**ECE 383 – Embedded Systems II**

**Final Project Format Guidelines**

# Final project

The final project in this class will be the design and implementation of an engineering prototype to address some need. The final projects in this class are to be completed individually. The following are significant deliverables in the completion of the final project.

## Proposal

The proposal describes the need that the project fulfills, and the requirements that should be met in order to satisfy this need. Project specifications may be modified by the instructor.

## Plan

The project plan describes the hardware organization used to realize your design. In addition, it defines the technical accomplishments for the first and second milestones.

## Milestone I

A milestone is an intermediate level of technical accomplishment required in the final system. The first milestone will generally focus on getting the low level units of the design operational.

## Milestone II

The second milestone generally seeks to integrate the units of the design. You should aim to have a simplified version of your design complete.

## Presentation

A presentation in front of the class covering the design needs, high level architecture, detailed design, and a demo of the final product.

## Write-up

A written document describing your design, its performance, and its operation.

# Proposal

You final project proposal outlines the need that your project will address, the requirements for the solution, and the behavior of your solution. The proposal will start out by defining the name of the project and your name (with signatures) on the project. The following is the suggested format.

The project proposal will then have the following three sections in the following order.

**The Bicycle Computer**

A final project proposal for ECE 383

by

C3C Cadet Jones \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

March 10, 2020

## Need Statement

A needs statement defines what need the project supposes to fulfill. When appropriate you should look for statistics to support your argument that there is an actual need.

## Marketing Requirements

The marketing requirements define the "soft" requirements of your design. These should be characteristics that you are going to design your system to meet. Do not be overly ambitious; generally engineering prototypes are NOT user friendly, portable, low cost, light weight, or low power. You are looking to build a proof-of-concept design, not a final project.

## Level-0 Description

A level-0 function table defines the overall input, output, and behavior of the system that you are building. You need to carefully consider what interactions a user will have with your system. This will give you clear goals for your project. You should generate two level-0 descriptions

* Graphical - Show your system as a box with the top level user inputs and outputs.
* Function Table - Describe the input, output and behavior of the system using this table format.

|  |  |
| --- | --- |
| Module | The module name |
| Inputs | Users inputs and sensors which are inputs to the modules |
| Outputs | All forms of outputs from the modules |
| Behavior | Describe the behavior of this module. Make sure to talk about all the modes that the module can be in. |

You may want to use a state-diagram or flow-chart to describe the behavior of the system.

# Plan

The project plan defines how you are going to go about implementing the design set forth in your proposal. All project plans should have the following information at the top of the first page. Your signature certifies that you agree to the plan set forth in this document.

**The Bicycle Computer**

A final project plan for ECE 383

by

C3C Cadet Jones \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

March 20, 2020

The plan should then go on to include the following sections.

## Proposal

Include the body of the updated proposal document - include any edits made to the original proposal by the instructor. Clearly, you should only include the Need Statement, Marketing Specifications, and Level-0 Function Table.

## Detailed Architecture

You need to provide the detailed design of your system. A detailed design should be split into level-1 and datapath and control.

### Level-1

A level-1 design breaks the level-0 function table into modules; each module generally corresponds to some physical chip, sensor, or actuator. A system boundary should be drawn showing where the system interacts with the user (signals which cross this boundary are the I/O from the level-0 function table).

### Datapath and Control

One of the modules in your level-1 diagram will be the Xilinx Spartan6 FPGA. Describe the internal organization of the chip using a datapath and control similar to those presented in Lab 1 and Lab2. Make sure that the top level signals match those in the Level-1 diagram.

## Calculations

You may need to perform some calculations in order for your project to work. Calculations are should have units attached to all units factoring calculations. Any unusual data structures which have bit fields which meet some requirements should be explained in this section, e.g. fixed point.

## Technical Requirements

All projects will have some technical requirements that need to be met. These technical requirements are numerically defined performance goals that you need to meet. For each technical requirement give some justification for the values choose.

## Bill of Materials

Include a list of the parts that you will need to complete the project; include parts that you may already own. For each component, please indicate if we have it and if not, will you be purchasing it, or will USAFA need to purchase it. If you need an item purchased, please provide the exact part number, cost, and URL where it can be ordered.

## Milestone I

A milestone represents an intermediate level of technical accomplishments required in the overall system. Your first milestone should focus on getting every unit defined in your level-1 design operational and communicating with your reprogrammable chip. The milestones will take on the form of tests which will be run to verify that each milestone was met. For example, if you are interfacing a thermometer to your chip then a milestone would be, "move thermometer from hot water to cold water and observe temperature change." Make sure to document these tests with pictures or measurements, so that they can be included in the final project write-up.

## Milestone II

The second milestone will represent a more advanced level of system functionality. At this point you should be examining the interactions between combinations of level 1 components. Again, the milestones should take the form of tests which verify that modules are working correctly. These tests should be built around the overall stimulus response of your final project. A second milestone based on the previous example might be, "move thermometer into hot water and wait for warning LED to come on."

## Functionality

Define the requirements that you will need to be meet in order to achieve minimum functionality. Likewise defined B and A-level functionality. The specifications for each grade level must include:

* Behavioral – tell me what the system should do
* Testing – describe tests performed demonstrating unit-level functionality and system performance
* Documentation – provide me with data showing test results and system performance

# Milestone I

You need to document that you have or have not met your deliverable obligations for the first milestone. In order to do this you will produce a document with the following sections.

## Detailed Architecture

Cut-and-paste the level-1 and datapath and control designs from the project plan. Incorporate any edits suggested by the instructor.

## Unit Test Plan

Enumerate the tests defined for the first milestone in the project plan along with, how it was performed, and the results of the test. Give details on any special programs written to perform these tests.

# Milestone II

You need to document that you have or have not met your deliverable obligations for the second milestone. In order to do this you will produce a document with the following sections.

## Detailed Architecture

Cut-and-paste the level-1 and datapath and control designs from the project plan.

## Integration Test Plan

Enumerate the tests defined for the second milestone in the project plan along with, how it was performed, and the results of the test. Give details on any special programs written to perform these tests.

# Presentation

You will be giving a technical presentation on your design. This presentation may be attended by other cadets. Thus, you must strive to have something in this presentation for everyone. The most common problem is design presentations is that students jump too quickly into the technical details of a project without first establishing the overall scope of your project. The second slide of every presentation must be titled "I built an embedded system which..." This slide should be comprehensible by the average 10-year old. You might want to give a demo of your circuit (or a video of it in action) at this point so that everyone absolutely positively knows what you have built. Your technical explanation should start with your level-0 diagram, then to your level-1 and then onto your datapath and control. For each component in level-1 you should show the tests (and their results) that verify its operation. Don't be afraid to get into the nitty-gritty details after you have properly addressed what you are building; just remember to keep your presentation within the time limits.

# Write-up

The final write-up should be hard copied, bound (GBC or spiral) with a clear cover and heavy weight back cover. The final write-up should have the following organization.

**Cover Page:** The cover page of the report should look like the following

**The Bicycle Computer**

by

C3C Cadet Jones

A Technical Report Submitted to the Faculty of

Electrical and Computer Engineering

United States Air Force Academy

Submitted in partial fulfillment for the requirements of

ECE 383 – Embedded Systems Design II

April 27, 2020

**Chapter 1: Design Goals**

1.1 Need Statement

1.2 Marketing Requirements

1.3 Level-0 Description

**Chapter 2: Detailed Design**

2.1 Level-1 - each module should have an accompanying function table.

2.2 Datapath and Control

2.3 Calculations

2.4 Technical Requirements

2.5 Bill of Materials

**Chapter 3: Implementation**

3.1 Milestone I - include test results.

3.2 Milestone II - include test results.

3.3 Final Implementation

**References:**

Include any books, technical documents, magazine articles, or web sites that you used to help complete your project. Use a proper reference format (IEEE would be good) found in your technical writing textbook. If you include a reference then it must be referenced somewhere within the body of your document.

**Appendix A: Running the Project**

Describe the procedure for a faculty member or student to duplicate your demo. I would like to have your project as a resource for students in later semesters so its important describe for them all the details necessary to make your project work. Include any special assembler or compliers that you used.

**Appendix B: Project Git Lab**

You should provide the faculty member with a GitLab repository containing four directories. SOURCE should contain all the project files (include all intermediate files generated by the compiler), PRESENTATION should contain your final power point presentation, DEMO should contain a mpeg, mov, avi, etc. of your project in action along with any documented tests, and REPORT should contain your written report. This drive will be return to the students during the final exam period.

**Final Written Report Guidelines**

The following are guideline that you are expected to follow in your final written report.

* Include page numbers in the bottom center of each page.
* Brief code snippets are OK, but do not hardcopy your entire source file.
* Double-sided copies are mandatory for the final bound report.
* Single space the body of your text.
* Correct spelling mistekes.
* Make sure that you do have not grammar mistakes.
* Consider the logical flow of the material; try to paint a complete picture in a logical manner.
* Font should be Times Roman 12 point (except software printouts as indicated above, which will be 10 point Courier).
* Use 1” margins for the left, right, top, and bottom the page.
* Each chapter of the report must begin on a new page. The heading for each chapter should be bolded 14 point font and the sections should be numbered consecutively.
* Figures in the text should be numbered consecutively, and properly labeled with the figure number and caption underneath the Figure. The figure numbers should be used to refer to figures in the body of text. An example Figure caption would be: Figure 1. Proposed conceptual design. If you have a figure in your text then it must be referenced somewhere within the body of your text.
* Tables in the text should be numbered consecutively, and properly labeled with the table number and caption underneath the table. The table numbers should be used to refer to tables in the body of the text. An example table caption would be: Table 1. Design specifications.
* All equations should be numbered consecutively, with the equation centered and the number right justified and inside parentheses. For example an equation would be shown as

 (1)

You then use the equation number inside parenthesis to refer to it in the body of the text.

* Example for references

In body of report: “Analog LVDT signal conditioners that operate by demodulating *s(t)* utilizing op amps and transistors can be designed, but they require stable sine wave generators and phase compensation networks to operate properly [1].”

Then refer to it in the reference section as follows:

[1] G. Novacek, “Accurate Linear Measurement Using LVDTs,” *Circuit Cellar Ink, Issue #106*, pp. 20 – 27, May 1999.