KETTERING UNIVERSITY

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

COMPUTER ENGINEERING CURRICULUM COMMITTEE

LABORATORY AND PROJECT REPORT WRITING GUIDELINES

October 10, 2017

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1. GUIDELINES FOR LABORATORY/PROJECT REPORT FORMAT

This document provides guidelines to ECE students at Kettering University for preparation of written laboratory and project reports. The information is drawn from sources used in other Universities and standards from the IEEE [1-3]. It describes the writing components of a report, both in format and content. The appropriate standards for the below items are discussed in the following subsections.

a) Title page
b) Table of contents
c) General format
d) Section and subsection headings
e) Figures
f) Tables
g) Equations
h) References (if appropriate)
i) Appendices (if appropriate)

1.1   Title Page

The title page should contain the following items in the same order as they are listed. You should center each item on a single line.

a) Name of the institution.
b) Name of the department.
c) Course number and course title, and section number (if applicable).
d) Lab exercise/experiment or report title.
e) Reporting individual's name (if students submit individual reports)
f) Team members' names.
g) Submission date.
h) Instructor section: space for comments and grade

Students can use the template provided in Appendix A (Report Title Page Sample).

1.2   Table of Content

The Table of Contents should start immediately following the Title Page, before the body of the report. The heading for this page should be "**TABLE OF CONTENTS**", and should be centered, bold, and capitalized. The actual table of contents consists of two columns. The first (left) column heading should be "**Section**", while the second (right) column heading should be "**Page**".

The "**Section**" column will contain a list of the major sections and subsections of the report. The "**Page**" column indicates the page number associated with the relevant sections and subsections. The "Table of Contents" of this document can be used as an example.

1.3   General Format

   a) Prepare your report in word processing software (such as Microsoft Word).

   b) Use a standard letter sized paper (11" x 8.5") with one-inch left, right, top and bottom margins.

   c) Use a standard 12 point font for each section, subsection, and sub-subsection headings, and a standard 10-12 point font for the narrative.

   d) Use 1.5 line spacing for all of your written reports; 3 lines between paragraphs (2x1.5).

   e) Do not indent the first line of a paragraph; use a blank line to separate the paragraphs.

   f) You can use bold, italic or underlined words to highlight the key words in your text.

   g) With the exception of the "Title Page" and the "Table of Contents" (if any), each page should have a page number centered at the bottom.

   h) Use left justification for all written reports.

   i) The standard page orientation is portrait. However, if a page is used completely for a figure, then you may use a landscape page orientation (for that page only). In this case, the right margin will become the bottom margin, and would carry the caption for the figure.

   j) The procedure part of your report describes what was done in the lab and should, therefore, be written in the past tense.

   k) Double check the writing to make sure you use correct spelling and proper English grammar.

l) Use the IEEE citation style [3] to cite references.

1.4 Section and Subsection Headings

Headings are used to display your report's arrangement to the readers, allowing them to read the report selectively. The heading itself is a phrase that describes what is discussed in the paragraphs that follow. Therefore, each section of your report should have a section number and a substantive heading. The narrative should be separated from the section heading using double spacing.

You can divide each section into as many subsections as you wish. The section number and heading should be typed entirely in bold capital letters. The subsection should be numbered and the first character of each word should be a capital letter. The subsection headings should also be typed in bold. The narrative should be separated from the subsection heading using double spacing. Use this document as a guideline.

1.5 Figures and Figure Captions

Figures in your reports include schematic diagrams, flow-charts, drawings, graphs, and photographs. When constructing a figure, you should consider the following:

 a) Keep figures simple and clear.
 b) Label and provide dimensions for all axes of graphs.
 c) Center the figure, figure number, and caption.
 d) If possible, reference figures in the text before they appear.
 e) Figures should generally be placed at the top of a page.
 f) Number figures consecutively within the section of a report (for example, the second figure in Section 3 would be labeled "Figure 3.2".)

The figure number and caption should be placed below the figure, which is opposite compared to a table number and title. The figure number should contain the word "Figure" followed by a number and a colon. You should then include the figure caption describing the figure on the same line. The figure, figure number, and caption should be centered on the page. See Figure 1.1 below as an example:
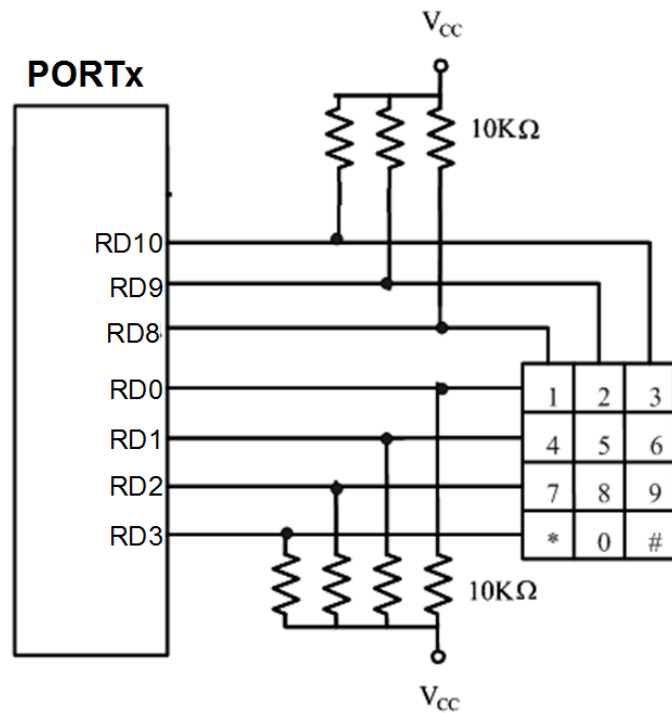
Figure 1.1: PIC32 GPIO pins for keypad interfacing

1.6 Tables and Table Headings

A table is any arrangement of data setup in vertical columns and horizontal rows. You need to consider the following when you decide to include a table in your report.

    a) Tables should be simple, clear, and logical.

    b) Tables should be referenced in text before they appear.

    c) Tables should be numbered consecutively within a section of the report.

The first line of a table is the caption which is the word "Table" followed by a number and a colon. Then you should include the table title on the same line. The table, and the table number and title should be centered on a page.

After the table number and the table title, you can proceed with the actual table, which will consist of several columns and subcolumns. Every column and subcolumn must have a heading that clearly identifies the data. If the heading has a dimension or unit, then you need to specify it inside parentheses. See Table 1.1 as an example.

Table 1.1: Summary of Resistance and Current Values

Voltage (mV)	Resistance (Ω)	Current (mA)
100.0	10.0	10.0
100.0	20.0	5.0
100.0	40.0	2.5
100.0	50.0	2.0

Tables may be placed wherever appropriate within a document, or at the top of a page.

1.7   Equations

All formulas and equations should be centered. Equations should be numbered consecutively within each section, independent of other graphics – for example, the second Figure in Section 1 would be labeled (1.2).

Formulas and equations should be explained in English, and all factors (variables or symbols) must be defined. For example,

$$V = I \bullet R \hspace{4cm} 1.1$$

Where V represents the voltage (V), I represents the current (A), and R represents the resistance (Ω).

Alternatively, you may define your variables in a list:

$$V = I \bullet R \hspace{4cm} 1.2$$

where,

   V: Voltage (V)

   I: Current (A)

   R: Resistance (Ω).

Variables in an equation, or when referenced within the narrative, are typically italicized, whereas functions (sin, cos, etc.) are not – for example, sin(x).

