

LEVEL 4 ASSESSMENT SPECIFICATION

Student name:	Parry Phillips	Student ID number:	
Programme:	HNC Electrical/Electronic Engineering & Instrumentation Engineering		
Module:	Embedded Systems		
Module code:	PCEE4004	Contribution to Overall Module Assessment (%):	100%
Lecturer:	Sarah Williams	Internal Verifier:	Jason Pointer
Assignment Title:	Office Environment Monitor	Word count (or equivalent):	2000 words
Submission deadline:	12 th May 2023	Return date of provisional marks & written feedback:	10 th June 2023
Submission method:	All written assessments, where practical and possible, must be submitted via Turnitin unless otherwise instructed by the Lecturer. (Please DO NOT put this assessment specification into Turnitin or it will match many similarities with other students' submissions.) Alternative submission method (if applicable): Late submission of the assessment will result in a late penalty mark. Penalties for late submission: Up to one week late, maximum mark of 40%. Over one week late, 0%. Only the Extenuating Circumstances Panel may approve a change to submission dates.		
Academic honesty / referencing:	Academic honesty is required. In the main body of your submission you must give credit to authors on whose research and ideas your work is based. Append to your submission a reference list that indicates the books, articles, etc. that you have used, cited or quoted in order to complete this assessment.		

Module Learning Outcomes (from module syllabus)

1. Demonstrate a good understanding of the fundamental principles of programming an embedded system.
2. Describe the basic elements of typical embedded hardware and apply that knowledge in the analysis of a number of simple system applications.

STUDENT FEEDBACK FORM

This section details the *extent* to which the assessment criteria are demonstrated by you, which in turn determines your mark. The marks available for each category of skill are shown. Lecturers will use the space provided to comment on the achievement of the task(s), including those areas in which you have performed well and areas that would benefit from development/improvement.

Generic Assessment Criteria	Marks available	Marks awarded
1. Engagement with Literature Skills		
	0	
2. Knowledge and Understanding Skills		
Hardware Gaps in knowledge of the basic underlying concepts and principles. You have justified your choice of components but not really considered other types such as an audible output or an LCD display. Further marks would have been awarded for a circuit schematic demonstrating your understanding of the components you are using and how they connect to the microcontroller. 5/15 Software Gaps in knowledge of the basic underlying concepts and principles. Whilst logically the flowchart is correct, your use of symbols is incorrect. The decision box (diamond) is only used for questions, where the code branches. It is correctly used initially where the reading is taken and the code needs to branch- but subsequently you use it where a process box or output box would be more appropriate. The program is very simple, and will only report if the temperature is outside the range and not if it is too hot or too cold. 5.5/15	30	10.5
3. Cognitive and Intellectual Skills		
Discussion, Evaluation and Conclusion Good evaluation of the underlying concepts and principles. Mostly valid arguments and logical judgements. Consideration of the usefulness of C with embedded systems is good and well referenced. Discussion regarding the improvements that can be made to the system is good, including the idea of a WIFI module to send alerts to a phone. 9/15	15	9
4. Practical Application Skills		
A reasonable awareness and mostly appropriate application of basic methods Program is functional and meets the most basic requirement of the assignment. Constants have been defined for the pins which is good practice. Try to use more meaningful names for your variables. Indentation on the whole is fine, but put your else statement on a new line to aid readability. Code is fully commented, but very basic. Whilst it does follow the flowchart- it does not indicate if the temperate is too hot or too cold, only that it is out of acceptable range. It is good practice to include a statement for detecting if the DHT11 is malfunctioning. It is understandable that the serial monitor will be used for testing purposes, but it is unlikely you would be using it on a day-to-day basis as you would need the system connected to the PC and running the Arduino IDE. As such, this code should be commented out. 19.5/40	50	22.5

Testing Rudimentary application of basic testing technique applied. Testing is not structured- values above and below the acceptable range should be tested and in particular those on the boundary where the temperature changed from being acceptable to unacceptable and vice – versa 3/10		
5. Transferable Skills for Life and Professional Practice		
Mostly ordered presentation and structure in which relevant ideas / concepts are reasonably expressed. Data sheets are missing. There is no discussion or justification as to why the temperature range used was selected. Introduction did not read very fluidly. Report is well structured, although images should be clearly labelled. 2/5	5	2

Assessment Mark (Assessment marks are subject to ratification at the Exam Board. These comments and marks are to give feedback on module work and are for guidance only until they are confirmed.)	Late Submission Penalties (tick if appropriate)		44%
	Up to 1 week late (40% Max)		
	Over 1 week late (0%)		

Embedded Systems



Module: Embedded Systems

Assignment: Office Environment Monitoring Device

Lecturer: Sarah Williams

Author: Parry Phillips

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Introduction

The purpose of this assignment is to evaluate the working temperature of an office environment using standardised sources to detail the design and development of microcontroller-based system that monitors room temperature and provides feedback to the employees when the temperature is outside of the programmed range. The system will use various components such as a temperature sensor, LCD, LEDs to enhance the performance of the system to contribute to the digital evolution by maintaining optimal room temperatures. A key factor in enhancing productivity, conserving energy, and ensuring comfort.

The assignment will delve into the hardware design of the system explaining the purpose of each individual component and why it was needed to achieve the working design. The software design will be included and will be explained with flowchart diagrams so that the process can be understood by the user. The software design will then be converted into code that the Arduino software can interpret and translate the code into working thermostat with feedback. The code will be commented on and will explain the outcome of that code. Testing of the code will take place and will include photos of the system in practice. Finally, once the system is enforced and evaluation on the system will be carried out to comment on the development of the system and what worked and what could be improved upon.

Task 1 – Hardware Design [15 marks]

Design a microcontroller-based system. Explain the function and purpose of each of the components in the system, justifying why you chose them and what other components you considered. Add the necessary datasheets to the back of the report as an appendix and refer to them in your text.

Arduino Board:

The Arduino board will serve as the microcontroller in our room temperature monitoring system. As a microcontroller, the Arduino board's main role is to process inputs from sensors, execute the program stored in its memory, and control output devices based on this program. One of the reasons the Arduino board was chosen was due to its simplicity and accessibility. Arduino boards are user-friendly and easy to program, which makes them suitable for a wide range of users, from beginners to advanced developers. Another reason is that Arduino is an open-source software meaning it can be modified and shared allowing for flexibility and customization tailoring the system to our specific requirements. Another advantage is the community of Arduino users who offer support and supply resources available online. This can be extremely helpful when troubleshooting. Finally compared to other microcontrollers, Arduino boards are affordable. (Arduino.cc, 2023)

Breadboard:

The breadboard serves as an essential component in our room temperature monitoring system. It is a device used for constructing an electronic circuit without needing any soldering. Breadboards have multiple rows and columns of holes into which circuit components can be inserted. The specific reasons for choosing a breadboard for our system include the ease of use. Breadboards are user-friendly. They allow for quick and easy changes to the circuit layout, ideal for testing and modifying our design throughout the development process. Another benefit of using a breadboard is the reusability. Components inserted into a breadboard are not permanently fixed and can be removed and reused in other projects. This makes breadboards a cost-effective choice for development. Unlike some circuit boards where soldering is required. However, the final version of the room temperature monitoring system, the circuit initially designed and tested on the breadboard may be transferred to a more permanent solution such as a printed circuit board (PCB). This

transition might be preferred for a more durable, compact, and professional-looking product. (WatElectronics, 2021)

Jumper Wires:

Jumper wires are used in our room temperature monitoring system as they provide the necessary connections between the components. They act as the connection that allow signals and power to travel between different parts of the circuit. A benefit of using jumper wires is their flexibility and easy to insert, remove, and replace. They make it simple to change the configuration of a circuit quickly and efficiently, which is useful during the development and testing stages. (Hemmings, 2018)

LED lights:

Our room temperature monitoring system relies on LEDs, or Light Emitting Diodes as the visual indication of the temperature status. Our system uses two LEDs, one green and one red. The green LED illuminates within the acceptable temperature range (16-24 degrees Celsius), while the red LED lights up outside of this range. I chose LEDs due to their instant feedback, low power consumption, long lifespan, ease of use, and high visibility. (Berkeys Air Conditioning, Plumbing & Electrical, 2016)

DHT11:

The DHT11 is the digital temperature and humidity sensor used in this system. It provides the data needed to determine whether the room temperature is within the coded parameters. The primary functions of the DHT11 in this system is to detect the temperature of the environment. The DHT11 is designed to monitor room temperature and alert the user if the temperature falls outside the specified range (16-24 degrees Celsius in this case) by illuminating an LED and displaying the feedback of the temperature to the serial window. While not used in this system, the DHT11 also has the capability to measure humidity which could be implanted into the code if needed.

The DHT11 was chosen for this system due to several reasons such as the simplicity and ease of use as the DHT11 is a digital sensor, which means it outputs a digital signal that can be easily read by the Arduino. It only requires one digital pin to read both temperature and humidity data. Another reason is the DHT11 is relatively

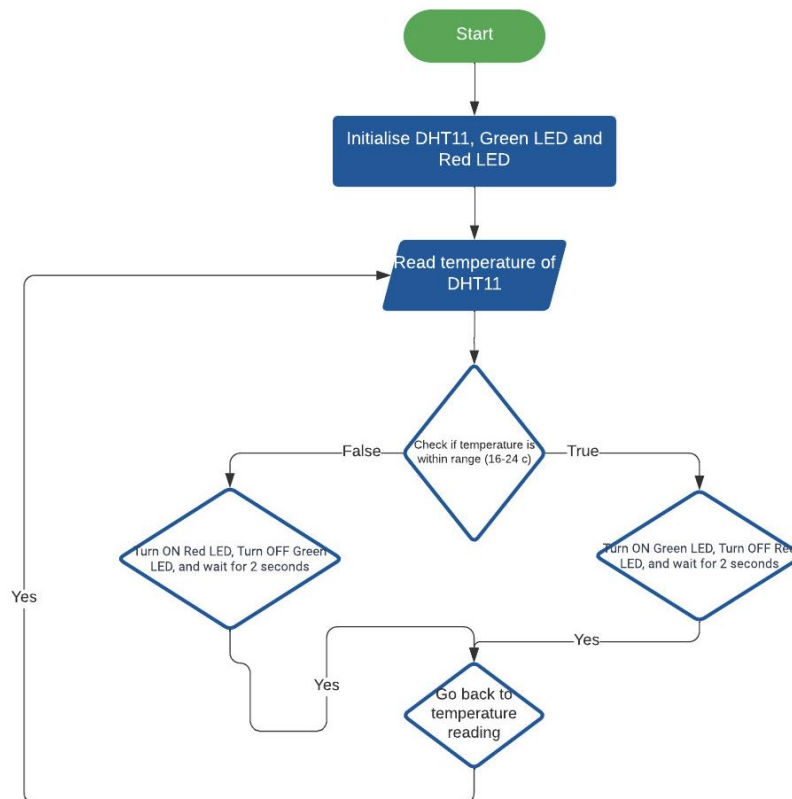
inexpensive and widely available, making it a suitable choice educational projects or simple environmental monitoring systems.

While not the most accurate temperature and humidity sensor on the market, the DHT11's accuracy is more than sufficient for a simple room temperature monitoring system like this one.

The DHT11 is easily installed on Arduino, with many libraries available like the "DHT.h" library used in this system that simplify the code needed to read the sensors output. While the DHT22 may offer higher accuracy and additional features, it is also more expensive and may be overkill for a simple system like this. The DHT11 offers a good balance of accuracy, ease of use, and cost for this application. (Techatronic, 2022)

Task 2 – Software Design [15 marks]

Design a C program to monitor the environment and report back if it is outside “comfortable working conditions”. Choose a range of acceptable values for the environment and embed these in your program. Use pseudo code and / or flowcharts to design your program.



Task 3 – Implementation [40 marks]

Marks will be awarded for functionality of your system, adherence to programming conventions, quality, and efficiency of code. Higher marks will be awarded for the use of your own defined functions in the program making it more readable.

Fully document your C program with comments explaining how it works and how it relates to your algorithm. Get a clear program printout, making sure each in-comment does not overflow onto the next line.

```
#include <DHT.h>

// Constants
#define DHTPIN 2      // Pin connected to the DHT sensor
#define DHTTYPE DHT11 // DHT11 sensor
#define GREEN_LED_PIN 10 // Pin connected to the green LED
#define RED_LED_PIN 11  // Pin connected to the red LED

// Initialize DHT sensor
DHT dht(DHTPIN, DHTTYPE);

void setup() {
    // Start the serial communication
    Serial.begin(9600);
    // Initialize sensor
    dht.begin();
    // Set LED pins as output
    pinMode(GREEN_LED_PIN, OUTPUT);
    pinMode(RED_LED_PIN, OUTPUT);
}

void loop() {
    // Wait a few seconds between measurements
    delay(2000);

    // Reading temperature
    float t = dht.readTemperature();

    // Check if any reads failed
    if (isnan(t)) {
        Serial.println("Failed to read from DHT sensor!");
        return;
    }

    // Print the temperature to the Serial Monitor
```

```

Serial.print("Temperature: ");
Serial.print(t);
Serial.println(" *C ");

// Check the temperature range and turn on the appropriate LED
if (t < 16.0 || t > 24.0) {
    digitalWrite(RED_LED_PIN, HIGH);    // Turn on red LED
    digitalWrite(GREEN_LED_PIN, LOW);   // Turn off green LED
} else {
    digitalWrite(RED_LED_PIN, LOW);     // Turn off red LED
    digitalWrite(GREEN_LED_PIN, HIGH);  // Turn on green LED
}
}

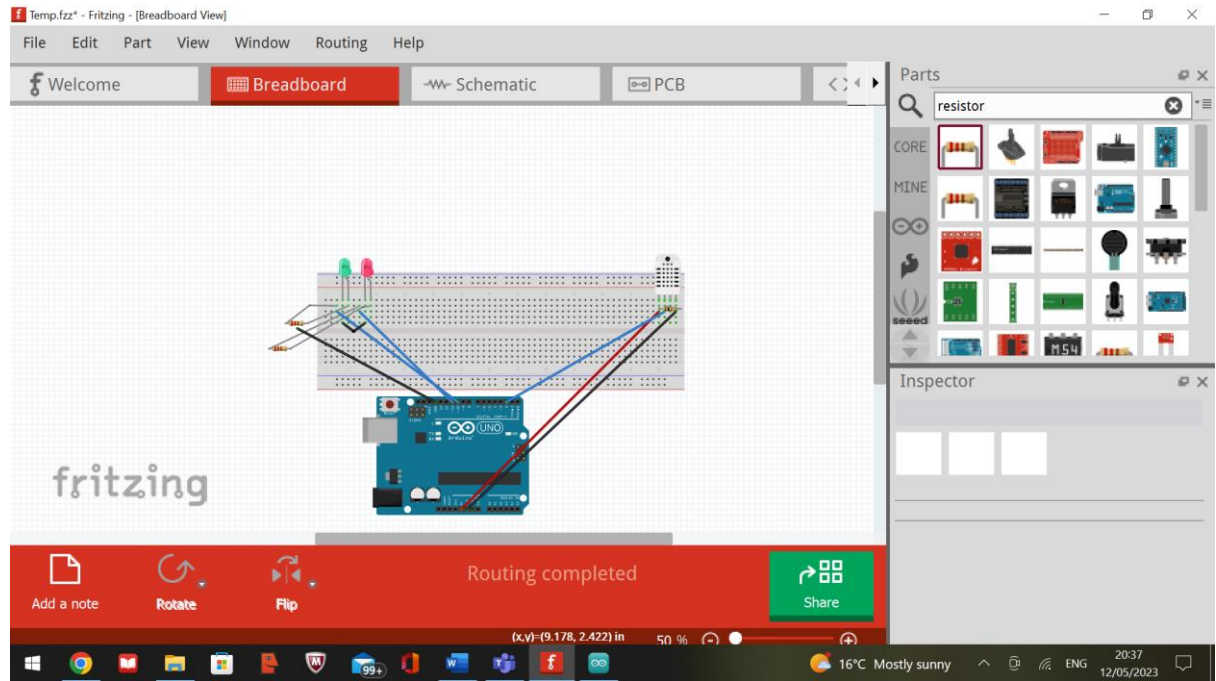
```

The C Program can be broken down into three main parts. Firstly, the setup which is where we set the serial communication for debugging and the DHT sensor for data collection. We also set the LED pins as output, as we will use them to indicate the temperature status. I also installed the DHT.H library which communicates with the DHT11 sensor, allowing us to read the temperature and humidity with simple code, like `dht.readTemperature()` and `dht.readHumidity()`.

In the data reading phase, we read the temperature from the DHT11 sensor and check for any errors in the reading. A prompt will be displayed on the serial monitor a separate window on the computer running the Arduino code. In the data processing phase, we compare the temperature to our desired range. If the temperature is outside this range, we turn on the red LED and turn off the green LED. If it is within the range, we do the opposite. This way, we always have a visual indication of whether the temperature is within the acceptable range.

Task 4 – Testing [10 marks]

Test your program to see how much of it works, using a structured approach. Record your results using suitable screen dumps and photographs. Ensure all eventualities are tested and evidenced.



Temp | Arduino IDE 2.1.1-nightly-20230510

File Edit Sketch Tools Help

Arduino Uno

Temp.ino

```
32     return;
33 }
34
35 // Print the temperature to the Serial Monitor
36 Serial.print("Temperature: ");
37 Serial.print(t);
38 Serial.println(" *C ");
39
40 // Check the temperature range and turn on the appropriate LED
41 if (t < 16.0 || t > 24.0) {
42     digitalWrite(REDF_LED_PIN, HIGH); // Turn on red LED
43     digitalWrite(GREEN_LED_PIN, LOW); // Turn off green LED
44 } else {
45     digitalWrite(REDF_LED_PIN, LOW); // Turn off red LED
46     digitalWrite(GREEN_LED_PIN, HIGH); // Turn on green LED
47 }
48 }
```

Output Serial Monitor

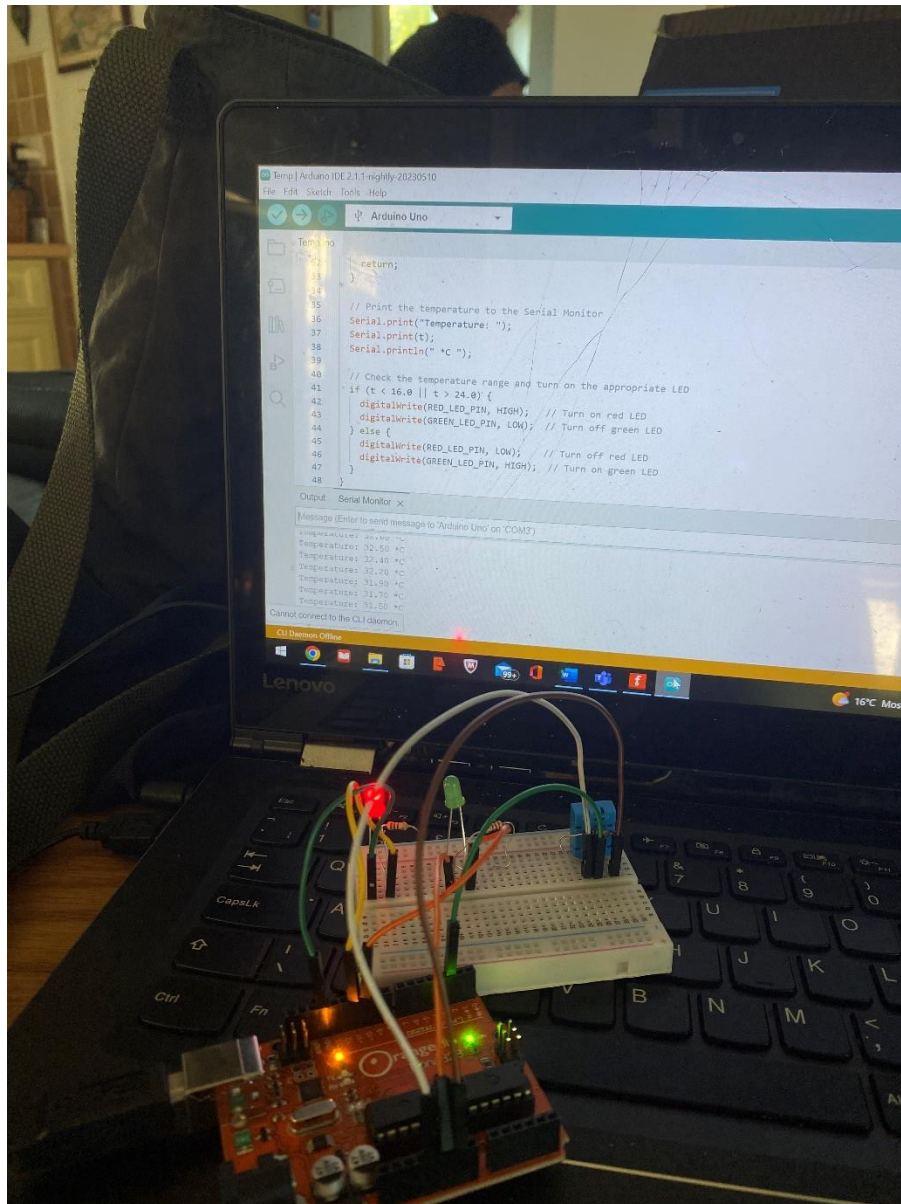
Message (Enter to send message to 'Arduino Uno' on 'COM3')

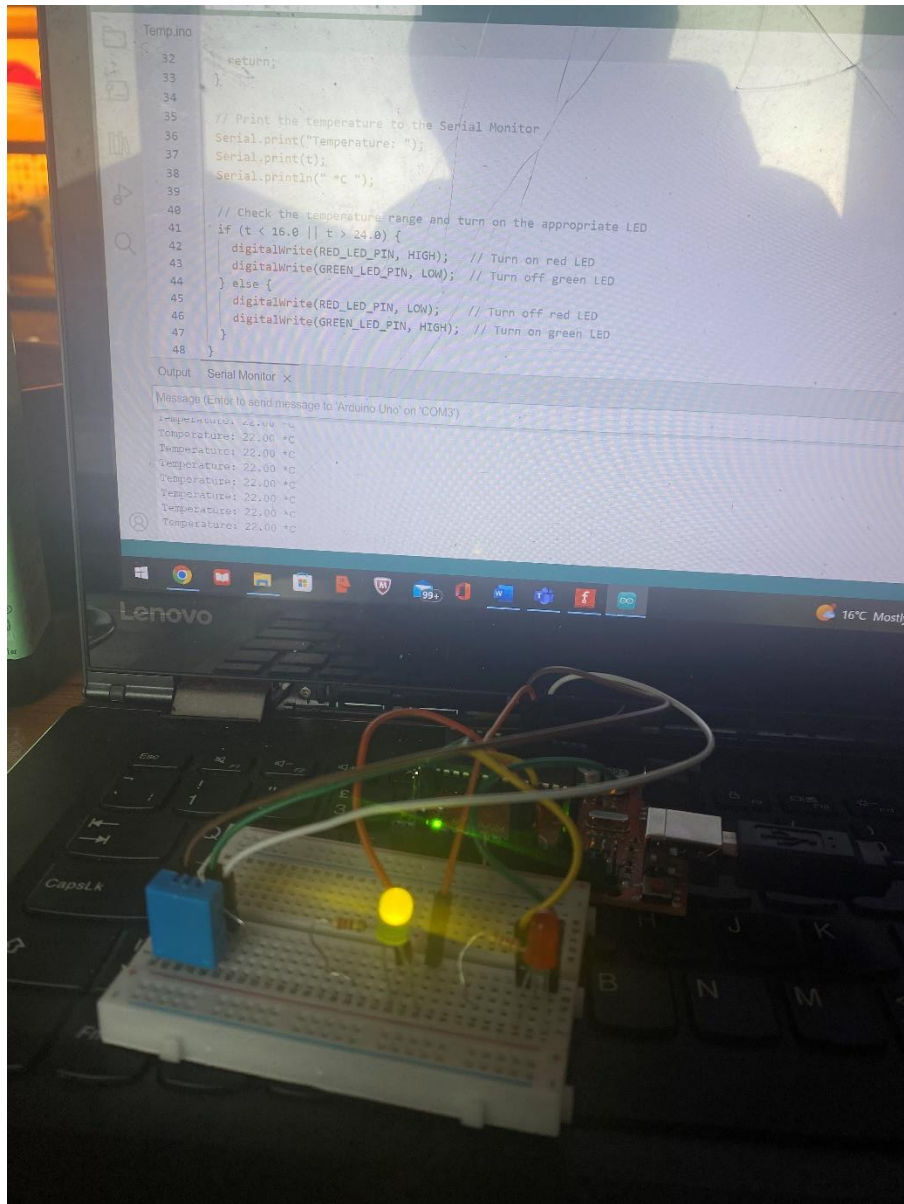
New Line 9600 baud

Temperature: 22.00 *C
Temperature: 22.80 *C
Temperature: 22.80 *C
Temperature: 22.80 *C
Temperature: 22.70 *C
Temperature: 22.80 *C
Temperature: 22.80 *C
Temperature: 22.70 *C

CLI Daemon Offline Ln 1, Col 1 Arduino Uno on COM3 19:28 12/05/2023

16°C Mostly sunny





Task 5 – Discussion, Evaluation and Conclusions [15 marks]

Discuss your results and comment on the power and usefulness of the C programming language used in embedded systems. What modifications could be made to make this system more useful? Provide a conclusion to your report stating whether you have met the requirements of the system.

C's programme access to memory, minimal runtime requirements, and direct interface with the hardware make it ideal for embedded systems such as the thermostat, where resources are limited, and the performance is critical. The compiled C code is compact, making it suitable for the microcontroller environment of the Arduino (Yasar, 2021). The Arduino libraries, written in C code, simplify the task with the hardware components like the DHT11 sensor and the LEDs. They provide a layer that hides the complexity of the hardware and allows us to focus on the logic of our application (Arduino cc, 2021). The current system meets the basic requirements by accurately reading the room temperature and providing a visual indication when the temperature is outside the accepted range. However, there are several ways we could enhance this system to make it even more useful such as adding a display. To do this we could Incorporate an LCD display would allow the system to show the exact temperature reading, not just an indication of whether it is within the desired range. Another design feature in future I would think about adding is implementing Wi-Fi or Bluetooth functionality which would allow the system to send alerts to a smartphone or a computer when the temperature goes outside the acceptable range. I also believe another design flaw is the likelihood of not acknowledging the temperature indication. To avoid this, I believe adding a buzzer could provide an additional alert which would be useful in environments where the LEDs might not be easily seen or acknowledged in a busy office. Another aspect which some employees would appreciate is data recording of the temperature which would provide insights into trends and patterns, which could be used to optimize the operation of ventilation and air conditioning systems.

In conclusion, the requirements of the system have been successfully met using the C programming language. The system accurately monitors room temperature and

visually indicates if the temperature goes outside of the accepted range. Through the power and flexibility of C programming, we have created an effective temperature monitoring system that can be easily expanded and adapted for a variety of applications in embedded systems.

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