**CG2111A Engineering Principles and Practices II**
**2021/22 Semester II**
**Quiz 1**
**(Backup Paper)**

(1) This paper is only to be used in the event that LumiNUS goes down.
(2) Listen to the instructions from your proctor, particularly the expected time of the end of the quiz.
(3) Enter your student ID in the word file. E.g. Student ID: AxxxxxxY
(4) Answer all questions in a WORD docx file, writing the question number and your answer. E.g.:

    Q1. a
    Q2. c, d

(5) Name your file AxxxxxxY.docx where AxxxxxxY is your student ID. Only docx format is accepted.
(6) Send your answer file to cg1112.exam@gmail.com within 5 minutes of the end of the quiz. No submissions will be accepted after that time.
(7) All other rules of the original quiz are still in force.

1. (MRQ) Choose ALL of the options that are true:

   a. Interrupts are more efficient for moving large amounts of data than DMA.
   When there are only one or two sensors and little other processing, polling may be better than interrupts due to smaller code size.
   b. The “volatile” results in code that always executes faster when an ISR shares a global variable with another function.
   c. Systems like the Arduino that only has on-chip memory cannot be used with an external DMA controller.
   d. Code written to use DMA is always smaller and faster than code written to use interrupts for data transfers.

2. (MRQ) Choose all the code fragments that would generate an 1 kHz square wave on pin 6 of the Arduino, with a 16MHz clock. Note: ^= is the bitwise XOR operator. The XOR truth table is shown here:

| a | b | a^b |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 0 |

a.

```
void setup() {
       TCCR0A = 0b00010010;
       TCNT0=0;
       OCR0A = 125;
}
void start() {
       TCCR0B = 0b00000011;
}

int main() {
       setup();
       start();
}
```

b.

```
void setup() {
       TCCR0A=0b01000010;
       TCNT0=0;
       OCR0A=250;
}
```

```
void start() {
	TCCR0B=0b00000011;
}

int main() {
	setup();
	start();
}
```

C.

```
#define MASK 0b01000000;
void setup() {
	TCCR0A=0b00000010;
	TNCT0=0;
	OCR0A=125;
	TIMSK0|=0b10;
	DDRD|=MASK;
	PORTD&=~MASK;
}

void start() {
	TCCR0B=0b00000011;
}

ISR(TIMER0_COMPA_vect) {
	PORTD^=MASK;
}

int main() {
	setup();
	start();
}
```

d.

```
#define MASK  0b01000000;
void setup() {
       TCCR0A=0b00000010;
       TNCT0=0;
       OCR0A=125;
       TIMSK0|=0b10;
       DDRD|=MASK;
       PORTD&=~MASK;
}

void start() {
       TCCR0B=0b00000011;
}

ISR(TIMER0_COMPA_vect) {
       PORTD|=MASK;
}

int main() {
       setup();
       start();
}
```

e. None of the code above would generate a 1 kHz square wave on Arduino pin 6.

3. (MRQ) We have a serial channel set up for an 8e1 frame at 9600 bps. Choose all the statements that are true (1 character = 8 bits):
    a. We are able to transfer at 1200 characters per second.
    b. A 4,800 character buffer would take 5 seconds to 6 seconds to transfer.
    c. When transmitting a character *c*, in the 8e1 frame consists of a total of 9 bits.
    d. We can transfer 1 character in approximately every 1.15 milliseconds.
    e. None of the above statements a. to d. are true.

4. (MCQ) Choose which ONE of the following statements is true:
    a. No additional code is needed to set up a DMA controller for  transfer.
    b. The Atmega328P is able to do DMA transfers.
    c. The Atmega328P can support separate ISRs for each and every pin change an external interrupts.
    d. Using interrupts to process keyboard inputs is generally more efficient than using DMA.
    e. Polling is efficient because it only makes use of times when the CPU is idle.

5 (MCQ) We are given the following code running on an Atmega328P processor clocked at 20MHz.

```
void setup() {
       TCCR0A=0b01010010;
       OCR0A=127;
       OCR0B=215;
}

void start() {
       TCCR0B=0b00000100;
}

int main() {
       setup();
       start();
}
```

Which ONE of the following statements is true? (Note: Rounding down for fraction portions of less than 0.5, and round up for 0.5 and above).

a. This code produces a square wave of approximately 182Hz on pin PD5 and approximately 308Hz on pin PD6
b. This code produces a square wave of approximately 308Hz on pin PD6 only.
c. This code produces a square wave of approximately 363Hz on pin PD5 and approximately 615Hz on pin PD6
d. This code produces a square wave of approximately 145Hz on pin PD5 and approximately 246Hz on pin PD6
e. This code produces a square wave of approximately 246Hz on pin PD6 only.

