PHYS& 222 – Engineering Physics II

Final Practicum Winter 2021 (2947)

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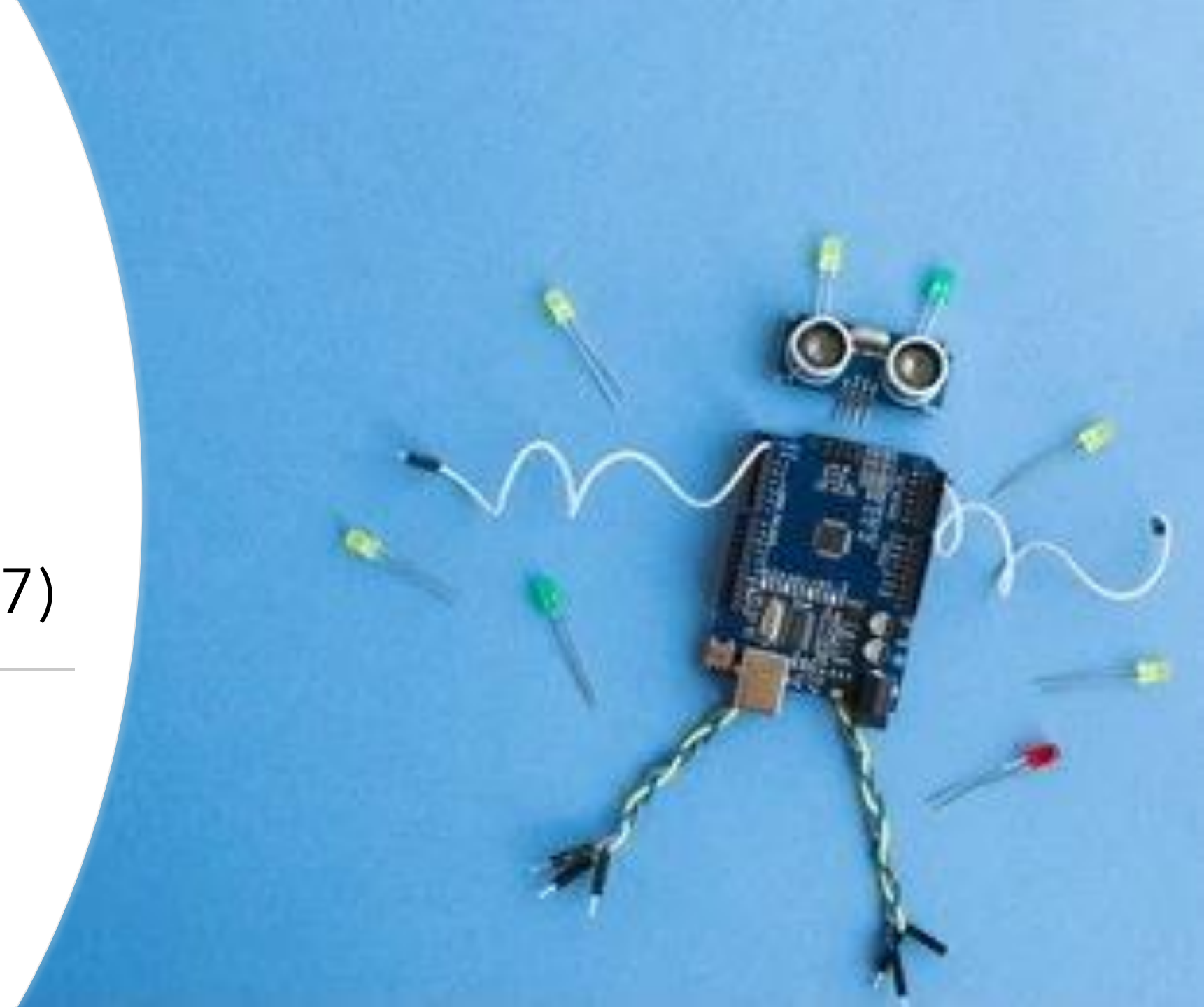


