CpE 3150 Project 1 (30 Points)

PROJECT DESCRIPTION: Using the Adafruit Circuit Playground board schematic (circuit_playground_schem.png), create a table (in Microsoft Word) to provide each I/O port bit connected to an LED and each I/O port bit connected to a push button. Create a Microchip Studio assembly workspace for the ATmega32U4. Modify the main.asm program to create a loop that monitors the push buttons and turns on the LED whenever at least one button is pushed. For each push button, remember to specify the corresponding port bit as an input (0 for bit position in I/O register DDRx) and set the corresponding pull-up resistor for that port bit (1 for bit position in I/O register PORTx). Use PINx to read the values from the configured input port pins and use PORTx to write/output the values to the port pins. Assemble the program and generate the .hex file to download to the Simon Board to execute your code to verify the correct operation. Submit a printout of the program with your project report. *Note that there is not a simulation model for the ATmega32U4 in the Microchip Studio environment, so you can create a separate workspace for the ATmega32 to simulate your program (individual and combined code). There are a few differences between the ATmega32, which only has I/O ports A-D, and the ATmega32U4, which has I/O ports A-F, that you will need to account for in testing and implementing your code on the ATmega32U4.*

For your first project, you will design a simple, self-contained AVR-based device (Adafruit Circuit Playground) that will, *at a minimum*, monitor two buttons – one is a up/down count button that specifies whether you are doing an up counter (positive) or a down counter (negative). The other button increments/decrements the count. In your program, you will need to address the debounce of the buttons so that each button push is treated as a single event (button push to change up/down counter, button to count). The count should be initialized as 0. The count range is 0-24. Designate a period of time to flash the LED on the Circuit Playground board to correspond to the current count. For a count of 0, the LED is OFF the entire period. For a count of 24, the LED is ON the entire period (constantly ON). At the end of the time period, the LED flash cycle repeats itself continuously. If the count is 24 and the button is pushed in up count mode, the count should reset to 0 with a 500 Hz waveform sent to the speaker on the Circuit Playground board for around 0.15 s (close is good enough). Similarly, if the count is 0 and the button is pushed to down count, the count should reset to 24 with a 1k Hz waveform sent to the speaker on the Circuit Playground board for around 0.15 s.

For this project, software must be written in ASM using the Microchip Studio environment. The schematic with the pin assignments for the ATmega32U4 on the Circuit Playground is included in *circuit_playground_schem.png*. This schematic shows the pin assignments for the left and right buttons, the LED, and the speaker on the Circuit Playground. The datasheet for the ATmega32U4 is included in the file *Atmel-7766-8-bit-AVR-ATmega16U4-32U4_Summary.pdf*.

> For those of you with **Mac OS**, there are 2 options: 1) Use the Microchip Studio environments available on the PCs in ECE rooms 105, 106, 107, 210. 2) There is a Boot Camp Support webpage (https://support.apple.com/boot-camp) that provides details for switching between Mac OS and Windows on your Mac computer. This requires obtaining a copy of Windows 10. Once you have Windows 10 installed, you download Microchip Studio as explained in the Tutorial from Homework 2.

TEAMS: Projects will be done in the groups of 4 designated in the **Canvas Announcement => Group Assignments**. Team member contribution will be evaluated in the final report and through a confidential evaluation after the project has been turned in. Please do not share your team's solution with other teams.

PARTS: Your project will be implemented on the Adafruit Circuit Playground board. It uses an ATmega32U4 microcontroller, which can be programmed using the serial port from the Atmel Studio 7 environment, as you

did in the tutorial. Every team must have at least one Circuit Playground board. I am also recommending that multiple team members have the board to make your lives easier for developing and testing your code. See the **Canvas Announcement** "**Adafruit Circuit Playground and Programming Environment"** for details to acquire a Circuit Playground Board and to install the Microchip Studio environment. Your team will use the Circuit Playground board for project 1 and project 2 this semester.

SOUND: You can generate a sound on the Circuit Playground speaker by sending it a square wave at the frequencies specified above (500 kHz and 1 kHz). The oscillator frequency from the board is 8 MHz (see circuit_playground_schem.png) for delay loop calculation purposes. Generating delay loops based on machine cycles are required for this project (Do not use timers for this project).

Involve all team members in code writing, calculations, and the report for this project. Having some team members write the code and others write the reports will result in **lower** project scores (see the Work effort distribution and Individual contributions below). For the project demo, a video submission is required from the team with all team members participating, discussing and showing their contributions to the project.

DELIVERABLES AND DEADLINES: Points are given for the following deliverables.
Team assignment

- **Project code** (6 Points) (due with project). Provide commented code for the team and individual portions of the project.
- **Report** (10 points). Your report should include:
    - **Title and team members**
    - **Description.** Overview the project. Describe what you did in your project, what problems you encountered, and how you got around them. Provide descriptions of what your programs are doing (as indicated above). BE SPECIFIC.
        - Calculations are required for delay loops used to generate the count LED display and up and down count over- and under-flow speaker sounds.
        - Pseudocode showing your overall design with the up/down counter and the features which have been implemented. Provide within the pseudocode who was responsible for the different aspects of the design.
        - List port pins for the individual buttons, speaker, and LED used in the project.
    - **Explanation.** If your code did not work, explain what you might do to fix it.
    - **Work effort distribution.** List each person in your group. Tell what their job was and the total percentage effort they contributed to the completion of the project.
- **Video Demo Submission** (7 Points)
    - Present what your team did for this project, including a demo of the basic up/down counter and the individual features. Be clear in indicating who contributed to the overall and individual feature design and implementation. The video submission does not need to be elaborate or long (no longer than 5 minutes). A cell phone video is fine.
    - Grading will emphasize the clarity in your video demo of the basic up/down counter and individual features.
- **Individual Contributions** (7 Points)
    - You will evaluate each group member in their contributions to the project in a rubric provided with this project. It is expected that, for many of you, this is your first experience working with hardware and software. The rubric is not to document expertise, but, rather, participation in the project.

Project submission (Completed by midnight Friday, October 21. Late submissions will NOT be accepted (based on the time stamp received)

- One ***email from each team*** containing a link for a shared Google drive folder. The subject of the email is CPE 3150 TEAM #. Include the following files in the shared Google drive folder:
    - .zip file containing your team's project ASM code workspace
    - Video file containing the presentation of the team up/down counter application and each team member's contributions to the project
    - Team report (Word document)
        - Title and team members
        - Project description with calculations (BE SPECIFIC WITH DETAILS AND INCLUDE CALCULATIONS)
        - Listing of the pins (with functions) from the Circuit Playground board used in your project design
        - Commented code
        - Work effort distribution
    - ***On Canvas for this Project assignment, each team member uploads*** the rubric evaluation form with your evaluation of each team member's contributions to the project.