- Coupler.
4- Temperature meter (HP-Model Number 2222).
5- Heat source (Westinghouse, Model Number 1111).

[*Notice that the equipment model number has been added. Add the model number whenever it is available*].

INTRODUCTION:

It is well-known that when the temperature of a rod is increased, the rod expands. The change in the length of a rod of length L (meter) dependence on the temperature T (C^o), according to the following relationship:

$$\Delta L = \gamma L \Delta T \tag{1}$$

This means that:

$$L(T_2) = L(T_1) + \gamma (T_2 - T_1) L(T_1) \tag{2}$$

[*Notice that:*

- *The equations were written using an equation editor.*
- *The equations were numbered.*
- *The equation numbers were aligned*].

Where ΔL and ΔT are the change in the length and temperature of the rod, respectively. The parameter $\gamma\,[1/C^o]$ is called the thermal expansion coefficient. The value of γ depends on the material used. The parameters T_1 and T_2 are the initial and final temperatures, respectively. The experimental data given in this report has been obtained using steel and copper rods. The established expansion coefficients of steel is given by $\gamma = 10^{-3}[1/C^o]$. [*This is not the actual value of γ for steel and remember that this is only a hypothetical experiment*]. This value will be used to assess the accuracy of our experimental results.

EXPERIMENTAL SETUP:

Figure 1 shows the experimental setup used in this experiment. The coupler is used to connect the steel rod to the heat source.

[*Notice that Figure 1 has been referred to in the text, before the figure is actually shown*].

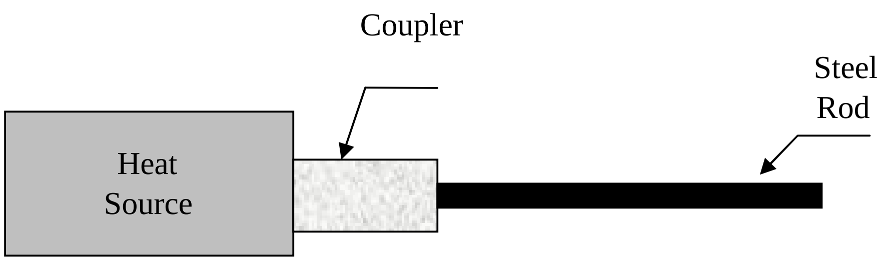

Figure 1: Experimental Setup Showing the Heat Source, Coupler and Steel Rod.

[*Notice the Figure has been given a number followed by a description*].

RESULTS AND DISCUSSION:

Tables 1 summarizes the experimentally obtained data for the steel. The data was taken using an initial steel temperature of $30\,C^o$.

[*Notice that the table has been referred to in the text, before the table is shown*].

Temperature $T\,(C^o)$	Length L (m), Experimental	Length L (m), Theoretical	Relative Error (%)
30	0.995	0.995	0
80	1.055	1.045	0.96
130	1.12	1.095	2.23
180	1.17	1.144	2.27
230	1.21	1.194	1.34
280	1.22	1.244	-1.93
330	1.45	1.294	12.1
380	1.39	1.343	3.50
430	1.50	1.393	7.68

Table 1: Experimental and Theoretical Data for the Steel Rod Length Dependence on Temperature.

[*Notice that:*
- *the table has been given a number followed by a description of contents.*
- *Also a column is added to show the percent error. Add this column, even if your were not asked to do so.*
- *The units are clearly indicated*].

Figure 2 shows the experimental and theoretical results based on the data presented in table 1. This figure shows that the experimental and theoretical calculations are generally in good agreement. The results shown in Figure 2 indicate that the length of the steel rod increases with temperature and follows roughly a linear variation, as predicted by theory.

[*Notice:*

- *The source of the data used to draw Figure2 is identified.*
- *Since the experimental curve is not a straight line, but it resembles a straight line, the word roughly has been added above.*
- *The results shown in Figure 2 have been discussed and were not left to the reader to make his own interpretation*].

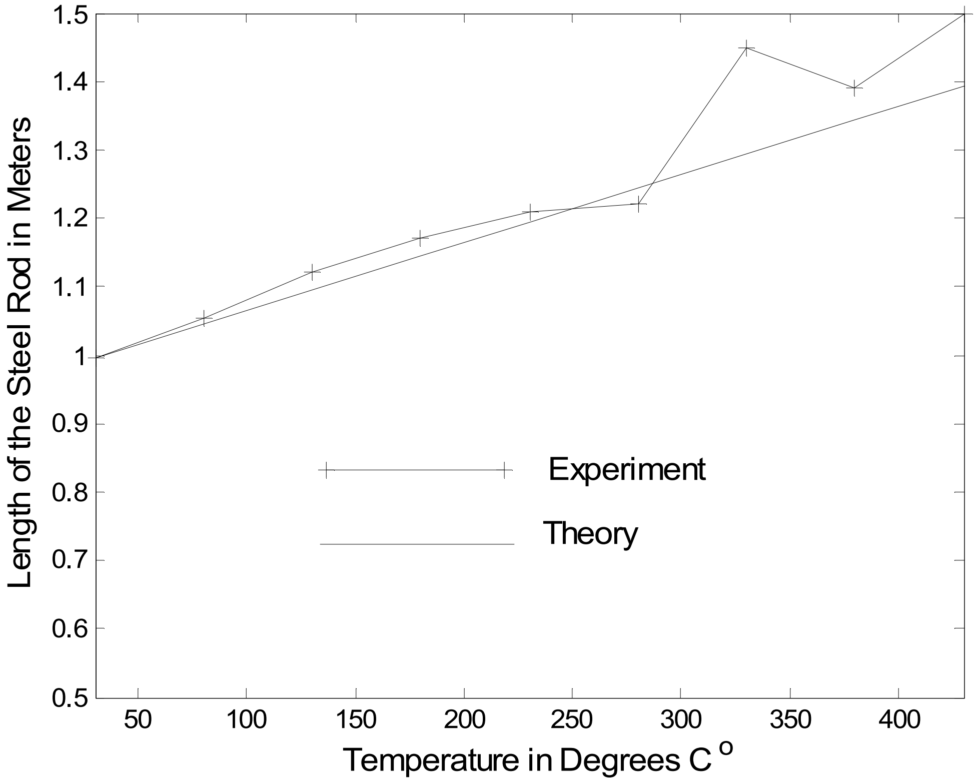

Figure 2: Experimental and Theoretical Variation of the Steel Rod Length as a Function of Temperature.

[*Notice that:*

- *Both axes of the figure are labeled and units were included.*
- *The two curves are clearly labeled to prevent confusion.*
- *The next available Figure number is assigned to this figure*].

Figure 3 shows the relative error in percent as a function of temperature, based on data from table 1. The relative error is generally low (below 5% for most reading). However, a relatively large disagreement between the experimental and theoretical results occur at $T = 330\,C^o$. The percent error reaches a maximum of approximately 12% at $T = 330\,C^o$. A possible source of this relatively large error may be due to the measurement of the steel rod length or due to inaccuracy of the temperature meter.

[*Notice that:*
- *Data source was identified.*
- *The error was discussed.*
- *Possible sources of error were identified*].

