CSCE 436/836: Embedded Systems
Homework 2

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Started: March 17, 2011
Due: March 31, 2011

Instructions: This homework is an individual assignment, collaboration is not allowed. If you discuss any problems with others, please note this on the assignment as described in the syllabus. Also note any materials outside of lecture notes, course textbooks, and datasheets that you used. Answer all questions with **complete sentences** and describe your reasoning where appropriate for full credit. This homework is due on the date listed above before the start of class. Email submissions are preferred, however, paper copies in class will be accepted.

Name:

Problem 1. *Embedded Systems Memory*

a) (5pts). *How much RAM and flash memory does the 5V processor on the hoverboard have?*

b) (5pts). *What section of memory does* `malloc` *use? Why is it a bad idea to use* `malloc` *on an embedded system?*

c) (5pts). *How many bytes can be written to the EEPROM in one second if it was previously erased?*
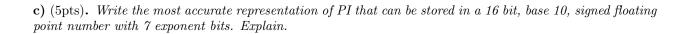
Problem 2. *Timers and Pulse Width Modulation*

a) (5pts). *Give the C code needed to set Timer0 to generate an interrupt as close to every 1 millisecond as possible on a 10MHz processor. What is the actual time between interrupts? Please comment your code to describe what the various register settings mean.*

b) (5pts). *What is the maximum PWM frequency for a 10MHz processor in fast PWM mode? What about in phase correct PWM mode?*

c) (5pts). *What is the purpose of the watch dog timer?*

Problem 3. *Debugging*

a) (5pts). *What are two ways to time how long how long a function call takes without using an oscilloscope or similar device?*

b) (5pts). *What is the most common compiler optimization level used for embedded systems? Why? What are the other levels and when are the useful?*

c) (5pts). *What is an advantage and a disadvantage of using the serial port to debug your code?*

Problem 4. *Analog to Digital Converters*

a) (5pts). *How many millivolts per bit do you get when using the internal 2.56V reference on the Atmel ADC?*

b) (5pts). *What is the maximum number of conversions per second you can perform on the Atmel ADC with a 10MHz clock while still maintaining full accuracy.*

c) (5pts). *On the hoverboard, if you wanted to measure the thruster current usage with a resolution of 10 milliAmps, what would you have to change? What is the maximum current you could measure?*

Problem 5. *Interrupts*

a) (5pts). *Write the code to enable receiving an interrupt when the ADC conversion is complete. This should include configuring the registers and also indicating what the signal handler should be, you do not need to actually do anything with the ADC reading. Please comment your code.*

b) (5pts). *If timer 0 compare match A and timer 2 compare match A both trigger at the same time, which handler will execute first? Why?*

c) (5pts). *Describe the steps that need to occur for the processor to context switch from executing the main loop code to executing an interrupt handler.*

Problem 6. *Floating and Fixed Point*

a) (5pts). *What basic math operations are accurate for floating point operations? What about fixed point operations?*

b) (5pts). *What is the largest number that can be represented with a 16-bit fixed point number with a scaling factor of 1000?*

c) (5pts). *Write the most accurate representation of PI that can be stored in a 16 bit, base 10, signed floating point number with 7 exponent bits. Explain.*

Problem 7 (5pts). *Which question took the most time on this assignment?*

Problem 8 (5pts). *Approximately how much time did the total assignment take?*