# Final Project Summary

The final project in this class will be the design and implementation of an engineering prototype to address some need. Projects should be completed in teams of two, with exceptions made on a case-by-case basis. Team members should have grade averages within 15% of each other. The instructor reserves the right to rearrange teams. The following are significant components in the completion of the final project.

### *Proposal*

A description of the level 0 system description, and its associated input, output, and behavior. Project specifications may be modified by the instructor.

### *Plan*

The project plan describes the internal organization required to realize the level 0 input, output and behavior as well as 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 10-minute 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. This should be around 10 pages.

### *Grade*

Like all complex design projects, your final design project has multiple components which will contribute to the project's success or failure. These components will contribute to your final project grade as follows.

| Component | Weight |
|---|---|
| Project Proposal | 10% |
| Project Plan | 10% |
| Milestone 1 – Technological accomplishment | 10% |
| Milestone 2 – Technological accomplishment | 10% |
| Presentation | 10% |
| Write-up | 20% |
| Technological difficulty and accomplishment | 30% |

# Project Deliverables

Deliverable #1: Preliminary Project Proposal

Your Preliminary Project Proposal should be submitted as a pdf on Canvas. Your Preliminary Project Proposal will be marked-up and returned along with the scored Preliminary Project Proposal grading rubric. You will get a chance to improve this score by incorporating the changes recommended in the grading rubric.

Deliverable #2: Preliminary Project Plan

Incorporate the feedback provided on the Preliminary Project Proposal in order to improve that grade. This Revised Project Proposal is the first part of the Preliminary Project Plan. The second part of the Preliminary Project Plan is new material detailed a subsequent section of this document. You will get a chance to improve your Preliminary Project Plan score by incorporating the changes recommended in the grading rubric.

Deliverable #3: Revised Project Plan

Incorporate the feedback provided on the Preliminary Project Plan into your Revised Project Plan.

Deliverable #4: Milestone 1

Deliverable #5: Milestone 2

Deliverable #6: Final Presentation

Deliverable #7: Final Report

# Project Proposal

Your project proposal will start out with a title page using the following format. The signatures of the team members certify that both agree to the proposal set forth in the document.

**The Bicycle Computer**
A final project proposal for EENG 383
by
Jane Engineer _____
Joe Student _____

December 1, 2020

The project proposal will then go into the following sections in this order.

### *Problem Statement*

Briefly state the need the project aims to fulfill, provide any motivation that is pertinent.

### *Level-0 Description*

Start this section by describing how the need described in the problem statement relates to the level-0 diagram shown Figure 1.

You will create a version of the level-0 block diagram shown in Figure 1. This block diagram is a graphical description of the top-level input and output of the system. Your level-0 block diagram should have all the following properties:

- the system name in the upper left corner,
- a boundary showing the interaction between the real-world and the system,
- a set of input and output arrows,
- each arrow is a transducer, converting between real-world phenomena and electrical signals,
- each arrow has two labels,
    - inside the boundary = electrical component or subsystem controlled by system,
    - outside the boundary = real-world phenomena,
- A power supply (show voltage) and ground signal.

You should be as specific as possible with the names of the real-world signals. For example, in Figure 1 the output from the LEDs could be described as "light" or even "light pattern", but the term "system status" conveys not only the type of real-world signal, but that signals intention. When the real-world signal comes from another electrical system (like a GPS), uses that system's name as the real-world phenomena. Inside the system boundary you should use the name of the electrical component or PIC subsystem (ADC, PWM, etc.) that converts between real-world signal and electrical signal.

