CSE 321
Project 3: Put Things Together For the *Real World*

CSE321 Project 3

Assigned: November 7, 2021
Lab required - bonus/penalty structure applies

- Show up and work on 321 stuff during that hour and you get 5 bonus project points
- Don't show up or are working on non-project 3 elements (unless your project is complete) will result is a 5 point penalty
- Need to miss - your responsibility is to notify ahead of time
- 11/9 and 11/10 session is the only time you can pick your peer supporter
    - If you don't sign up here there will no be another opportunity

Opening Plan: Nov 11, 2022
Midpoint Due: November 18, 2021
Project Due: December 10, 2021, 11:59 pm ET

Problem

You will be creating a real-time embedded system that can be used to help solve a problem that exists in the world today. Effectively you are making a *prototype to save the world.* This system will incorporate core embedded operating systems elements including the principles of RTOS. You'll have a limited set of constraints and requirements- beyond that it's up to you to have fun.

You need to design a system to help solve a problem. There are many problems out there, so to help narrow down your options, your system will need to help in one of the following areas:

- Food Waste Minimization
- Environmental Controls
- Environmental Protection
- Accessibility support
    - Physical Challenge
    - Neurodiversity
    - Cognitive Impairment
- Autonomous devices

- Safety
- Control system

Topic constraints:

- The following topics are off limits:
    - Social Distancing, Simon Says, Trivia Games, Security System
- If you are taking the class for a second time, your project can't be in the same area as what you chose previously
- If you are taking the class for a second time, you will need to use at least 1 peripheral from the project 3 list that you did not use the first time.
- You and your peer support partner can not be doing the same topic
- If you choose the same area or choose not to include the new peripherals, it will be an academic integrity violation.

Experience Mapping

NACE Competency	Included in Assignment		Learning Objective	Included in Assignment
Career and Self Development			1. Characteristics	x
Leadership			2. Programming	x
Communication	x		3. Documentation	x
Professionalism	x		4. Use of real-time elements	x
Critical Thinking	x		5. Security	x
Teamwork	x		6. Design and implementation of systems	x
Equity and Inclusion	x			
Technology	x			

Policy reminders

- **THIS IS A SOLO PROJECT** (based on in class vote)
    - A score of at least 50% must be earned across the weighted sum of the projects to maintain eligibility to pass the course
    - Incorrect file types will not be graded

    - Files without names in them (either on the cover page, in the header or top of the page with the work on it is necessary)
- **Academic Integrity**
- Collaborating is not allowed
    - Exception: You can discuss about the project with the peer you signed up to support during Recitation on 11/9 or 11/10
        - You can not share in anyway code content (no looking at or reading code or listening to code)
- Support is available through recitation sections, digital communication, office hours, and appointments. It is your responsibility to use those resources appropriately and communicate with your instructor if there are issues.
- Use the UB Writing Center.
- Pronouns are not allowed to be used except for in the reflection question assignment at the end of the project.
- You should review the rubrics for additional information on the expectations

Implementation Requirements

General

- Proper Header on all code and read me files
- Properer commenting
- Readme file

Peripherals

All peripherals used must be from the list provided as we need to be able to build your project and test it while grading the submission.

- Previous external output peripherals
    - LCD
    - LEDs
- At least 2 keys on the Matrix Keypad
- A new external input peripheral
    - DHT11
    - Transducers
        - UltraSonic
        - Audio
    - Rotary Encoder
    - IR
    - Tilt sensor
- A new external output peripheral
    - Buzzer
    - Servo

    - Vibration Motor
    - 7 Segment Display
    - Dot-matrix array

If you would like to use any other peripheral, please check with Dr. Winikus first.

Internal Element Requirements

The following OS elements are required in the implementation of the project.