1.8   Program Design (if necessary)

If the primary objective of the lab or project assignment is to design and implement a program for a specific task, the report should include a section on software or program design. Tools such as flowchart, pseudocode, state diagrams, state flow, or other tool specifically recommended by the instructor needs to be utilized for the program design. See Figure 1.2 below as an example of flowchart used for program design. Reference [4] gives information about Flowchart with some examples. Free online tool, such as [5], can be used for creating flowcharts.
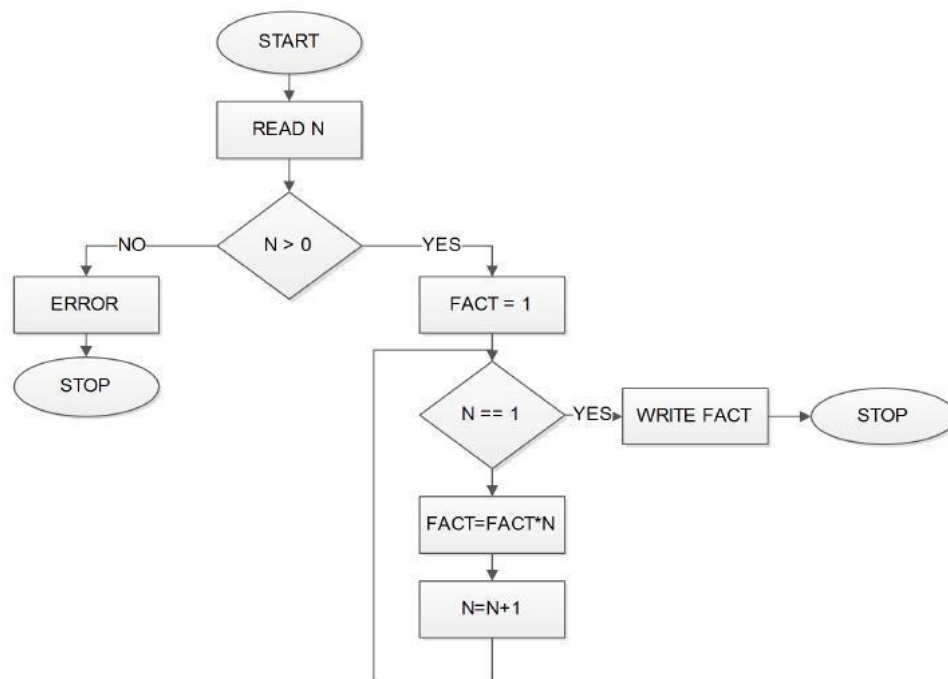
Figure 1.2: An example of flowchart.

1.9   Program Source Code and Comments (if necessary)

If the primary objective of the lab or project assignment is to design and implement a program for a specific task, the report should include a section on the program code. The program needs

to be well formatted with proper indentations and white spaces to enhance readability of the code.

Give a caption for the program listing and place it above the program (see Listing 1.1 below).

Program documentation using properly written comments is important component of the program. Always keep in mind that the comment needs to be kept concise and describe what you are trying to achieve with the specific function or piece of code. A general formatting guideline for comments is as follows:

- Include a top level comments section at the beginning of the program that provides information about the course, instructor, program authors, lab assignment number and title, brief description, hardware used to run the program, program input and output parameters.
- Include comments at the beginning of each function or subroutine, describing the specific task the function or subroutine does and its input/output parameters.
- To improve understanding of the program you may also include brief comments to explain the internal implementations of the code. Use your judgment to keep a good balance between providing the reader with useful information without over-commenting.
- Assume the reader is familiar with the programming language so you do not need to explain the language syntax, instead focus on what the code is trying to achieve.

Listing 1.1: Lab 4 main program listing

```
;*******************************************************************
; CE-420 Microcomputer Systems II
; Instructor: Professor Tewolde
; Author: Girma Tewolde
; Lab 4: Keypad Interfacing
;
: Description: This program implements a keypad scanning technique to detect if any key
; is pressed by the user on the keypad input. If a key is detected the program returns the
; ASCII code of the key, otherwise it returns NULL.
```

```
;
; Hardware: The 4x3 keypad is interfaced to the PIC32 MCU over 7 GPIO pins. The rows
; of the keypad are driven by pins RD0, RD1, RD2, and RD3. The columns of the keypad
; are interfaced to the pins RD8, RD9, and RD10. External 10 kOhm pullup resisters are
; used on all pins.
;
; Program input/output: The program inputs are provided from the user by pressing keys
; on the keypad. The detected keys by the program are then displayed on the user's
; computer screen using the 'putty' serial monitor program.
; ********************************************************************
;
```

1.10 References (if necessary)

The reference section of the report should contain a list of the material (book or article) to which you have referred. References should be the commonly available publications. Unpublished work or reports of limited circulation should not be referenced. However, it may be necessary to append copies of not readily available articles in one or more appendices.

References within the narrative are referred to by a number inside of brackets. The numbers should be arranged in a sequential manner throughout the report. (For example: "Voltage is related to current via Ohm's Law [1]. Power represents energy dissipated or generated by a device per unit time [2-4].")

For every reference number provided in the narrative, list the appropriate citation in the "References" section. The heading for the "References" section is "**REFERENCES**", and should be centered, bold, and capitalized.

A reference list should contain the following information – in the same order they are presented in the narrative:

1. Authors' names (first initial of first name and full last name), separated by commas.
2. Report or article title in quotations; book titles in italics.

