Appendix B - Writing Assignment Guidelines

Writing Assignments Overview

The purpose of these writing assignments is to give you experience in writing about the work you are doing such that it can be understood and (if necessary) reproduced by your professional colleagues and fellow students. The ability to write about your work clearly and informatively is one that you will need to develop, whether your future plans are to work in industry or in academia.

The writing assignments for this course will be done in two different formats: you will be keeping a Lab Notebook, which will contain information about the day-to-day work that is performed in the lab; and you will be writing two Design Reports, one for the Game Lab sequence, and one for the Smart Car sequence.

In general, the Lab Notebook should cover the development process of the lab experiments. They should include notes on testing procedures and data generated (including charts or plots), problems encountered and how they were solved, changes made to your system that make it different from the original specifications or schematics, answers to the homework assignments, and copies of the final code for each lab. Details about your Lab Notebook can be found below and on the following pages.

In general, the Design Reports will cover an entire system or project, in this case, the game or the Smart Car. The Design Reports do not need to include detailed information about the working of common components or the use of laboratory tools. However, they should include information about the development process, including the building, testing, and functioning of the various subsystems. In addition, the Design Reports will be expected to contain more detail and be understandable to a wider audience than the Lab Notebook. More information about the Design Report format can be found in *Final Design Report Guidelines* on page 154.

LITEC Lab Notebook Requirements

Purpose

The purpose of a lab notebook is to document the procedures, hypotheses, evolution, and results of experimental work. It serves as a basis for complete reporting of your work. Lab notebooks are essential in establishing the credibility of scientists and engineers, and are frequently used to establish time lines for intellectual property disputes. The lab notebook should convey the essence and progression of your experiment to the reader in such a way that he or she can reproduce exactly what you did.

Notebook Requirements

You are required to maintain one lab notebook for your team. DO NOT LOSE YOUR NOTEBOOK. *You are responsible for making sure that the Lab Notebook is brought to the lab any time one or both partners is working in the lab.*

The notebook can be purchased in the bookstore and must meet the following requirements:

1. It must be quad-ruled to facilitate neat schematic and graph drawing.

2. The pages must be permanently bound to the notebook (i.e., no perforated pages, no three-ringed binders.

3. Pages should be at least 9.75”x7.5”

Format Requirements

Lab notebooks will be graded on strict format guidelines. Some of these requirements may seem tedious, however they are necessary parts of effective documentation.

Notebook Entries

Left page	Right page
Miscellaneous notes and calculations necessary to support right page. All entries must be in permanent ink. All mistakes should be crossed out with a single line and remain legible.	All entries must be in permanent ink. You will be graded on neatness, format, and efficient writing. Entries on this side should be thought out *before* writing. Graphs of data should be computer generated and taped into the book. All entries must be hand-written. Each day should start on a new page.

For each lab experiment, the following sections are required on the right hand page, in this order:

Lab Title

Lab Description

This should be a 1-2 paragraph description of what the lab will accomplish, how it will be done and what metrics will be used to verify performance. These should be your own words based on your reading of the lab manual.

Pseudo-code

This should be correctly-formatted and indented pseudo-code, describing the progress and flow of your computer program for this lab.

Circuit Schematics

These must be hand-drawn representations of the circuits you have built in the lab. The schematics should be neatly-drawn, using ink and a rule as necessary for straight lines. Titles and labels should be neat, well-spaced, and legible. In most cases the schematics will match those provided in the lab manual. In some cases you may need to use different pins on the EVB or chips. It is important that there is agreement between your schematic, your code and your lab discussion.

Data and Notes

This section will present the data, if needed, to support the lab. Any measured/recorded data should be compiled appropriately and written in the notebook. Any data that is collected that does not represent final data should be noted (e.g., if you start an experiment, but stop before all data is collected, just note that the data in the table is not valid.) Any data in graph or chart form produced on the computer should be printed out and attached to a notebook page.

Data Analysis

In this section you should identify which data you are basing your discussion and conclusions upon. Is the data as expected? If not, why? Did you need to do anything beyond the lab instructions to achieve satisfactory performance? If so, describe (e.g., “we needed to use P0.4 instead of P0.5 to drive the OTU LEDs because P0.5 was not functioning properly on car #16.”)

Computer Code

Attach computer printouts of your final code versions.

The above sections are required as part of the check-off procedure. Subsequent modifications to subsystem hardware or software must be documented in Lab 5. For example, in Lab 3 you will use certain hardware, software and EVB pins to get the steering system to work appropriately. If you need to change hardware functionality, pin connections or software algorithms, document them in the lab notebook when the changes are made.

