

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 I²C 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*

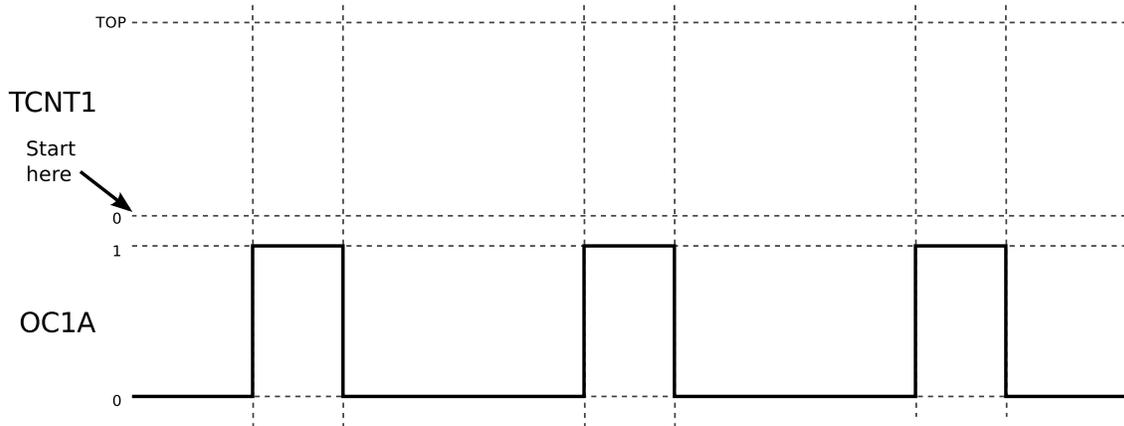
Problem 2. Timer/PWM

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
}
```

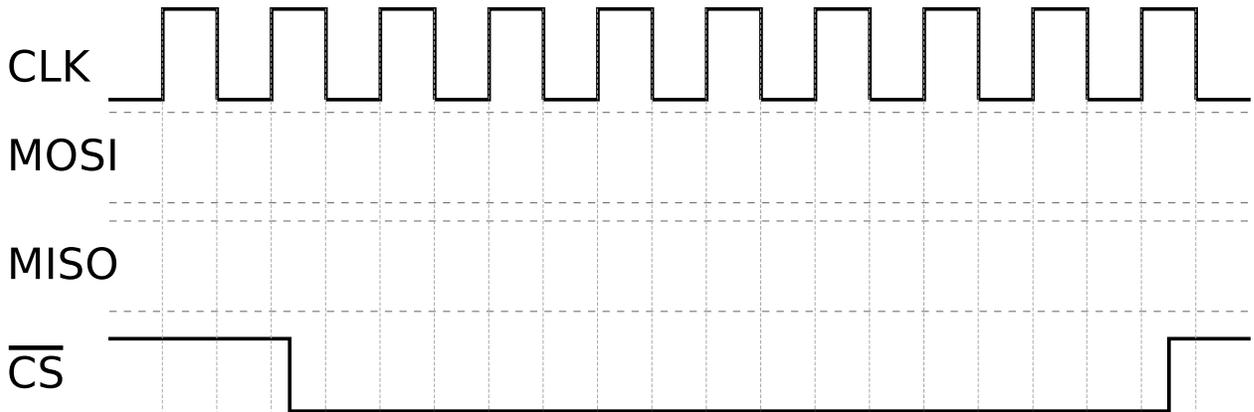
b) (10 pts.). In the following figure, draw the clock, TCNT1, that will generate the lower square wave when it is configured in fast PWM mode. Also draw the correct line in the upper part of the diagram to indicate the location of OCR1A. (Also make sure to read the next question before completing this one.)



c) (5 pts.). For the previous figure, what are the proper mode bit settings (COM1A0 and COM1A1) to generate the signal from the timer register you drew?

Problem 3. Communication

a) (10 pts.). In the following figure, draw the proper signal for sending the from the master to the slave the value 0x61 on the rising edge and from the slave to the master the value 0xCD on the falling edge.



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

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?*