John Danison

ECET 32900 – Lab 3 Report

2/9/2025

Lab Goal:

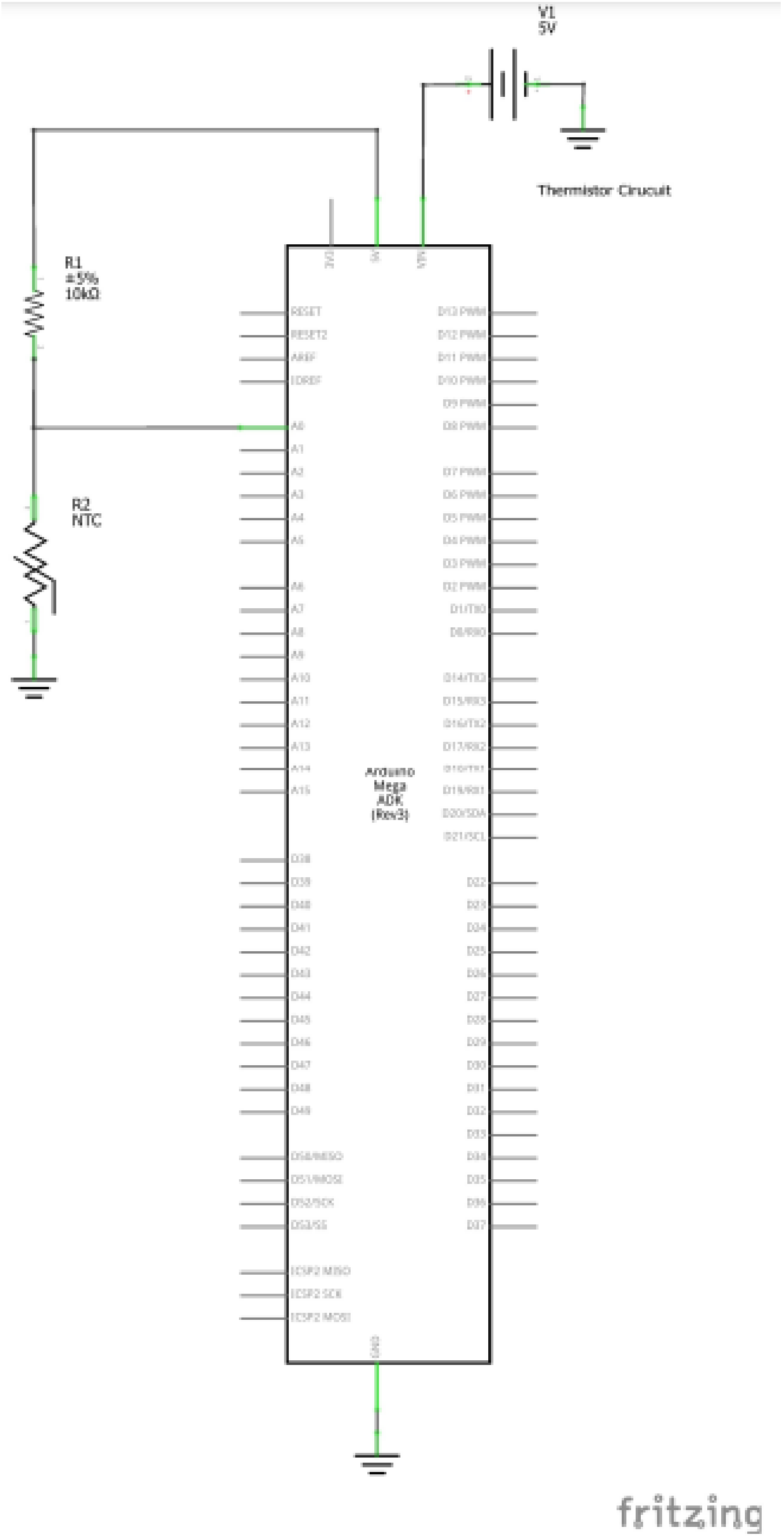
The goal of this lab was to program an ATMEGA 2560 for temperature measurement using a thermistor and a calibration process.

Procedure:

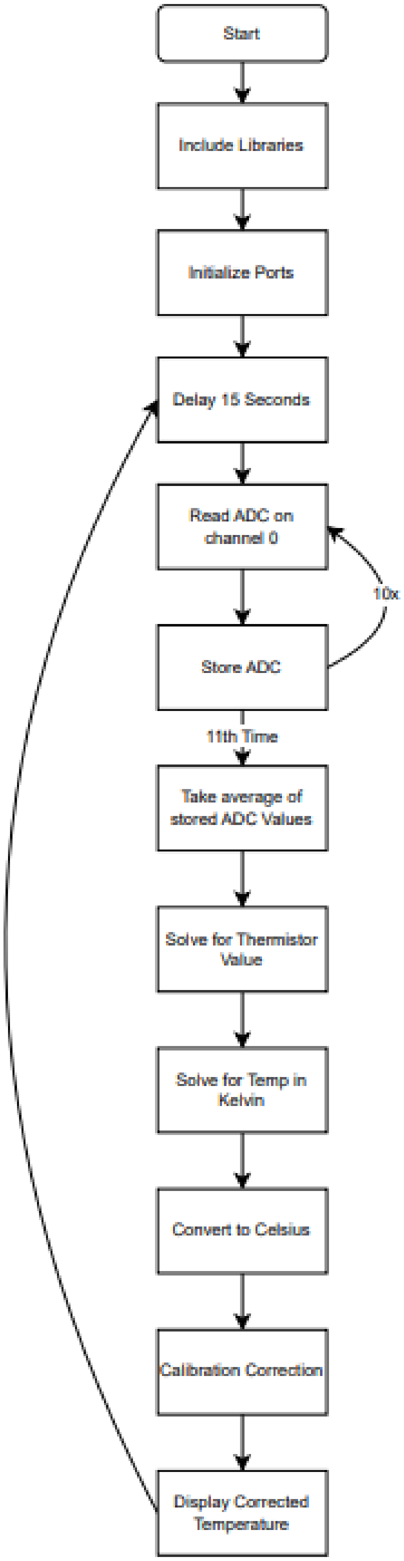
The procedure for this lab was very straightforward. I started with reviewing lab instructions and getting specifications answered by the Lab TA. Afterwards, the hardware for recreation was selected using an ATMega 2560 microcontroller, a 10kΩ resistor, and a NTC thermistor model 3950 from Adafruit. With components selected, a schematic was drawn to connect each of these items. Once completed, a flowchart was created in preparation for programming the microcontroller. Then the program was created, and a functional prototype was created. After testing, the system was checked off by Professor Panigraphi.

Lab Results:
The results of the lab are presented on the next page.

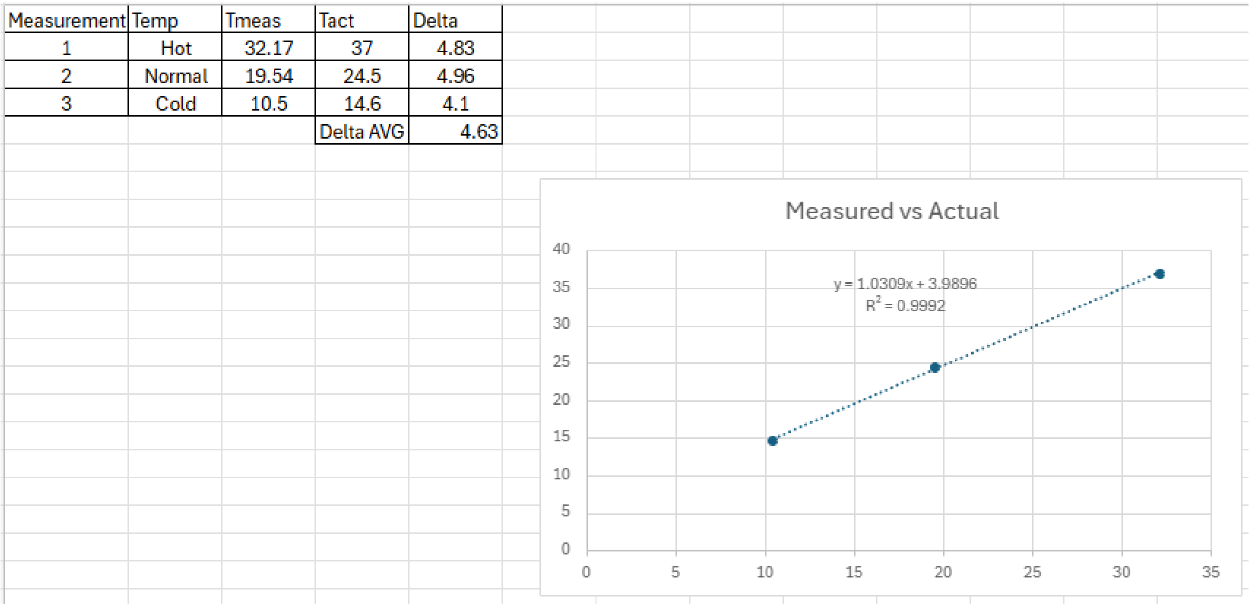
Below is the schematic for the system.