Tips for Good Lab Notebooks and Reports

1. Be concise. We don’t grade by the word. In fact, we will be looking for points to be conveyed as efficiently as possible. Lab notebooks and reports are necessary evils for all of us. You should invest enough time into them both so that you are able to encapsulate days’ or weeks’ worth of effort into a “big picture”. You should not be spending so much time on your notebook that you can’t complete the experiments.

2. Know your units and use them. Know the abbreviations for the units as well.

3. Tables and Figures need special attention. Units for table contents and graph axes should always be clearly labeled. All tables and figures should be numbered and captioned. Table captions go above the table and Figure captions go below the figure. Always refer to tables and figures by number. If you are not referring to a table or a figure that is in your notebook or report, it either does not belong there or further discussion is needed. In reports, tables and figures should not appear before they are referred to.

4. Grammar and spelling are important, especially in reports. Don't rely on software checks; they are inadequate. Read what you have written so you can catch mistakes, such as "there" when you want to say "their".

Embedded Control Design Report format

Your design reports will help you to exercise and refine your communication skills as an engineer, while conveying your knowledge and understanding of the course material to your grader. The design report communication is especially important if labs generally proceed smoothly, and you have little occasion to consult either your TA or professor. ***Communication*** **is one of the most important elements of engineering, with most people judging your work by the way it is communicated to them.**

The criteria for judging the quality of a report are the same as those that apply to any written document: the report should be clear, complete, and concise, with appropriate attention to spelling, grammar, and neatness. The length of the report should be sufficient to convey all relevant information, while being easy to read. A good way to gauge whether a report is well-written is to see how quickly another person can read and fully understand it. More often than not, the quicker the better. You may refer to the list of items below to get an idea of what is expected from you.

General Guidelines

- A *good* lab report explains what you did, how you did it, why you did it, and what conclusions (if any) can be drawn.
- An *excellent* lab report is grammatically correct, has no spelling errors, and looks professional. For those who wish to have their reports critiqued before submitting them to their TA, RPI has a writing center which can provide critique and guidance.

Formatting and Appearance

- Reports should be formal, *machine-printed*, engineering reports.
- They should have a cover page. This page should have the title of the project, as well as other information such as your section number, TA name, the names of your team members, and the due date.
- A Table of Contents should be included, specifying the report's sections and subsections and what page they begin on.
- To allow for TA comments, text should be spaced 1.5 to 2 lines, or as preferred by your TA. The fonts in the report should be consistent
- All pages in the report should be numbered consecutively, including any appendices.

- The section headings should be distinct.
- Graphs and other figures should be placed in the body of the report near the point where they are discussed, and should have a caption below the figure, e.g., ***Figure 1 - System Step Response Using Proportional Control with K_p = 10***. Graphs should have labeled axes, a title, and should be appropriately scaled. All figures should be numbered consecutively.
- Schematics should be professional quality, i.e., produced on a computer (pSpice or Logic-Works is available on most public PCs) or hand-drawn very carefully and neatly. It should show the entire system, not be broken down into individual lab exercises. Schematics should not be copied or scanned from the lab manual, the on-line tutorials, or other non-original sources.
- Be sure to provide a complete list of references.
- In general, there are no established length requirements for reports. They should be long enough to adequately explain what you did in the lab, no longer. Upping your page count by adding unnecessary fluff will not improve your grade.
- Your instructor or grading TA may specify additional formatting requirements.

Introduction and Statement of Purpose

This section will introduce the project, give any background, and provide a brief overview of the intent of the project. It is very important to inform the reader about the contents of the report in a concise manner (about half a page). This should include an overview of the system and state the basic goals for this work. These might include such objectives as designing and testing software or hardware, acquiring and analyzing data, and any additional objectives that you may have chosen. *These should not be a copy of what is stated in the lab descriptions from the manual* - note that some of the objectives listed in the lab manual are important from an academic point of view, but may not be of primary importance to the functionality of the system, and therefore *should not be included in the report*.

System description and development

Here you will describe your development methodology, including a description of any hardware and/or software that you used in meeting the project objectives. Within this portion of the report, you will have subsections to describe the hardware and software developed for the lab. In addition, other subsections should be included as needed to provide complete documentation of the development and experimentation process. Each section should be used to describe that portion of the lab.

Description of hardware

Describe the function and assembly of the circuitry you used. In addition to a text description, you must also include a detailed schematic of your circuitry. This section should not include redundant information on how to use the laboratory tools or on basic equipment used (e.g., explaining how to use the computer or the EVB). Any hardware problems, solutions, or potential solutions should be documented in this section. This would allow the readers to investigate these problems if they wish to duplicate the experiment or to analyze the problem in more depth.

