**Project Title**

*CEN 492/493- Graduation project*

**Team Members**

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# Abstract

The abstract is a brief summary of the senior design project. It should present a brief statement of the problem and the proposed solution. It is important to keep the abstract concise, clear and objective. It should be no longer than 200 words.

# Chapter 1 The Problem Statement

In this chapter, the student provides an introduction and context to the design project. The chapter should start with one or two introductory paragraphs followed by the two parts of the problem statement: *Needs* and *Objective* statements.

## Section 1.1 Need Statement

The *needs statement* identifies and motivates the need for the design project without providing a solution to the problem. The need statement should:

* Briefly and clearly state the need that is being addressed (or to be met).
* Not provide a solution to the problem.
* Provide supporting information, statistics and anecdotes that support the need.
* Describe current limitations.
* Describe any supporting processes that are needed to understand the need. For example, some industry-sponsored projects may have specific needs that may not be clear to the design engineer.

## Section 1.2 Objective Statement

The *objective statement* consists of one or more paragraphs that summarizes what is being proposed to meet the need. It may include:

* Some preliminary design objectives (detailed requirements are developed later).
* A preliminary description of the technical solution (without detailed description of the design or implementation). Often, the input and output behavior of the system are described

The complete solution is not posted until after the engineering requirements are fully determined.

# Chapter 2 Research Survey

This chapter provides a summary of the research survey on the relevant technologies and systems. The length and content of this chapter varies, depending upon the project. However, it must be concise and written correctly with proper citation of the sources. In general, the goal is to provide the reader an understanding of the underlying scientific principles and demonstrates a familiarity with the state of the art in the particular field. As a guideline, the student may provide introductory answers to the following questions in his research survey

* What is the basic theory behind the concept?
* How is it currently being done?
* What are the limitations of the current designs or technology?
* What are the similarities/differences between your concept and current systems?

# Chapter 3 Requirements Specification

In this chapter, the student formulates and writes the formal *requirements specification* of the design project. The requirements specification is the complete set of engineering requirements that the system must satisfy in order for it to meet the needs of customers. These requirements are developed based on customer needs (marketing requirements) and survey of existing technologies in addition to feedback from the technical community. Also, engineering requirement may come from external constraints (such as government, environment, safety, etc). All relevant technical standards that apply to the target product must be stated explicitly in the engineering requirement.

The requirement specification must be *valid* which means it must meet the following minimum conditions [IEEE Std 1233-1998]:

1. Each engineering requirement is **well-formed** (i.e. *Abstract*, *Verifiable*, *Unambiguous*, *Traceable* and *Realistic*).
2. The set of engineering requirement is **normalized**/Orthogonal (i.e. no overlap or redundancy between engineering requirements)
3. The set of engineering requirement is **complete** (i.e. it addresses all the needs of the end user (customer) and the needs required for system implementation)
4. The set of engineering requirement is **consistent** (i.e. should not have self-contradiction between engineering requirements).
5. The set of engineering requirement is **bounded** (i.e. the scope is identified with min/max acceptable bound for target values).

The chapter should start with an opening paragraph and must include the following sections.

## Section 3.1 User Needs

This section provide an enumerated list of *Needs* (also called *Marketing Requirements*). These are short sentences that describe the need in the language of the customer. Marketing requirements are short, action-oriented phrases that express what the product must do, NOT how it is done. Typically, they do not have a numerical target and are described as a state of being of the system. For examples, the following are sample marketing requirements from different projects.

* The system shall operate autonomously after power-up.
* The system should have high quality audio.
* The system should be portable.
* The system should be easy to use.
* The system shall be stable and able to withstand strong wind and rain.
* The system shall be able to move forward, backward, up and down.
* The system shall minimize the use of wires.

The list must be numbered. Also, the needs must be specific to the project and NOT too general.

## Section 3.2 Requirement Specification

This section consists of a table of engineering requirements for the system and their justification. Engineering requirements are short statements that states a technical need of the design. For example, “*The system should be able to supply 50 watts of power*”. These requirements do not specify a solution, but a technical target that help the design engineer generate concepts for the solution. Also, attach the list of user needs (marketing requirements) to the end of the table and map (link) each engineering requirement to the appropriate user need in the same table.

