Department of Electrical and Computing Engineering

UNIVERSITY OF CONNECTICUT

ECE 3411 Microprocessor Application Lab: Fall 2015

Lab Test V

There are 2 long programming problems in this test. There are 4 pages in this booklet. Answer each question according to the instructions given.

You have **100 minutes** to answer the questions. Once you are done, you need to show the output to the Instructor or TA and e-mail the code to the TA.

Some questions are harder than others and some questions earn more points than others—you may want to skim all questions before starting.

If you find a question ambiguous, be sure to write down any assumptions you make.
Be neat and legible. If we can't understand your answer, we can't give you credit!

Write your name in the space below. Write your initials at the bottom of each page.

THIS IS AN OPEN BOOK, OPEN NOTES TEST.
YOU CAN USE YOUR LAPTOP BUT PLEASE TURN YOUR NETWORK DEVICES OFF.

Any form of communication with other students is considered cheating and will merit an F as final grade in the course.

Do not write in the boxes below

1(a) (x/15)	1(b) (x/25)	2(a) (x/30)	2(b) (x/30)	Total (xx/100)

Name:

Student ID:

1. [40 points]: In this task, you need to design a digital thermometer using the ADC and an external temperature sensor. The thermometer should display the room temperature in both Celsius and Fahrenheits down to $1/10th$ of a degree.
You may refer to the provided data sheet of the temperature sensor (MCP9701A).

a. (15 points) First, connect a potentiometer to the ADC channel and sample the analog input voltage after every second.

- The potentiometer should generate a variable voltage between 0V and 5V.
- Print the current voltage (in millivolts) on LCD.

b. (25 points) Now replace the potentiometer with a temperature sensor (MCP9701A) to read the temperature every second.

- Convert the input voltage from the temperature sensor to the equivalent temperature.
- Print the temperature reading on LCD in both Celsius and Fahrenheits down to $1/10th$ of a degree.

Hint: The temperature sensor produces $400mV$ at 0 degree Celsius.

Initials:

2. [60 points]: In this task, you need to generate a 'rectified' 62.5Hz sine waveform using PWM. Generate a 64kHz PWM signal at PB2 using `Timer1` such that the duty cycle of the PWM is a function of a 62.5Hz sine wave. I.e. for $f = 62.5$

$$duty\_cycle \propto |\sin(2\pi f t)|$$

An example of such a PWM signal is shown in Figure 1 where the duty cycle follows a sine function.

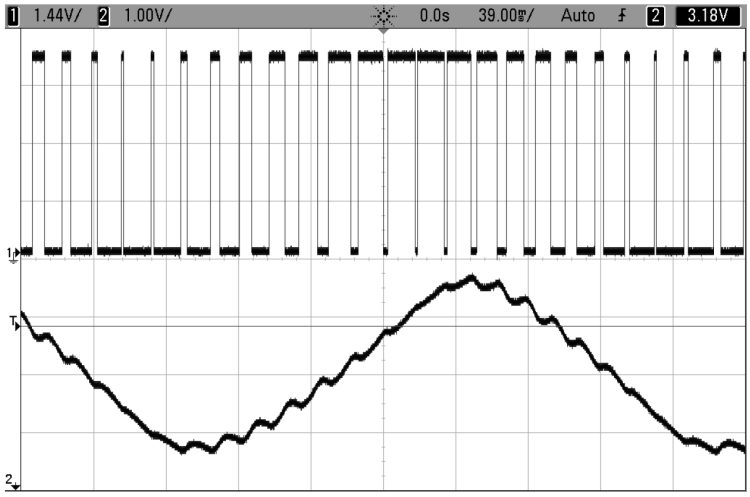

Figure 1: Example PWM Signal.

Connect the PWM signal to a RC low pass filter as shown in Figure 2.

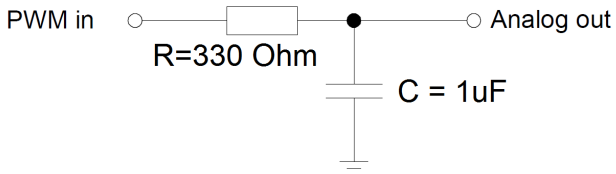

Figure 2: Low Pass Filter.

Connect the output of the low pass filter to an oscilloscope and observe the resulting waveform. This waveform should look like the one shown in Figure 3 where the negative half cycles are also transformed into positive half cycles.

The credit for this task is based on the following two criteria:

a. (30 points) Correct frequency of the resulting sine wave.
Hint: Include '`math.h`' library and use `sin()` function to compute the sine value.
Hint: Use `Timer0` to generate the argument to `sin()` function.

b. (30 points) Quality of the resulting signal.
Hint: Signal quality depends upon the number of steps taken from 0 to 2π to update duty cycle.

Notice that for this task, `_delay_ms()`/`_delay_us()` function calls are not allowed.

Initials:

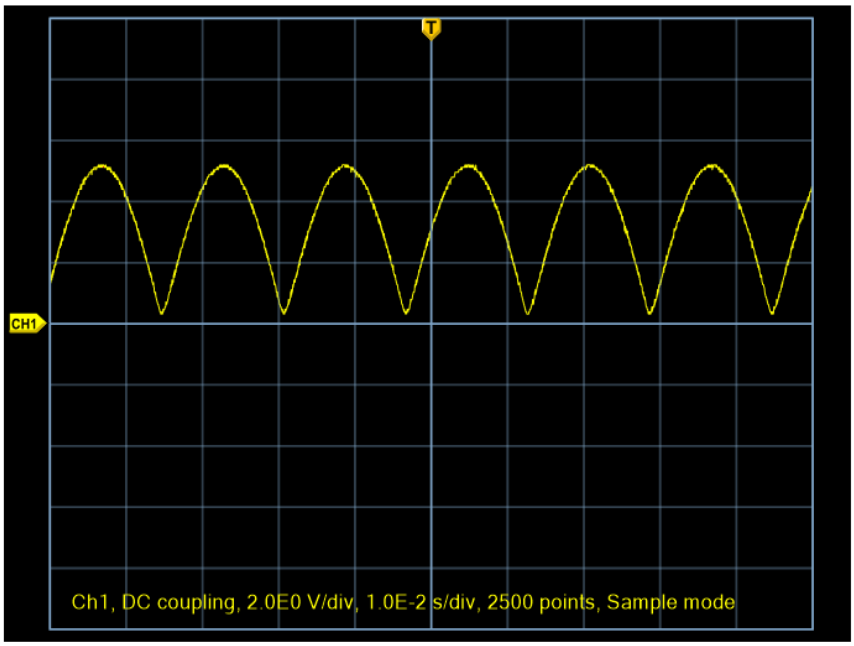

Figure 3: Expected sine waveform.

End of Quiz

Please double check that you wrote your name on the front of the quiz.

Initials: