

## LEVEL 4 ASSESSMENT SPECIFICATION

|                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                 |                                 |
|----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|---------------------------------|
| <b>Student name:</b>                   | <b>Chelsi Mason</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Student ID number:</b>                                       | <b>1810505</b>                  |
| <b>Programme:</b>                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                 |                                 |
| <b>Module:</b>                         | <b>Embedded Systems</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                 |                                 |
| <b>Module code:</b>                    | <b>PCEE4004</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Contribution to Overall Module Assessment (%):</b>           | <b>100%</b>                     |
| <b>Lecturer:</b>                       | <b>Sarah Williams</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>Internal Verifier:</b>                                       |                                 |
| <b>Assignment Title:</b>               | <b>Office Environment Monitor</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>Word count (or equivalent):</b>                              | <b>2000</b>                     |
| <b>Submission deadline:</b>            | <b>10<sup>th</sup> May 2019</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Return date of provisional marks &amp; written feedback:</b> | <b>24<sup>th</sup> May 2019</b> |
| <b>Submission method:</b>              | <p>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.)</p> <p><b>Alternative submission method (if applicable):</b></p> <p><b>Late submission of the assessment will result in a late penalty mark.</b> 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.</p> |                                                                 |                                 |
| <b>Academic honesty / referencing:</b> | <p>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.</p>                                                                                                                                                                                                                                                                                              |                                                                 |                                 |

# 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 |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|---------------|
| <b>1. Engagement with Literature Skills</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                 |               |
| Evidence of appropriate research independently selected is provided.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 10              | 5             |
| <b>2. Knowledge and Understanding Skills</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                 |               |
| In your introduction you state your project will control the temperature in the office, however the assignment required only that you monitored the temperature, and this is what you have correctly implemented.<br><br>Evidence of planning and consideration of components to use, justification of decisions made included. Discussion in the software development section is a little confused at times. Flowchart and schematic comments need to be included both missing from report! A flowchart demonstrating design of the code and a schematic of the circuit would have increased you marks in this section. | 20              | 9             |
| <b>3. Cognitive and Intellectual Skills</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                 |               |
| Evidence is provided to show that the system has been tested effectively, although you should include in the testing table what the system “should” do, so that it can be confirmed that the test has actually been successful or not. Project was demonstrated as working as required in class. Evaluation discussion again refers to the system actually controlling the temperature within the workplace. Further marks would have been gained in this section by further considering how the project could be developed further giving reasons for these modifications and suggestions in to how they could be made. | 25              | 15            |
| <b>4. Practical Application Skills</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                 |               |
| Basic circuit however it effectively allows for the user to identify when the temperature is within acceptable ranges, and when outside. You have discussed the need for commenting and yet your code on the whole had little annotation, although you have included a description of the functionality of the code in the report. Overall the project demonstrates an adequate understanding and deployment of both practical programming and electrical circuit design and                                                                                                                                             | 35              | 16            |

|                                                                                                                          |    |   |
|--------------------------------------------------------------------------------------------------------------------------|----|---|
| construction.                                                                                                            |    |   |
| <b>5. Transferable Skills for Life and Professional Practice</b>                                                         |    |   |
| Work is mostly coherent and ideas are reasonably well expressed. You ensure your report is proof read before submission. | 10 | 5 |

|                                                                                                                                                                                                            |                                                        |  |            |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|--|------------|
| <b>Assessment Mark</b> (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. ) | <b>Late Submission Penalties (tick if appropriate)</b> |  | <b>50%</b> |
|                                                                                                                                                                                                            | Up to 1 week late (40% Max)                            |  |            |
|                                                                                                                                                                                                            | Over 1 week late (0%)                                  |  |            |



## GENERIC ASSESSMENT CRITERIA

### Level 4

In accordance with the Framework for Higher Education Qualifications, at the end of Level 4 students will be expected to have demonstrated knowledge of the basic underlying concepts and principles of a subject, and an ability to evaluate and interpret these within the context of that area of study. They should be able to present, evaluate and interpret qualitative and quantitative data in order to develop lines of argument and make sound judgements in accordance with basic theories and concepts of their subject(s) of study. They will have learned how to evaluate different approaches to solving problems, and will be able to communicate the results of their study/work accurately and reliably, and with structured and coherent arguments. They will be able to undertake further training and develop new skills within a structured and managed environment and will have the qualities and transferable skills necessary for employment requiring the exercise of some personal responsibility.

