Name: _key_
PLEASE PRINT CLEARLY

ECE 205 Exam No. 3 (100pts. - 25% of the final grade)

General Remarks

This exam is limited open notes. You can and should have up to 5 double-side letter-size pages of notes that are stapled together and signed. Notes must not be exchanged during exam. Standardized test approved calculators are allowed. No textbooks, computer, or cell phones. Do not use back side without authorization as it may not be graded.

DL: _23 ERR: __ PTS: __

DL – exam difficulty level (adjustment), ERR – exam errors, PTS – exam points.

Question 1A (10pts.)

Write a piece of code that does certain operations on the given variable *uint8_t data;* so that certain bits are set off, on, and shifted as indicated by the following diagram. D_n indicates the value of the nth bit in the original state *data* where D_0 is the least significant bit. Correct solution that requires only one formula without temporary variables or if-else statements will receive full credit.
Using arithmetic operations like * / + - may also produce the result but will not receive any credit.

before	Old D_7	Old D_6	Old D_5	Old D_4	Old D_3	Old D_2	Old D_1	Old D_0
after	**0**	**1**	**0**	**Old D_4**	**Old D_3**	**0**	**0**	**1**

data = _(data & 0b00011000) | 0b01000001_ ; // () are important or -1

Question 1B (10pts.)

Consider the homework that focused on serial communication between the two boards:

How many wires are needed to set up communication between two microcontrollers that are, otherwise, not connected in any other way? **0 / 1 / 2 / 3 / 4**

Does use of a PIN as a TX output require setting of the digital IO as an output? **No / Yes**

Which IO PIN is used as UART1 TX ? (port name and #) **_D3____**

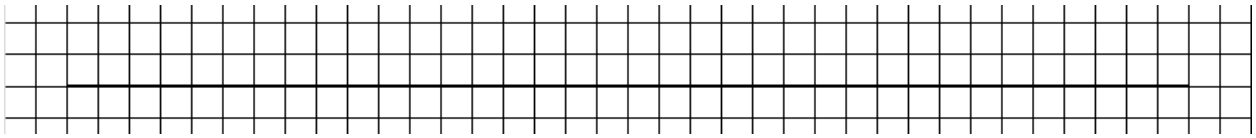
Consider the homework that focused on generating PWM:

How many PWM channels were used when PWMs were controlled by buttons? **_____4_**

Does use of a PIN for a software PWM output require setting of the digital IO? **No / Yes**

Question 2A (10pts.)

Draw a timing diagram for the UART transmission of two bytes. Indicate start, data, and stop bits. The transmission parameters are: 8 data bits, no parity check, and 2 stop bits. The data is 41_{16}, $5A_{16}$.



(optional some H before)(Lstart)LHLLLLLH(Hstop)(Hstop)(Lstart)LHLHHLHL(Hstop)(Hstop)(optional more H after)

Grading: P - reversed polarity -2; R - order opposite to lowest to highest bit -3; BB - only one byte -4, S – no start or stop but -1; X - each other mistake -1.

Question 2B (10pts.)

How much time does it take to send 45 eight-bit characters using Serial Communication UART (or RS-232C) assuming transmission 9,600bps, 8 bit transmission, 1 start bit, 2 stop bits, no parity, and no flow control? Show your work to get full credit.

45 * (8 +1 +2 +0) / 9600

Answer: _____51.6_ ms.

Question 3A (10pts.)

A: What is the resolution in miliVolts of a 10-bit A/D converter that uses 5V reference voltage?
B: The A/D converter described above is connected to an accelerator transducer that produces signal in the range 0 to 3.3V. What is the accuracy of the measured acceleration? Show your work.

5000 / 2^{10}

(4.88 / 3300) * 100%

Answer A: _____4.88_ mV. **Answer B: _____0.15_ %.**

Question 3B (10pts.)

In ATMega 128: There is a DAC inside of the ADC circuit. Explain briefly the reason for the existence of that DAC. In other words, why that DAC is essential in the operation of ADC?

This ADC works by attempting to reproduce the measured voltage by using the internal DAC.

Ex □ Vg □ Ok □ Ge □ No □

Question 3C (10pts.)

Explain briefly what is missing code in the context of ADC. A brief explanation in the form of a figure is recommended.

See the explanation in the Microchip ATMega series documentation – link in the sample exam.

Ex □ Vg □ Ok □ Ge □ No □

Question 4 (20pts.)

Assume use of an ATMega128A 8-bit counter with the system clock of 8MHz. The project requires PWM at 100Hz controlled with 0.25% resolution. What are: the maximum value of the software counter inside the interrupt routine (counting down by 1 to 0), the minimum required timer interrupt rate, the best choice(s) of prescaler, the value of the Output Compare A register, and approximately how many clock cycles maximum can be spent in the timer interrupt routine. Show your work to get full credit.

Answers: **Use this space to show your work:**

The software counter counts between _____400_ and 0.

The Timer Interrupt frequency is ____40000_ Hz.

The best prescaler is _____1_.

The value of the Output Compare A is _____200_.

The max clock cycles spent in T_{int} is _____200_.

Question 5 (10pts.)

Complete the code that sets PWM rate based on the following requirements:

- **The ADC reference voltage is 5V. The measured ADC signal is in the range of 0 to 4V.**
- **We are using only the 8 most significant bits of the ADC.**
- **The input of 1V or lower corresponds to PWM of 0%.**
- **The input of 3V and higher corresponds to the PWM of 100%.**
- **The function that sets PWM accepts a value between 0 and 255**

  with 0 corresponding to 0% PWM and 255 corresponding to 100% PWM.

```
_uint8_t_ adcbits;  // declare the variable

adcbits = getADC(); // returns the most significant 8 bits of the conversion

if ( adcbits < _51U____ ) adcbits = _51U____ ;      // below 1V is 1V

else if ( adcbits > _153U___ ) adcbits = _153U___ ; // cap at 3V

adcbits = adcbits - _51U____ ;                      // 1V becomes 0 value
```

```
setPWM( _(uint8_t) ( (uint16_t)adcbits * 255U / 102U )_ 5p );

// stretch the 2 V band to 0… 255, use typecasting to prevent overflow

// 51 == 1V/5V * 2^8, 153= 3V/5V * 2^8, 2V range – 51 to 153 becomes 0 to 102
```