ECE-218 Project 2 Report Format

Except for the title page, all the sections names below (Introduction, Design Overview, etc) should be included to organize your report. Note this document has changed since Project 1.

Title page – should include a project title, author (that's you), course number and title, and date.

> **Note**: It is not acceptable to copy any part of the project assignment in your report. The report should be written in your own words.

Objectives – This section should orient the reader to the project topic and detail the goals of the design. In addition to the goals given in the assignment, elaborate on any requirements that got clarified during the project implementation, or that you added as a specification.

Design – Begin this section with a design overview that describes how the behaviors required in the project are implemented in the hardware and the software. Follow this with an overview of the major steps you took to complete the design.

Hardware

This subsection should start with **text** that introduces the hardware diagram for the project. This hardware diagram (schematic) shows the external components and their connections to the Nucleo board. Pin numbers and connections to power and ground should be included. **For Project 2, your hardware diagram should be a schematic that includes only the keypad(s) and the servo motor.** You can just give a list of Nucleo pins that are connected to the other parts of the smart home system. An example is shown below for the gas sensor. Power and ground connections for these other components will be assumed.

Component	Component Input/Output	Nucleo Board Pin
MQ-2 Gas Sensor	D0 - digital output	PE_12 - digital input

An example schematic for the circuit build in Chapter 1 is shown in Figure 1. This was made using EasyEDA.com and if you choose to use this program, you can see this page for hints.
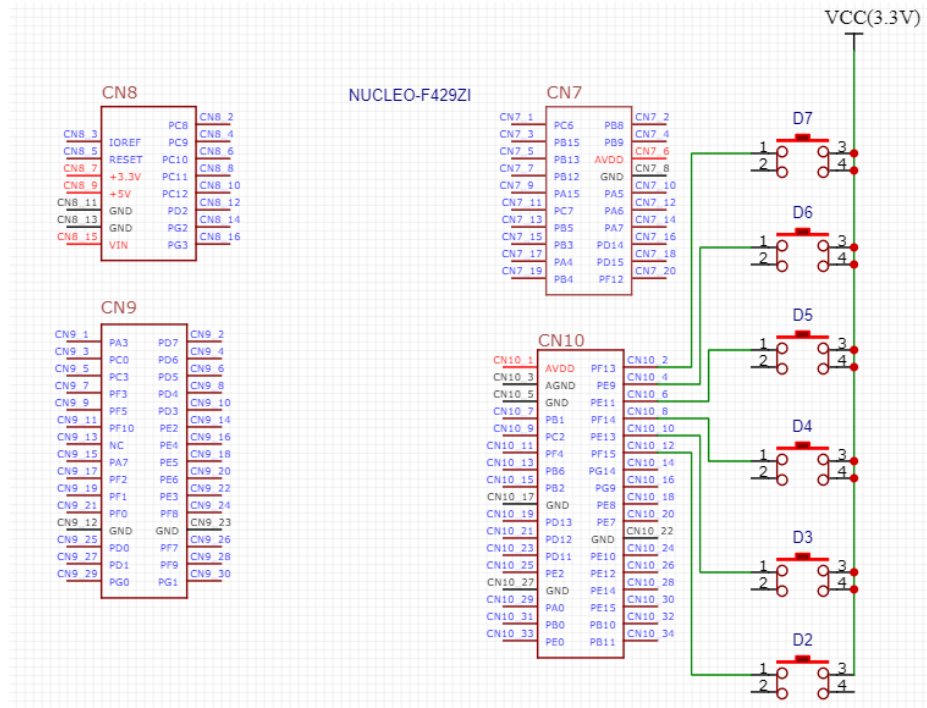
Figure 1. Hardware Diagram of Embedded Microcontroller System

The hardware subsection should then explain this schematic in some detail, referring to the detailed diagram and any data you used from component datasheets. For Project 2, your description should focus on the keypad and servo motor.

