CPE301 – SPRING 2019

DA5

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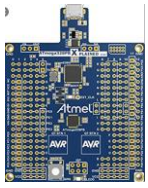
Directory: https://github.com/MeralAbuJaser/Submission_da/tree/master/DA5

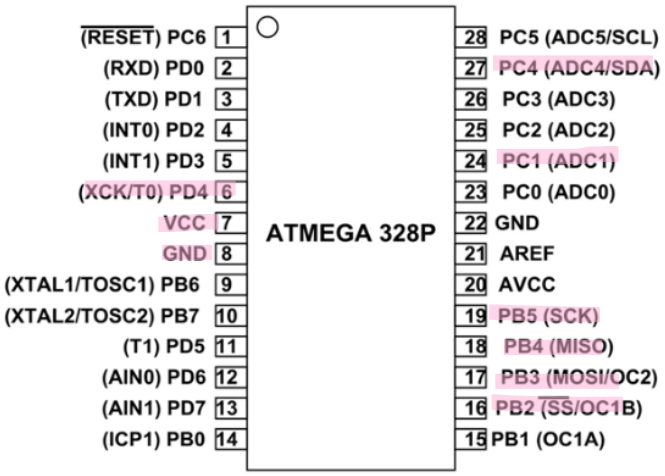
1. COMPONENTS LIST AND CONNECTION BLOCK DIAGRAM w/ PINS



Atmega 328pb

Atmel Studio 7.0
-debugger
-simulator
-assembler
-programmer
-terminal window

Additional components
- LM35



2. INITIAL/MODIFIED/DEVELOPED CODE OF TASK 1/A

```
/*
 * DA5_TASK1.c
 *
 * Created: 5/1/2020 11:28:34 PM
 * Author : Meral
 */
#define F_CPU 16000000UL
#define BAUD 9600
#include <avr/io.h>
#include <stdio.h>
#include <stdlib.h>
#include <avr/interrupt.h>
#include <util/setbaud.h>
#include <util/delay.h>

#define LATCH 4 /* PD4-RCK */
#define CLOCK 7 /* PD7-SRCK */
#define DATA 0  /* PB0-SER IN */
#define LSBFIRST 0
#define MSBFIRST 1

volatile uint8_t counter = 0; //global variable
volatile int adc_cel;   //global variable FOR C

/* Segment byte maps for numbers 0 to 9 */
const uint8_t SEGMENT_MAP[] = {0xC0, 0xF9, 0xA4, 0xB0, 0x99,
                                                        0x92, 0x82, 0xF8, 0X80, 0X90};
/* Byte maps to select digit 1 to 4 */
const uint8_t SEGMENT_SELECT[] = {0xF1, 0xF2, 0xF4, 0xF8};
void shift_out_init(void) {
       DDRB |= (1 << DATA);
       DDRD |= (1 << CLOCK) | (1 << LATCH);
}
void uart_init(void) {
       UBRR0H = UBRRH_VALUE;
       UBRR0L = UBRRL_VALUE;

       #if USE_2X
       UCSR0A |= _BV(U2X0);
       #else
       UCSR0A &= ~(_BV(U2X0));
       #endif

       UCSR0C = _BV(UCSZ01) | _BV(UCSZ00); /* 8-bit data */
       UCSR0B = _BV(RXEN0) | _BV(TXEN0);   /* Enable RX and TX */
}

int uart_putchar(char c, FILE *stream) {
       if (c == '\n') {
              uart_putchar('\r', stream);
       }
       loop_until_bit_is_set(UCSR0A, UDRE0);
       UDR0 = c;
       return 0;
}

int uart_getchar(FILE *stream) {
       loop_until_bit_is_set(UCSR0A, RXC0);
       return UDR0;
}
```

```
FILE uart_output = FDEV_SETUP_STREAM(uart_putchar, NULL, _FDEV_SETUP_WRITE);
FILE uart_input = FDEV_SETUP_STREAM(NULL, uart_getchar, _FDEV_SETUP_READ);

void shift_out(uint8_t indata) {
	for (uint8_t i = 0; i < 8; i++) {
		/* Write bit to data port. */
		if (0 == (indata & _BV(7 - i))) {
			// digital_write(SHIFT_OUT_DATA, LOW);
			PORTB &= (0 << DATA);
			} else {
			// digital_write(SHIFT_OUT_DATA, HIGH);
			PORTB |= (1 << DATA);
		}

		/* Pulse clock to write next bit. */
		PORTD |= (1 << CLOCK);
		PORTD &= (0 << CLOCK);
	}
}

void shiftOut(uint8_t dataPin, uint8_t clockPin, uint8_t bitOrder,
uint8_t val) {
	uint8_t i;

	for (i = 0; i < 8; i++) {
		if (bitOrder == LSBFIRST)
		dataPin |= !!(val & (1 << i));
		else
		dataPin |= !!(val & (1 << (7 - i)));

		PORTD |= (1 << CLOCK);
		PORTD &= (0 << CLOCK);
	}
}

void shift_out_latch(void) {
	PORTD &= (0 << LATCH);
	PORTD |= (1 << LATCH);
}

void USART_init(void){
	UBRR0H = UBRRH_VALUE;
	UBRR0L = UBRRL_VALUE;
	UCSR0C = _BV(UCSZ01) | _BV(UCSZ00); //8-bit data
	UCSR0B = _BV(RXEN0) | _BV(TXEN0);   //Enable RX and TX
}

//Send data to the serial port
void USART_tx_string( char *data ){
	while ((*data != '\0')){ //while the register is empty enter date
		while (!(UCSR0A & (1 <<UDRE0)));
			UDR0 = *data;
			data++; //increment data location forward
	}
}

ISR(TIMER0_OVF_vect){
	counter++;           //increment counter
}
```

```
// Initialize ADC
void adc_init(void) {
	/**Setup and enable ADC**/
	ADMUX =  (0<<REFS1) | //Reference selection bits
	(1<<REFS0) | //AVcc - external cap at AREF (5)V
	(0<<ADLAR) | //ADC right adjust result
	(1<<MUX2)  | //Analog channel selection bits
	(0<<MUX1)  | //ADC4 (PC4 PIN27)
	(0<<MUX0);

	ADCSRA = (1<<ADEN)  | //ADC enable
	(0<<ADSC)  | //ADC start conversion
	(0<<ADATE) | //ADC auto trigger enable
	(0<<ADIF)  | //ADC interrupt flag
	(0<<ADIE)  | //ADC interrupt enable
	(1<<ADPS2) | //ADC Prescaler select bits
	(1<<ADPS1) | //128 AS PRESCALAR SELECION BIT
	(1<<ADPS0);    //Select channel
}

void read_adc(void){
	unsigned char i = 10;
	adc_cel = 0;
	while(i--){
		ADCSRA |=(1<<ADSC);
		while(ADCSRA & (1<<ADSC));
		adc_cel += ADC;
	}
	adc_cel = (adc_cel/18);//convert fahrenheit to celcius
}

void display(){
	_delay_ms(300);
	read_adc();

	int digit1 = adc_cel/10; //to display the seven segment position 1-4
	int digit2 = adc_cel%10; //to display the number 0-9

		switch(digit1){
			//dipaly 1-4 for 300ms
			case 1:
					//diplpay 1
					PORTD &= (0 << LATCH);
					shift_out(SEGMENT_MAP[1]); //0xF9
					shift_out(SEGMENT_SELECT[0]);     //0xF1
					PORTD |= (1 << LATCH);
					break;
			case 2:
					//display 2
					PORTD &= (0 << LATCH);
					shift_out(SEGMENT_MAP[2]);  // 0xA4
					shift_out(SEGMENT_SELECT[0]);     //0xF1
					PORTD |= (1 << LATCH);
					break;
			case 3:
					//display 3
					PORTD &= (0 << LATCH);
					shift_out(SEGMENT_MAP[3]); //0xB0
					shift_out(SEGMENT_SELECT[0]);     //0xF1
					PORTD |= (1 << LATCH);
					break;
```

```
case 4:
       //display 4
       PORTD &= (0 << LATCH);
       shift_out(SEGMENT_MAP[4]);   //0x99
       shift_out(SEGMENT_SELECT[0]);//0xF1
       PORTD |= (1 << LATCH);
