ECE2049: Homework 6

Content: Lectures 10-12

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.
- Please staple your work before submitting and remove any "ruffled" edges from notebook paper.
- Points for each problem are as indicated. Some problems are marked as "BONUS," which count as extra credit.

Fun fact: This entire homework assignment is composed of old exam problems.

1. (Lecture 11-12, 10 pts) An MSP430 is being used to monitor the temperature in an experimental chamber. The temperature sensor (called a "thermistor") used in the chamber outputs a voltage that is linear across the temperature range of interest (-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. 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.

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2. (Lecture 10, 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();




    }
}
```

(continued on the next page)

3. (Lecture 12, 10 pts) Answer the following questions about the MSP430 low power modes.

a. What causes the MSP430F5229 to return to active mode from low power mode?

b. Alkaline AAA batteries have a capacity of 1100 mAh. A certain embedded system uses the MSP430F5529 powered by 2 AAA batteries in series (i.e. Vcc = 3V). How long can the system run if the MSP430F5529 is always in active mode? How long can it run if the system is in LPM0 84% of the time?

You may assume the system is running at the default clock frequencies. If you need to make any further assumptions, state them clearly.