Software

The purpose of this subsection is to explain the code in the system. The software introduction should give an overview by referring to a connection diagram such as Figure 5.3 in your textbook that gives the overall code structure. Use flow diagrams or pseudo code, or the code itself if it is short, to convey the structure of individual modules.
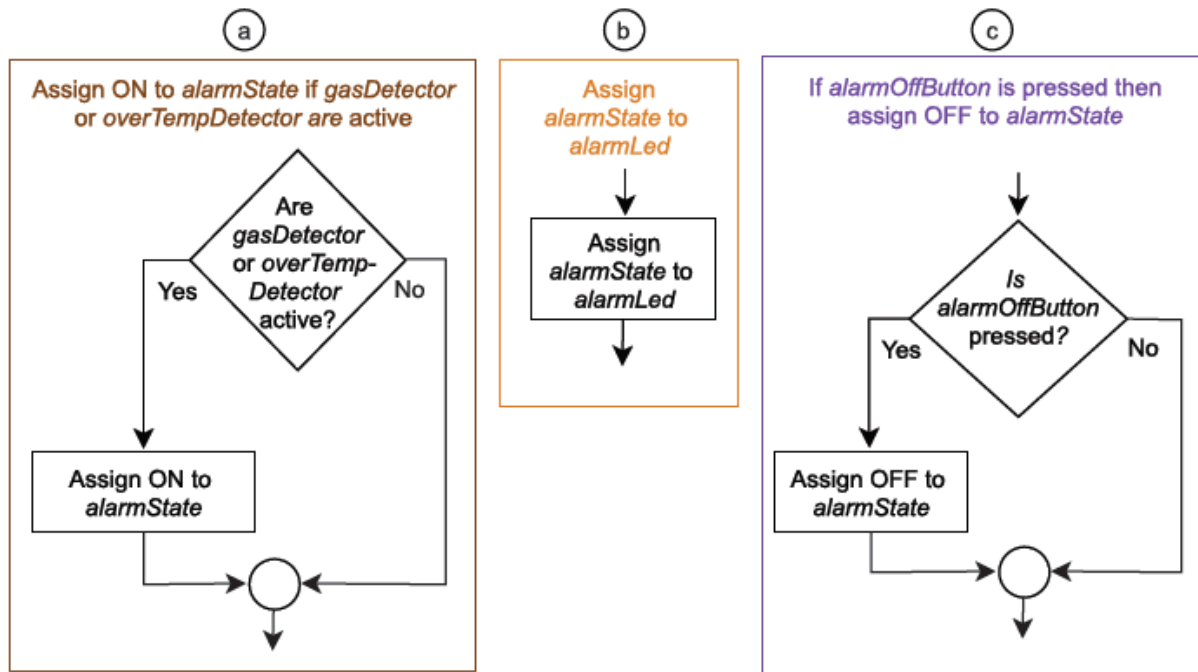
Figure 2. Example flow diagram

After this the software should also be described in a logical way, usually from beginning to end for a particular module. The completed commented code will be submitted separately, so your explanation of the code can be done with smaller segments. An example is shown below for a Chapter 1 code segment.

Example code segment with explanation:

```
if ( enterButton && !incorrectCodeLed && alarmState) {

    if ( aButton && bButton && !cButton && !dButton ) {
        alarmState = OFF;
        numberOfIncorrectCodes = 0;
    } else {
        incorrectCodeLed = ON;
        numberOfIncorrectCodes = numberOfIncorrectCodes + 1;
    }
}
```

The inner loop checks first to see if the user has pressed the enter button while the alarm is on, and cleared the incorrect code Led. If so, then the a-d buttons are checked, and if the correct code (a and b) are being entered, the alarm and the incorrect code entry counter are cleared. Otherwise the incorrect code Led is turned on and the incorrect code entry counter is incremented.

Results and Discussion – The purpose of this section is to objectively describe the behavior of the system when operating and compare it to the goals. The following topics should be included, but these are not subsection titles.

- **Observed Behavior -** Give the testing conditions for the results, and be as quantitative and complete as possible. For example, don't say "the correct code opens the gate", but give a table of combinations tried and the results. Also discuss the behavior if more or less than four keys are pressed . **An image of the completed system should be included**. You should include other figures and data as appropriate. Be sure to compare the behavior of the system with the original specifications.
- **Code Maintainability** – Report on the cohesiveness of your new modules, and how they are coupled to other modules in the system. Discuss any features that you added to make your system maintainable.
- **Debugging -** If there were problems encountered in the design and implementation, discuss these. The reader should learn about any difficulties to watch out for, and any useful strategies if they were to repeat this design.
- **Improvements -** If there are improvements or added features that you could have made if time permitted, describe these.

Conclusion – The purpose of this section is to provide the reader with an understanding of the significance of the project design. Select at least two of the most important aspects of the project, such the peripherals used (ADC, GPIOs, Timers, et) state machine design, interrupts, code structure, etc. Review the results relevant to each aspect, discuss what is significant or meaningful about it, and how it relates to embedded systems in general. Here is a example:

The equations used for scaling were important for converting the analog input value from the potentiometer to the pulse width of the PWM signal. The generalized formula is shown below, and could be used in any situation where an input is used to linearly control an output, and the input and outputs have different ranges and units.

$$scale(input) \ = \ OutputMin \ + \ \frac{Input - InputMin}{InputMax - InputMin}(OutputMax - OutputMin)$$

$$reverse\_scale(input) \ = \ OutputMin + \frac{InputMax - Input}{InputMax}(OutputMax - OutputMin)$$