Below is the Flow Chart for the system.

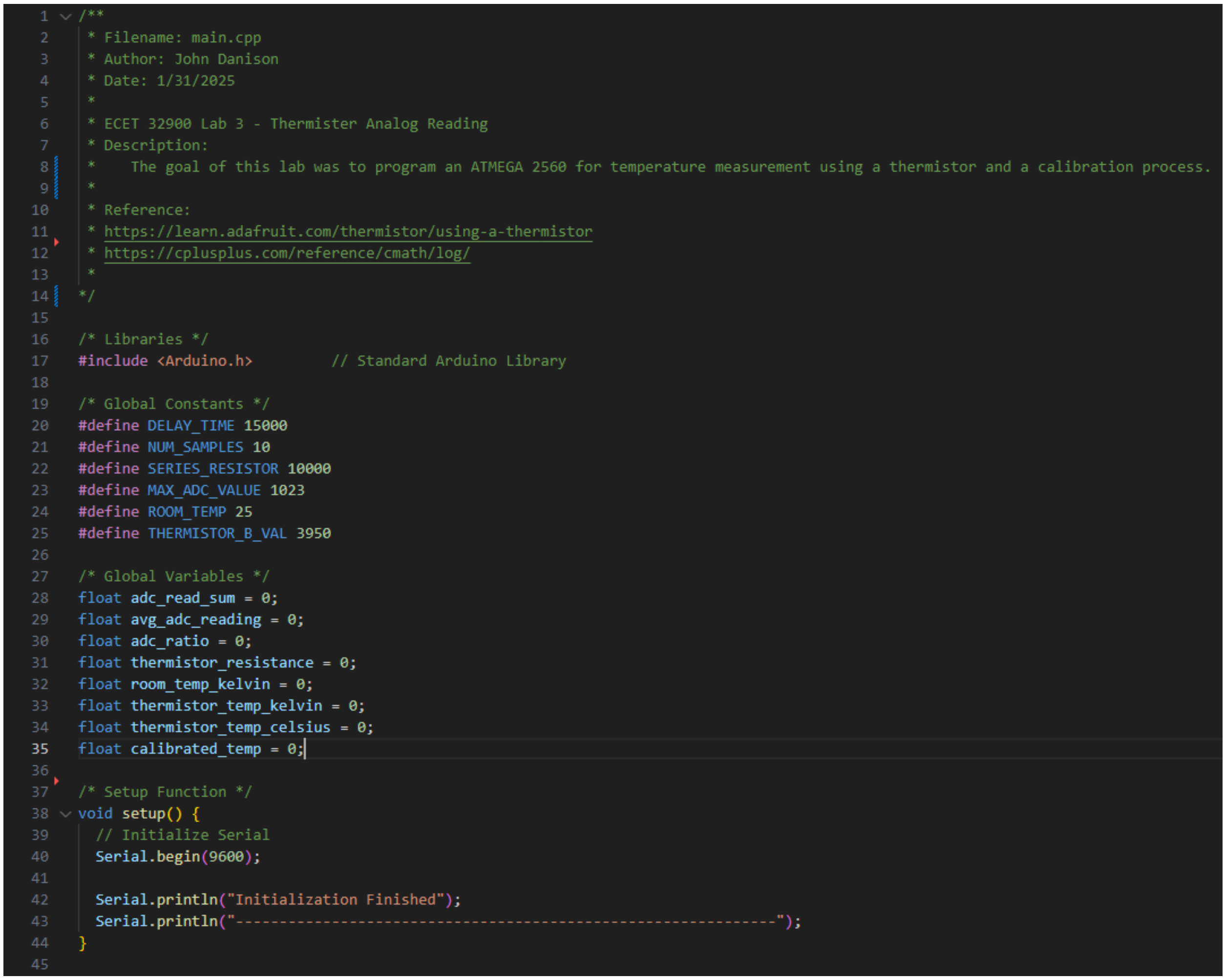


Below is the calibration chart and calibration equation.