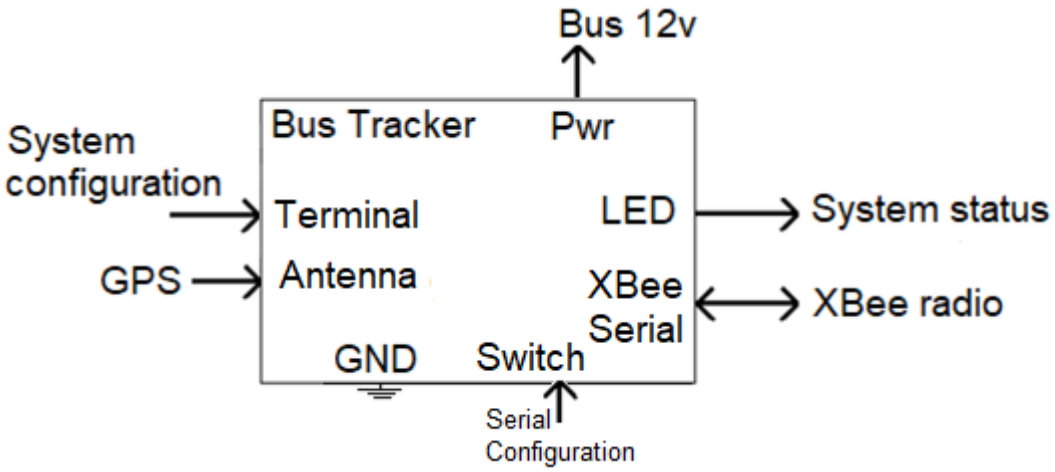



**Figure 1: A level-0 block-diagram of a Bus Tracking system.**

The block diagram must be accompanied by a paragraph describing the system behavior. This description should tell a story of how the inputs are transformed into the outputs. Make sure that your story touches on every input and output shown in the block diagram. Think about edge cases, like how the user configures the system and conditions that may cause the system to fail.

# Project Plan

Your project plan will start with the (revised) project proposal sections and add some new sections. The project plan defines how you are going to go-about implementing the design set forth in your proposal. The title page is slightly modified to reflect that this is a plan.

**The Bicycle Computer – Team #xx**
The final project plan for EENG 383
by
Jane Engineer _____
Joe Student _____

December 8, 2020

The plan will then go into the following sections in this order.

## *Problem Statement*

From the project proposal.

## *Level-0 Description*

From the project proposal.

## *Level-1 Description*

In this section you will provide the detailed level-1 block diagram of your system. A level-1 diagram looks inside the level-0 block diagram and shows the individual hardware modules and their interconnections that you will build the system from. For example, Figure 2 is the level-1 block diagram for the bus tracker system shown in Figure 1. Your level-1 block diagram should have all the following properties:

- the boundary should be identical to the level-0 block diagram,
  - All I/O arrows, including power and ground,
  - Same real-world signal names,
  - Same internal component names,
  - Same system name in the upper left corner.
- for every component inside the level-1 block diagram
  - provide its name in the upper left corner or draw the electrical equivalent symbol