- Watchdog timer must be configured appropriately
- Synchronization technique
- At least 1 direct bitwise driver configuration
- Critical Section protection is required for entire implementation
    - Make sure that two threads don't try to access and/or modify the same memory at the same time
    - It must be in addition to a synchronization technique
    - See Lecture 16 for more details
- A task/thread intentionally incorporated
- At least 1 interrupt

Tasks

Overall you will complete the following tasks to complete the project:

- Opening Plan
    - Problem Definition
    - Plan
    - Bill of Materials (BOM)
    - Repository
        - Index
        - Project Files
- Update
    - Memo
    - Repository
        - Index
        - Project Files
- Implement and demonstration
    - Demonstrate
    - Submit code
- Summary Document
    - Slide Deck
    - Recording
- Final Repository

    - Index
    - Project Files
- Reflection

Opening Plan

(100 Points)

Repository

Index

This is a page (can be in the project repository or hosted separately) that contains any keywords, key concepts, key references, definitions, and links (and page numbers) related to this specific project (not to the class as a whole).

It will be compiled using the following table template:

Keyword /Concept /Assignment /Segment	Definition	Purpose	Link	Page(s) to reference	Explanation of how this is relevant to the project

Project

For this project, you will organize your work from all stages of the project and include demonstration of version control and file management.

All these files will have links included in your Index.

Submission

- Link to where the index is hosted
- Link to where the project repository is hosted
- PDF copy of your index
- Screenshot of your project repository

Problem Definition

For the problem you have to define it before you can plan for it. To assist with making sure you have the key elements to plan for, answer the following questions.

1. What topic area did you choose your project to be related to?
2. What issue or challenge does your project aim to address?
3. What is the goal/purpose/objective of your project?
4. How does this project relate to the topic area you chose?
5. How does this project address the issue/challenge you selected?
6. What are the inputs to the system you need to consider for this problem?
    a. These need to be in terms of the problem, not anything related to devices (so no mention of things like GPIO)
    b. Each input will need to have a statement of how it is part of the system
7. What are the outputs from this project?
    a. These need to be in terms of the problem, not anything related to devices (so no mention of things like GPIO)
    b. Each output will need to have a statement of how it is part of the system
8. Are there any constraints?
    a. Consider physical behaviors for the implementation and elements of the design.

Submission

Type up these answers and save them as a PDF, upload the PDF to UB Learns.

Plan

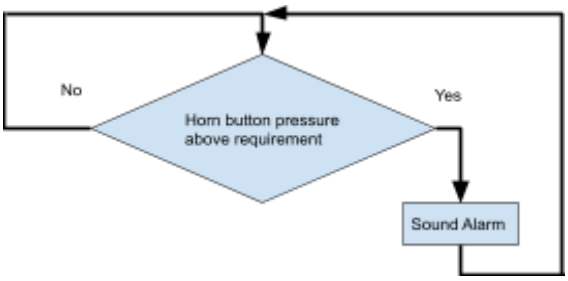
At this point you designed a plan on how to address problem solving and have practiced it. Create a planning document that can be presented to a *client* to show the plan of what happens in the project when it is implemented.

This is for the implementation, not your tasks to accomplish implementing the project.

This plan should not include any submission elements, it should be the plan to implement.
For example an implementation plan for a car horn to go off could look like this:

1. Sense pressure of horn trigger
2. If pressure exceeds minimum threshold
    a. Sound horn alarm
3. Return to step 1

Or it could look like this:



You can effectively create a flowchart, FSM, ASM, algorithm, etc. as your method of representing the plan for the implementation.

Submission

Submit this work as a professionally organized PDF.

Bill Of Materials

Create a list of all the elements that are needed to implement your project that you know of at this point. (It may change when you start revising)

This time you will create it in a spreadsheet since there are more elements. The spreadsheet will be saved and submitted as an XLSX. There will be one sheet in it. The header row will have the columns: ***Component, Quantity, Purpose, Additional Notes***

The ***Component*** column will be where you put the names of the elements that are needed. ***Quantity*** tells how many of those components. The ***Purpose*** is where you tell how that will contribute to the system you are designing. The ***Additional Notes*** column for a component may not have anything in it or it may be like the LCD where you need to specify 1602 or 1802 model.

Remember, consider this as if someone were to only use the materials in your BOM. They should not have to go get more materials if they followed the BOM you created.

Submission

Save the BOM as a XLSX and upload it to UB Learns.

