ECE2049: Homework 6

Content: Lectures 11-12

Submission notes:

- For full credit, please show your work and denote your answers with a circle or a box.
- Always write and draw your diagrams neatly! We cannot be expected to GUESS what you meant to write! Some problems (such as those involving code) must be typed to be graded—the others may be handwritten (neatly!) or typed.
- Points for each problem are as indicated. Some problems are marked as "BONUS," which count as extra credit.

1. (Lecture 12, 10 pts) An MSP430 is being used to monitor the temperature in an experimental chamber. The temperature sensor used in the chamber outputs a voltage that is linear across the temperature ranges used in the experiment, -60 to 90° C, based on the following formula:

$$V_{Temp} = 0.00475 * (Temp\ °C) + 1.29V$$

a. What are the output voltages (V_{Temp}) that correspond to the minimum and maximum temperatures?

b. Assuming that you are using the MSP430's ADC12, which of the standard reference voltages (V_{CC}, 1.5V, or 2.5V) would you choose for the reference voltage V_{Ref+} to achieve the finest resolution? Explain your reasoning.
You can assume that $V_{Ref-} = 0V$.

c. Assuming that you are using the reference voltages configured in part (b), what is the smallest change in *temperature* that you can measure?

d. What is the output voltage of the sensor *and* the ADC code output if the temperature inside the chamber is 24.8° C?

e. What is the temperature if the output code of the ADC is equal to the decimal value 2415?

f. (**BONUS**, 3pts) Write a C function to convert an output code from the ADC for this sensor into temperature in degrees Celsius. Your function should take one argument (the ADC code), and return the temperature as a single-precision floating point value (ie, type `float`).

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2. (Lecture 11, 5 pts) Read the text below and answer the following questions about keeping track of wall-clock time using timers.

In computing, time scales usually store the current time as the number of seconds that have elapsed since the beginning of some "epoch", which is an arbitrary date that determines the starting time. For example, the Network Time Protocol (NTP) uses an epoch of midnight on January 1st (GMT) 1900. The elapsed seconds since the epoch are stored in a 32-bit unsigned integer.

a. How many years can be represented in an NTP timestamp (ie, an unsigned 32-bit integer storing the number of seconds since 1 January 1900)?

b. In many embedded systems, it is more practical to just consider the current year. In this case, the format is often modified such that 0 corresponds to midnight on January 1st of the current year. If a clock that was initialized to 0 at midnight of 1 January 2020 currently has a count of 3665044 seconds, what day and time does it represent?
(For example, your answer should be in the form June 6, 8:47:12 am)

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4. (Lecture 11, 5 pts) **Using a global time count**: The program listed below is an incomplete main() for a system using a timer that triggers interrupts every 25ms.
Complete the `main()` function below such that the function `do_thing()` is called once every 500ms. You may declare additional variables as necessary, but your code must not change the value of `time_count`. Assume the timer configuration (not shown) is correct—there is no need to change it.

Hint: you do not need a lot of code for this, keep it simple!

```
volatile unsigned long time_count = 0;

// This ISR runs every 25ms
#pragma vector=TIMER2_A0_VECTOR
__interrupt void Timer_ISR(void) {
   time_count++;
}

void main(void)
{
    configure_everything();
    start_25ms_timer();
    _enable_interrupt();

    while(1) {




        do_thing();




    }
}
```