3. Publication's name and volume number, or the book publisher.

4. Date of publication.

5. Chapter, section, and page numbers, as appropriate.

1.11 Appendices (if necessary)

Appendices are important parts of your technical report. Many readers want to extract the heart of the report in a very short time. Therefore, many technical reports are limited to 10-20 pages. Consequently, much useful information is transferred into the appendices. Select appendix information that is relevant, and has been referred in the text of the report. Typically the following items are included in the appendices:

- Extended analyses

- Case histories and variations

- Intermediate mathematical steps

- Printout of computer programs and runs

If you incorporate Appendices, list them in the order they are referenced in the narrative. Use alphabetic numbering – for instance, the heading for the first appendix is "**APPENDIX A**". The heading should be centered, bold, and capitalized.

Each Appendix should start on a separate page, including "Appendix A".

The Appendices of this document can be used as an example.

2. GUIDELINES FOR LABORATORY/PROJECT REPORT STRUCTURE

The sections required to complete your lab reports should be written in their following order:

2.1 Title Page

The "Title Page" should include the title of the lab exercise or experiment, course number, name of author(s), and date the experiment was performed, etc. Allow space for the instructor to write

general comments and assign a grade to each team member. See format specifications outlined in Section 1.1. You may use the sample Title Page in Appendix A.

2.2   Table of Contents

A "Table of Contents" is required for big reports that incorporate many of the components listed below on multiple pages. Follow the format guidelines presented in Section 1.2.

In small lab assignment reports the "Table of Contents" may not be required. Follow the instructions provided in corresponding lab assignments.

2.3   Objectives

The "Objectives" section should be written in a concise manner (3-5 sentences), using bullet or paragraph form. The laboratory manual or instruction sheet will help here. Objectives should state the problem that your lab assignment attempts to answer. In a design type laboratory assignment, the objective states the expected outcomes of the product that is going to be designed.

2.4   Theoretical Background (If Necessary)

If necessary, the "Theoretical Background" section should present a concise description of the relevant theory that is needed to understand other parts of the report, such as the "Experimental Procedure" or "Data Analysis" sections. Relevant equations should be introduced, and all technical terms to be used in the report should be defined in a list form. Equations presented in this section must be numbered and referred to in the narrative of the text. Simulations are appropriate for this section.

2.5   High level system Architecture (If Necessary)

In a lab or project report that involves system design, this section presents the high level system architecture of the proposed solution. Use block diagram or other illustrations to show the system components. Explain the purpose of each component, and how they interconnect and work together to provide the overall system functionality.

You may also provide several sub-sections for the description of each component of the system.

2.6   Hardware Design (If Necessary)

If your lab assignment or project involves a hardware design, you need to provide details about the actual design of the hardware portion of the system. You may need to evaluate different design options and provide justifications why you ended up building the system your way, describing the trade-offs, etc. Include block diagrams, schematic diagrams, pictures, etc. of the actual hardware setup

2.7   Software Design (If Necessary)

Provide a high level design for the software part of your system. Make sure you follow structured and modular design approaches. For complex projects, divide your application into a number of smaller and manageable modules with well-defined interfaces. Clearly state the function of each module and provide details on how they are implemented. You may use flowchart, pseudocode, or other commonly used tools to present your software designs.

2.8   Software Source Code (If Necessary)

If the primary objective of the lab or project assignment is software design, the actual implementation of the program (with the program comments) may be included in this section of the report.

2.9   Experimental Procedure (If Necessary)

The "Experimental Procedure" section includes the list of equipment used, any schematic diagrams used to perform the experiment, and a description of the laboratory procedure.

NOTE: There are times when it becomes necessary to repeat the "Experimental Procedure" and "Analysis" sections if multiple experiments are performed within a laboratory experiment.

2.9.1   Equipment Used (If Necessary)

In experiments or projects that involve data collection, list the main pieces of equipment and components used in the experiment. Include identifying models, serial numbers, and brands of all equipment. The reader must be able to connect each item in this section to the items used in the rest of the section and subsections.

2.9.2   Laboratory Procedure (If Necessary)

Detail the procedure used to carry out the experiment step-by-step, and include a neat, technically correct, clear schematic drawing of the experimental setup, showing all interconnections and interrelationships. If necessary, you should also include a short description that refers to all parts of the schematic drawing and discusses how they are used. This subsection should have all the information needed for a reader to duplicate the setup independently.

As with all sections of the report, the procedure describes what was done in the lab and should, therefore, be written in the past tense. The procedure must be written in your own words. Copying the procedure from a lab manual would be an inaccurate reflection of the work completed in the lab and is not acceptable.

2.10   Analysis

The "Analysis" section includes any experimental results which were obtained during the procedure, in addition to all analysis of your data.

2.10.1   Experimental Results (If Necessary)

All the pertinent raw data obtained during the experiment are presented in this section. Raw data, versus manipulation of the data toward an end result, should be identified clearly as such. The type of data will vary according to the individual experiment and can include numbers, sketches, images, photographs, etc. All numerical data should be tabulated carefully. Each table, figure and graph in the report must have a caption or label and a number that is referenced in the written text. Variables tabulated or plotted should be clearly identified by a symbol or name.

Units, if any, should always be clearly noted. Data should indicate degree of accuracy with which measurements were made.

2.10.2 Data Analysis (If Necessary)

This section provides the reader with the equations that are used to analyze the data obtained from the experiment. It also describes the accuracy of the data, supported where necessary by an error analysis, in addition to your interpretation of the outcome of the experiment.

Any relevant information from the data should be described, analyzed, and explained, and should answer the question, "What does the data mean?". Describe any logical projections from the outcome – for example, the need to repeat the experiment, or to measure variables in a unique way.

Assess the quality and accuracy of your procedure. Compare your results with expected behavior (if such a comparison is useful or necessary), and explain any unexpected results or observations.

2.11 Conclusions

The "Conclusion" section should base each technical conclusion on actual results. Explain the meaning of the experiment and the implications of the results. Examine the outcome in light of the stated objectives. This section should answer the question, "So what?". Seek to state your conclusions in a broad context in light of theory versus experimental results.

2.12 References (If Necessary)

If a "References" section is necessary (especially if a "Theoretical Background" section is used), apply all necessary reference numbers and citations to the document in the appropriate location.

Reference numbers, and the citations used in the "References" section should be used in ascending order in order of appearance, and must conform to the "IEEE Citation Reference" format.

See Section 1.10 regarding the format for References.

2.13 Appendices (If Necessary)

If an "Appendices" section is necessary, be sure to place separate documents, such as specification sheets, each in a unique Appendix.

See Section 1.11 regarding the format for Appendices.

3   REFERENCES

[1] "Guidelines and Standards for Laboratory Reports and Technical Writing," California State University, Fresno, Lyles College of Engineering, Department of Electrical and Computer Engineering, 2012-2013.

[2] W. J. Eccles, "Guidelines and Standards for Writing Assignments," Rose-Hulman Institute of Technology Department of Electrical and Computer Engineering Standard, 2003.

[3] Dr. Graffox. (2009, September). *IEEE Citation Reference*. [Online]. Available: http://www.ieee.org/documents/ieeecitationref.pdf.

[4] Lucid Software Inc, "What is a Flowchart?" [Online]. Available: https://www.lucidchart.com/pages/what-is-a-flowchart-tutorial [Accessed October 9, 2017].

[5] Online software tool for making flowcharts. https://www.draw.io/ [Online]. Available: https://www.draw.io/ [Accessed October 9, 2017].

Kettering University
College of Engineering
Department of Electrical and Computer Engineering

Laboratory Report

Course No. & Title: _____

Instructor's Name: _____

Lab Title: _____

Date Submitted: _____

Team Members:

(1) _____

(2) _____

INSTRUCTOR SECTION

Comments: _____

_____

_____

_____

Grade: Team Member 1: _____

Team Member 2: _____

APPENDIX B

Example Skeleton Format for Computer Engineering Laboratory or Project Reports

TITLE PAGE

TABLE OF CONTENTS

1. OBJECTIVES

2. THEORETICAL BACKGROUND *(If Necessary)*

3. HIGH LEVEL SYSTEM ARCHITECTURE *(If Necessary)*

4. HARDWARE DESIGN *(if Necessary)*

5. PROGRAM DESIGN *(If Necessary)*

6. PROGRAM SOURCE CODE *(If Necessary)*

7. ANALYSIS *(If Necessary)*

    7.1 Experimental Results

    7.2 Data Analysis

8. ANSWERS TO QUESTIONS *(If Necessary)*

9. CONCLUSIONS

10. REFERENCES *(If Necessary)*

11. APPENDICES *(If Necessary)*

Note: The program source code may be included in either section 5 following the program design or in the appendix, depending on the size of the program, focus of the report, and the instructor's preference.