| Level 4                                                                                                          | FAIL                                                                                                                                                                                                 | MARGINAL FAIL                                                                                                                                                                                                                                         | SATISFACTORY<br>(3 <sup>rd</sup> / Pass)                                                                                                                                                                                                                           | GOOD<br>(2.2 / Pass)                                                                                                                                                                                              | VERY GOOD<br>(2.1 / Merit)                                                                                                                                                                                        | EXCELLENT<br>(1 <sup>st</sup> / Distinction)                                                                              | EXCEPTIONAL<br>(1 <sup>st</sup> / Distinction)                                                                                          |
|------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| Category                                                                                                         | 0-29%                                                                                                                                                                                                | 30-39%                                                                                                                                                                                                                                                | 40-49%                                                                                                                                                                                                                                                             | 50-59%                                                                                                                                                                                                            | 60-69%                                                                                                                                                                                                            | 70-84%                                                                                                                    | 85-100%                                                                                                                                 |
| <b>Engagement with literature</b><br>(including reading, referencing, academic conventions and academic honesty) | Little or no evidence of reading and/or reliance on inappropriate sources. Views and findings mostly unsupported and non-authoritative. Referencing conventions used incoherently or largely absent. | Poor engagement with essential reading. No evidence of wider reading. Reliance on inappropriate sources, and/or indiscriminate use of sources. Heavily reliant on information gained through class contact. Inconsistent and weak use of referencing. | Engagement with a limited range of mostly relevant and credible sources but with some reliance on information gained through class contact. Some omissions and minor errors. Referencing conventions evident though not always applied accurately or consistently. | Engagement with an appropriate range of literature, including sources retrieved independently. Some over-reliance on texts rather than other sources. Referencing may show minor inaccuracies or inconsistencies. | Engagement with a wide range of literature, including sources retrieved independently. Selection of relevant and credible sources. Generally sound referencing, with no/very few inaccuracies or inconsistencies. | Engagement with an extensive range of relevant and credible literature. Consistently accurate application of referencing. | Exceptional engagement with an extensive range of relevant and credible literature. High-level referencing skills consistently applied. |
| <b>Knowledge and understanding</b><br>(Knowledge of the basic underlying concepts and principles of a subject.)  | Major gaps in knowledge and understanding of the basic underlying concepts and principles of the subject matter. Inclusion of irrelevant material. Substantial inaccuracies.                         | Gaps in knowledge of the basic underlying concepts and principles, with flawed or superficial understanding. Some significant inaccuracies and/or irrelevant material.                                                                                | Limited knowledge and understanding of the basic underlying concepts and principles within the subject area. Some elements may be missing.                                                                                                                         | Knowledge of the basic underlying concepts and principles is accurate with a good understanding of the field of study but lacks depth and/or breadth.                                                             | Competent knowledge of the basic underlying concepts and principles. Exhibits very good understanding.                                                                                                            | Excellent knowledge and understanding of the basic underlying concepts and principles of the subject.                     | Exceptional, detailed knowledge and understanding of the basic underlying concepts and principles                                       |

| Level 4                                                                                                                                                                                                                 | FAIL                                                                                                                                                                                                                                   | MARGINAL FAIL                                                                                                                                                                                                                                                                                                                                    | SATISFACTORY<br>(3 <sup>rd</sup> / Pass)                                                                                                                                                                                                                                                                                    | GOOD<br>(2.2 / Pass)                                                                                                                                                                                                                                                      | VERY GOOD<br>(2.1 / Merit)                                                                                                                                                                                                                                                   | EXCELLENT<br>(1 <sup>st</sup> / Distinction)                                                                                                                                                                                                                                                 | EXCEPTIONAL<br>(1 <sup>st</sup> / Distinction)                                                                                                                                                                                                             |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Category                                                                                                                                                                                                                | 0-29%                                                                                                                                                                                                                                  | 30-39%                                                                                                                                                                                                                                                                                                                                           | 40-49%                                                                                                                                                                                                                                                                                                                      | 50-59%                                                                                                                                                                                                                                                                    | 60-69%                                                                                                                                                                                                                                                                       | 70-84%                                                                                                                                                                                                                                                                                       | 85-100%                                                                                                                                                                                                                                                    |
| <b>Cognitive and intellectual skills</b><br>(Evaluate underlying concepts and principles of a subject and interpret qualitative and quantitative data in order to develop lines of argument and make sound judgements.) | Wholly or almost wholly descriptive work. Little or no evaluation of the underlying concepts and principles. Failure to develop arguments, leading to illogical or invalid judgements. Minimal or no use of evidence to back up views. | Largely descriptive work, with superficial evaluation of the underlying concepts and principles. Weak interpretation of data, flawed development of arguments and judgements. Information accepted uncritically, uses generalised statements made with scant evidence and unsubstantiated opinions. Ideas sometimes illogical and contradictory. | Limited attempt at evaluation of the underlying concepts and principles, tending towards description. Can interpret qualitative and quantitative data but with some errors. Some evidence to support emerging arguments and judgements but these may be underdeveloped or with a little inconsistency / mis-interpretation. | Good evaluation of the underlying concepts and principles. Can interpret qualitative and quantitative data, with minor errors. An emerging ability to use evidence to support the argument. Mostly valid arguments and logical judgements.                                | Sound evaluation of the underlying concepts and principles. Can interpret qualitative and quantitative data accurately. Ability to devise arguments using evidence to make mostly appropriate and valid judgements.                                                          | Excellent evaluation of the underlying concepts and principles. Can interpret qualitative and quantitative data accurately and with some insight. Excellent ability to devise arguments using evidence and make appropriate and valid judgements.                                            | Exceptional evaluation of the underlying concepts and principles based evidence. Outstanding interpretation of qualitative and quantitative data. Exceptional ability to devise arguments using evidence and make wholly appropriate and valid judgements. |
| <b>Practical skills</b><br>(Different approaches to solving problems in particular contexts.)                                                                                                                           | Limited or no use of taught, basic methods, materials, tools and/or techniques. Little or no appreciation of the context of the application. Very weak evidence of different approaches to problem-solving in particular contexts.     | Rudimentary application of taught, basic methods, materials, tools and/or techniques but without consideration and competence. Flawed appreciation of the context of the application. Weak evidence of different approaches to problem-solving in particular contexts.                                                                           | An adequate awareness and mostly appropriate application of basic methods, materials, tools and/or techniques. Basic appreciation of the context of the application. Can identify problems in particular contexts and propose basic alternative approaches or solutions though there may be errors.                         | A good and appropriate application of basic methods, materials, tools and/or techniques. Clear appreciation of the context of the application. Good evidence of different approaches to problem-solving in particular contexts and proposes mostly appropriate solutions. | A very good application of a range of basic methods, materials, tools and/or techniques. Very good consideration of the context of the application. Very good evidence of different approaches to problem-solving in particular contexts and proposes appropriate solutions. | An advanced application of a range of taught, basic methods, materials, tools and/or techniques. The context of the application is well considered, and insightful. Excellent evidence of different approaches to problem-solving in particular contexts and proposes appropriate solutions. | Exceptional levels of application and deployment skills in particular practical contexts. Outstanding identification of problems in particular contexts and formulation of wholly appropriate, thoughtful solutions / different approaches.                |

