EE 3501 PROJECT INSTRUCTIONS

PROJECT OPTION #1: TIME AND TEMPERATURE DISPLAY

Overview

Each student will be required to program his/her microcontroller to display the current time and temperature to the LCD screen. The format of the displayed output will be as follows:

hh:mm:ss xx yy T

hh – is the 2-digit representation of the current hour
mm – is the 2-digit representation of the current minute
ss – is the 2-digit representation of the current second
xx – is either AM or PM depending on the current time
yy – is the 2-digit integer representation of current temperature
T – is either C or F. These letters are used to represent the unit of temperature in degrees Celsius or Fahrenheit, respectively.

An example of the displayed output is shown below
12:45:12 AM 66 F

Detailed Specifications

This section presents the specifications for the two operational blocks of this project: the clock and the temperature acquisition/display block.

Clock Operation

The clock has two modes of operation – Normal Mode and Set Mode. The mode is selected by pressing the '*' key on the keypad. Operation will begin in Normal Mode by default but will enter into Set Mode once the '*' key has been pressed.

Normal Mode

During Normal Mode, the system will output the current time to the LCD screen according to the format specified previously. The time display specifications are as follows:

1. Update the time display every second.
2. Update the AM/PM portion of the display every 12 hours.

Set Mode

During Set Mode, the system will perform the following tasks:

1. Suspend time and temperature display.
2. Prompt the user to set the current hour by displaying the text "HOUR" and enable the user to set the current hour via the keypad followed by pressing the '#' key. Ensure that the user input is mirrored on the LCD. Also, signal an error to the user if a value outside the range 1 – 12 is entered by displaying the text "ERROR" and then restart step 2.
3. Prompt the user to set the current minute by displaying the text "MIN" and enable the user to set the current minute via the keypad followed by pressing the '#' key. Ensure that the user input is mirrored on the LCD. Also, signal an error to the user if a value outside the range 0 – 59 is entered by displaying the text "ERROR" and then restart step 3.
4. The current seconds value must be reset automatically to 00.
5. Prompt the user to set AM/PM value of the current time by displaying the text "AM or PM" and enable the user to enter their selection via the keypad followed by pressing the '#' key. Ensure that the user input is mirrored on the LCD. Also, signal

an error to the user if the value entered does not match AM or PM by displaying the text “ERROR” and then restart step 5.

6. Once appropriate values are entered to the set current hour, current minute and AM/PM, code execution should automatically return to the Normal Mode of clock operation.

Temperature Acquisition/Display Operation

The current temperature will be displayed based on an analog input from the LM35 precision centigrade temperature sensor. This temperature sensor output must be connected to an AnalogIn pin of the microcontroller, and it must be powered according to the specification found in the following datasheet http://www.ti.com/lit/ds/symlink/lm35.pdf. The current temperature will only be displayed during the Normal Mode of clock operation. The temperature acquisition/display specifications are as follows:

1. Acquire and display the temperature every second.
2. Toggle the display unit of temperature between Fahrenheit and Celsius based on pressing the push button.
3. Round the current temperature displayed to the nearest integer.

PROJECT OPTION #2: ARITHMETIC CALCULATOR USING THE KEYPAD

Overview

Each student will be required to program his/her microcontroller to perform all four arithmetic operations (add, subtract, multiply and divide) on two user-supplied operands and display that output to the LCD screen.

Detailed Specifications

The calculator will add, subtract, multiply and divide INTEGER numbers and show the result on the LCD screen. The user will utilize the keypad to enter the operands and select the operation according to the Calculator Operation section below.

Calculator Operation

1. Calculator operation will begin by displaying the text "NO 1" on the screen and wait for the user to use the keypad to type the first integer operand followed by pressing the '#' key. Ensure that the user input of the 1st operand is mirrored on the screen. Also, signal an error to the user if non-integer value is entered by displaying the text "ERROR" and then restart step 1.
2. Next, the text "NO 2" will display on the screen and the calculator will wait for the user to use the keypad to type the second integer followed by pressing the '#' key. Ensure that the user input of the 2nd operand is mirrored on the screen. Also, signal an error to the user if non-integer value is entered by displaying the text "ERROR" and then restart step 2.
3. Upon the entry of the second operand, the calculator will display the text "SELECT OPERATION" on the screen. The keys A – D are mapped to the four arithmetic operations as follows: A – add, B – subtract, C – multiply, D – divide. The calculator will wait for entry of the operator selection, which is signaled by entering one of the four letters and pressing the '#' key. Ensure that the user input of the operation selected is mirrored on the screen. Also, signal an error to the user if the entry is not equal to A – D by displaying the text "ERROR" and then restart step 3.
4. After step 3, the calculator will display the operation result on the screen.
5. After step 4 has been completed, calculator operation returns to step 1.

Implementation Constraints

1. Each **operation must be implemented using an assembly language-based function**, that is, a .asm file.
2. You must be able to **enter multi-digit operands up to 4 digits and display multi-digit results up to 6 digits.**

Project Grade Guideline

The project grade will consist of a demonstration and a formal report. The demonstration will be worth 50% of your overall project grade. Your grade will be allocated according to the following rubric.

Description of Demonstration	Points Awarded
All design specifications met.	50
Most design specifications met.	40
Some design specifications met.	30
Minimal design specifications met.	10

The formal project report will have the following requirements:

Cover Page: The project report should include a cover page giving the course name and number, current semester, project title and your name.

Objective: A brief but complete statement of what you intend to design. (5 points)

Apparatus List: List the items of equipment used in system design and testing. (5 points)

Engineering Design: A detailed review on HOW your design approach meets the project design requirements must be presented. Specifically, you should include call graphs and flowcharts in this section, and you should describe how each module in your design enables you to meet the design specifications. The Engineering Design section should be used to demonstrate that all the specifications of your project will be implemented once the design is complete. (10 points)

Test Plan: A test plan describes how to test the implemented software against the given requirement specifications. Specifically, you should state how each module in your design hierarchy will be tested to ensure that it is functioning correctly. (10 points)

Source Code: Fully commented source code for both C++ language and assembly language programs must be included in the laboratory report. The comments used in these programs should be clear, easy to read and explain how the program works. (10 points)

Conclusion: Discuss the advantages and/or disadvantages of your solution to the design problem. (10 points)

Online Project Demonstration Guidelines

Project Option #1: Time and Temperature Display
Please include the following in your demonstration videos:

Normal Mode Operation

1. Include a 5 second video that shows time being updated every second.
2. Include two, 5 second videos that show the AM/PM portion of the display changing during the 11:59:59 to 12:00:00 transition.
3. Include a 5 second video that shows the 12:59:00 to 1:00:00 transition.

Set Mode Operation

1. Include a video that shows the transition into set mode after pressing '*' button on keypad.
2. In addition to this, show the setting of the hour, minute and AM/PM values and the return to normal operation.
3. Repeat Step 2 for another set of hour, minute and AM/PM values.
4. Show that your system can catch entering erroneous values for current hour (1 – 12), current minute (0 – 59) .

Temperature Display Operation

1. Show the update of the temperature display every second.
2. Show the toggle of the display unit of temperature between Fahrenheit and Celsius based on pressing the push button.

Project Option #2: Arithmetic Calculator Using the Keypad.
Please include the following in your demonstration videos:

1. Include 4 separate videos. One for each operation: addition, subtraction, multiplication and division.
2. In each video, use two different multi-digit operands, and do not use any of these operands for more than one operation, that is, two different operands for addition, subtraction, multiplication and division.