6. (MCQ) Given the following register values on an Atmega328P running at 16MHz, choose the most correct answer from the list below. If interrupts are being used, you may assume that all the necessary interrupt enable bits have been set appropriately, and that the USART is powered on.

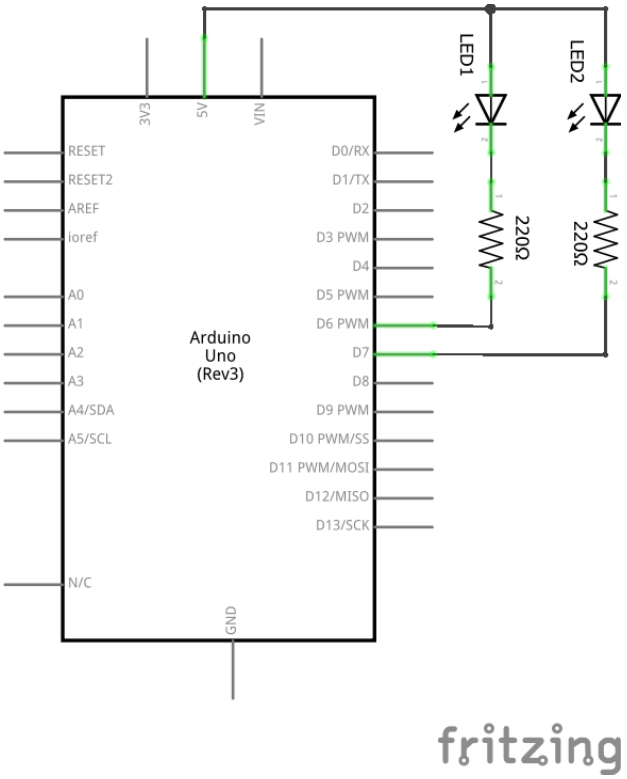
| Register | Value |
|---|---|
| UCSR0B | 0b10111000 |
| UCSR0C | 0b00110100 |
| UBRR0 | 51 (decimal) |

   a. The USART is configured for 8N1, 9600 bps, and will trigger an interrupt when a character is received and when it has finished sending a character.
   b. The USART is configured for 8O1, 115200 bps, and will trigger an interrupt when a character is received and when the UDRE0 register is empty.
   c. The USART is configured for 7E1, 9600 bps, and will trigger an interrupt when the UDRE0 register is empty.
   d. The USART is configured for 7O1, 19200 bps, and is configured only for polling.
   e. The USART is configured for 7O1, 19200 bps, and will trigger an interrupt when a character has been received and when the UDRE0 register is empty.

7. To configure the USART for 38400 bps on an Atmega328P processor clocked at 20MHz, what should the UBRR0L and UBRR0H register values be in decimal?

8. You have an Atmega328P microcontroller clocked at 8MHz. Find suitable values for the prescalar, OCR1AL, OCR1AH for an interrupt period of 2.5 seconds in CTC mode (i.e. TIMER1_COMPA_vect interrupt is triggered once every 2.5 seconds), ensuring that the absolute error of your time interval is minimized. Valid prescalars for Timer 1 are 1, 8, 64, 256 and 1024. (Again round down if the fraction portion is less than 0.5, round up otherwise)

9. (MCQ) Two red LEDs are connected to the Atmega328P as shown below:




These are the Pin to Port Mappings.

| Arduino Pin | AT328 Port, Pin |
|---|---|
| 6 | Port D, pin 6 |
| 7 | Port D, Pin 7 |

You are given the following C function.

```
char MASK(unsigned char bit_position)
{
    return (1 << bit_position);
}
```

*Note: 0x is prefix for Hexadecimal and B is prefix for binary.

Which code below correctly configures **BOTH** the LED's?

