



**Question 2B (10pts.)**

How much time does it take to send 80 9-bit characters using Serial Communication UART (or RS-232C) assuming transmission 19,200bps, 9 bit transmission, 1 start bit, 2 stop bits, even parity, and no flow control? Show your work to get full credit.

Answer: \_\_\_\_\_ ms.

**Question 3A (10pts.)**

A: What is the resolution in miliVolts of a 9-bit A/D converter that uses 2.56V reference voltage?

B: The A/D converter described above is connected to an accelerator transducer that produces signal in the range 0 to 1V. What is the accuracy of the measured acceleration? Show your work.

Answer A: \_\_\_\_\_ mV.

Answer B: \_\_\_\_\_ %.

**Question 3B (10pts.)**

In ATmega 128: The ADC input is routed through an analog multiplexer. Explain briefly what is the reason for the existence of that multiplexer in the microcontroller.

Ex  Vg  Ok  Ge  No

**Question 3C (10pts.)**

Explain briefly what is: ADC gain error / offset error / full scale error / non-linearity / missing code / voltage range / resolution, etc. Need to review the terms? See “AVR127: Understanding ADC Parameters” at [http://ww1.microchip.com/downloads/en/AppNotes/atmel-8456-8-and-32-bit-avr-microcontrollers-avr127-understanding-adc-parameters\\_application-note.pdf](http://ww1.microchip.com/downloads/en/AppNotes/atmel-8456-8-and-32-bit-avr-microcontrollers-avr127-understanding-adc-parameters_application-note.pdf)

**Question 4 (20pts.)**

Assume use of an ATmega128A 16-bit counter with the system clock of 1MHz. The project requires PWM at 500Hz controlled with 0.5% 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 \_\_\_\_\_ and 0.

The Timer Interrupt frequency is \_\_\_\_\_ Hz.

The best prescaler is \_\_\_\_\_.

The value of the Output Compare A is \_\_\_\_\_.

The max clock cycles spent in  $T_{int}$  is \_\_\_\_\_.**Question 5 (10pts.)**

Complete the code that generates the software PWM.

```
#define PWM_RATES 20 // equivalent to 100% PWM signal
```

```
static _____ uint8_t pwm_rate = 5; // controlled from the main loop
```

```
void MyTimerPWM ( ) { // called each time from a timer interrupt routine
```

```
    _____ _____ uint8_t pwm_counter = 0;
```

```
    _____ _____ uint8_t pwm_cached = 0;
```

```
    if ( pwm_counter _____ 0) {
```

```
        pwm_cached = _____ ;
```

```
        _____ = pwm_cached ;
```

```
    } else pwm_counter--;
```

```
    if ( pwm_couter < _____ ) setPin(1); else setPin(0);
```

```
} ...
```

### **Question 5 Alternatives**

**Consider a somehow changed fragment of code for main loops for any of recent 4-level HW assignments, or of the future final project as discussed in class, or fragment from our library code for Timer, software PWM, UART, or ADC. Either complete the blanks or explain what each line of the provided code does / why it is needed.**