TED UNIVERSITY
Department of Computer Engineering

CMPE451-Microprocessors

Fall 2022, Midterm Exam

Date: 26/11/2022, Saturday - Time: 11:00-13:00
Duration: 120 minutes

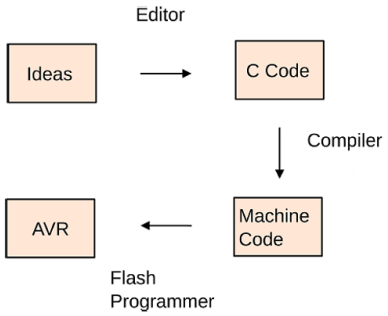
QUESTIONS	POINTS	
Q1	20	
Q2	20	
Q3	20	
Q4	20	
Q5	20	
TOTAL	100	

SOLUTION

1- **(General Properties).** Answer the following questions.

a- Write 3 ways of creating delay in AVR microcontrollers.
- Using a simple foor loop
- Using predefined C functions
- Using AVR Timers

b- Draw the tool-chain used while programming AVR Microcontrollers.



c- Write the roles of Program/Code ROM and EEPROM in AVR Microcontrollers

Program/Code ROM: Storing compiled program

EEPROM: storing permanent data

d- Write the conditions for the I/O properties in the table for AVR Microcontrollers.

I/O	Output	Input
Logic 0	Ground	<Vcc/2
Logic 1	supply voltage	>Vcc/2

2- **(PORT Programming).** Write an AVR C program to get one byte of data from port D. If the data is greater than 103, set pin 6 of PORT B as output, otherwise toggle only the pin-3 of PORT C, continuously.

```
#include <avr/io.h>
int main (void)
{
        DDRD = 0x00;
        DDRC = 0xFF;
        unsigned char tmp;

        while (1){
                tmp = PIND;
                if (tmp >113){
                        DDRB = 0b01000000;

                }
                else {
                        PORTC = PORTC ^ (1<<3);
                }
        }
        return 0;
}
```

3- **(UART Interface).** Transmit ASCII 113 from PC to AVR by using UART protocol.

a. To configure the UART to run at 900 Baud (normal mode), what value would you put in the UART BAUD registers. (Note clock = 8MHz). Calculate the value and write the corresponding pin values on the following register.

$$BAUD = \frac{f_{osc}}{16(UBRRn + 1)}$$

$$UBRRn = \frac{f_{osc}}{16BAUD} - 1 \qquad UBRRn = \frac{8x10^6}{16x900} - 1 = 554.55 \cong 555$$

555 = 0b 001000101011 (12 bit)

15	14	13	12	11	10	9	8	
-	-	-	-	0	0	1	0	UBRR0H
0	0	1	0	1	0	1	1	UBRR0L
7	6	5	4	3	2	1	0	

b. Write the received bits by AVR in correct order and show the required steps clearly to get the actual data (113).

113 = 0b01110001

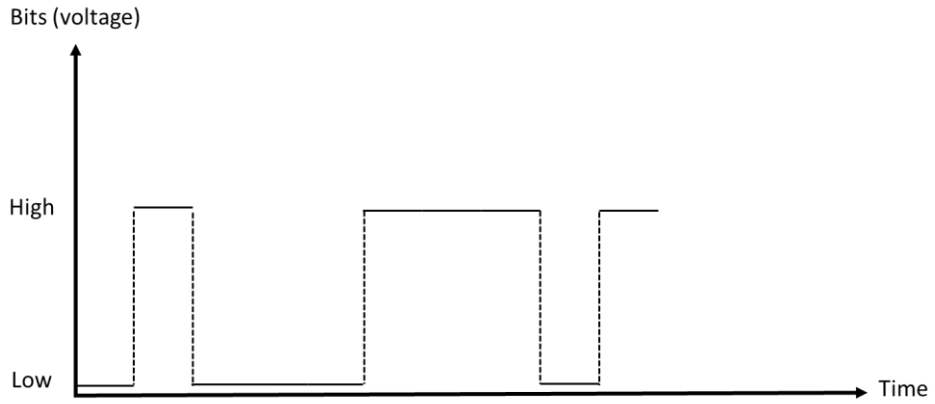
Sent bits (starting from LSB): Start bit (0)-1-0-0-0-1-1-1-0-stop bit (1)

Received bits: 0-1-0-0-0-1-1-1-0-1

Flipped bits: 1011100010

Remove start and stop bits: 011100010 = 113 (decimal)

c. Roughly, draw the voltage level of transmitted data on graph by considering 1 sec for each bit transmission time.



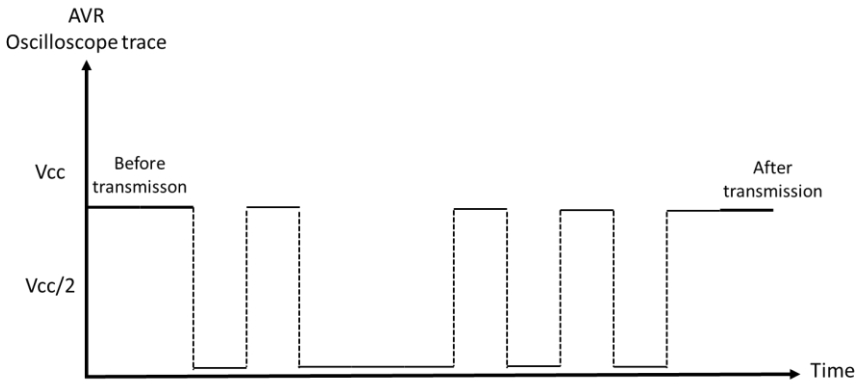
4- **(Creating Delay).** Write a *produceDelay(int freq, int ddelay)* method which gets the clock frequency and desired delay as inputs and return the desired delay value as integer. You should implement a for loop inside that method. Each iteration of for loop can be considered as the unit fetch time derived from clock frequency.

```
int produceDelay(int freq, int ddelay) {

        double t = 1/freq;
        int nofcycles = ddelay/t
        for(int i=0;i<nofcycles;i++){
        }
        return ddelay;
}
```

```
double t = 1/freq;
int nofcycles = delay/t;
for(int i=0; i< nofcycles; i++)
{ }
return ddelay;
```

5- **(UART Serial Communication).**Following is the figure for an oscilloscope trace of AVR microcontroller for a serial data transmission.



a. Decode the data into bits by considering UART communication.

0-1-0-0-0-1-0-1-0-1 (0 and 1 are start and stop bits)

b. By using the same structure, draw the oscilloscope trace for the transmitted decimal data 75 and 143 one after the other. Indicate all bits by writing their values on the graph.

75 = 0b 01001011 , 143 = 0b 10001111