       break;
              }
              _delay_ms(200);

                     switch(digit2){
                            //display 0-9 for 200 ms
                            case 0:
                                   //display 0
                                   PORTD &= (0 << LATCH);
                                   shift_out(SEGMENT_MAP[0]);          //0xc0
                                   shift_out(SEGMENT_SELECT[1]);//0xF2
                                   PORTD |= (1 << LATCH);
                                   break;
                            case 1:
                                   //display 1
                                   PORTD &= (0 << LATCH);
                                   shift_out(SEGMENT_MAP[1]);          //0xF9
                                   shift_out(SEGMENT_SELECT[1]);//0xF2
                                   PORTD |= (1 << LATCH);
                                   break;
                            case 2:
                                   //display 2
                                   PORTD &= (0 << LATCH);
                                   shift_out(SEGMENT_MAP[2]);          //0xF9
                                   shift_out(SEGMENT_SELECT[1]);//0xF2
                                   PORTD |= (1 << LATCH);
                                   break;
                            case 3:
                                   //display 3
                                   PORTD &= (0 << LATCH);
                                   shift_out(SEGMENT_MAP[3]);          //0xB0
                                   shift_out(SEGMENT_SELECT[1]);//0xF2
                                   PORTD |= (1 << LATCH);
                                   break;
                            case 4:
                                   //display 4
                                   PORTD &= (0 << LATCH);
                                   shift_out(SEGMENT_MAP[4]);          //0x99
                                   shift_out(SEGMENT_SELECT[1]);//0xF2
                                   PORTD |= (1 << LATCH);
                                   break;
                            case 5:
                                   //display 5
                                   PORTD &= (0 << LATCH);
                                   shift_out(SEGMENT_MAP[5]);          //0x92
                                   shift_out(SEGMENT_SELECT[1]);//0xF2
                                   PORTD |= (1 << LATCH);
                                   break;
                            case 6:
                                   //display 6
                                   PORTD &= (0 << LATCH);
                                   shift_out(SEGMENT_MAP[6]);          //0x82
                                   shift_out(SEGMENT_SELECT[1]);//0xF2
                                   PORTD |= (1 << LATCH);
                                   break;
                            case 7:
                                   //display 7
                                   PORTD &= (0 << LATCH);
                                   shift_out(SEGMENT_MAP[7]);          //0xF8
                                   shift_out(SEGMENT_SELECT[1]);//0xF2
                                   PORTD |= (1 << LATCH);
                                   break;
```

```
                        case 8:
                                //display 8
                                PORTD &= (0 << LATCH);
                                shift_out(SEGMENT_MAP[8]);        //0x80
                                shift_out(SEGMENT_SELECT[1]);     //0xF2
                                PORTD |= (1 << LATCH);
                                break;
                        case 9:
                                //display 9
                                PORTD &= (0 << LATCH);
                                shift_out(SEGMENT_MAP[9]);        //0x90
                                shift_out(SEGMENT_SELECT[1]);     //0xF2
                                PORTD |= (1 << LATCH);
                                break;
                }
}

int main(){
        USART_init(); //call function to initialize
        TCCR0A = 0x00;       //normal mode timer
        TCCR0B = 0x05;       //set pre-scaler = 1024
        TCNT0 = 0;           //counter = 0
        TIMSK0 = (1<<TOIE0); //enable interrupt
        sei(); //enable global
        adc_init();//initialize adc
        shift_out_init();
        char celcius[20];

        while (1){
                //call the display function to output on temperture of the senser
                display();

                USART_tx_string("Celcius degree: ");     //print string
                USART_tx_string(celcius); //print the temperture
                snprintf(celcius,sizeof(celcius),"%u\r\n",adc_cel); //print formatted output
        }
        return 0;
}
```

Task 2

```
/*
 * DA5_TASK2.c
 *
 * Created: 5/5/2020 9:02:20 PM
 * Author : Meral
 */
#define F_CPU 16000000UL
#define BAUD 9600
#include <avr/io.h>
#include <stdio.h>
#include <stdlib.h>
#include <avr/interrupt.h>
#include <util/setbaud.h>
#include <util/delay.h>

/* Segment byte maps for numbers 0 to 9 */
const uint8_t SEGMENT_MAP[] = {0x03, 0x9F, 0x25, 0x0D, 0x99,
                                                0x49, 0x41, 0x1F, 0x01, 0x09};
/* Byte maps to select digit 1 to 4 */
const uint8_t SEGMENT_SELECT[] = {0xF1, 0xF2, 0xF4, 0xF8};

//variables to use for calculations
volatile uint8_t data;       //to send data
volatile uint8_t adc_value;  //to read the analoge value
volatile uint8_t adc_cel;    //to save the temperture value

void USART_init(void){
       UBRR0H = UBRRH_VALUE;
       UBRR0L = UBRRL_VALUE;
       UCSR0C = _BV(UCSZ01) | _BV(UCSZ00); //8-bit data
       UCSR0B = _BV(RXEN0) | _BV(TXEN0);   //Enable RX and TX
}
//Send data to the serial port
void USART_tx_string(char *data ){
       while ((*data != '\0')){ //while the register is empty enter date
              while (!(UCSR0A & (1 <<UDRE0)));
                     UDR0 = *data;
                     data++; //increment data location forward
       }
}
void enableADC(){
       ADMUX |= (1<<REFS0)|(1<<MUX2);      //AREF ,analog channel bit selection

       ADCSRA |= (1<<ADEN)|(1<<ADPS2)|(1<<ADPS1); //Enable ADC
}
uint8_t Read_ADC() {
       DDRC &= ~(1<<4);                        //PINC4 set as input
       enableADC();                            //enable adc
       ADCSRA |= (1<<ADSC);                //adc conversion
       while (!(ADCSRA&(1<<4)));           //Wait
       ADCSRA |= (1<<4);                       //clear ADIF
       return ADC;                                    //returns adc value
}

void SPIinitialize() {
       DDRD |= (1<<PIND4);                     //sets latch clock pin as output
       DDRB |= (1<<PINB3);                     //sets MOSI pin as output
       DDRB |= (1<<PINB5);
       PORTD &= ~(1<<PIND4);               //sets clock output to zero
       SPCR0 = (1<< MSTR)| 0xFF;           //enable SPI mode as master
}
```

```
void SPIwrite(data){
	SPDR0 = data;                              // Sends data
	while (!(SPSR0&(1<<SPIF)));        // Waits until data is sent
	SPSR0 |= (1<<SPIF);                        //clears flag
}

void CSC(){
	PORTD |= (1<<PIND4); //high
	_delay_ms(20);                      //delay for 20ms
	PORTD &= ~(1<<PIND4);       //low
}

void SendDigits(uint8_t digits[]) {

	for (uint8_t i = 0; i < 4; i++) {
		SPIwrite(SEGMENT_MAP[digits[i]]);  //send seven-segment value
		SPIwrite(1<<(4+i));                                //send value to seven-segment
		CSC(); //Clear the clock, 20ms delay, set clock
	}
}

void SetDigits(uint16_t temp, uint8_t array[]) {
	for (uint8_t i = 0; i < 4; i++) {
		array[i] =((uint8_t)(temp/pow(10, i)))%10;
	}
}

int main(void) {
	uint8_t digits[4];   //array to stores the the 4 digits for display
	SPIinitialize();     //initialize SPI
	USART_init();
	char celcius[15];    //to hole the value of the temperture

	while (1) {
		adc_value = Read_ADC();     //setting the value read by sensor to adc_value
		adc_cel = adc_value-27;     //temp in celcius
		SetDigits(adc_cel, digits); //to output the degree on the seven-segment display
		SendDigits(digits);

		USART_tx_string("Celcius degree: ");      //print string
		USART_tx_string(celcius); //print the temperture
		snprintf(celcius,sizeof(celcius),"%u\r\n",adc_cel); //print formatted output
	}
}
```

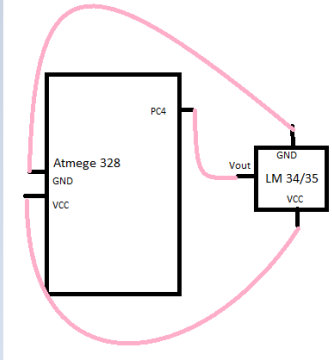
Task 3

```
/*
 * DA5_TASK3.c
 *
 * Created: 5/6/2020 1:08:53 AM
 * Author : Meral
 */
#define F_CPU 16000000UL
#include <stdlib.h>
#include <string.h>
#include <avr/interrupt.h>
#include <util/delay.h>
#include <avr/io.h>
#define PRESCALE (((F_CPU / (BAUDRATE * 16UL))) - 1)

void write(uint8_t value){
	//set low and high input/output
	PORTC &= ~ (1<<PC1);
	DDRC |= (1<<PC1);

	if(value)	//if 1 is passed go high
		DDRC &= ~(1<<PC1);
	else //if not 1 stay low
		DDRC |= (1<<PC1);

	//wait 60uS and release data
	_delay_us(50);
	DDRC &= ~(1<<PC1); //input
}
uint8_t ds18b20_readbit(void){
	uint8_t bit=0;
	//1us delay on low
	PORTC &= ~ (1<<PC1); //low
	DDRC |= (1<<PC1); //output
	_delay_us(1);

	//send data and wait for 14us
	DDRC &= ~(1<<PC1); //input
	_delay_us(14);

	//read the value
	if(PINC & (1<<PC1))
		bit=1;

	//wait for 45us and return bit value
	_delay_us(45);
	return bit;
}
void write_byte(uint8_t byte){
	uint8_t i=8;
	while(i--){
		write(byte&1);
		byte >>= 1;
	}
}
uint8_t ds18b20_readbyte(void){
	uint8_t i=8, n=0;
	while(i--){
		n >>= 1;
		n |= (ds18b20_readbit()<<7);
	}
	return n;
}
```