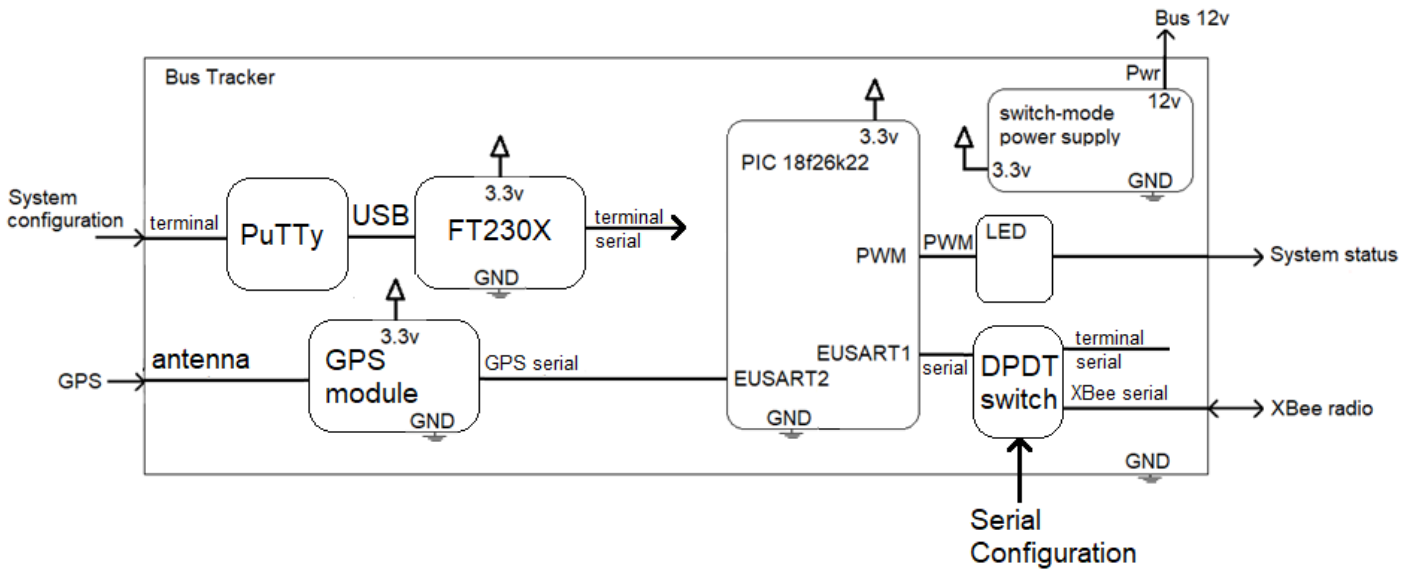
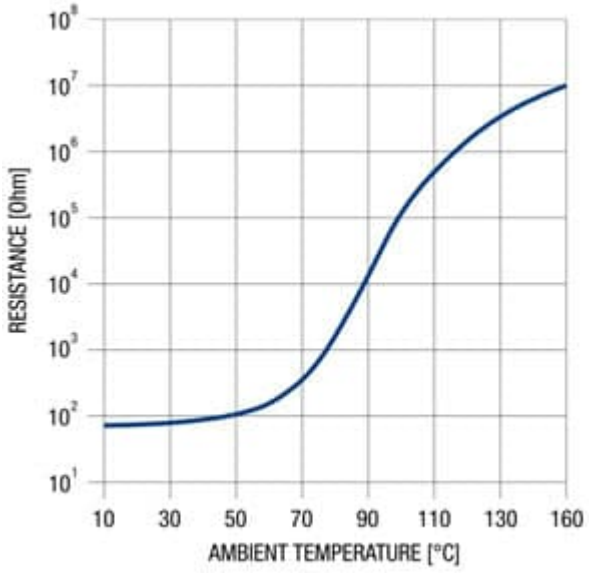



**Figure 2: The level-1 block-diagram of the level-0 block-diagram shown in Figure 1.**

## *Milestone I*

A milestone represents an intermediate-level of technical accomplishments required in the overall system. Your first milestone should focus on getting every module defined in your level-1 design operational and communicating with your microcontroller. 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 microcontroller then a milestone would be, "move thermometer from hot water to cold water and observe temperature change." Generate 3 tests that your modules should be able to pass when you are three weeks-out from completion. Generally, these tests consist of an input/output behavior exhibited by the modules that make up your system.

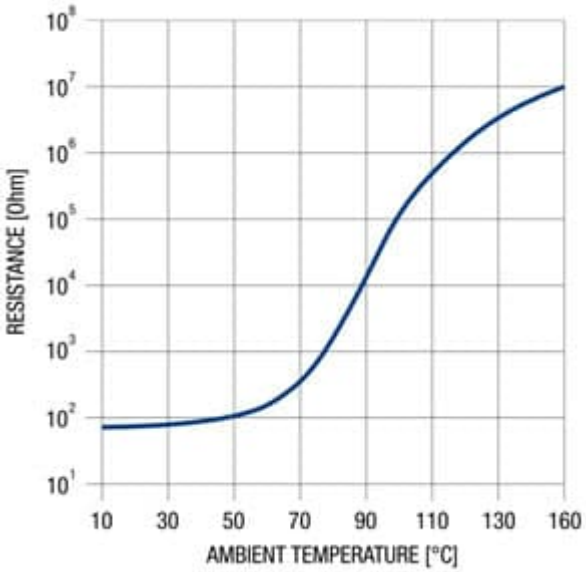
| Test name: Thermistor test | |
|---|---|
| Modules: | Thermistor |
| Setup: | Attach the thermistor to a digital multimeter set in ohms' position. |
| Input: | Move thermometer from hot water to cold water |
| Expected output: | Since we are using a PTC thermistor, the resistance should increase as the temperature increases. The following graph is from the thermistor datasheet and shows that we should see a resistance ranging from 100 ohms to 1000 ohms.   |
| Observed output: | |
| Sign-off: | |

Note that the observed output and sign-off boxes are empty. You are just outlining what tests to complete, not performing the tests at this point.

## *Milestone II*

The second milestone will represent a more advanced-level of system functionality. At this point you should be examining the interactions between level-1 components. Again, the milestones should take the form of tests which verify that modules are working correctly. Generate a set of 3 tests, different from the tests you specified in the first milestone, built around the overall stimulus response of your final project. The following is an example

| Test name: Thermometer range test | |
|---|---|
| Modules: | Thermometer and microcontroller |

| | |
|---|---|
| Setup: | Include a menu option that prints the raw ADC value once every second. The PTC thermistor will be connected to the lower-half of a voltage divider as shown in the level-1 diagram. |
| Input: | Move thermometer from hot water to cold water |
| Expected output: | Since we are using a PTC thermistor, the resistance should increase as the temperature increases. This will cause the voltage at the ADC input to increase as the temperature increases. The following graph is from the thermistor datasheet and should be similar to the increase in voltage.   |
| Observed output: | |
| Sign-off: | |

# Milestone I

Two weeks before the final project presentation the professor and lab assistants will check your progress. At this time, you will document the results of your test plan by submitting a test report for milestone I. The test report should contain:

- A title page (see below),
- Your level-1 block diagram (from your project plan),
- The three milestone I tests with observed output completed (from your project plan).

You can demo your system live or use include pictures, videos, oscilloscope traces, or measurements. Make sure to capture to keep these to include in your final project write-up.

**The Bicycle Computer – Team #xx**
Test report for milestone I for EENG 383
by
Jane Engineer _____
Joe Student _____

December 15, 2020

# Milestone II

One week before the final project presentation the professor and lab assistants will check your progress. At this time, you will document the results of your test plan by submitting a test report for milestone II. The test report should contain

- A title page (see below),
- Your level-1 block diagram (from your project plan),
- The three milestone II tests with observed output completed (from your project plan).

You can demo your system live or use include pictures, videos, oscilloscope traces, or measurements. Make sure to capture to keep these to include in your final project write-up.

**The Bicycle Computer – Team #xx**
Test report for milestone II for EENG 383
by
Jane Engineer _____
Joe Student _____

December 22, 2020

## Presentation

You and your partner will give a 10-minute technical presentation on your design. The most common problem in design presentations is that students jump too quickly into the technical details of a project without first

establishing its overall scope. After the title slide, the second slide of every presentation must be titled "We 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 and then onto your level-1 diagram. For each component in level-1 you should show the tests (and their results) that verify its operation – oscilloscope traces are a powerful tool to communicate your results. 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 – Team #xx**
by
Jane Engineer _____
Joe Student _____

A Technical Report Submitted to the Faculty of
Electrical Engineering
Colorado School of Mines

Submitted in partial fulfillment for the requirements of
EENG 383 – Microcomputer Architecture and Interfacing
December 29, 2020

**Chapter 1: Design Goals**
1.1 Problem Statement
1.2 Level-0 Description

**Chapter 2: Detailed Design**
2.1 Level-1 Description

**Chapter 3: Implementation**
3.1 Milestone I
3.2 Milestone II
3.3 Final Implementation

**References:**
Include any books, technical documents, magazine articles, or web sites that you used to help complete your project. If you include a reference, then it must be referenced somewhere within the body of your document. Use the "IEEE Citation Reference" style to document your sources, make sure to include references in the text.

**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 Image uploaded during presentation**
You should provide your professor an electronic copy of your project as a folder titled TEAMxx, where xx is your two-digit team number. The folder must contain the following four folders (named in capital letters).

- 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 mp3, mp4, mov, avi, etc. of your project in action along with any documented tests, and
- REPORT should contain your written report.

# Final Written Report Guidelines

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

- Include page numbers on the bottom of each page.
- Brief code snippets are OK, but do not include 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 12-point (except code which is always 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 is shown in Figures 1 and 2 in this document. If you have a figure in your text, then it must be referenced in a meaningful sentence before it is drawn. Typically, you would use this reference to move your narrative towards some goal stated in a topic sentence at the beginning of the paragraph.
- Tables in the text should be numbered consecutively, and properly labeled with the table number and caption underneath the table. Like figures, table numbers should be used to refer to tables in the body of the text before the table is drawn.
- 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

  $$f(x) = x^2 + 3x + 5 \qquad (1)$$

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