LECTURE 7
Humidity and Temperature Sensor

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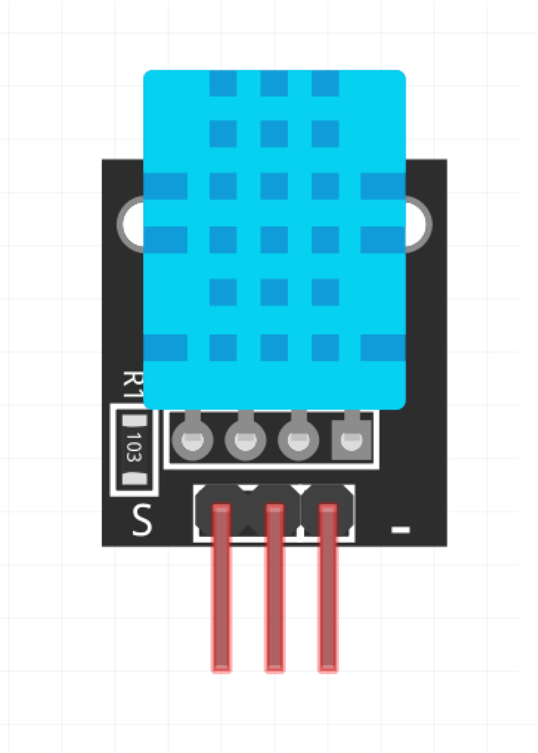
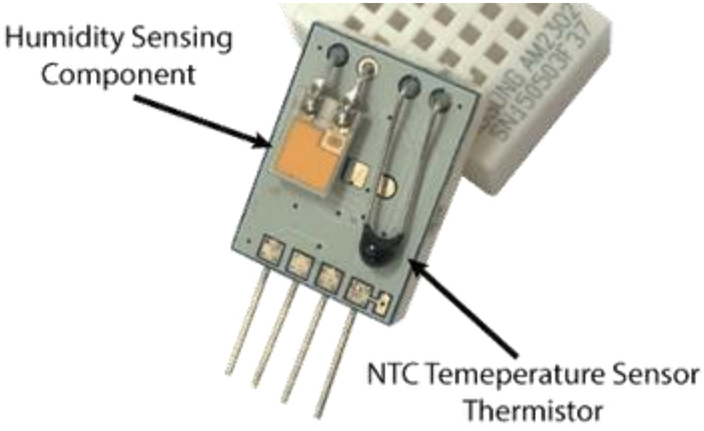
Department of Mechanical Engineering
Korea Advanced Institute of Science and Technology (KAIST)

Syllabus:

Week	Date& Time*	Content
1		No Class (Course Add/Drop Period)
2	March 6 (Mon) 20-22	Orientation and Course Overview
3	March 13 (Mon) 20-22	Sensor Fundamentals
4	March 20 (Mon) 20-22	Arduino Fundamentals
5	March 27 (Mon) 20-22	Arduino Programming and Applications
6	April 3 (Mon) 20-22	Force Sensor and Application: Control Multiple LEDs
7	April 10 (Mon) 20-22	Light Sensor and Application: Solar Tracker
8	April 17	No Class (Midterm)
9	April 24 (Mon) 20-22	Humidity and Temperature Sensor and Application: Temperature Controlled Fan
10	May 1 (Mon) 20-22	Gas Sensor and Application: Smoke Detector
11	May 8 (Mon) 20-22	Sound Sensor and Application: Control LED by Clapping
12	May 15 (Mon) 20-22	Accelerometer Sensor and Application: Ping Pong Game
13	May 22 (Mon) 20-22	Ultrasonic Sensor and Application: Flappy Bird Game
14	May 29 (Mon) 20-22	Course Wrap-up
15	June 5	No Class (Final)
16	June 12	No Class (Final)

Humidity and Temperature Sensor




Humidity Sensing Component
NTC Temeperature Sensor Thermistor
SONG AM2302
SN150503F37

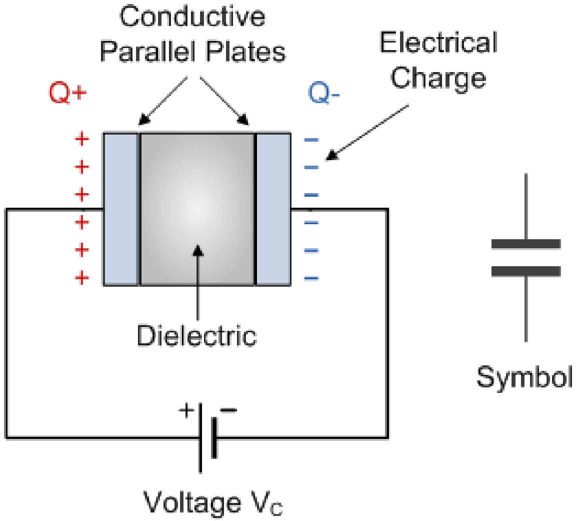
CAPACITOR AND CAPACITANCE

https://www.youtube.com/watch?v=mliaqpBYQIs

Capacitance is the ability of a component or circuit to collect and store energy in the form of an electrical charge.

Capacitors are energy-storing devices available in many sizes and shapes. They consist of two plates of conducting material (usually a thin metal) sandwiched between an insulator made of ceramic, film, glass or other materials, even air.

The insulator is also known as a **dielectric**, and it boosts a capacitor's charging capacity.



Capacitors and batteries both store energy. While batteries release energy gradually, capacitors discharge it quickly.

How does a capacitor work?

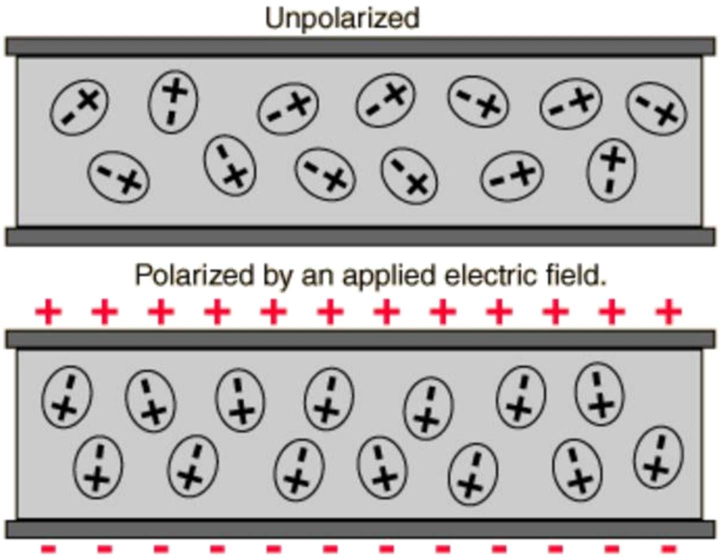
- A capacitor collects energy (voltage) as current flows through an electrical circuit.
- Both plates hold equal charges, and as the positive plate collects a charge, an equal charge flows off the negative plate.

- **Capacitance** is expressed as the ratio of the electric charge on each conductor to the potential difference (i.e., voltage) between them.

- The capacitance value of a capacitor is measured in farads (F), units named for English physicist Michael Faraday (1791–1867).

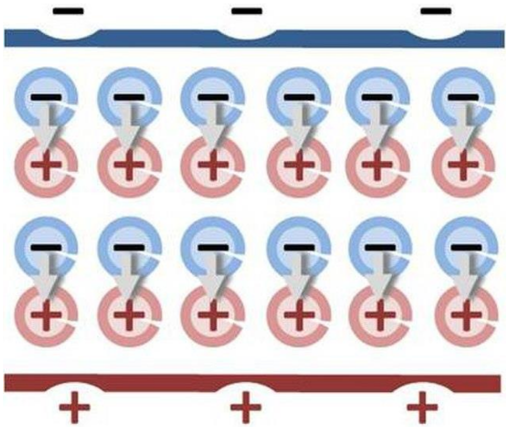
Polarisation is the orientation of polar molecules inside the dielectric towards opposite electrodes.

A dielectric consists of lots of polar molecules that have both a positive and a negative end. When no charge is stored by the capacitor, there is no electric field, and these molecules randomly point in different directions.



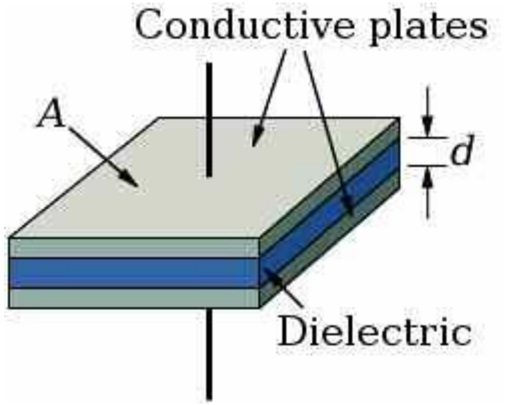
When a voltage is applied to a capacitor, an electric field is generated. The positive ends of the molecules are attracted to the negatively charged plate and vice versa.

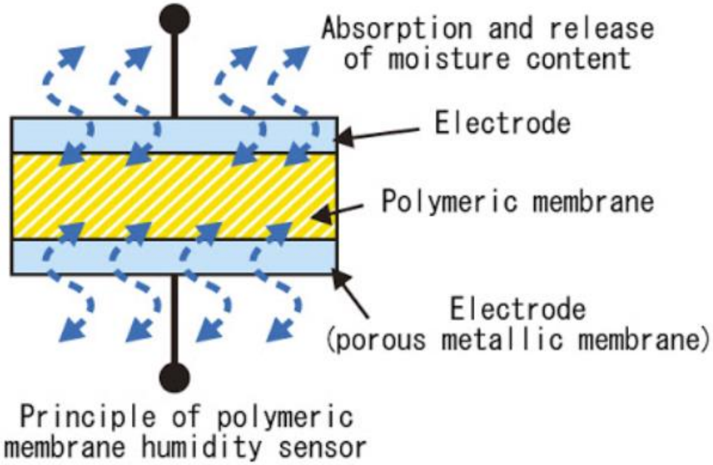
As the dielectric is an insulator and the molecules cannot shift, the polarised molecules orient themselves in such a way that opposite charges on the molecules and the plates face each other.

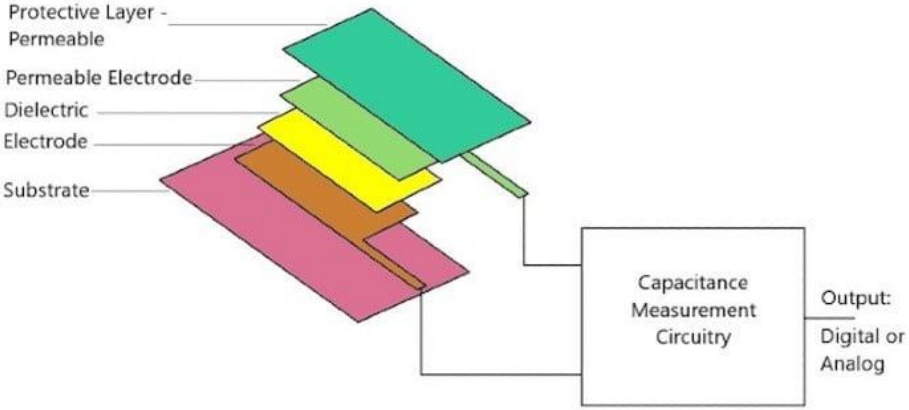


As the electric field of the polarised molecules is in the opposite direction to the capacitor plates, the potential difference is reduced, and the capacitor’s capacity to store charge per unit potential difference is increased.

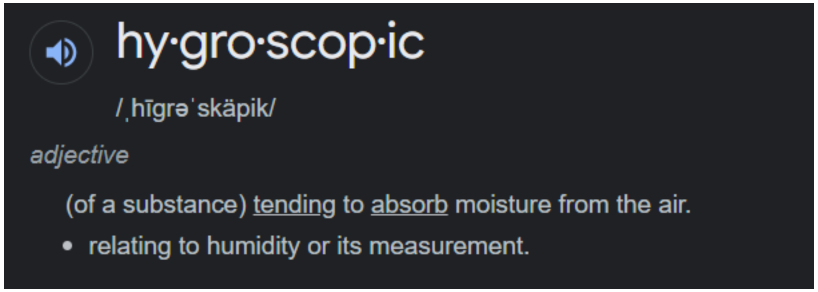
Capacitive Humidity Sensor







The capacitive humidity sensor consists of a hygroscopic dielectric material placed between a pair of electrodes that forms a small capacitor.



hy·gro·scop·ic

/ˌhīɡrəˈskäpik/

adjective

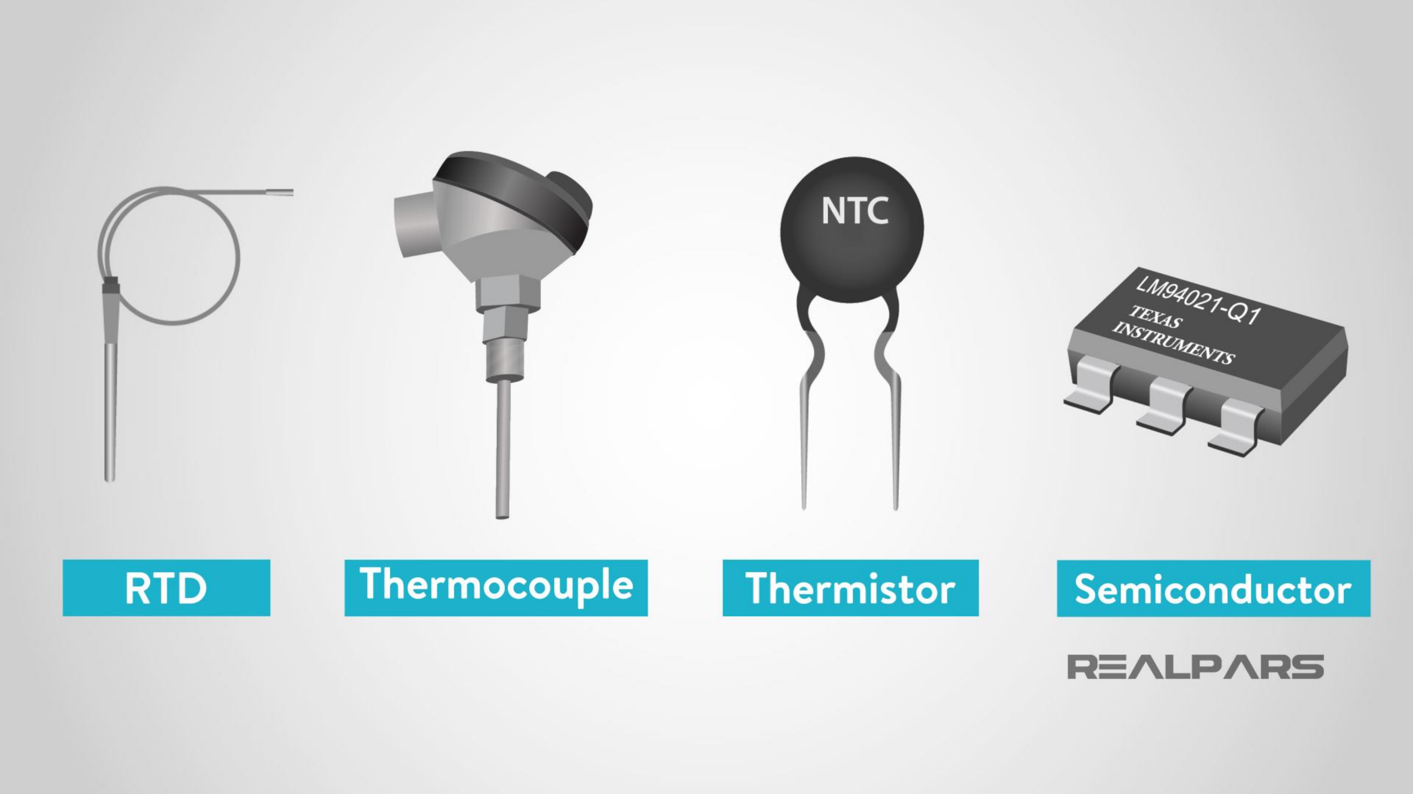
(of a substance) tending to absorb moisture from the air.

- relating to humidity or its measurement.

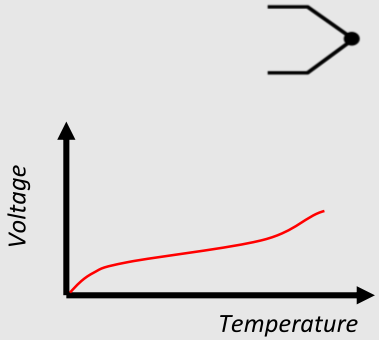
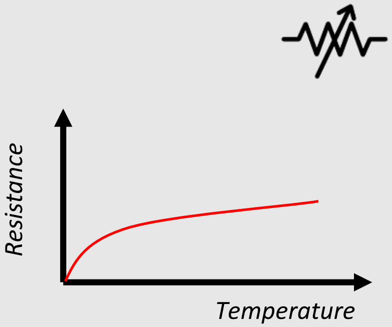
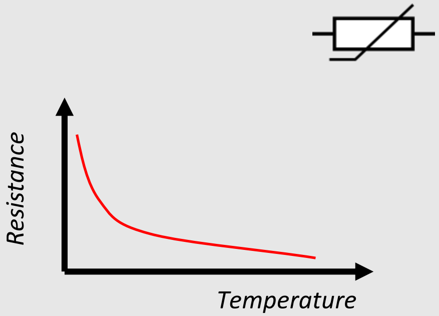
The water molecule is highly polarized (with a dielectric constant of around 80), which can be much higher than polymers. When the dielectric absorbs water vapor, its dielectric constant increases, thus increasing the capacitance. At lower humidity, the dielectric gives up some water, and the capacitance goes back down. The change is nearly linear with RH (relative humidity) and is only slightly affected by temperature.

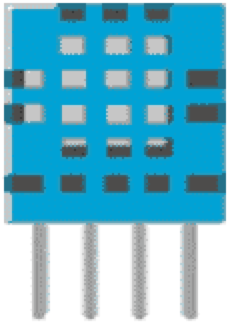
Temperature Sensors

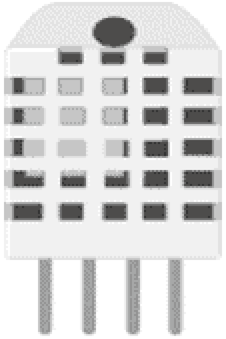
A temperature sensor is an electronic device that measures the temperature of its environment and converts the input data into electronic data to record, monitor, or signal temperature changes.



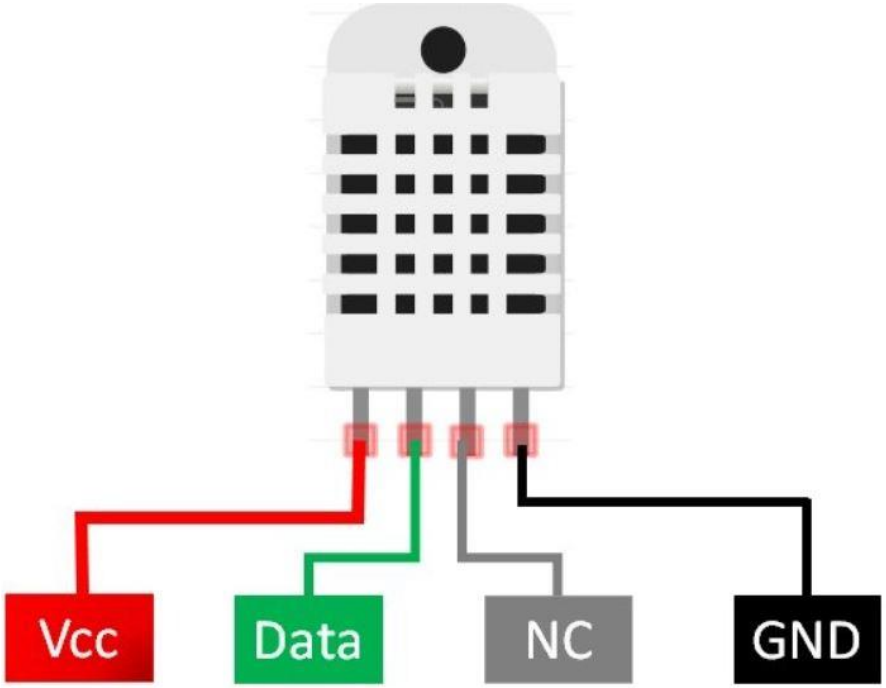
Temperature Sensors

	Thermocouple	RTD	Thermistor
Principle			
Advantage	Simple structure Wide temp. range	Stable Accurate	Fast High output
Disadvantage	Non-linear response	Low-sensitivity	Limited temp. range

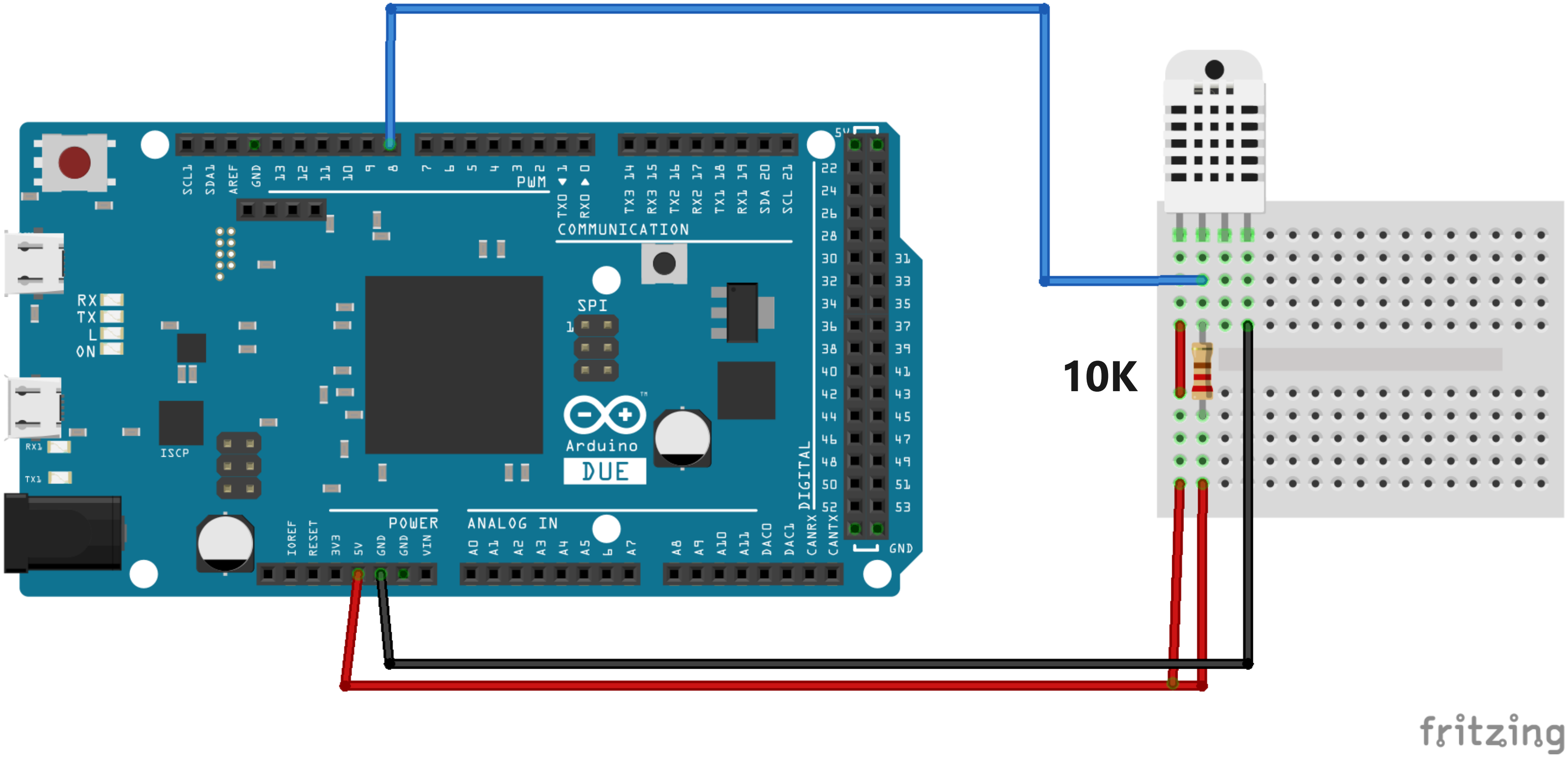


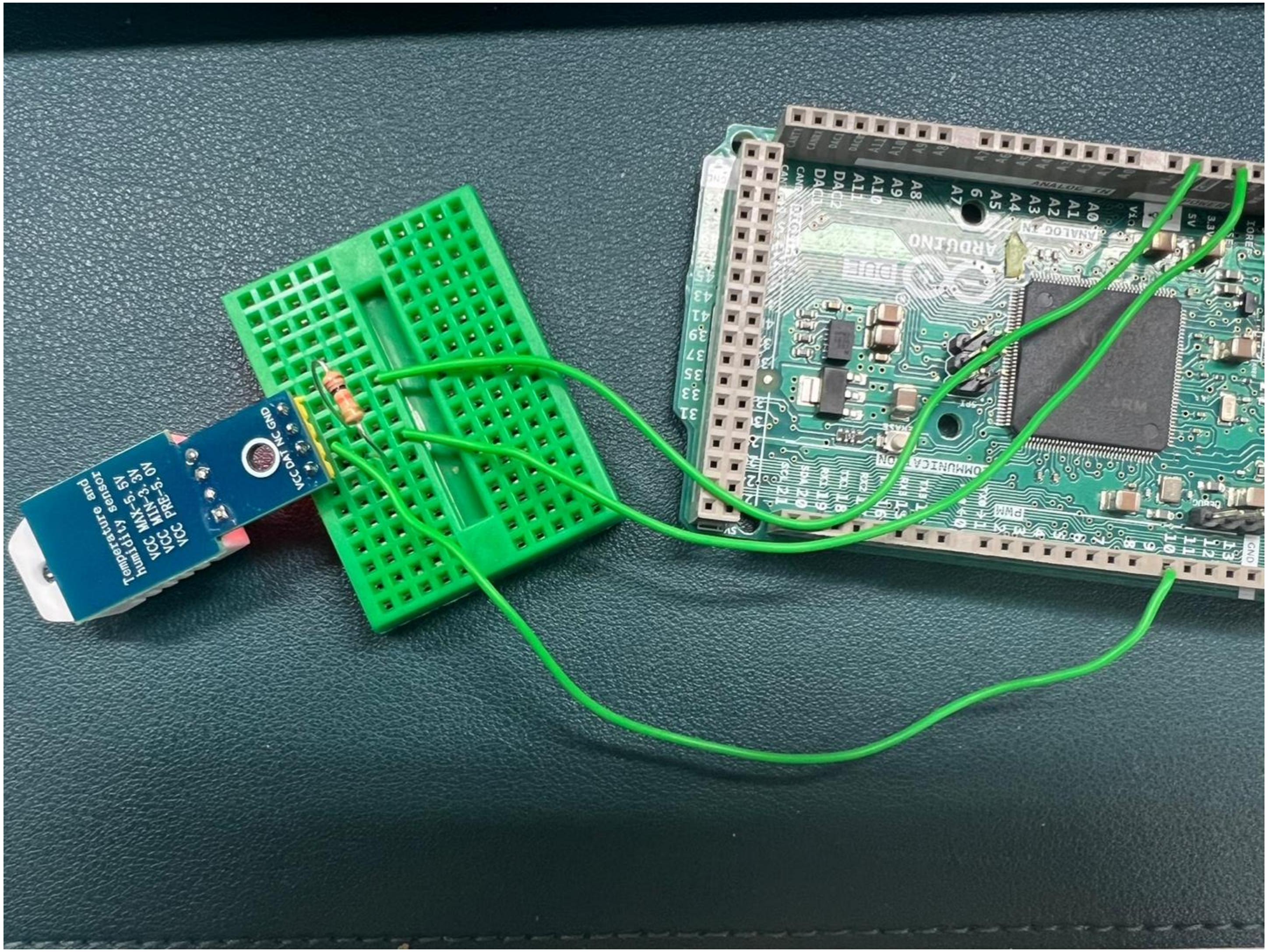


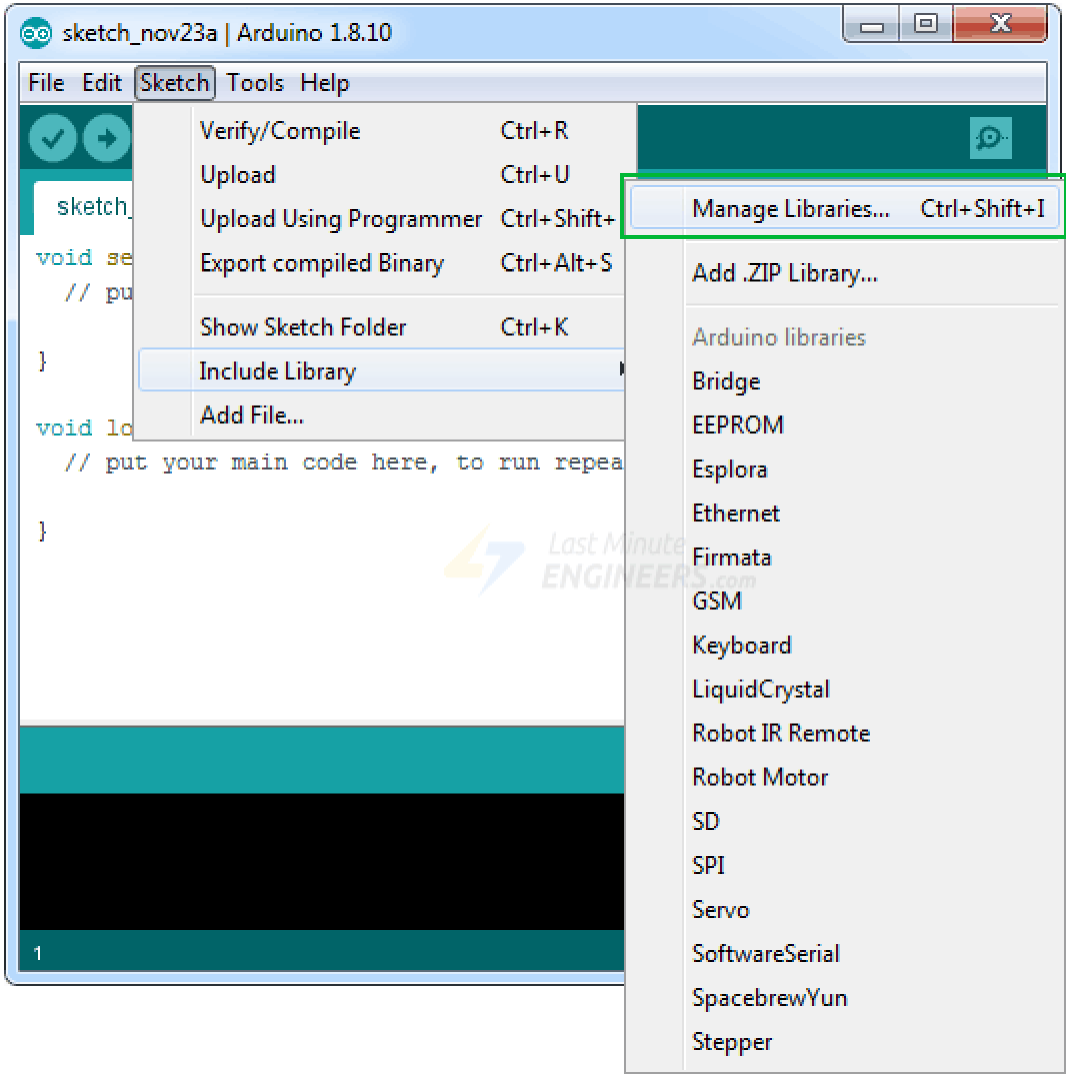
	DHT11	DHT22
Operating Voltage	3 to 5V	3 to 5V
Max Operating Current	2.5mA max	2.5mA max
Temperature Range	0-50°C / ± 2°C	-40 to 80°C / ± 0.5°C
Humidity Range	20-80% / 5%	0-100% / 2-5%
Sampling Rate	1 Hz (reading every second)	0.5 Hz (reading every 2 seconds)
Advantage	low cost	More Accurate



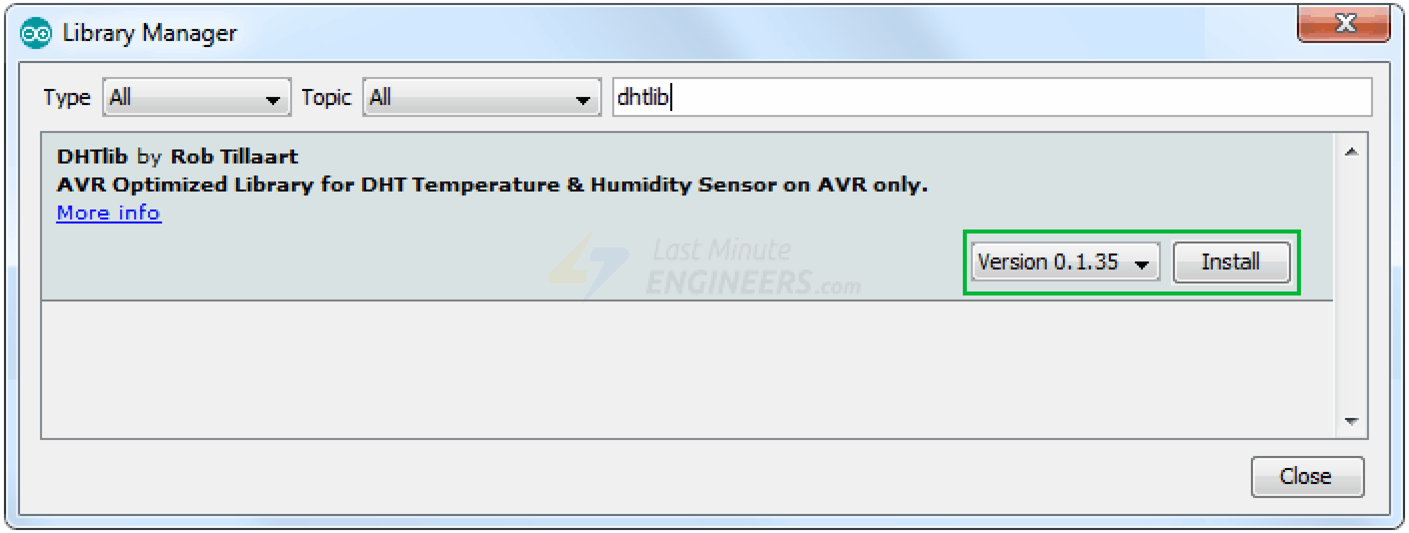
Pin Type	Parameters
Vcc	This is Power Pin at this pin we apply 3.5 v to 5.0 volts.
Data	Through this pin, we get outputs both Temperature and Humidity through serial Data.
Ground	Ground Pin (Connected to 0V or GND)


10K
fritzing
Arduino
DUE
COMMUNICATION
PWM
SPI
ICSP
POWER
ANALOG IN
DIGITAL
RX
TX
L
ON
IOREF
RESET
3V3
5V
GND
GND
VIN
SCL1
SDA1
AREF
GND
TX0
RX0
TX3 14
RX3 15
TX2 16
RX2 17
TX1 18
RX1 19
SDA 20
SCL 21
DAC0
DAC1
CANRX
CANTX


Temperature and
humidity sensor
VCC MAX-5.5V
VCC MIN-3.3V
VCC PRE-5.0V
VCC DAT NC GND
ARDUINO
DUE
ANALOG IN
COMMUNICATION
PWM



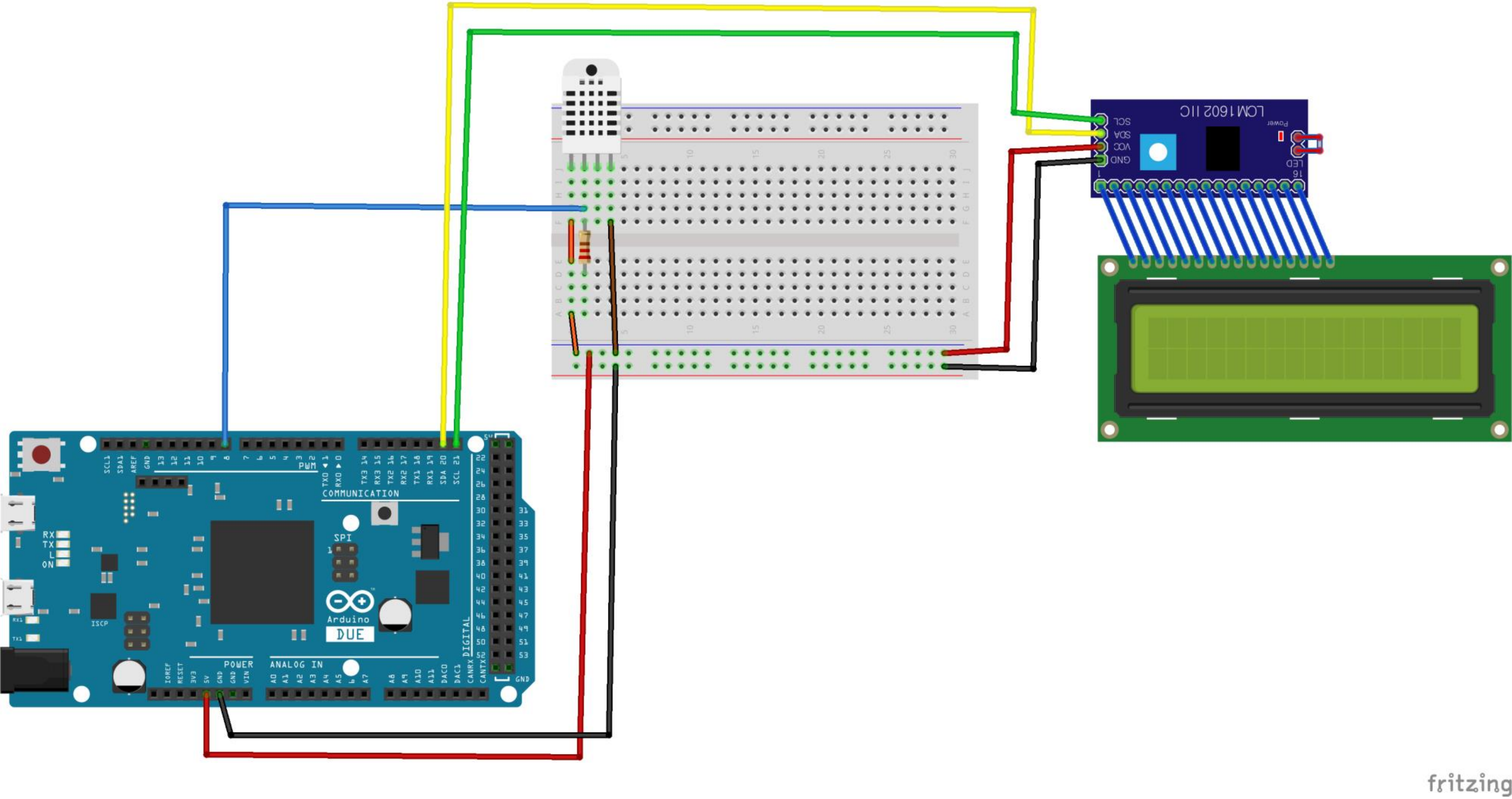
```
void se
  // pu

}

void lo
  // put your main code here, to run repea

}
```

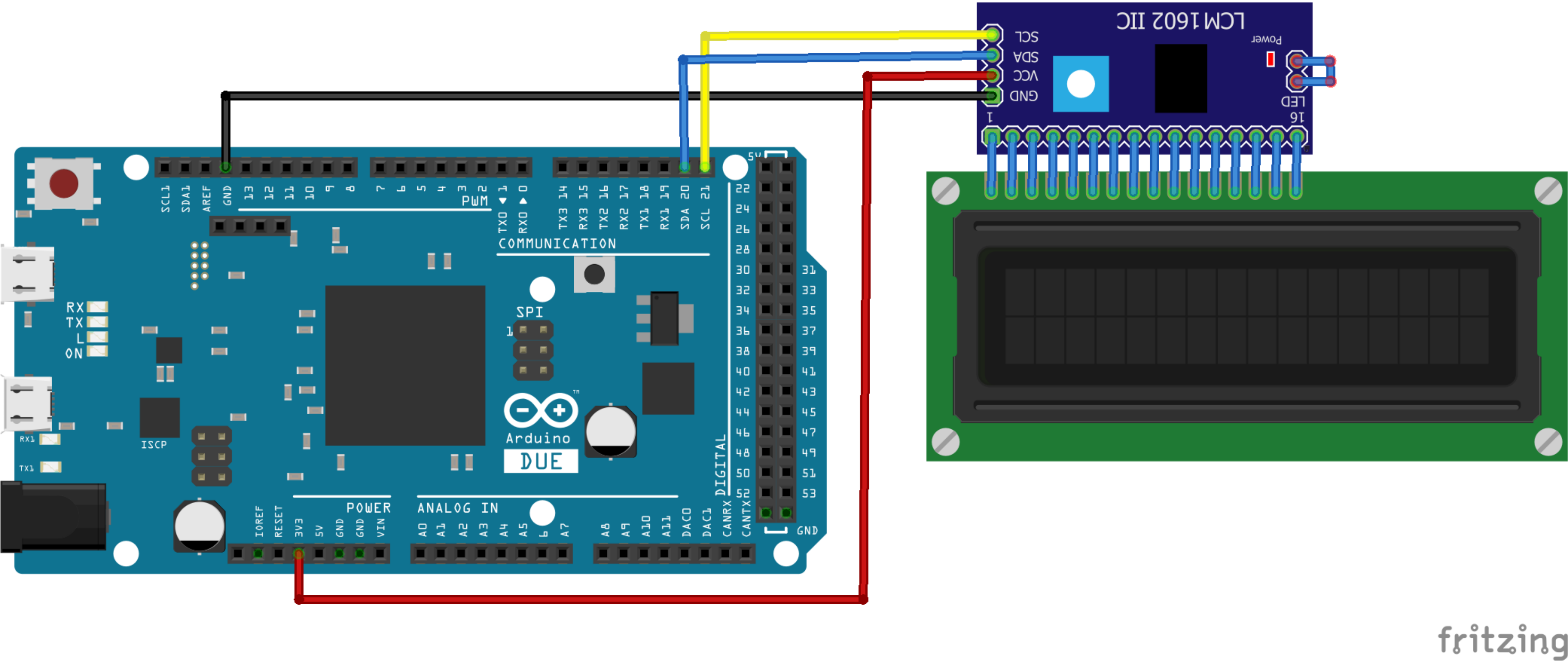


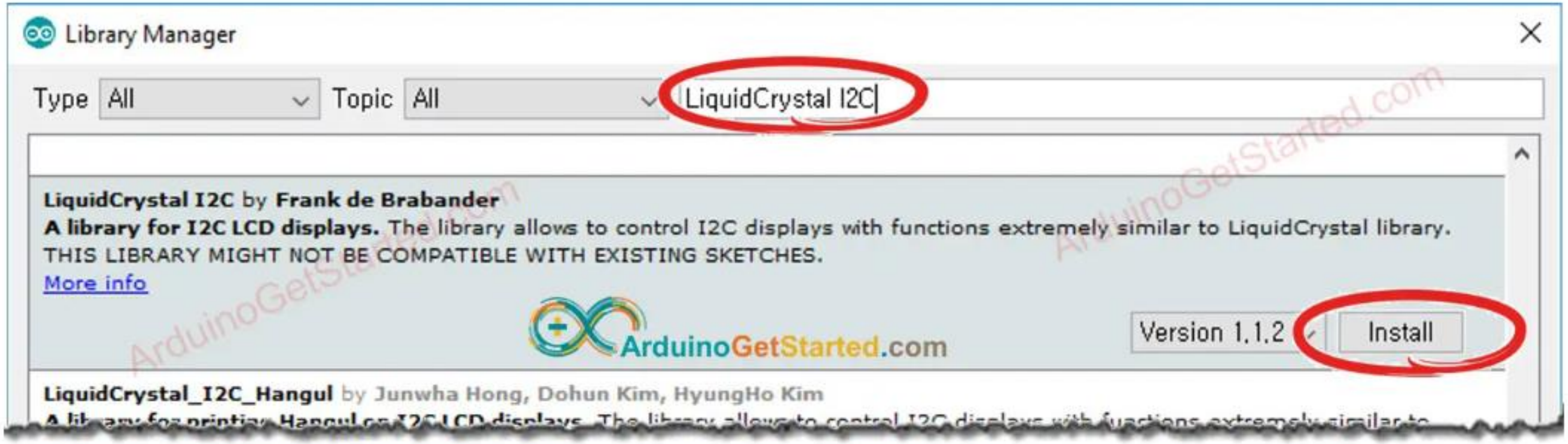
dhtlib

DHTlib by **Rob Tillaart**
AVR Optimized Library for DHT Temperature & Humidity Sensor on AVR only.
More info

```
#include "DHT.h"
DHT dht(8, DHT22);

void setup() {
  Serial.begin(9600);
  dht.begin();
}


void loop() {
  delay(2000);

  float h = dht.readHumidity();
  float t = dht.readTemperature();
  float hic = dht.computeHeatIndex(t, h, false);

  Serial.print("Humidity: ");
  Serial.print(h);
  Serial.print(" %\t");
  Serial.print("Temperature: ");
  Serial.print(t);
  Serial.print(" *C ");
  Serial.print("Heat index: ");
  Serial.print(hic);
  Serial.println(" *C ");
}
```


LCM1602 IIC
SCL
SDA
VCC
GND
Power
LED
1
16
Arduino
DUE
COMMUNICATION
PWM
SPI
ICSP
RX
TX
L
ON
POWER
ANALOG IN
DIGITAL
fritzing


LCM1602 IIC
SCL
SDA
VCC
GND
Power
LED
1
16
SCL1
SDA1
AREF
GND
PWM
TX0
RX0
COMMUNICATION
TX3 14
RX3 15
TX2 16
RX2 17
TX1 18
RX1 19
SDA 20
SCL 21
5V
SPI
RX
TX
L
ON
RX1
TX1
ICSP
Arduino
DUE
IOREF
RESET
3V3
5V
GND
GND
VIN
POWER
ANALOG IN
A0
A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
A11
DAC0
DAC1
CANRX
CANTX
DIGITAL
GND
fritzing



Type All

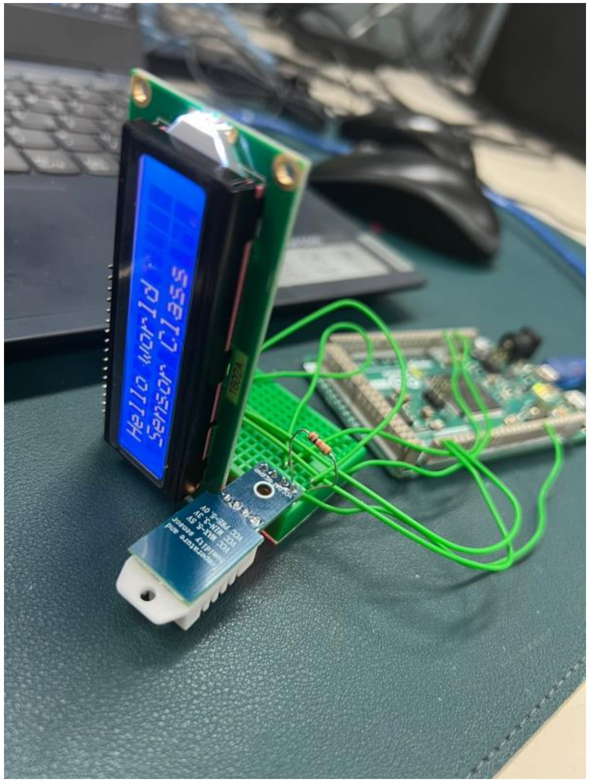
Topic All

LiquidCrystal I2C

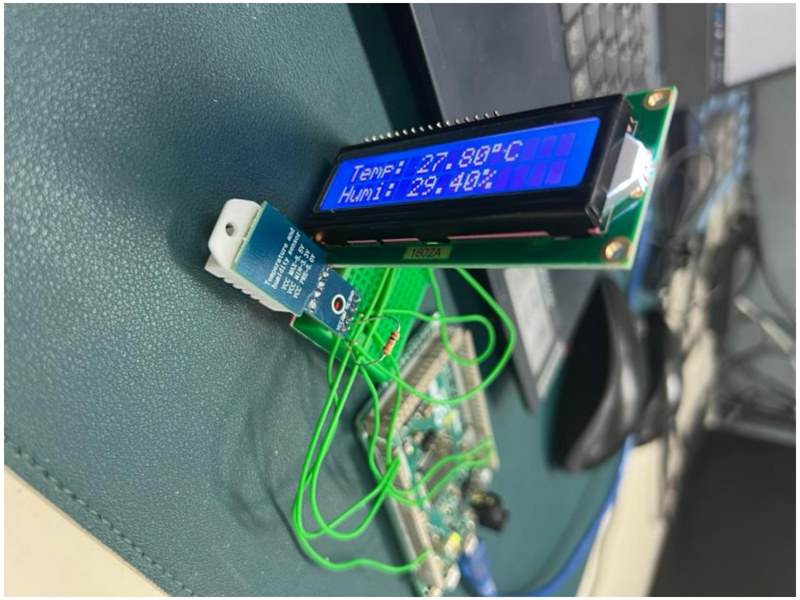
LiquidCrystal I2C by **Frank de Brabander**
A library for I2C LCD displays. The library allows to control I2C displays with functions extremely similar to LiquidCrystal library. THIS LIBRARY MIGHT NOT BE COMPATIBLE WITH EXISTING SKETCHES.
More info

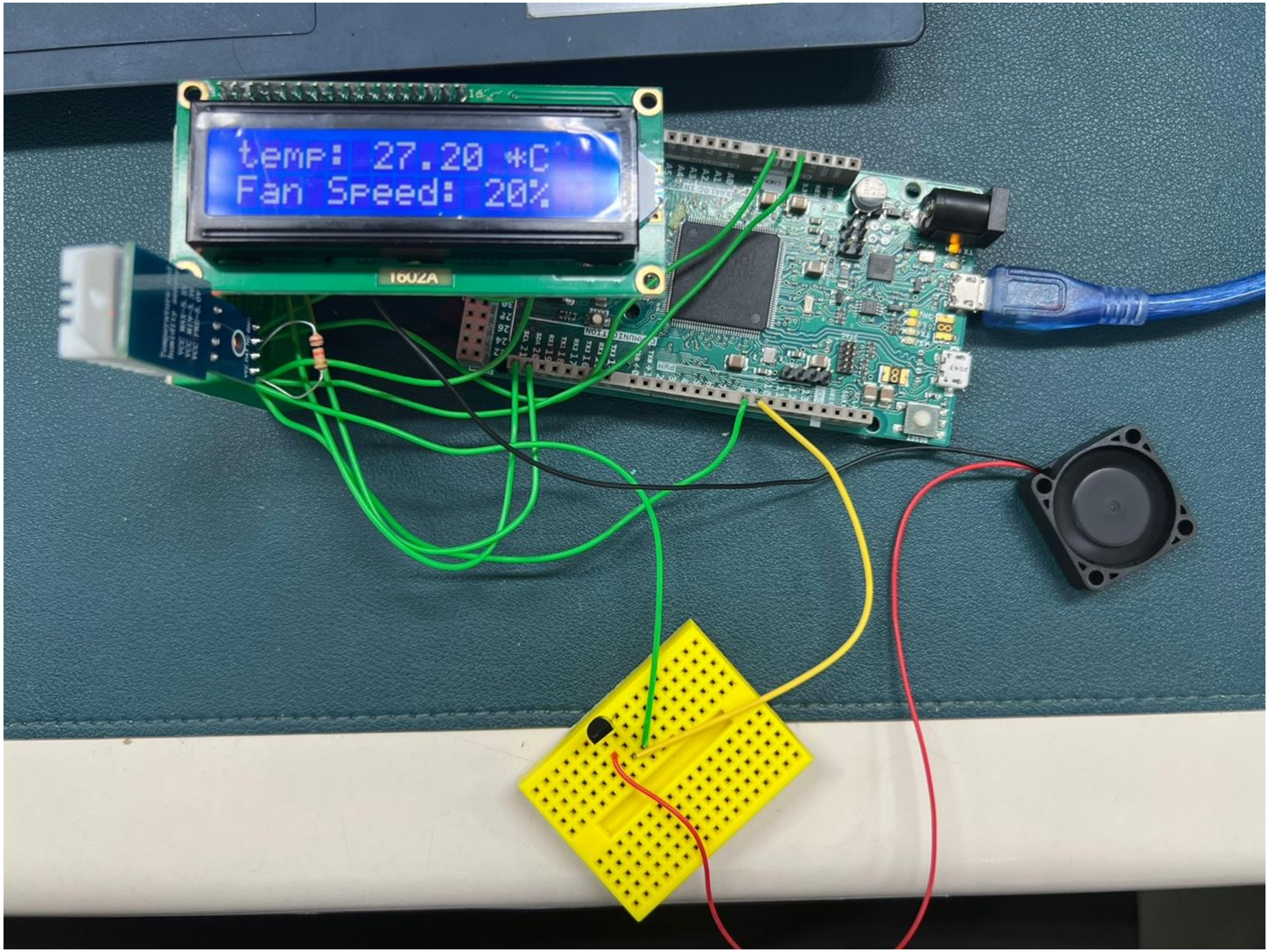
LiquidCrystal_I2C_Hangul by Junwha Hong, Dohun Kim, HyungHo Kim
A library for printing Hangul on I2C LCD displays. The library allows to control I2C displays with functions extremely similar to

```
#include <LiquidCrystal_I2C.h>


LiquidCrystal_I2C lcd(0x27,16,2); // set the LCD address to 0x3F or 0x27 for a 16 chars and 2 line display

void setup()
{
lcd.init(); // initialize the lcd
// Print a message to the LCD.
lcd.backlight();
lcd.setCursor(0,0);
lcd.print("Hello world");
lcd.setCursor(1,1);
lcd.print("Sensor Class");
}

void loop()
{

}
```

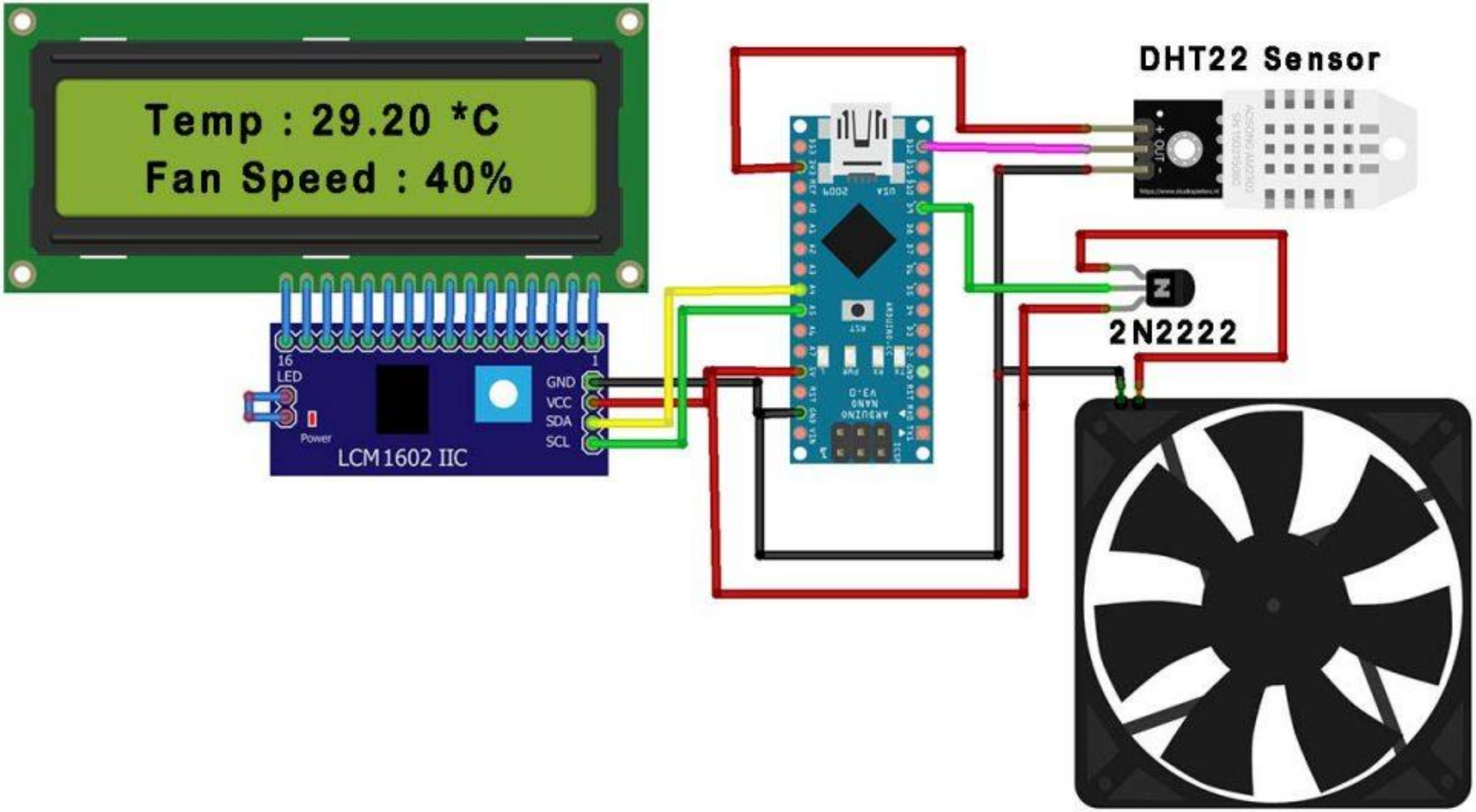


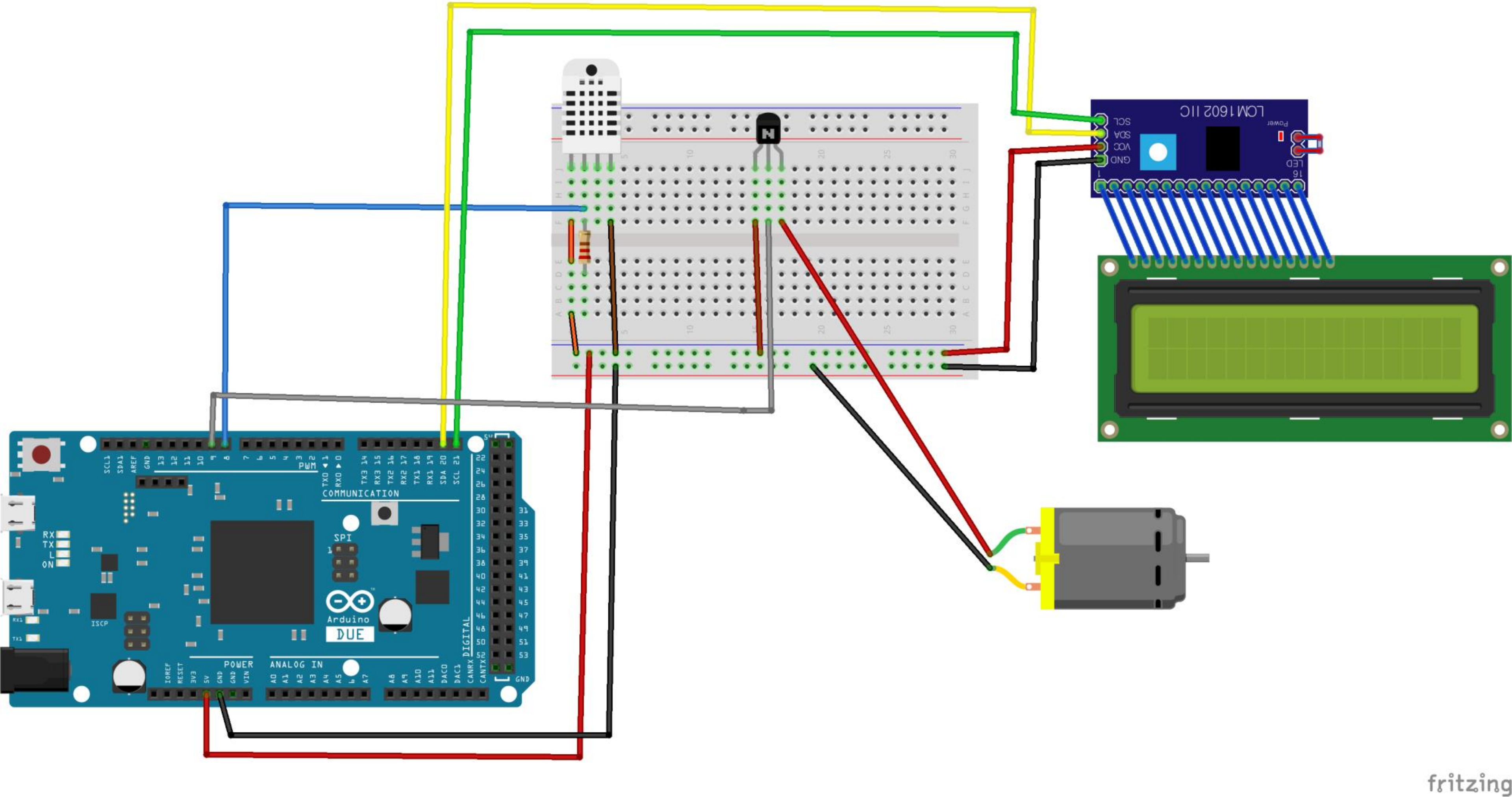
```
#include <LiquidCrystal_I2C.h>
#include "DHT.h"
#define DHTPIN 8
#define DHTTYPE DHT22

LiquidCrystal_I2C lcd(0x27, 16, 2);  // I2C address 0x3F, 16 column and 2 rows
DHT dht(DHTPIN, DHTTYPE);

void setup()
{
  dht.begin();     // initialize the sensor
  lcd.init();      // initialize the lcd
  lcd.backlight(); // open the backlight
}

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

  float humi  = dht.readHumidity();    // read humidity
  float tempC = dht.readTemperature(); // read temperature

  lcd.clear();
  // check if any reads failed
  if (isnan(humi) || isnan(tempC)) {
    lcd.setCursor(0, 0);
    lcd.print("Failed");
  } else {
    lcd.setCursor(0, 0);  // start to print at the first row
    lcd.print("Temp: ");
    lcd.print(tempC);     // print the temperature
    lcd.print((char)223); // print ° character
    lcd.print("C");

    lcd.setCursor(0, 1);  // start to print at the second row
    lcd.print("Humi: ");
    lcd.print(humi);      // print the humidity
    lcd.print("%");
  }
}
```





temp: 27.20 *C
Fan Speed: 20%
1602A


Temp : 29.20 *C
Fan Speed : 40%
DHT22 Sensor
2N2222
16
LED
Power
LCM1602 IIC
1
GND
VCC
SDA
SCL


LCM1602 IIC
SCL
SDA
VCC
GND
Power
LED
16
1
N
COMMUNICATION
PWM
SPI
ICSP
Arduino
DUE
POWER
ANALOG IN
DIGITAL
fritzing

```
/*Introduction to Sensors and Application Class #7 */

#include "DHT.h"
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27, 16, 2);
#define DHTPIN 8    // what pin we're connected to
//#define DHTTYPE DHT11   // DHT 11
#define DHTTYPE DHT22   // DHT 22
#define pwm 9
byte degree[8] =
{
 0b00011,
 0b00011,
 0b00000,
 0b00000,
 0b00000,
 0b00000,
 0b00000,
 0b00000
};
// Initialize DHT sensor for normal 16mhz Arduino
DHT dht(DHTPIN, DHTTYPE);
void setup() {
 //lcd.begin();
 lcd.init();     // initialize the lcd
 lcd.backlight(); // open the backlight
 lcd.createChar(1, degree);
 lcd.clear();
 lcd.print("   Fan Speed  ");
 lcd.setCursor(0, 1);
 lcd.print("  Controlling  ");
 delay(2000);
 analogWrite(pwm, 255);
 lcd.clear();
 lcd.print("Temp Sensor");
 lcd.setCursor(0, 1);
 lcd.print("Sensor Class");
 delay(2000);
 lcd.clear();
 Serial.begin(9600);
 dht.begin();
}
void loop() {
 // Wait a few seconds between measurements.
 delay(2000);
 // Reading temperature or humidity takes about 250 milliseconds!
 // Sensor readings may also be up to 2 seconds 'old' (its a very slow sensor)
 float h = dht.readHumidity();
 // Read temperature as Celsius
 float t = dht.readTemperature();
 // Check if any reads failed and exit early (to try again).
 if (isnan(h) || isnan(t)) {
 Serial.println("Failed to read from DHT sensor!");
  return;
 }
 Serial.print("Humidity: ");
 Serial.print(h);
 Serial.print(" %\t");
 Serial.print("temperature: ");
 Serial.print(t);
 Serial.print(" *C ");
 lcd.clear();
 lcd.setCursor(0, 0);
 lcd.print("temp: ");
 lcd.print(t);   // Printing temperature on LCD
 lcd.print(" *C");
 lcd.setCursor(0, 1);
 if (t < 27 )
{
 analogWrite(9, 0);
  lcd.print("Fan OFF          ");
  delay(100);
 }
 else if (t >= 27 && t <= 29)
{
 analogWrite(pwm, 51);
  lcd.print("Fan Speed: 20%  ");
  delay(100);
  digitalWrite(pwm, 51);
 }
 else if (t >= 29 && t <= 30)
{
 analogWrite(pwm, 102);
  lcd.print("Fan Speed: 40%  ");
  digitalWrite(pwm, 102);
  delay(100);

 }
 else if (t >= 30 && t <= 31)
{
  analogWrite(pwm, 153);
  lcd.print("Fan Speed: 60%  ");
  digitalWrite(pwm, 153);
  delay(100);
 }
else if (t >= 31 && t <= 32)
{
  analogWrite(pwm, 204);
  lcd.print("Fan Speed: 80%   ");
  digitalWrite(pwm, 204);
  delay(100);
 }
 else if (t >= 32)
{
  analogWrite(pwm, 255);
  lcd.print("Fan Speed: 100%  ");
  digitalWrite(pwm, 255);
  delay(100);
 }
 delay(2000);
}
```