Opening Plan Grading Rubrics

Repository

[15 Points]

Due to the freedom to choose where/how to host your repository (minus the fact it must be private until given the go ahead), work to be graded has to be collected on UB Learns, but content will be verified by visiting your live repository. Each element will be graded by looking at the uploaded work (PDF and screenshots) and verifying by checking the live repository.

	Not gradable or beginning	Acceptable	Exemplary
Index Organization	Significant issues or not done [0 Points]	Slight details missing or inappropriate [2 Points]	Appropriate and complete, following assigned format [5 Points]
Index Content	Significant issues or not done [0 Points]	Some key elements are missing or inappropriate [5 Points]	Appropriate and complete based on starting point [5 Points]
Project Location	Significant issues or not done [0 Points]	Slight details missing or inappropriate [4 Points]	Appropriate initial setup [5 Points]

Problem Definition

(58 Points)

	Not gradable or beginning	Acceptable	Exemplary
Quality of Answers	Significant issues with the quality of the answers. [0 Points]	Minor issues that are noticeable in the quality of the answers pertaining to sentence structure and content. [4 Points]	Overall answers are well written. Answers are in complete sentences with overall professional grammar and spelling (nothing noticeable). [10 Points]
Questions each are graded as follows	Not answered or not clear or not appropriate. [0 Points]	Attempted but either incomplete or is not entirely clear. [2 Point]	Answered the entire question and the answer is appropriate. [6 Points]

Plan

[20 Points]

	Not gradable or beginning	Acceptable	Exemplary
Format	Substantial issues. [0 Points]	Minor issues in clarity or ability to follow how the project will work. [2 Point]	Plan for implementation is easy to read and follow. Follows one of the representation methods presented in the course. [5 Points]
Complete	All other cases. [0 Points]	Lacks detail or missing 1-3 items. [7 Points]	The project behavior specified in the problem definition is clear and all the elements needed to accomplish that behavior are present. [15 Points]

Preliminary BOM

(12 Points)

	Not gradable or beginning	Acceptable	Exemplary
Format	Substantial issues. [0 Points]	Minor issue with 1-2 columns [1 Point]	Columns are all configured appropriately [3 Points]
Complete	All other cases. [0 Points]	Lacks detail or missing 1-3 items. [3 Points]	Each item needed is listed with a general description. [9 Points]

Midpoint Assignment (70 Points)

This stage of submission is aimed for you to demonstrate that progress is being made on accomplishing the task of designing and implementing your *prototype to save the world*.

Memo

Update the *client* on your design and progress. Use project 2 as a starting template and adapt it to present an update on the implementation of the project.

Submission

Upload the PDF of your memo to UB Learns.

Submit and Commit

This is the time to demonstrate progress and also verify you have your work backed up. You should be updating frequently, but this check point is a good time if you haven't been saving your work carefully.

Submission

For grading purposes, upload your current README, code, a PDF of your Index and a Screenshot of your Project Repository. Verify that your name is on your file(s) and then convert them to PDF form (you can create a pdf for each part or one big one). Upload the file(s) to UB Learns.

Criteria for Success

Memo

(40 Points)

	Not gradable or beginning	**Acceptable**	**Exemplary**
Format	Unprofessional or substantial errors [0 Points]	Minor errors that distract [2.5 Points]	Professional [5 Points]
Language	Unprofessional or substantial errors [0 Points]	Minor errors that distract. [2.5 Points]	Professional [5 Points]

Summary Introduction	Not done or substantial issues in relevance or conciseness [0 Points]	Minor issues in content or presentation of content [2.5 Points]	Concise, relevant to project, relevant to memo contents [5 Points]
Update on Progress	Not done or substantial issues in relevance or conciseness [0 Points]	Minor issues in content or presentation of content [5 Points]	Concise, relevant to the project, actual progress communicated. [10 Points]
Identified Concerns at this stage	Not done or substantial issues in relevance or conciseness [0 Points]	Minor issues in relevance or thoughtfulness of concern [2.5 Points]	Concise, relevant to the project and thoughtful. [5 Points]
Next Steps	Not done or substantial issues in relevance or conciseness. [0 Points]	Minor issues in relevance or thoughtfulness of concern [5 Points]	Concise, relevant to the project and thoughtful. [10 Points]