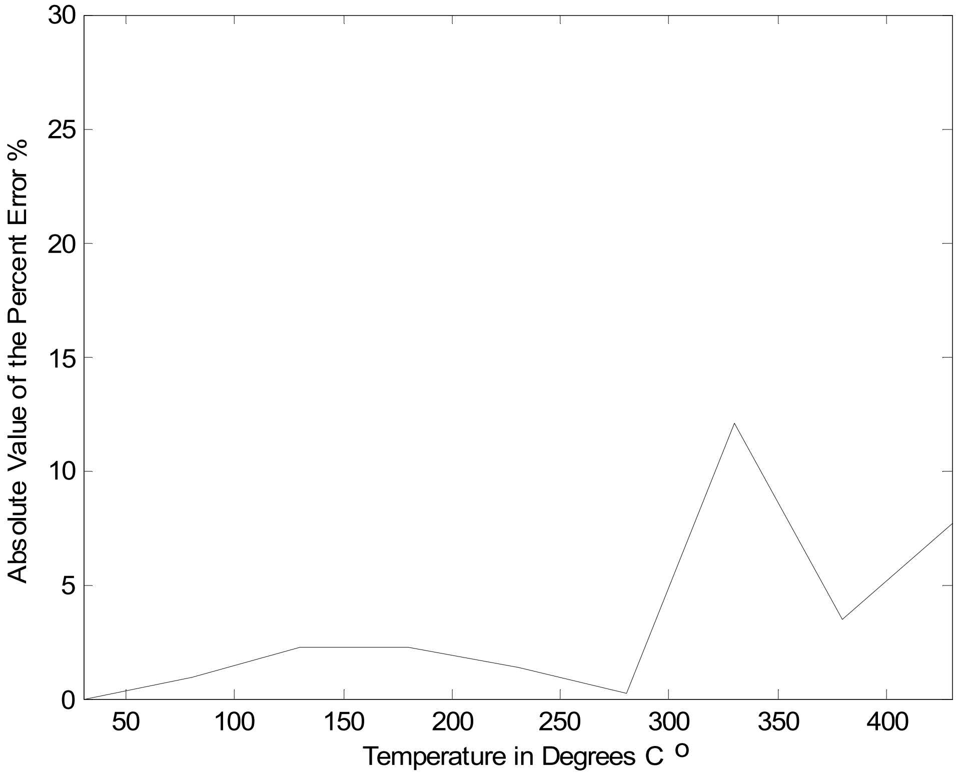

Figure 3: Absolute Value of the Percent Error (for the Experimental and Theoretical Lengths of the Steel Rod) as a Function of Temperature.

[*Notice that the* <u>*absolute value*</u> *of the percent error was plotted, not the relative error documented in table 1. The label of the vertical axis in Figure 3 clearly indicates this*].

In order to experimentally determine the expansion coefficient γ of steel from the experimental data, a straight line fit was first performed. Using the slope of the resulting straight line in conjunction with equation (2), we have calculated γ for steel. The resulting experimental value of γ is approximately 1.06×10^{-3} $[1/C^o]$, which is in good agreement with the established value of 1.00×10^{-3} $[1/C^o]$.

[*Notice:*
- *The method used to calculate γ was described.*
- *A comment on the degree of agreement was made*].

<u>SUMMARY:</u>

In this experiment, we have measured the length of a steel rod as a function of temperature. The experimental and theoretical results are in good agreement for most measurements. The thermal expansion coefficient of steel has been also calculated using experimental data.

[*Notice that the summary generally and briefly mentions what has been done in the experiment with little detail, if any, of the specific results obtained*].

CONCLUSION:

From the results of this experiment, we can conclude the following:

1- The length of a steel rod increases with temperature.
2- The relation between the steel rod length and temperature is roughly linear.
3- The experimentally determined thermal expansion of steel $\gamma \approx 1.06 \times 10^{-3}\ [1/C^o]$ is in good agreement with the established value of $\gamma = 1.00 \times 10^{-3}\ [1/C^o]$.
4- The relative error is found to be below 5% for most readings. However at $T = 330\, C^o$ the relative error reaches its maximum value of about 12%.
5- The sources of error in this experiment could be due to measurement of the length of the steel rod and the poor accuracy of the temperature meter used.

[*Notice that:*

- *The conclusion briefly mentions the specific results and the most important outcomes obtained after performing the experiment.*
- *The conclusions are itemized.*
- *A number of conclusions were written, not just one or two conclusions.*
- *Possible sources of error are indicated*].

ANSWERS TO QUETIONS

Q1: Does the length of the steel rod increases or decreases with temperature?

Answer: It increases with temperature.

Q2: Estimate the length of the steel rod used in the experiment when its temperature is raised to $600\,C^{\circ}$?

Answer: 1.6 m.

[*Notice:*
- *The answers to the questions were written at the end of the report.*
- *The answers were written on a separate page.*
- *<u>Both</u> the questions and their corresponding answers were written.*]

[*Notice also that fancy fonts were not used in the sample report*].