|                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                     |
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| <p><b>Transferable skills for life and professional practice</b><br/>(Communicate the results of their study/work accurately and reliably, and with structured and coherent arguments; the qualities needed for employment requiring the exercise of some personal responsibility within a structured and managed environment.)</p> | <p>Work is poorly structured, disorganised, inaccurate and/or confusingly expressed. Very weak use of language and/or very inappropriate style. Failure to work effectively individual or as part of a group. Little or no evidence of the skills for employment requiring the exercise of some personal responsibility.</p> | <p>Work is poorly presented in a disjointed manner. It is loosely, and at times incoherently, structured, with information and ideas often poorly expressed. Weak use of language and/or inappropriate style. Flawed approach to individual or group work, meeting only partial obligations to others. Limited evidence of the skills for employment requiring the exercise of some personal responsibility.</p> | <p>Mostly ordered presentation and structure in which relevant ideas / concepts are reasonably expressed. Work may lack coherence and/or accuracy in places. Can work as part of a group, meeting most obligations to others but perhaps with limited involvement in group activities. Demonstrates the basic skills for employment requiring the exercise of some personal responsibility, with some areas of minor weakness.</p> | <p>Mostly coherent, organised and accurate work, in a suitable structure and is for the most part clearly expressed. Can work effectively independently and/or as part of a team, with clear contribution to group activities. Demonstrates the skills for employment requiring the exercise of some personal responsibility, with some areas of strength and some of minor weakness.</p> | <p>Work is accurate, coherent, fluent, well-structured and organised. Can work effectively independently and/or as part of a team, with very good contribution to group activities. Demonstrates very good skills for employment requiring the exercise of some personal responsibility, with just occasional minor weakness.</p> | <p>Work is coherent, very fluent and is presented professionally. Can work effectively independently and/or as part of a team, with an excellent contribution to group activities. Demonstrates excellent skills for employment requiring the exercise of some personal responsibility with an appetite for further development.</p> | <p>Work is accurate, exceptionally coherent, very fluent and presented well. Can work effectively independently and/or as part of a team, with an exceptional contribution to group activities. Demonstrates exceptional skills for employment requiring the exercise of some personal responsibility with an appetite for further development.</p> |
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Embedded Systems

Assignment 1

Office Environment Monitor

Chelsi Mason

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## Introduction

The system that is explained within this report is made to help maintain a 'normal' working condition temperature that has been set by the HSE. The purpose of this system is to monitor the temperature within the workplace and decide whether it is a normal working temperature, below the normal working temperature or above it. If it is above the normal working temperature the programme will indicate this by making the LED light up red indicating it is too hot and turn on the air conditioning system to cool the environment down. If the temperature is below the normal working temperature then the programme will indicate this by making the LED light up blue indicating it is too cold and turn on the heating. If the temperature is within this limits the LED will be green to indicate it is a normal working temperature. The system is made using C Code, an Arduino software and an Orange pip board as the hardware system. The embedded system will be put in workplace environment at a central location to get the most accurate temperature. If it was by the door or window it would give a cooler temperature due to drafts and breezes.

## Hardware Design

The embedded system is made up of the following hardware components:

- 3 x 220 Ohm resistors
- Tri coloured LED
- DHT temperature and humidity sensor
- Breadboard
- Orange Pip board
- Connecting wires

The resistors are used in the circuit to protect the LED. Resistors control the flow of current running in the circuit so that it doesn't destroy the LED which would damage the circuit. Resistors are also used within circuits for communication purposes. The voltage within the circuit decides the current too. If the voltage is doubled then the current is doubled too. This rule is within Ohm's Law. The resistance within a circuit is measured by dividing the voltage in the circuit by the current.

The tri coloured LED is used to save space firstly. Instead of having 3 different LED's it is simpler to have a three coloured LED. Each colour has a resistor attached as each resistor protects each leg/colour. The colours used in this system are green, red and blue. Each colour represents different stages. Green is the normal working temperature, blue signifies the temperature is below the normal working temperature and red means it is above the normal working temperature.

The DHT temperature and humidity sensor is only used to measure the temperature in this system. The DHT detects temperature through a thermistor. A resistance change between the electrodes within the sensor indicates a change in temperature. This resistance change is proportional to a change in the temperature. When the temperature increases so does the resistance.

Bread board is used as the circuit board. It is easy to install components onto it as it doesn't require any soldering. The power of the circuit travels vertically through the tracks. Any components are just connected through the holes on the breadboard.

The Orange Pi boards are a microcontroller. This was used as it works with Arduino which is the software used to design and upload the code for this embedded system. There was enough pins to accommodate for each component which made it simple to implement.

Connecting wires were used to connect the components on the breadboard to the correct pins on the Orange Pi microcontroller.

### Software Design

Firstly a flow chart using Visio was created. Visio was a suitable software as it was easy to navigate and each box shape signified whether it was a decision, action or data saving process. The flowchart gave a visual representation of what the code would do. When switched on the code would send a signal to the DHT to take the temperature. If the temperature was within the normal working temperature then the LED would light up green. If the temperature was too cold it would light up blue and if it was too hot it would light up red. The flowchart said that the DHT would take the room temperature at set time intervals. This flow chart can be located in the appendix.

C code is a universal language used on this system. The code can be used for very simple circuits which this one is and it works well with microcontrollers which is what the Orange Pi is. To design the code the main areas need to be outlined. First each variable needs to be defined and allocated its pin. This was the first part of the code. The limits for the code were met and allocated a specific pin on the board. The picture of the code is located in the appendix.

### Implementing the system

To implement the system it will be installed within the centre of the workplace. Alongside certain parts of the code comments were made to make it simpler to read. For example the second line of the code the DHT is defined as pin A0. A comment is made alongside this to tell the reader that this will be the location of the DHT on the Orange Pi. The constants within this circuit are LED pin 4 which is when the

temperature is too hot. There is also a comment alongside this to tell the reader when this happens the LED will be red. Another constant in the code is LED pin 5 which is when the temperature is too cold. Again there is a comment alongside this to tell the reader that when this occurs the LED will be blue. After the entire code was written it was compiled. On Arduino when the code is compiled if it finds any errors it will highlight them and give an explanation at the bottom telling you why it cannot compile. If this happens it needs to be corrected and compiled again. After successful compilation the code can be debugged if needed and then uploaded onto the Orangepip to begin testing.

### Testing

To test the functionality of the system the following steps were taken:

- Upload the code onto the Orangepip
- Connect breadboard circuit onto the Orangepip
- Make sure the breadboard is powered
- Check the LED colour and the temperature
- Use a hairdryer to increase the temperature
- Monitor the LED colour and record
- Use cold spray to decrease the temperature
- Monitor the LED colour and record
- Monitor the LED colour from the temperatures 14 to 23 degrees
- Record the LED colours alongside the temperatures

| Temperature (°c) | LED Colour |
|------------------|------------|
| 13               | BLUE       |
| 14               | BLUE       |
| 15               | GREEN      |
| 16               | GREEN      |
| 17               | GREEN      |
| 18               | GREEN      |
| 19               | GREEN      |
| 20               | GREEN      |
| 21               | GREEN      |
| 22               | RED        |
| 23               | RED        |

The table above shows the results from the testing which took place. As shown the system was successful. The LED showed the correct colours for the correct temperatures. When the temperature was equal to or below the minimum

temperature of 14 degrees then the LED was blue. When the temperature was equal to or above the maximum temperature of 22 degrees the LED was red. When the temperature was within the set limits the LED was green. Evidence of the testing can be found in the appendix.

### Documentation

The first part of the code is where the DHT is defined as a variable. It is also allocated the pin A0. This pin is on the Orangepi microcontroller. After this the limits of the DHT are defined as constants and the temperature limits and pins are allocated. The red LED is pin 4 and the blue led is pin 5. The constants have to be defined before the setup and loop so that when the terms are written within the code it will know what they represent. Next the set up is written. This includes the beginning of the code which is `Serial.begin (9600)`. This means the serial link 9600 is beginning and will be delayed by 5 seconds before accessing the sensor. The code activates the DHT and then accesses the sensor. Within the setup the DHT is set as the input which is the temperature and the LED is the output as the colour will signify the temperature.

The next part of the code is the loop. Here in the code the system sends a signal to the DHT to take the current temperature. Within the code it will print the temperature. This is when the term '`Serial.print`' are used. The code tells the DHT to loop and take this temperature every 60 seconds. The code then prints the value. Next the code takes the temperature and compares it to the previously set limits. If it is below or equal to the minimum temperature the code sends a high signal to the cold LED pin so the LED shines blue and sends a low signal to the hot LED pin so it doesn't shine red. While doing this the code does an 'if' command and if the temperature is above or equal to the maximum temperature then the code will send a high signal to the hot LED and shine red and a low signal to the cold LED so that it doesn't shine blue.