Submit and Commit

[30 Points]

	Not gradable or beginning	**Acceptable**	**Exemplary**
Index Organization	Significant issues or not done [0 Points]	Slight details missing or inappropriate [2 Points]	Appropriate and complete, following assigned format [5 Points]
Index Content	Significant lack of progress suggesting that completing the project may not be possible. [0 Points]	Work appears to relate to about 1 week worth of progress. [2 Points]	Appropriate and complete based on 2 weeks of progress. [5 Points]

Project Organization	Significant issues or not done [0 Points]	Slight details missing or inappropriate [2 Points]	Appropriate and complete, format is easy to follow [5 Points]
Project Content	Significant lack of progress suggesting that completing the project may not be possible. [0 Points]	Work appears to relate to about 1 week worth of progress. [2 Points]	Appropriate and complete based on 2 weeks of progress. [5 Points]
README Progress	Significant lack of progress suggesting that completing the project may not be possible. [0 Points]	Work appears to relate to about 1 week worth of progress. [2 Points]	Appropriate and complete based on 2 weeks of progress. [5 Points]
Implementation Progress	Significant lack of progress suggesting that completing the project may not be possible. [0 Points]	Work appears to relate to about 1 week worth of progress. [2 Points]	Appropriate and complete based on 2 weeks of progress. [5 Points]

Wrap Up and Final Submission

As part of completing the project, in addition to demonstrating you will need to communicate your work in a report. This sharing of technical design is good practice for future careers.

Use the slides from Project 2 as a starting point and adapt them to be appropriate for this project. You need to make sure they are appropriate for being slides, making use of the notes to do so.

The notes section may not always be enough to clearly explain or discuss the slide. To help address that, you will need to *present* your project with the slides. This presentation will be done as a recording.

Presentation of Project

Slide Deck

Using the powerpoint slide structure that was used before, create a new slide show deck to present on this project. It is up to you now to put one together based on what you have and can explain.

Required sections:

- Title slide
- Interactive functional index/ToC
- Introduction to the project slides
    - What is the problem? Real world description of it, nothing about implementation
    - What is the implementation tasks that will be used to solve the problem
- Overview of features and specifications
- Slides for how the required internal features are integrated
- Recap of design process
- Block Diagram
- ASM/FSM State Diagram/Flow Chart
- BOM
- User Instructions (similar to a “getting started”) section
    - Schematic
    - Instructions how to build the system
    - Instructions how to use the system
- Test Plan Instructions
- Development Timeline/Revision History
    - Include highlights of development

Where/When to cite?

When in doubt- cite it!

- Content
    - What to cite: Anything not in the lecture slides
        - If it is from one of my sources, you cite the reference repository that is at the link provided in the slides
    - Where: In the report
- Code
    - What to cite: anything not given to you (Mbed API and classwork does not need a citation)
    - Where: In the header section
        - And adjacent to the code if incorporated to your files
        - And license comments should appear in that code file as a header. And that file needs to be provided.

Recording

To record your presentation, you have a maximum of 5 minutes. Use Zoom to make the recording with your screen shared with your slides showing (that is the only thing you can share) and you need to have your camera on.

Use the provided tips files from SWE to help guide you to success.

Demonstrations

This can happen between Wednesday, December 7 and Friday December 9 during your assigned section or office hours.

Submission

On UB Learns you will submit the following elements:

- PPTX of slide deck
- Link to recording
- Properly commented and completed Code
- Completed Readme
- PDF of repository index
- Screenshot of Project Repository

Criteria for Success

The project is broken down into multiple tasks to support the process of working with projects. Most of the elements in each task will be evaluated on completion, with the relevance and appropriateness of the response considered. If there is anything irrelevant or inappropriate present in addition to appropriate answers then that section will be subject to a penalty. Correctness-based parts will be evaluated in a similar manner, but partial credit will be possible based on the following rubric criteria. These partial credit elements will be applied to the section or overall depending on the situation, and they can be accumulated if multiple parts have issues.

Documentation - Presentation of Project (___ points)

Slide Deck (345 points)

	Not gradable or beginning	Acceptable	Exemplary
Title Slide	Missing or substantially	Missing some	Appropriate standard

	incomplete or incorrect or unprofessional [0 Points]	components or all components are there but not professionally presented. [5 Points]	content (name, course, purpose, term) that is professionally presented. [10 Points]
Table of Contents	Not done [0 Points]	Present but not complete [2 Points]	Present and complete [5 Points]
Introduction	Does not describe the project as a whole, is not a high level summary, or does not mention the application of the project. [0 Points]	Summarizes the project at a high level. Describes what the application is for the project. [5 Points]	Summarizes the project at a high level. Describes what the application is for the project and how it is a benefit in that area. [10 Points]
Project Requirements	Enough issues to justify that this project does not help one of the assigned areas or meet the requirements for implementation. [0 Points]	Requirements do not fit the assigned system constraints fully, slight issues to unapproved elements or not satisfying requirements. [5 Points]	Project described and prototyped fits approved constraints and requirements. [10 Points]
What is needed to solve the problem	Not done or substantial issues [0 Points]	Present but issues with appropriateness or completeness [2 Points]	Present, appropriate, and complete explanation [5 Points]
Real World	Not done or substantial issues [0 Points]	Present but issues with appropriateness or completeness [2 Points]	Present, appropriate, and complete explanation [5 Points]
Real World Safety Critical	Not done or substantial issues [0 Points]	Attempted but minor issues with relevance or completeness. [4 Points]	Presentation of safety and ethical concerns related to problem. Identification of how to address the relevant ones.

			[10 Points]
Overview of Specifications and Features	Not done or significantly unclear or incomplete [0 Points]	Some unclear aspects or incomplete [5 Points]	Clearly presented and complete [10 Points]
Explanation of watchdog element and how it was incorporated	Substantial aspects of explanations are incomplete or inadequate. [0 Points]	Incomplete explanation or inadequate explanation for the purpose, reasoning, and methods of integration. [5 Points]	Element's purpose is explained, the decision on how integration was chosen, and general description of how it was integrated. [10 Points]
Explanation of synchronization technique and how it was incorporated	Substantial aspects of explanations are incomplete or inadequate. [0 Points]	Incomplete explanation or inadequate explanation for the purpose, reasoning, and methods of integration. [5 Points]	Element's purpose is explained, the decision on how integration was chosen, and general description of how it was integrated. [10 Points]
Explanation of bitwise driver control and how it was incorporated	Substantial aspects of explanations are incomplete or inadequate. [0 Points]	Incomplete explanation or inadequate explanation for the purpose, reasoning, and methods of integration. [5 Points]	Element's purpose is explained, the decision on how integration was chosen, and general description of how it was integrated. [10 Points]
Explanation of critical section protection and how it was incorporated	Substantial aspects of explanations are incomplete or inadequate. [0 Points]	Incomplete explanation or inadequate explanation for the purpose, reasoning, and methods of integration. [5 Points]	Element's purpose is explained, the decision on how integration was chosen, and general description of how it was integrated. [10 Points]
Explanation of thread/tasks and how it was incorporated	Substantial aspects of explanations are incomplete or inadequate. [0 Points]	Incomplete explanation or inadequate explanation for the purpose, reasoning, and methods of	Element's purpose is explained, the decision on how integration was chosen, and general description of how it

		integration. [5 Points]	was integrated. [10 Points]
Explanation of interrupt and how it was incorporated	Substantial aspects of explanations are incomplete or inadequate. [0 Points]	Incomplete explanation or inadequate explanation for the purpose, reasoning, and methods of integration. [5 Points]	Element's purpose is explained, the decision on how integration was chosen, and general description of how it was integrated. [10 Points]
Solution Development	Substantial errors or not done. [0 Points]	Minor errors. [5 Points]	Complete, clear, concise. [10 Points]
Block Diagram	Not done or hand drawn with missing elements [0 Points]	Correct and complete but not digitally created. Or missing some elements. [5 Points]	All key blocks and interactions shown Labels present as appropriate. Digitally created. [10 Points]
Diagram of system	Not done [0 Points]	Complete and correct. Properly labeled. Created by hand. Or some errors in completeness/correctness/labels Created digitally (7.5 Points)	Complete and correct. Properly labeled. Created digitally. [15 Points]
Diagram Readability	Very difficult to read. Or no diagrams. [0 Points]	Some challenges due to color, font, font size or layout; but with some effort can be read. [2.5 Points]	Both are easy to read and follow. [5 Points]
BOM	Not done or substantial issues [0 Points]	Partially complete [5 Points]	Present and complete [10 Points]
User Instructions Section	The section exists but as the subsections instead of a larger	Section exists but the content is not appropriate for a	Section exists and is written for a general user.

	section. [0 Points]	general user. [5 Points]	[10 Points]
Schematic	Not done Substantial issues. [0 Points]	Not 100% clear, either confusing in spots or missing steps. Hand drawn figures present but can successfully follow your schematic. [10 Points]	Able to create your implementation. Figures (created digitally) used as appropriate to aid in creation. [20 Points]
Instructions to build	Not able to follow sufficiently. Difficult to read. Missing [0 Points]	Readable but not successful based on reading alone [10 Points]	Complete, readable and able to follow to achieve successful construction. [20 Points]
Instructions to use	Not able to follow sufficiently. Difficult to read. Missing. [0 Points]	Readable but not successful based on reading alone. [10 Points]	Complete, readable and able to follow to achieve successful use. [20 Points]
Test Plan	Not done[0 Points]	Slightly Incomplete and/or some inappropriate aspects [10 Points]	Complete and appropriate [20 Points]
Outcome of Implementation	Significant inadequate explanation or not done. [0 Points]	Outcome is mentioned but does not support design and test plan elements. [5 Points]	Explanation of the outcome of the project. Including the satisfaction of the test plan and design criteria. [10 Points]
Future Considerations - Identification of shortfalls	More errors/issues than described in “Developing” [0 Points]	Overall valid and appropriate, but mention of implementation was made as a design shortfall. [5 Points]	Valid features identified and justification for being a shortfall explained. Features must be in design. [10 Points]
Future	More errors/issues	Lacks complete	Valid feature

Considerations-General Improvement	than described in "Developing" [0 Points]	identification, justification and/or benefit on a small scale of error/issue. [5 Points]	identified and justification for inclusion explained. Explanation of expected impact included. [10 Points]
Professionality - Formatting	Significant issues. [0 Points]	Slight issues with inconsistencies or use of inappropriate elements or missing elements. [5 Points]	Format of report is professional, well organized and contains appropriate formatting. [10 Points]
Professionality - Figures	More errors/issues than described in "Developing" [0 Points]	Easy to read but not digital. Digital but slight readability issues [5 Points]	Created digitally, easy to read [10 Points]
Professionality - Language	More errors/issues than described in "Developing" [0 Points]	Less than 5 incidents that are not appropriate [5 Points]	Appropriate [10 Points]
Professionality - Pronouns	5 or more uses of pronouns. [0 Points]	Less than 5 incidents [5 Points]	No Pronouns Used. [10 Points]

Recording (70 Points)

Modified from Illinois State University - University Assessment Services Department, Sample Scoring Rubrics for Presentations, 2018
https://assessment.illinoisstate.edu/

These are based on an overall view of the presentation. (Potentially you can have a really good slide and really bad cancel out). Your presented slides must match the ones submitted.

	Not gradable or beginning	**Acceptable**	**Exemplary**

Slide Quality	Substantial issues. [0 Points]	Minor issues with being professional. [5 Points]	Professional appearance. [10 Points]
Slide Organization	Substantial issues. [0 Points]	Minor issues. [5 Points]	Easy to follow between slides. Consistent and approachable to understand the slides. Content on slide is laid out well. [10 Points]
Slide Content	Substantial issues. [0 Points]	Minor issues. [5 Points]	Content on the slides is appropriate for the topic and the amount of content is appropriate for a presentation. [10 Points]
Presentation Delivery: Clear and understandable (This includes articulation, volume, and word choice)	Substantial issues in communicating content. [0 Points]	A few spots where delivery was not clear. [5 Points]	Well done with no noticeable issues. [10 Points]
Presentation Delivery: Slide Presentation Quality	Slides are mostly narrated as what is written. [0 Points]	Minor occurrences of reading the slides. Or minor occurrences that narration either has elements that are beyond the scope of the slides that would benefit from having more slides or slides are not fully explained/ discussed. [5 Points]	Slide served as a guide for the narration of the presentation. The relation between what is written and said exists but slides are not read. [10 Points]
Presentation Delivery: Messages and Content on Slides Communicated	Substantial issues that the explanations do not match the content for the slide. [0 Points]	Some minor issues with content/narration not being the same idea. [5 Points]	Communication was appropriately related in terms of content/context to the slides. [10 Points]

Presentation Take Away	Substantial Issues. [0 Points]	Most outcomes from the exempatory level of outcome are satisfied, but some errors or omissions. [5 Points]	At the end of the recording it is clear what the project was, what it prototypes for, the approach, what was done, outcomes and recommendations. [10 Points]

Code (270 points)

Implementation - the code itself (120 points)

This is graded with the submission

	Not gradable or beginning	Acceptable	Exemplary
Commenting- Header	More errors/issues than described in “Developing” [0 Points]	Minor errors. Still readable and makes sense. [5 Points]	Complete, correct and appropriate. [10 Points]
Commenting- Code	More errors/issues than described in “Developing” [0 Points]	Minor errors. Still readable and makes sense. [10 Points]	Complete, correct and appropriate. [20 Points]
Integration of a previously used output peripheral	More errors/issues than described in “Developing” [0 Points]	Minor errors in technique that make it incomplete or incorrect or inappropriate, this may be an error location that prevents your code from running. [5 Points]	Complete, correct and appropriate. [10 Points]
Integration of a new external output peripheral	More errors/issues than described in “Developing”	Minor errors in technique that make it incomplete or	Complete, correct and appropriate. [10 Points]

	[0 Points]	incorrect or inappropriate, this may be an error location that prevents your code from running. [5 Points]	
Integration of a new input peripheral	More errors/issues than described in “Developing” [0 Points]	Minor errors in technique that make it incomplete or incorrect or inappropriate, this may be an error location that prevents your code from running. [5 Points]	Complete, correct and appropriate. [10 Points]
Integration of Watchdog Timer	More errors/issues than described in “Developing” [0 Points]	Minor errors in technique that make it incomplete or incorrect or inappropriate, this may be an error location that prevents your code from running. [5 Points]	Complete, correct and appropriate. [10 Points]
Integration of a synchronization technique	More errors/issues than described in “Developing” [0 Points]	Minor errors in technique that make it incomplete or incorrect or inappropriate, this may be an error location that prevents your code from running. [5 Points]	Technique used and comments included to highlight the setup and use. [10 Points]
Integration of at least 1 direct bitwise driver	More errors/issues than described in “Developing” [0 Points]	Minor errors in technique that make it incomplete or incorrect or inappropriate, this may be an error location that prevents	Complete, correct and appropriate. [10 Points]

		your code from running. [5 Points]	
Integration of Thread/Task element	More errors/issues than described in "Developing" [0 Points]	Minor errors in technique that make it incomplete or incorrect or inappropriate, this may be an error location that prevents your code from running. [5 Points]	Complete, correct and appropriate. [10 Points]
Integration of an interrupt	More errors/issues than described in "Developing" [0 Points]	Minor errors in technique that make it incomplete or incorrect or inappropriate, this may be an error location that prevents your code from running. [5 Points]	Complete, correct and appropriate. [10 Points]
Critical section protection	More errors/issues than described in "Developing" [0 Points]	Minor errors in technique that make it incomplete or incorrect or inappropriate, this may be an error location that prevents your code from running. [5 Points]	Complete, correct and appropriate. [10 Points]

Functionality (150 points)

This is evaluated when course staff tests your project.

Your program must run when tested by course staff to earn these points. If it doesn't run, then you won't receive any points. If it crashes, partial credit is still possible based on what it does before crashing.

	Not gradable or beginning	Acceptable	Exemplary
Functionality of a previously used output peripheral	More errors/issues than described in "Developing" [0 Points]	Peripheral implementation either doesn't fully meet the report's description of functionality or the functionality of the peripheral. [5 Points]	Based on the report, this works as described. And it works in line with the functionality of that peripheral. [10 Points]
Functionality of a new external output peripheral	More errors/issues than described in "Developing" [0 Points]	Peripheral implementation either doesn't fully meet the report's description of functionality or the functionality of the peripheral. [10 Points]	Based on the report, this works as described. And it works in line with the functionality of that peripheral. [20 Points]
Functionality of a new input peripheral	More errors/issues than described in "Developing" [0 Points]	Peripheral implementation either doesn't fully meet the report's description of functionality or the functionality of the peripheral. [10 Points]	Based on the report, this works as described. And it works in line with the functionality of that peripheral. [20 Points]
Functionality of Watchdog Timer (You can not get points here if you don't get points for it in the code)	More errors/issues than described in "Developing" [0 Points]	Setup but doesn't work in a way that makes sense. [5 Points]	Based on the report, this works as described. And it works in line with the functionality of the watchdog. [10 Points]
Functionality of a synchronization technique (You can not get points here if you don't get points for it in the code)	More errors/issues than described in "Developing" [0 Points]	Minor issues [10 Points]	Part of the system that uses this makes sense and it works considering that. [20 Points]
Functionality of at least 1 direct bitwise driver	More errors/issues than described in "Developing"	The thing configured bitwise has no impact.	Elements described as bit wise configured in the code works

(You can not get points here if you don't get points for it in the code)	[0 Points]	[5 Points]	correctly in the system. [10 Points]
Functionality of thread/task element. (You can not get points here if you don't get points for it in the code)	More errors/issues than described in "Developing" [0 Points]	The thing configured bitwise has no impact. [5 Points]	Elements described as bit wise configured in the code works correctly in the system. [10 Points]
Functionality of interrupt. (You can not get points here if you don't get points for it in the code)	More errors/issues than described in "Developing" [0 Points]	The thing configured bitwise has no impact. [5 Points]	Elements described as bit wise configured in the code works correctly in the system. [10 Points]
Functionality matches project description and objective.	More errors/issues than described in "Developing" [0 Points]	Some minor deviations in meeting requirements for the project. [15 Points]	Based on the report, this works as described. Also matches the specifications/requirements/constraints for the project. [30 Points]
Functionality- runs forever	No [0 Points]	----------	Yes [10 Points]

Implementation Demo (100 Points)

- Do not show any code during the demo
- If code submitted does not run, you forfeit these points
- Everyone demos individually
- If you don't do this part, there's a 15% penalty on the entire project

	Not gradable or beginning	Acceptable	Exemplary
Overview of Project	More errors/issues than described in "Developing" [0 Points]	Incomplete description of the system, application and/or benefit. [2.5 Points]	Explains the point of the project, including: functionality, situation it is designed to help with and how it will help. [5 Points]
Runs	No [0 Points]	----------	Yes [10 Points]
Functionality of a previously used output peripheral	More errors/issues than described in "Developing" [0 Points]	No code shown but errors with what the peripheral is, what it does, and the roll in the system, and then shows it does that. [5 Points]	No code shown. Tells what the peripheral is, what it does, and the roll in the system, and then shows it does that. [10 Points]
Functionality of a new external output peripheral	More errors/issues than described in "Developing" [0 Points]	No code shown but errors with what the peripheral is, what it does, and the roll in the system, and then shows it does that. [10 Points]	No code shown. Tells what the peripheral is, what it does, and the roll in the system, and then shows it does that. [20 Points]
Functionality of a new input peripheral	More errors/issues than described in "Developing" [0 Points]	No code shown but errors with what the peripheral is, what it does, and the roll in the system, and then shows it does that. [10 Points]	No code shown. Tells what the peripheral is, what it does, and the roll in the system, and then shows it does that. [20 Points]
Functionality matches	More errors/issues	Does not match the	Matches completely

project description and objective	than described in “Developing” [0 Points]	project description fully. [15 Points]	[30 Points]
Functionality- runs forever	No [0 Points]	----------	Yes [5 Points]