CSCE 236 Embedded Systems, Spring 2013
Exam 1

Thursday, February 14, 2013

Instructions: You will have the full class period to complete this test. **Make sure to show your work to ensure you receive partial credit if your final answer is incorrect.** This is a closed book quiz, no computers, textbooks, notes, etc. are allowed.

Name:

Problem 1. *Hex and bit operations (all references to bit locations are zero referenced). For each bit operation subproblem write a* **single** *line of* `C` *code to achieve the desired result.*

a) (5 pts.). *Set bit 7 in the variable* `var`*.*

b) (5 pts.). *Clear bit 2 in the variable* `var`*.*

c) (5 pts.). *What is the value of* `((3<<6) & (0xF<<3))` *in hex?*

d) (5 pts.). *What is the value of* `(((0xA<<4) | (1<<6)) + 2)` *in hex?*

e) (5 pts.). *Set bits 2-4 (inclusive) in the variable* `var` *to the top three bits in the 8-bit variable* `config`*. As with all of these problems, do this in a single line of code.*

Problem 2. *Memory operations. Refer to the following code example for this question:*

```
uint8_t data[] = {0,1,2,3,4,5,6,7};
uint16_t globalVar = 0x236;
uint8_t *globalPtr;

int8_t main(void){
  uint8_t var = 0x1F;
  uint8_t *p1 = data + 2;
  //Draw Memory Map Here

  p1[1] = 4;
  *(p1+3) = data[0];
  var += globalVar;
  globalVar = (p1++)[1];
  data[3] = p1[2];

  return 0;
}
```

a) (10 pts.). *Fill in the below memory map for the above code after execution has reached the statement* `Draw Memory Map Here`. *Assumptions you should make: 1) the compiler allocates the memory in the order the statements appear; 2) global variables are allocated starting with the high address; 3) the stack starts at zero; and 4) each memory location stores 8 bits.*

Address	Variable	Value
0x14		
0x13		
0x12		
0x11		
0x10		
0xF		
0xE		
0xD		
0xC		
0xB		
0xA		
0x9		
0x8		
0x7		
0x6		
0x5		
0x4		
0x3		
0x2		
0x1		
0x0		

b) (5 pts.). *What are the values of all the variables and arrays once the code reaches the* `return` *statement?*

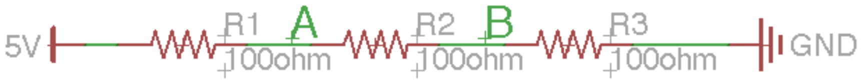
c) (5 pts.). *Where does* `malloc` *allocate memory? Describe why you should avoid using* `malloc` *on an embedded system.*

d) (5 pts.). *Does the Atmel Processor on the Arduino keep the memory for the program and variables together or separate? What is this memory architecture called? Give one advantage of this type of memory architecture.*

Problem 3. *Circuits.*

a) (5 pts.). *If a LED connected to the Arduino drops 1.0 volts, what resistor would be required to limit the current going through the LED to 10mA? Answer in fractions.*

b) (5 pts.). *For the following circuit, what is the voltage at points A and B? Also, what is the current running through each of the resistors? Answer in fractions.*



Problem 4. *Debugging.*

a) (5 pts.). *Give two debugging capabilities that are enabled by using a JTAG. Explain a situation where using a JTAG would not help in debugging.*

b) (5 pts.). *What are two other methods to debug embedded systems besides using a JTAG? Give one advantage and one disadvantage of each of these methods.*

Problem 5. *Timer/Counter. For these questions, see the provided register description pages for Timer1 and assume this is running on the Arduino we use in class. The timer is configured as:*

```
TCCR1A = 0;
TCCR1B = (1 << CS12) | (1 << CS10);
TCCR1C = 0;
TCNT1 = 0;
```

a) (5 pts.). *How many seconds will it take before the timer will roll over (reset to zero). Leave your answer as a fraction.*

b) (5 pts.). *Write the code to configure the registers to count the number of times a button on pin* `T1` *has been released.*

Problem 6. *Digital I/O*

a) (5 pts.). *Write code using Arduino commands to set pin* `A2` *as an input with the pullup resistor enabled.*

b) (5 pts.). *Write the* `C` *code to configure pin* `PB5` *as an output and set it low by directly writing to the processor registers (recall the I/O registers have the general names* `DDRx`*,* `PORTx`*,* `PINx`*).*

c) (5 pts.). *Write the code to test if pin* `7` *on the Arduino (*`PD7` *on the Atmel) is high by using the Arduino commands and using the Atmel registers directly.*

d) (5 pts.). *Describe two different approaches to debouncing a button? Which approach is better and why?*