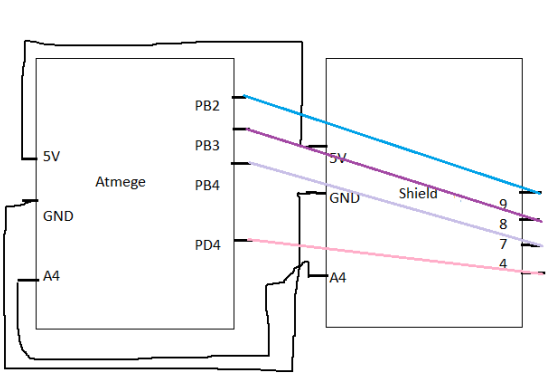
```
void USART_Init(unsigned long BAUDRATE)     {
       UCSR0B |= (1 << RXEN0) | (1 << TXEN0);      //enable USART transmitter and receiver
       UCSR0C |= (1 << UCSZ00) | (1 << UCSZ01);//write USCRC and 1 stop bit
       UBRR0L =  PRESCALE;                                                  //load UBRRL
       UBRR0H = (PRESCALE >> 8);                                      //load UBRRH
}

void USART_Tx(char data){
       UDR0 = data;                                  //Write data
       while (!(UCSR0A & (1<<UDRE0)));     //data transmit? buffer set to empty
}

void USART_SendString(char *str){
       int i=0;
       while (str[i]!=0){
              USART_Tx(str[i]);
              i++;
       }
}

double Read_temp(){
       PORTC &= ~ (1<<PC1); //low
       DDRC |= (1<<PC1); //output
       _delay_us(480);//low for 480us

       //release line and wait for 60uS
       DDRC &= ~(1<<PC1); //input
       _delay_us(500);

       write(0xCC); //skip next
       write(0x44); //convert the temp
       if(!ds18b20_readbit()); //while still converting stay here

       //reset
       PORTC &= ~ (1<<PC1);
       DDRC |= (1<<PC1);
       _delay_us(480);

       //input the data
       DDRC &= ~(1<<PC1); //input
       _delay_us(500);

       write_byte(0xCC); //skip next
       write_byte(0xBE); //read

       //read 2 byte
       uint8_t temp1 = ds18b20_readbyte();
       uint8_t temp2 = ds18b20_readbyte();

       //return the converted temp
       return (( temp2 << 8 ) + temp1) * 0.0625;
}

void display(){
       char celcius[50];
       dtostrf(Read_temp(), 3, 0, celcius);
       USART_SendString("Celcius degree: ");
       USART_SendString(celcius);
       USART_SendString("\n\n");
       _delay_ms(500);
}
int main(void) {
       USART_Init(9600);
              while (1){
                     display();
              }
       return 0;
}
```