**DDR bit configuration: '1' : Output, '0' : Input**

Note: You **CANNOT** assume any default value for the bits in the registers.

a. DDRD = MASK(0x01 | 0x02);

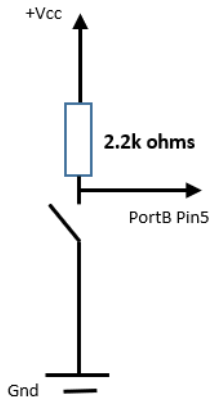
b. DDRD = MASK(0x07 | 0x06);

c. DDRD = MASK(0x01) | MASK(0x02);

d. DDRD = MASK(0x07) | MASK(0x06);

e. DDRD = MASK(0x07) & MASK(0x06);

10. (MCQ) You wish to connect a switch to Port B Pin 5. The figure shows the HW connection of the switch.




You are given the following definition

#define PIN5 (1 << 5)

Which code correctly configures the Port Pin 5 **WITHOUT** affecting the other bits in the register. You cannot assume any initial value for the DDRB register.

a. DDRB = PIN5;
b. DDRB = ~PIN5;
c. DDRB |= PIN5;
d. DDRB &= PIN5;
e. DDRB &= ~PIN5;

11. (MRQ) When the Switch connected to Port B Pin 5 is pressed, you are required to make both the LED's light up for 1s and then stay OFF.

Which of the following statements are TRUE with respect to the HW configuration in the earlier two questions?

a. INT0 can be used to capture the switch event.
b. To switch ON the LED's a Logic '0' must be written to Port D Pin 6 and 7.
c. To know the state of the switch, we must read from PORTD register.
d. To switch ON the LED's a Logic '1' must be written to Port D Pin 6 and 7.
e. The requirements can be fulfilled without the use of Interrupts

12. (MCQ) The following code snippet shows the setup() for the Timer 0 block to generate a PWM signal to control an LED connected in Active-High configuration to Port D Pin 6. The ISR() and loop() functions are not shown here. A continuous PWM signal is observed.

```
#include "Arduino.h"
#include <avr/io.h>
#include <avr/interrupt.h>

void setup() {

  TCNT0 = 0;            // LINE 1
  TCCR0A = 0b10000001; // LINE 2
  TIMSK0 |= 0b10;       // LINE 3
  OCR0A = <???>;        // LINE 4
  TCCR0B = 0b00000011; // LINE 5
  DDRD |= (1 << 6);     // LINE 6
  sei();                // LINE 7
}

ISR(TIMER0_COMPA_vect)
{
  <???>                 // LINE 8
}

void loop()
{


}
```

What value should be loaded into the OCR0A register in Line 4 to achieve a Duty Cycle of approximately 25%?

a. OCR0A = 0x19;
b. OCR0A = 0x25;
c. OCR0A = 0x40;
d. OCR0A = 0x64;
e. OCR0A = 0x75;

13. (MRQ) The following code snippet shows the modified ISR at LINE 8.

```
ISR(TIMER0_COMPA_vect)
{
   TCCR0A &= 0x3F;     // LINE 8
}
```

Which of the following statements are TRUE?

a. The PWM signal's Duty Cycle will be doubled to 50%.
b. Timer 0 is now operating in CTC mode.
c. Timer 0 ISR will continue to trigger at the same interval as before.
d. The PWM signal will no longer be seen at Port D Pin 6.
e. Timer 0 prescale value has been changed to 128.

14. (MRQ) With reference to the Arduino Uno board that we use in the lab, which of the following statements about the ADC module are true?

a. The maximum sampling rate we can achieve is 8MHz.
b. We are able to physically access all the EIGHT ADC channel pins on the microcontroller.
c. We can sample the input analog signal on only one channel at a time.
d. Having more quantization levels can improve the accuracy of the ADC result
e. There are a total of 8 ADC modules within the microcontroller.

15. (MCQ) An input signal in the range of 0 – 1.6V is supplied to ADC Channel 0. The code for the setup and ADC conversion is as what we did in the studio. What is the largest ADC value (rounded-up) you can expect from it?

a. 160
b. 328
c. 511
d. 934
e. 812

16. (MRQ) Which of the following statements about Soldering and Wire-Wrapping are TRUE.

a. When holding the soldering iron, you must hold its metal part to have a firm grip.
b. Unleaded solder is more environmentally friendly.
c. The Proto-Board used in the studio has rows and columns that are already internally connected.
d. Wire-Wrapping headers allow us to easily change components without having to un-wrap and re-wrap.
e. The wire-wrapping tool can perform both wrapping and unwrapping of wires.