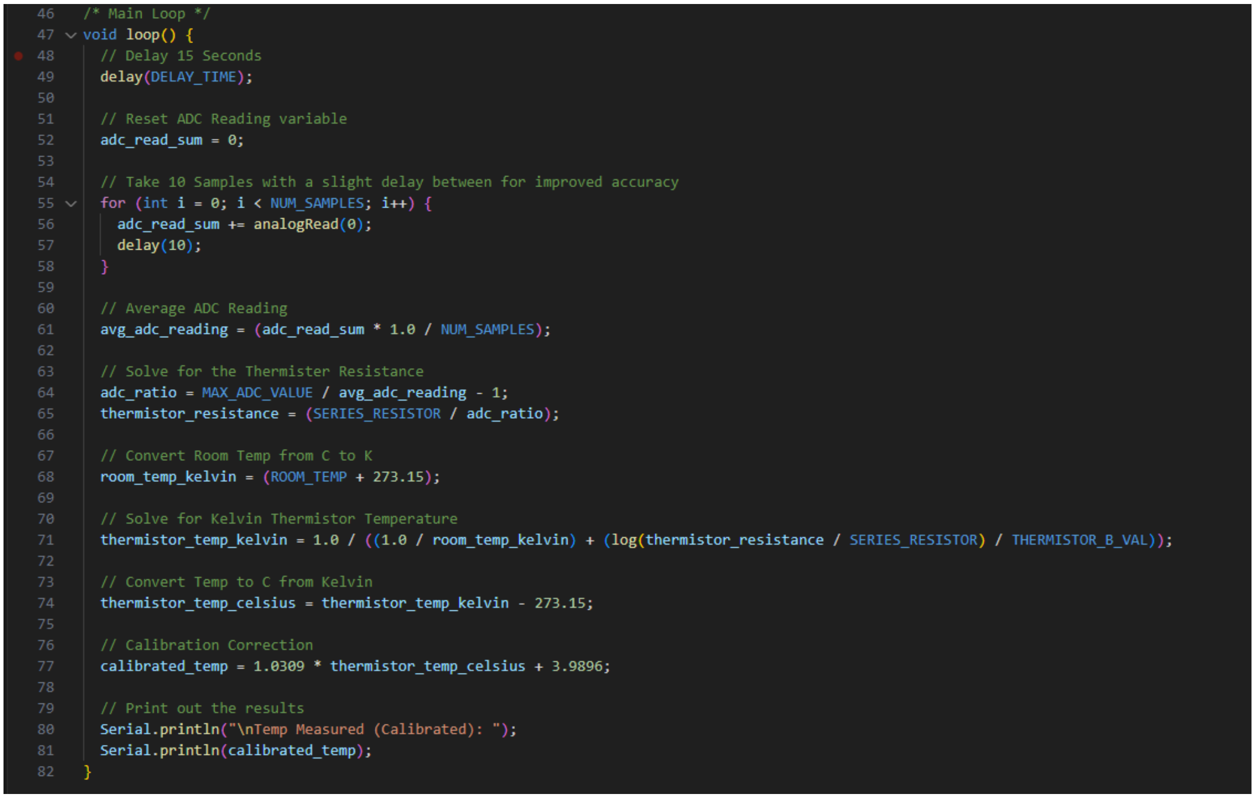


Measurement	Temp	Tmeas	Tact	Delta
1	Hot	32.17	37	4.83
2	Normal	19.54	24.5	4.96
3	Cold	10.5	14.6	4.1
			Delta AVG	4.63