3. SCHEMATICS

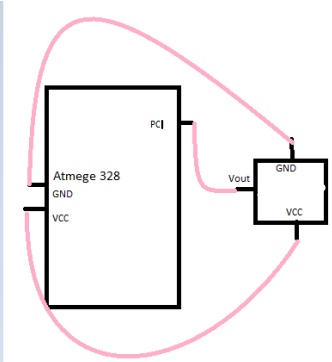
Task 1



task 2



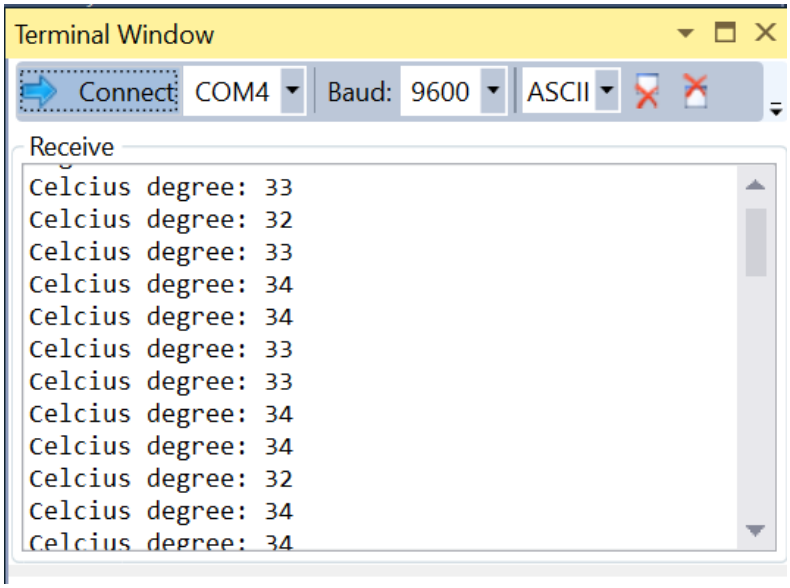
Task 3



DS18B20

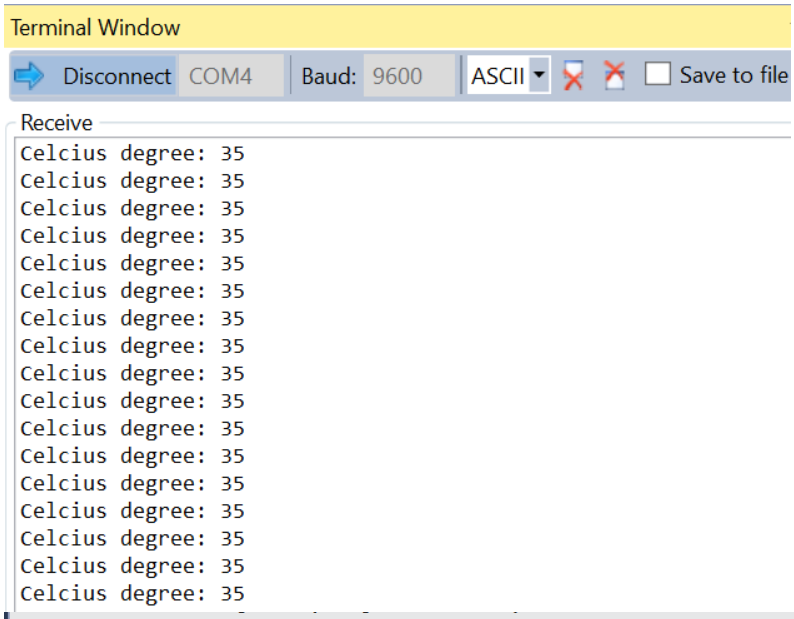
4. SCREENSHOTS OF EACH TASK OUTPUT (ATMEL STUDIO OUTPUT)

Task 1



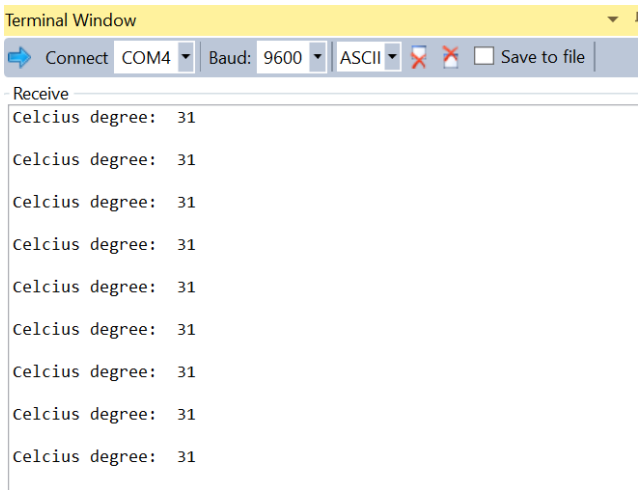
```
    Done executing task "RunOutputFileVerifyTask".
Done building target "CoreBuild" in project "DA5_TASK1.cproj".
Target "PostBuildEvent" skipped, due to false condition; ('$(PostBuildEvent)' != '') was evalua
Target "Build" in file "C:\Program Files (x86)\Atmel\Studio\7.0\Vs\Avr.common.targets" from pro
Done building target "Build" in project "DA5_TASK1.cproj".
Done building project "DA5_TASK1.cproj".

Build succeeded.
========== Build: 1 succeeded or up-to-date, 0 failed, 0 skipped ==========
```

Task 2




```
    Done executing task "RunOutputFileVerifyTask".
Done building target "CoreBuild" in project "DA5_TASK2.cproj".
Target "PostBuildEvent" skipped, due to false condition; ('$(PostBuildEvent)' != '') was evaluated as ('' != '').
Target "Build" in file "C:\Program Files (x86)\Atmel\Studio\7.0\Vs\Avr.common.targets" from project "C:\Users\Meral\Do
Done building target "Build" in project "DA5_TASK2.cproj".
Done building project "DA5_TASK2.cproj".

Build succeeded.
========== Build: 1 succeeded or up-to-date, 0 failed, 0 skipped ==========
```