# Chapter 4 The Design

In this chapter, the student describes the detailed design of the system and the design decisions that were taken in realizing the design. The chapter should start with an introductory paragraph describing the final system. Then, at least the following sections should be included.

## Section 4.1 Concept Overview

This section provides a conceptual overview of the final system and how it operates to satisfy the requirements. It should describe in plain English the general architecture of the system and the major components. The student must provide a drawing that illustrate the concept and how the different parts are related. The different part should be described along with a discussion of the engineering tradeoffs that were made in choosing these modules from available alternatives. If a systematic evaluation of different alternatives was made, then the criteria used and results should be briefly discussed.

## Section 4.2 Design Specifications

This section presents the detailed design using functional decomposition. The functional specifications should presented for each of the constituent modules starting at the most abstract level (level 0) down to the most detailed level of the major modules in the system.

Each level starts with a block diagram illustrating the architecture of the module and how the sub-modules are connected. Then, the functional specifications tables of all these sub-modules are presented. Each table must define the module name, the input, the output and the functionally of the module. The functionality should be described using the appropriate behavior models (e.g. state diagrams, flow charts, data flow diagram, UML, etc) whenever necessary. If there are specific equations or algorithmic transformation that are done by the module, then they must be described inside the functional table using proper symbols or behavior models.

### Design Level-0:

Block diagram showing all inputs and outputs to overall system, followed by a functional specification table for the whole system.

### Design Level-1:

Block diagram of system architecture which show the major modules inside the system. Each hardware component in the physical system must correspond to a module in the block diagram. The software components should not be shown here, but the processing unit (e.g. Raspberry Pi, microcontroller, general computer, etc) should be drawn as a single module in this level-1. The software components should be described later at design level-2 under the functional decomposition of the processing unit.

Then, write the functional specification table for each module shown at this level.

### Design Level-2:

Module X block diagram followed by functional specification tables.

Module Y block diagram followed by functional specification tables.

Module Z block diagram followed by functional specification tables.

Etc.

### Design Level-3:

Module X1 block diagram followed by functional specification tables.

Module Y1 block diagram followed by functional specification tables.

Module Z1 block diagram followed by functional specification tables.

Etc.

# Chapter 5 Implementation and Verification

In this chapter, the student presents the implementation of the system and the design verification. It consists of the following sections.

## Section 5.1 Prototype Implementation

This section describes how the student implemented each module in the system. Illustrations, drawings or photos of the prototype should be included to describe these modules. If there were software modules, then a photo of the user interface or program components should be included. The section should also include any implementation challenges and how they were handled in the project.

## Section 5.2 Design Verification

This section presents the results of testing the system’s porotype to verify the design requirements. At least one *Acceptance Test* case need to be included to verify the primary function of the system. The student need to write the test case using the standard acceptance test format. If applicable, the section should include other verification tests that were conducted to demonstrate operation of the system. Limitations of the prototype relative to the requirements should be discussed.

# References

This section includes a list of all sources that are used to generate this report. The reference list must conform to IEEE bibliography style format. The student may use MS Word built-in reference management features or other tools such as Mendeley, RefMan, EndNotes, Bibtex and other online reference management services.

# Appendix A The Project Plan

In this appendix, the students must present the project plan for the complete design project based on the detailed design. This part must be created and included in phase 1 (CEN492). The plan should provide clear path to completion and identify the schedule and responsibilities of the assigned team members. It consists of the following sections.

## Section A.1 Work Breakdown Structure

The Work Breakdown Structure (WBS) defines all the project activities. An activity is a **task** and its associated **deliverables**. Since the design specification has been completed at this stage, the remaining project activities includes all tasks related to purchasing the material, implementation, building the prototype, testing and design verification. The activities should generated from the given level-1 design specification. The distribution of activities should be balanced among team members throughput the remaining project time.

## Section A.2 Gantt Chart

This section presents a Gantt chart showing the time duration and dependencies of each activity in the WBS. It can be generated using available software tools such as MS Projects.

## Section A.3 Cost Estimation

In this section, the student develop an approximate cost estimate for the design project and writes a table listing the costs (most likely estimates) for all equipment and material needed for the project.

# Appendix B Program code

Include code listing of the software modules.

# Appendix C Supplementary information

Include other supplementary information or data sheets if applicable.