A complete description of all of your hardware is required. A person should be able to duplicate your efforts and have a full understanding of your system by reading your report. For example, the hardware of the *Smart Car* is comprised of subsystems for optical tracking, steering actuation, and drive-motor control. The hardware description should start with a brief explanation of each subsystem in a logical manner from input to output of the subsystem (including what port it is connected to). Following that, each subsystem can be described in more detail. Do not use specific pin numbers when describing the hardware in the body of the report (i.e.“pin 1 of the LM324 quad op-amp is connected to the servo connection block for the servo motor”). Pin numbers can be read from the schematic. What cannot be read from the schematic (in general) is the function of each component, why it was included in the system, and how it affects your system. That is what your hardware description is for.

In Summary:

Areas which should be included:

- Functions of all chips/components used in the circuit (i.e., ***Why*** is the chip/component needed in the circuit? It is obvious what an inverter does, but *why* was it included in the circuit?);
- Which ports control which functions (i.e., Port 1 is used to control the LEDs);
- Any special calibration procedures (i.e., How the gains on the OTU amplifier circuits are set).

Areas which should not be included

- Specific pin connections, which can be read off of the schematic (i.e., Pin 30 on the EVB is connected to pin 2 on the 7404 inverter). Also, don’t give pin numbers in the text of your report because not all versions of the C8051 have the same pin-outs.
- Do not describe software in the hardware section (i.e., LEDs turn on because of a potential difference across them, not because you set a bit high in your code).

Description of software

Describe the software you have written, and show how it meets the performance requirements of the system being designed. Again, a complete system description is required. In addition to an overall description, you should provide details on segments of interest.

The software should begin with an overview of the system as a flow of subsystems. The function of each subsystem can be described along with the information that it needs, obtains or generates. For example, the code for *Smart Car* can be broken down into the A/D conversion, steering control, and speed control subsystems. Following this general description, each subsystem and the individual lines of code within each can be described in further detail.

A flow chart should be included to clearly show the logical progression of your program. It may be helpful to map out a flow chart for your program before you start writing any code. Doing so will help you identify likely candidates for functions, as well as simplify your report writing. Information on flow charts may be found in the online tutorials: *Software -> C Programming -> More -> Flowcharts.*

In Summary:

Areas which should be included:

- An overview of the program structure and then details on each of the subroutines. This summary should include when each function is called from the main function and what the function accomplishes;
- A flow chart showing the progression of your program's functioning;
- Description of the information which passes to and from each function;
- Specific description of code (i.e. How and why a masking procedure is performed. How the timer output compares are configured, and how they produce a pulsewidth modulated signal. How the control algorithm is implemented.).

Areas which should not be included:

- Detailed descriptions of included header files, *define* statements, and function and variable declarations. You may need to state some of these as part of your software description, but details on these are not significant. A listing of any important variables with a brief description next to each may be sufficient.

Results and conclusions

In this section of the report you will present an overview of how the system and subsystems work, the results you obtained, the various tests you performed, and the conclusions you derived from these tests. You should also briefly outline your success in meeting the project's objectives. You should describe any unique features of your approach, any substantial problems which you encountered and hopefully surmounted, and anything, in retrospect, you would have done differently. This is a good opportunity to provide feedback to the course about any difficulties you may have had with the material or equipment.

In Summary:

Areas which should be included:

- Graphs of any responses obtained during experimentation or system development. Example: Optical tracking unit versus lateral track position response, closed loop speed control responses.
- Discussion of your results. Example: Compare and contrast speed control responses for different values of closed loop gain.
- Any results from the project to report. (i.e., Were the OTUs balanced? What was the best procedure for calibrating the OTUs? What were the optimal control constants, and how did the system performance change when these constants were changed?)

List of references

Any information you used which was not your own and is not considered common knowledge must be referenced. List all the references you used, correctly formatted. At the least, this should include the LITEC Lab Manual, but if you used other textbooks or handbooks for your work, they should be listed here as well. References should be documented in typical bibliography format.

Appendices

The appendices should contain all extra material which does not to fit into the body of the report. This includes *well-commented* C source code (about a 1:3 ratio of comments to lines of code), schematics, and raw data, as required. Any source code should be well commented. Schematics should accurately represent the circuit which was constructed for the laboratory, and all pin numbers for all connections should be included. There are several software tools with circuit design tools available on campus if you want to draw your own schematic. It is also possible to use a plain drawing package such as FrameMaker or ProENGINEER.

Participation

A section-by-section outline or summary of who did what toward the completion of the project, including each section of the lab report, must be included in all lab reports. *This portion should be signed by both lab partners on a line after each partner's name*. We will assume that the lack of a signature indicates a lack of participation of a lab partner with respect to the report.

Final Design Report Guidelines

In addition to the Design Report requirements outlined in the previous pages, the Final Design Report should follow the following guidelines. The final report is intended to document the culmination of your work in the Embedded Control course. It is to be written for someone who is assumed to be familiar with the C8051, but not necessarily with embedded control or the course. As such, you need to provide concise explanations of everything that your car does, from the steering algorithm to how you determined your optimal propulsion gain. You do not need to write an authoritative text on the subject; a clear and concise explanation will be sufficient.

- The final design report should not regard or describe the system as a series of individual labs. For example, don't simply collect the goals given at the beginning of each lab exercise to form the list of goals achieved for the entire project. Do not refer to the individual lab exercises, e.g., "... in Lab 4 we investigated the..." in the final report.
- Do not have statements like "familiarizing with C, logic probe, tutorials...".
- The report may include an abstract which gives an overview of the entire project.
- In describing the system, there are several approaches you could take - two of them are described here.
  - You may describe all the hardware involved, followed by a thorough description of the C code developed for the system.
  - You could describe each subsystem in terms of its need, function, design and construction of the system, the control method used to control the system and a description of the code developed to implement the control algorithm. Thus, in the second method, each section may include a simpler version of the subsystem's schematic and the relevant section of the code. You may also describe any special feature you found interesting in the development of the subsystem, any problem you had and how you detected and solved it.

- Be sure to include:
  - Any algorithms or calculations
  - State and justify options used (PCA mode, etc.)
  - Charts or graphs of any data obtained, clearly labeled, along with an explanation of the data collection procedure, and analysis of the results
  - Any additional information needed for another individual to repeat your work
- You may wish to provide a section on system integration. System integration is a non-trivial task and discussing it in your report gives you a natural place to talk about issues you encountered while finishing the basic system.
- Be sure to include a detailed description of the control algorithm(s) used by your group. It forms the crux of the entire project. When doing so, include system response curves to support your arguments and make sure to provide response curves with control constants on either side of the value that you have chosen to be the optimum for your system. Provide the mathematical formulation of the control algorithm used and the C code implementation of the algorithm.
- When drawing the schematic, do not draw the schematic for each lab separately. Draw a functional block diagram of the system, and follow it up with a detailed schematic of the various blocks. You may opt for a colored schematic if it helps to make the wiring connections easier to follow. Clearly indicate power and ground connections.

A few words on plagiarism:

Plagiarism is defined as: “1: a piece of writing that has been copied from someone else and is presented as being your own work 2: the act of plagiarizing; taking someone's words or ideas as if they were your own” (*WordNet ® 1.6, © 1997 Princeton University).*

Plagiarism is a serious breach of honesty in any venue; in an academic setting it will not only have a significant negative impact on your grade, but it will prevent you from learning writing skills that will be needed in future academic and professional work. In a professional setting, it can be grounds for dismissal from a job or from professional societies, as well as casting doubt on the integrity of your work as a whole.

Some examples of plagiarism include:

– Copying sentences, parts of sentences, paragraphs, or longer pieces of text from the lab manual, the online tutorials, books, articles, or other people’s writing in any form, and using them in your writing assignments without attribution. Changing some of the words, or rearranging the sentences or portions of sentences still constitutes plagiarism.

– Copying schematics, graphics, illustrations, charts, graphs, tables, or other illustrative material from the lab manual, the online tutorials, books, articles, or other people’s writing in any form, and using them in your writing assignments without attribution.

Avoiding plagiarism is not difficult, and will benefit you in the long run. The following guidelines may help:

1. In the course of your lab work, try to make notes on what you are doing, what you have tried, problems encountered, etc. Keeping your lab notebook complete and up-to-date will be very helpful in this.

2. When you go to write your lab reports or other technical writing, use these notes as a starting point for describing **in your own words** the goals, concepts, techniques, results, and other components of the development process.

3. If there are certain things that you feel are best described by text from the lab manual or other source, make sure you reference that material. A word-for-word copy should be placed in quotation marks, and a footnote or endnote reference placed at the end of the quoted portion. A paraphrase or idea-by-idea copy should have a footnote or endnote reference placed at the end of that portion of text.

Plagiarism, even if inadvertent, will have serious consequences on your future career - now is the time to learn the skill of writing about your own work, and referencing others’ writing appropriately.