

# CSCE 236 Embedded Systems, Spring 2014

## Exam 2

Wednesday, April 23, 2014

**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.

Unless otherwise specified, assume that questions are referring to the Arduinos/Atmel processors we have been using in class.

**Name** (3 pts.):

**Problem 1.** *Warmups (Circle all answers that apply).*

**a)** (5pts). *If a PWM signal was 200Hz in Phase Correct Mode, approximately what would the frequency be in Fast PWM mode?*

- (a) 100Hz
- (b) 200Hz
- (c) 300Hz
- (d) 400Hz

**b)** (5pts). *What are the advantage(s) of using differential signaling when communicating (e.g. like RS485)?*

- (a) *Less subject to noise*
- (b) *More power required*
- (c) *Few wires*
- (d) *Greater range*

**c)** (5pts). *Which way(s) would let you set bit 5 in reg to bit 3 in val?*

- (a) `reg = val >> 3;`
- (b) `reg >> 5 = val >> 3;`
- (c) `reg |= ((val >> 3) & 0x1) << 5;`
- (d) `reg = (reg & ~(1 << 5)) | (((val >> 3) & 0x1) << 5);`

**d)** (5pts). *The SPI protocol has which of the following properties:*

- (a) *Multi-master*
- (b) *Multi-slave*
- (c) *Full duplex*
- (d) *Parallel*

e) (5pts). *The I<sup>2</sup>C protocol has which of the following properties:*

- (a) *Multi-master*
- (b) *Multi-slave*
- (c) *Full duplex*
- (d) *Parallel*

f) (5pts). *Which of the following are stored in the Flash area of the memory?*

- (a) *Function calls*
- (b) *.text*
- (c) *.bss*
- (d) *.data*

**Problem 2. Timer/PWM**

a) (10 pts.). *What frequency will the interrupt be triggered on our Arduino with the following configuration (use the datasheet for this problem)? (You can leave the answer as a fraction.)*

```
void setup(){
  TCCR1A = (1<<WGM11);
  TCCR1B = (1<<WGM13) | (1<<WGM12) | (1 << CS12) | (1 << CS10);
  TIMSK1 = (1 <<OCIE1A);
  ICR1 = 300;
  OCR1A = 200;
}

SIGNAL(TIMER1_COMPA_vect){
  //Interrupt handler code goes here
}
```



**b)** (5 pts.). In I<sup>2</sup>C, describe how arbitration works when there are two masters. What is unique at the physical layer that enables multiple masters with I<sup>2</sup>C?

**Problem 4. Interrupts**

**a)** (5pts.). Describe one benefit and one drawback of using interrupts in your code.

**b)** (5 pts.). What are the steps that occur to switch from executing the main code to executing interrupt handler code when an interrupt occurs?

**Problem 5. Analog to Digital Converters**

**a)** (5 pts.). If a 2.36V value is input to a 14-bit ADC, with a 3.3V reference, what digital value will it report? (You can leave the answer as a fraction.)

**Problem 6.** *Embedded Operating Systems*

**a)** (5 pts.). *What is the difference between a non-cooperative multi-tasking operating system and a cooperative multi-tasking operating system?*

**b)** (5 pts.). *What does it mean when an OS has a fully preemptive scheduler? What is one advantage and one disadvantage of a fully preemptive scheduler?*