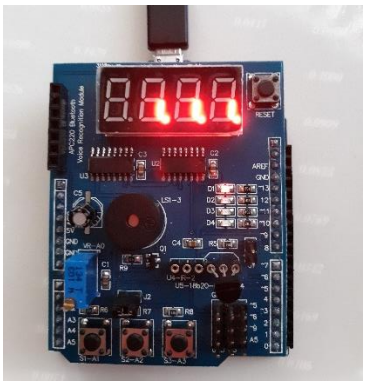
Task 3



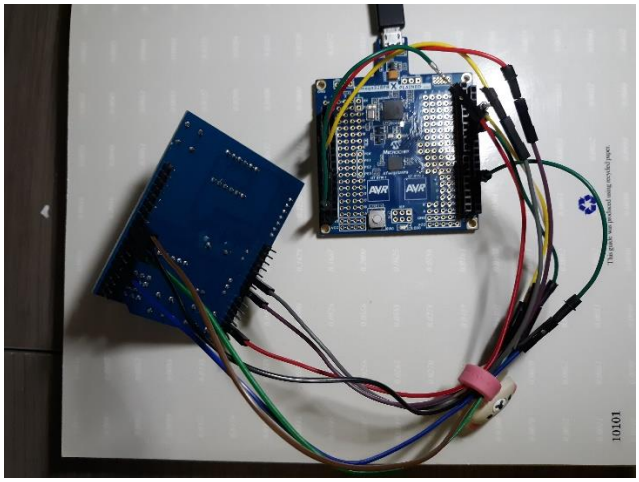
```
    Done executing task "RunOutputFileVerifyTask".
Done building target "CoreBuild" in project "DA5_TASK3.cproj".
Target "PostBuildEvent" skipped, due to false condition; ('$(PostBuildEvent)' != '') was evaluated as ('' != '').
Target "Build" in file "C:\Program Files (x86)\Atmel\Studio\7.0\Vs\Avr.common.targets" from project "C:\Users\Meral\Docum
Done building target "Build" in project "DA5_TASK3.cproj".
Done building project "DA5_TASK3.cproj".

Build succeeded.
========== Build: 1 succeeded or up-to-date, 0 failed, 0 skipped ==========
```

5. SCREENSHOT OF EACH DEMO (BOARD SETUP)

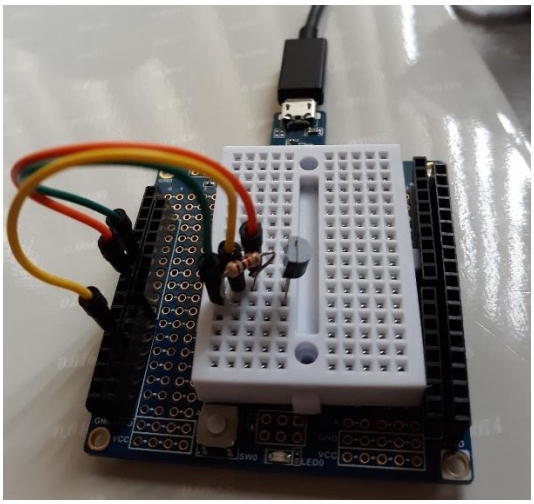
Task 1



Task 2



Task 3



6. **VIDEO LINKS OF EACH DEMO**
   Task 1
   https://www.youtube.com/watch?v=LOpEfzyZpzU
   task 2
   https://www.youtube.com/watch?v=QG6HupvmTyA
   task 3
   https://www.youtube.com/watch?v=AU19JpWueyE
7. **GITHUB LINK OF THIS DA**
   https://github.com/MeralAbuJaser/Submission_da/tree/master/DA5

"*This assignment submission is my own, original work*".
Meral Abu-Jaser