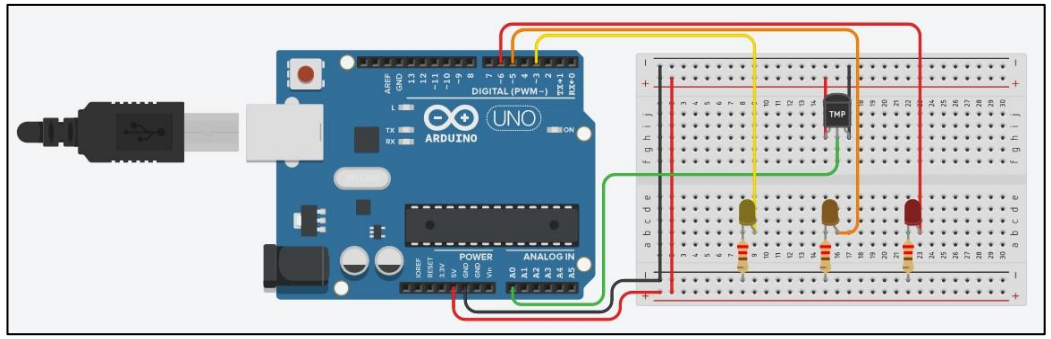
Goals

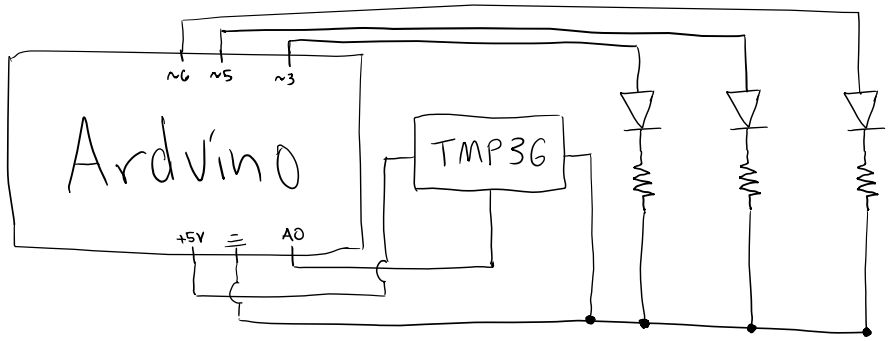
The objective of this project was to:

- Build a simulated circuit with a low-voltage analog sensor, calibrating and test it.
- Write code to run the sensor, and trigger actions at particular threshold temperatures.

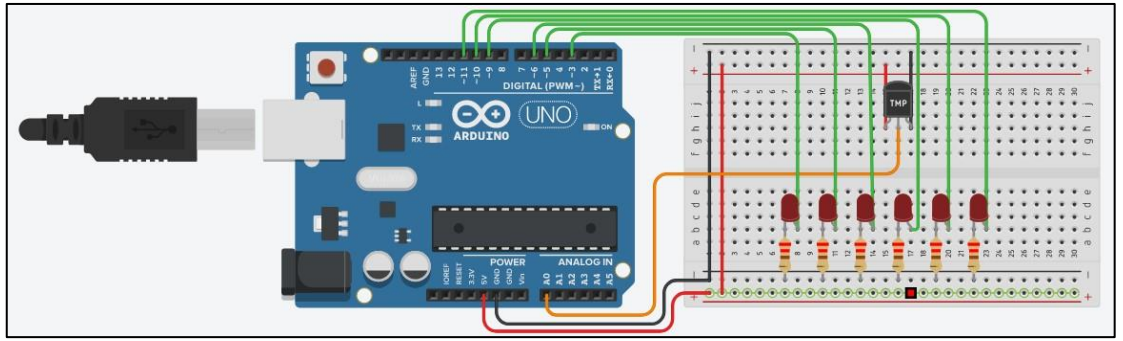
Schematic

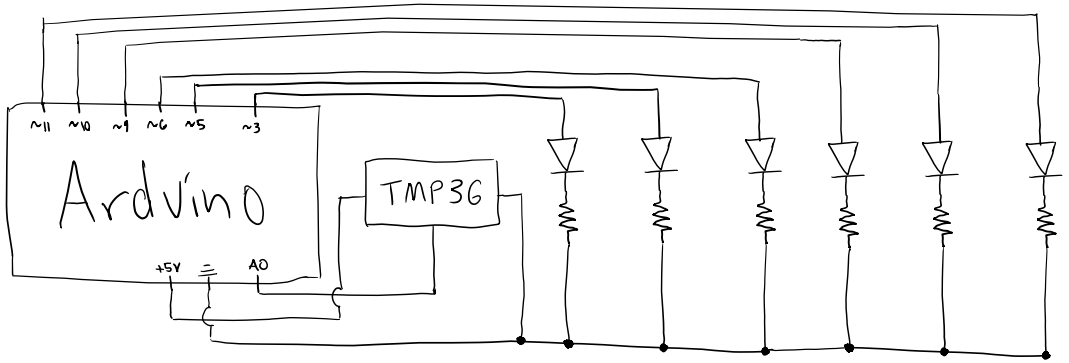
Digital Circuit





Analog Circuit





Code – Overview

The control flow for this project consists of an initialization phase to set up serial communication and select the operating mode of the selected pins, followed by two routines:

- a primary routine that runs continually, reading temperature values, displaying them to the serial console, and selecting the correct LEDs to light; and
- a sub-routine that handles the LED selection for each temperature reading.

The following two slides detail the differences between the control flow in each project.

Code – Digital Thermometer

```
int pins[3] = {3,5,6};
int pins_len = sizeof(pins)/sizeof(int);

// the setup routine runs once when you press reset
void setup() {
  // initialize serial communication at 9600 bits per second
  Serial.begin(9600);
  for (int i=0; i<pins_len; i++) pinMode(pins[i], OUTPUT);
};

// choose which LEDs to light up
void light_leds(int led) {
  for (int i=0; i<pins_len; i++){
    digitalWrite(pins[i], i==led ? HIGH : LOW);
  };
};

// the loop routine runs over and over again forever
void loop() {
  // read the input on analog pin 0:
  int sensorValue = analogRead(A0);

  // Convert the analog reading (which goes from 0 - 1023) to a voltage (0 - 5V):
  float voltage = sensorValue * (5.0 / 1024.0);

  // convert voltage to C
  float C = (voltage - 0.5) * 100;

  // print C temp
  Serial.println();
  Serial.print("C: ");
  Serial.print(C);

  // choose which LED to light
  if (C < 10) light_leds(0);            // <10 == cold/yellow
  if (C >= 10 && C < 25) light_leds(1); // 10-25 == mild/orange
  if (C >= 25) light_leds(2);           // >25 == hot/red
}

```

For the digital thermometer, the primary routine varies only at the end where it selects from one of three LEDs to light.

The sub-routine for this version selects one LED that corresponds to the temperature zone currently being read.

Code – Analog Thermometer

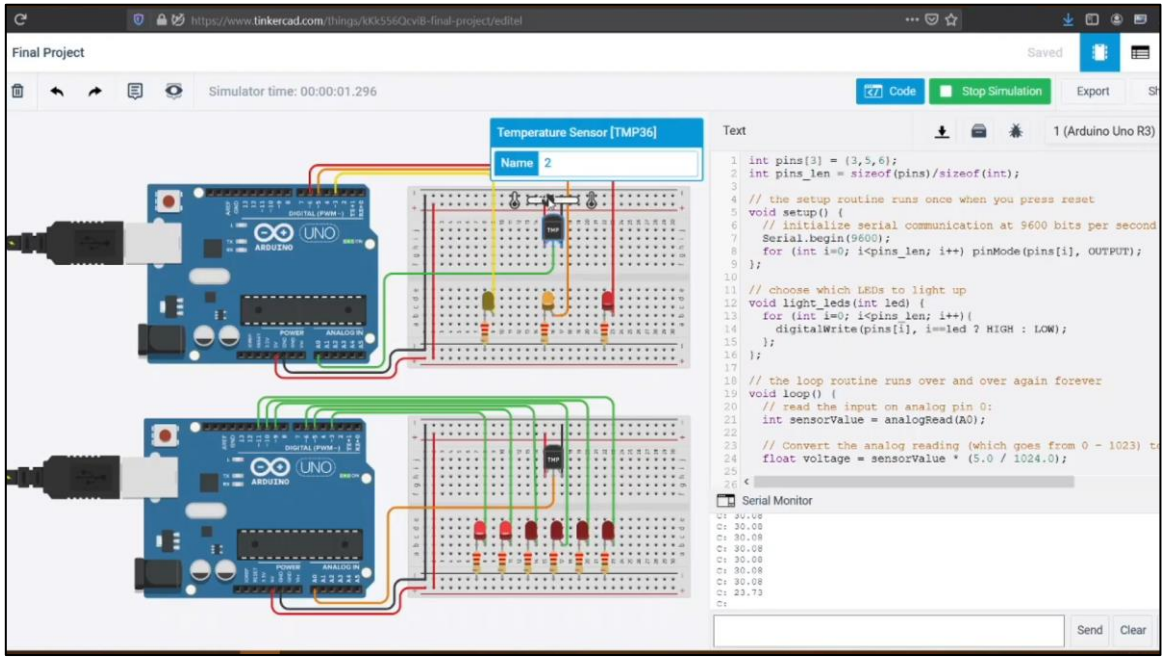
For the analog thermometer, the primary routine again varies only at the end where it selects multiple LEDs to light, instead of a single LED.

The sub-routine for this version selects the LEDs that corresponds to all temperature zones at and below the current value being read.

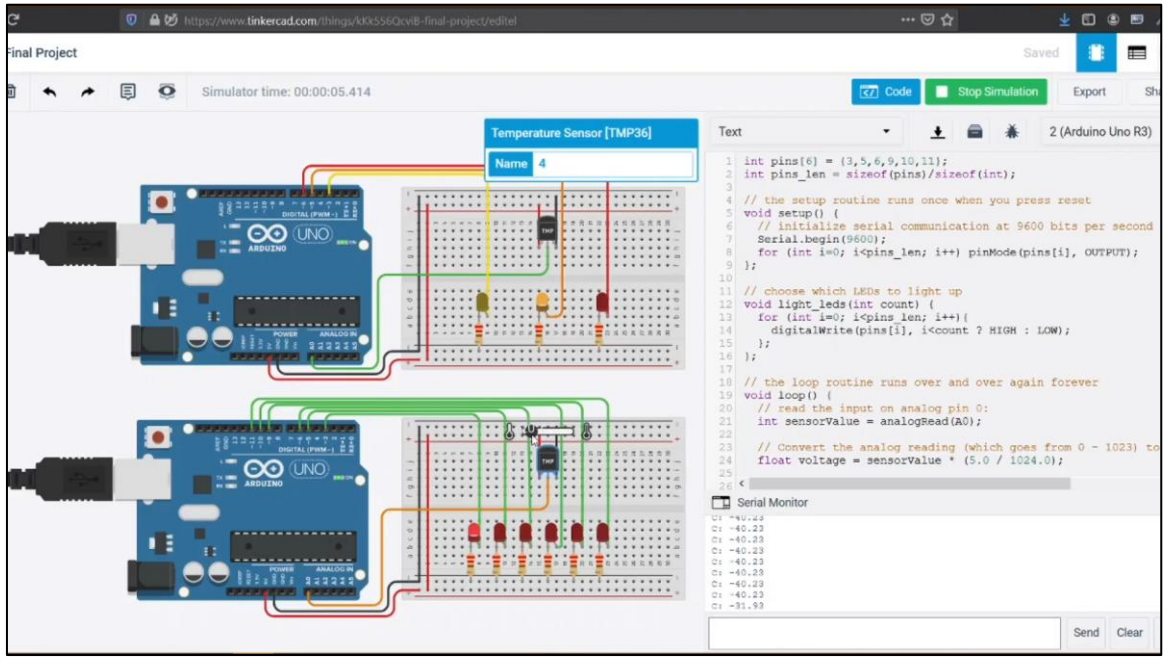
```
int pins[6] = {3,5,6,9,10,11};
int pins_len = sizeof(pins)/sizeof(int);

// the setup routine runs once when you press reset
void setup() {
  // initialize serial communication at 9600 bits per second
  Serial.begin(9600);
  for (int i=0; i<pins_len; i++) pinMode(pins[i], OUTPUT);
};

// choose which LEDs to light up
void light_leds(int count) {
  for (int i=0; i<pins_len; i++){
    digitalWrite(pins[i], i<count ? HIGH : LOW);
  };
};

// the loop routine runs over and over again forever
void loop() {
  // read the input on analog pin 0:
  int sensorValue = analogRead(A0);

  // Convert the analog reading (which goes from 0 - 1023) to a voltage (0 - 5V):
  float voltage = sensorValue * (5.0 / 1024.0);

  // convert voltage to C
  float C = (voltage - 0.5) * 100;

  // print C temp
  Serial.println();
  Serial.print("C: ");
  Serial.print(C);

  // choose which LED(s) to light
  if (C < 20) light_leds(1);            // <20 == 1
  if (C >= 20 && C < 40) light_leds(2);  // 20-40 == 2
  if (C >= 40 && C < 60) light_leds(3);  // 40-60 == 3
  if (C >= 60 && C < 80) light_leds(4);  // 60-80 == 4
  if (C >= 80 && C < 100) light_leds(5); // 80-100 == 5
  if (C >= 100) light_leds(6);          // >100 == 6
};

```

Results

Digital Circuit Demo



Analog Circuit Demo



Conclusion

As seen in the demonstrations, both circuits operate according to the required specifications:

- Both continually read ambient temperature values from the TMP36.
- The digital thermometer lights a single LED to indicate a specific “temperature zone.”
- The analog thermometer lights multiple LEDs to indicate a “temperature level.”