Below is the source code used for the system.



```
/**
 * Filename: main.cpp
 * Author: John Danison
 * Date: 1/31/2025
 *
 * ECET 32900 Lab 3 - Thermister Analog Reading
 * Description:
 *    The goal of this lab was to program an ATMEGA 2560 for temperature measurement using a thermistor and a calibration process.
 *
 * Reference:
 * https://learn.adafruit.com/thermistor/using-a-thermistor
 * https://cplusplus.com/reference/cmath/log/
 *
*/

/* Libraries */
#include <Arduino.h>         // Standard Arduino Library

/* Global Constants */
#define DELAY_TIME 15000
#define NUM_SAMPLES 10
#define SERIES_RESISTOR 10000
#define MAX_ADC_VALUE 1023
#define ROOM_TEMP 25
#define THERMISTOR_B_VAL 3950

/* Global Variables */
float adc_read_sum = 0;
float avg_adc_reading = 0;
float adc_ratio = 0;
float thermistor_resistance = 0;
float room_temp_kelvin = 0;
float thermistor_temp_kelvin = 0;
float thermistor_temp_celsius = 0;
float calibrated_temp = 0;

/* Setup Function */
void setup() {
  // Initialize Serial
  Serial.begin(9600);

  Serial.println("Initialization Finished");
  Serial.println("--------------------------------------------------------------");
}

```



```
/* Main Loop */
void loop() {
  // Delay 15 Seconds
  delay(DELAY_TIME);

  // Reset ADC Reading variable
  adc_read_sum = 0;

  // Take 10 Samples with a slight delay between for improved accuracy
  for (int i = 0; i < NUM_SAMPLES; i++) {
    adc_read_sum += analogRead(0);
    delay(10);
  }

  // Average ADC Reading
  avg_adc_reading = (adc_read_sum * 1.0 / NUM_SAMPLES);

  // Solve for the Thermister Resistance
  adc_ratio = MAX_ADC_VALUE / avg_adc_reading - 1;
  thermistor_resistance = (SERIES_RESISTOR / adc_ratio);

  // Convert Room Temp from C to K
  room_temp_kelvin = (ROOM_TEMP + 273.15);

  // Solve for Kelvin Thermistor Temperature
  thermistor_temp_kelvin = 1.0 / ((1.0 / room_temp_kelvin) + (log(thermistor_resistance / SERIES_RESISTOR) / THERMISTOR_B_VAL));

  // Convert Temp to C from Kelvin
  thermistor_temp_celsius = thermistor_temp_kelvin - 273.15;

  // Calibration Correction
  calibrated_temp = 1.0309 * thermistor_temp_celsius + 3.9896;

  // Print out the results
  Serial.println("\nTemp Measured (Calibrated): ");
  Serial.println(calibrated_temp);
}
```

The system works by waiting 15 seconds for the thermistor to adjust to the temperature of the environment. After waiting 15 seconds, 10 ADC measurements were taken and averaged to gain the most accurate measurement. With that most accurate reading, math was done to convert this ADC value to be the temperature measured in Celsius. This normal reading was slightly incorrect when compared to a regular thermometer, so a correction curve equation was calculated and implemented. After this value was corrected, it was displayed to the terminal.

Conclusion:

This lab was useful for learning the process behind designing embedded systems while reviewing fundamentals taught in previous courses. I learned how to use a thermistor and learned the process behind how this thermistor measures the temperature. I also learned an effective process for calculating a calibration for a sensor.

References

Adafruit Industries. (n.d.). *Using a thermistor*. Adafruit Learning System. Retrieved February 9, 2025, from https://learn.adafruit.com/thermistor/using-a-thermistor

cplusplus.com. (n.d.). *log - C++ reference*. Retrieved February 9, 2025, from https://cplusplus.com/reference/cmath/log/

Cox, J., Leathers, J., & [John Danison]. (2025, February 9). Discussion on thermistor applications and logarithmic functions [Personal communication].

ECET 32900. (2025). *Course materials for ECET 32900*. Purdue University