The code is set to loop every 60 seconds to effectively monitor the room temperature and control it too.

### System Explanation

When the system is turned it powers the whole circuit. The code will tell the DHT to take an initial temperature. The resistance within the thermistor of the DHT is proportional to the temperature. The DHT will take the temperature every 60 seconds. The code will then take the data that the DHT has collected and use it with the code. When the temperature is taken it is converted from a resistance into a temperature. The code using digital programming which allows figures instead of just on and off output will read this value. If the temperature is below or equal to the minimum temperature the code will send a signal to the LED to light up blue. However if it is not equal to or below the minimum temperature the code will see if it

is above or equal to the maximum temperature then the code will send a signal through the Orangepip to the LED to light red. After this the code will go to an else command and send a signal to the LED to light green as the temperature is within the set limits of the code.

## Conclusion

Overall the system did what it was intended to do and met the requirements of the system. It took and monitored the room temperature. When the temperature went outside of the set limits the correct coloured LED turned on. This means the system could successfully be implemented within office environments. The testing of this embedded system was successful. Each component worked correctly and did as it should. The resistors protected the LED legs and the LED turned on as it should the colours that it should. When checked for faults the software code showed none. Arduino worked well alongside the Orangepip and allowed for successful uploads of the code with no issues.

## Evaluation

Although the code was simple it met the requirements of the system. Microcontrollers do not need complicated codes with a multitude of commands. The controller only needs to turn on the air con and heating at the correct time which the LED signified. However an improvement that could be made would be to have the limits be adjusted at any given time. This due to different people having different opinions on what they see as a 'normal' working environment temperature. Another improvement would be to have DHT's placed at different points in the room and have an average temperature decide whether the temperature is within the set limits. This is because the temperature differs at each part of a room. For example it's colder near windows than it is in the centre. By having an average temperature it would allow a more accurate reading.

## References

Handouts and presentation within class

<http://www.hse.gov.uk/temperature/faq.htm>

<https://www.programiz.com/c-programming/examples>

<https://en.wikipedia.org/wiki/Resistor>

<https://www.arduino.cc/en/guide/introduction>

<https://www.orangepipboards.com/>

Boysen. E, Kybett. H, Complete Electronics Self Teaching Guide with Projects, Wiley Publishers,

## Appendix

The code:



```
temperature_control_sketch

#include "dht.h"
#define dht_pin A0 //Analog Pin sensor is connected to

dht DHT;

const int ledPinHOT=4; // Red LED (too hot)
const int ledPinCOLD=5; //Blue LED (too cold)
const int ldrPin=A0;
const int MIN_TEMP 15
const int MAX_TEMP 22

void setup() {

Serial.begin(9600);
  delay(500); //Delay to let system boot
  Serial.println("DHT11 Humidity & temperature Sensor\n\n");
  delay(1000); //Wait before accessing Sensor
  pinMode (ldrPin, INPUT);
  pinMode (ledPin HOT, OUTPUT);
  pinMode (ledPin COLD, OUTPUT);
}

void loop() {
  int temperature;
  DHT.read11(dht_pin);

  Serial.print("Current temperature = ");
  Serial.print(DHT.temperature);
  Serial.println("C ");
  temperature=DHT.temperature;
  delay(60000); //Wait 60 seconds before accessing sensor again.

  Serial.println(val);

  if (temperature<= MIN_TEMP){
    digitalWrite (ledPinCOLD, HIGH);
    digitalWrite (ledPinHOT, LOW);
  }
  else if (temperature>=MAX_TEMP){
    digitalWrite (ledPinHOT, HIGH);
    digitalWrite (ledPinCOLD, LOW);
  }
  else {
    digitalWrite (ledPinHOT, LOW);
```

Visio Flow chart for software design:

Testing evidence:

When the temperature was above or equal 22 degrees and the red LED was on:



When the temperature was below 15 degrees and the blue LED was on:



When the temperature was within the temperature limits and the green LED was on:



Fritzing schematic wiring diagram of the hardware design: