Moisture Content using sensor

IDEA BEHIND:

Water content through the oven-dry method is often time-consuming, while utilizing a rapid moisture meter, though efficient, can be energy-intensive when employed Determining consistently over an extended duration.

In this project, we aim to speed up the process of getting results while studying how soil behave in relation to water content and other factors.

Our project revolves around calibrating the sensor module based on local conditions and subsequently using the sensor probe to obtain real-time, in situ water content measurements at any given location.

APPROACH

Initially, our focus was on defining the desired project outcomes, and we allocated research tasks among team members. We delved into understanding the various components crucial to our project, such as the soil moisture module. Online resources guided us in comprehending the component's pin configurations.

We undertook comprehensive research on the Arduino IDE further facilitating our programming needs.

COMPONENTS REQUIRED

- **THE COMPONENT REQUIRED ARE AS FOLLOWS :**

1. **Arduino UNO :** It is the core of the project. It is where all the processing of data takes place. It is a microcontroller.
2. **Breadboard:** It is used for connecting the different equipment together. For example, connecting the servo motor to arduino. Though we have not used it for our project, we have connected the wires directly..
3. **Jumper Wires:** Wires used for connection.

COMPONENTS REQUIRED

4. Soil moisture module: It is used to detect moisture of the soil. It measures the volumetric content of water inside the soil and gives us the moisture level as output. The module has both digital and analog outputs.

5. USB: The soil moisture sensor is connected to a microcontroller, such as Arduino, which reads the analog or digital signals from the sensor. The microcontroller processes this data and can communicate with a computer or other devices.

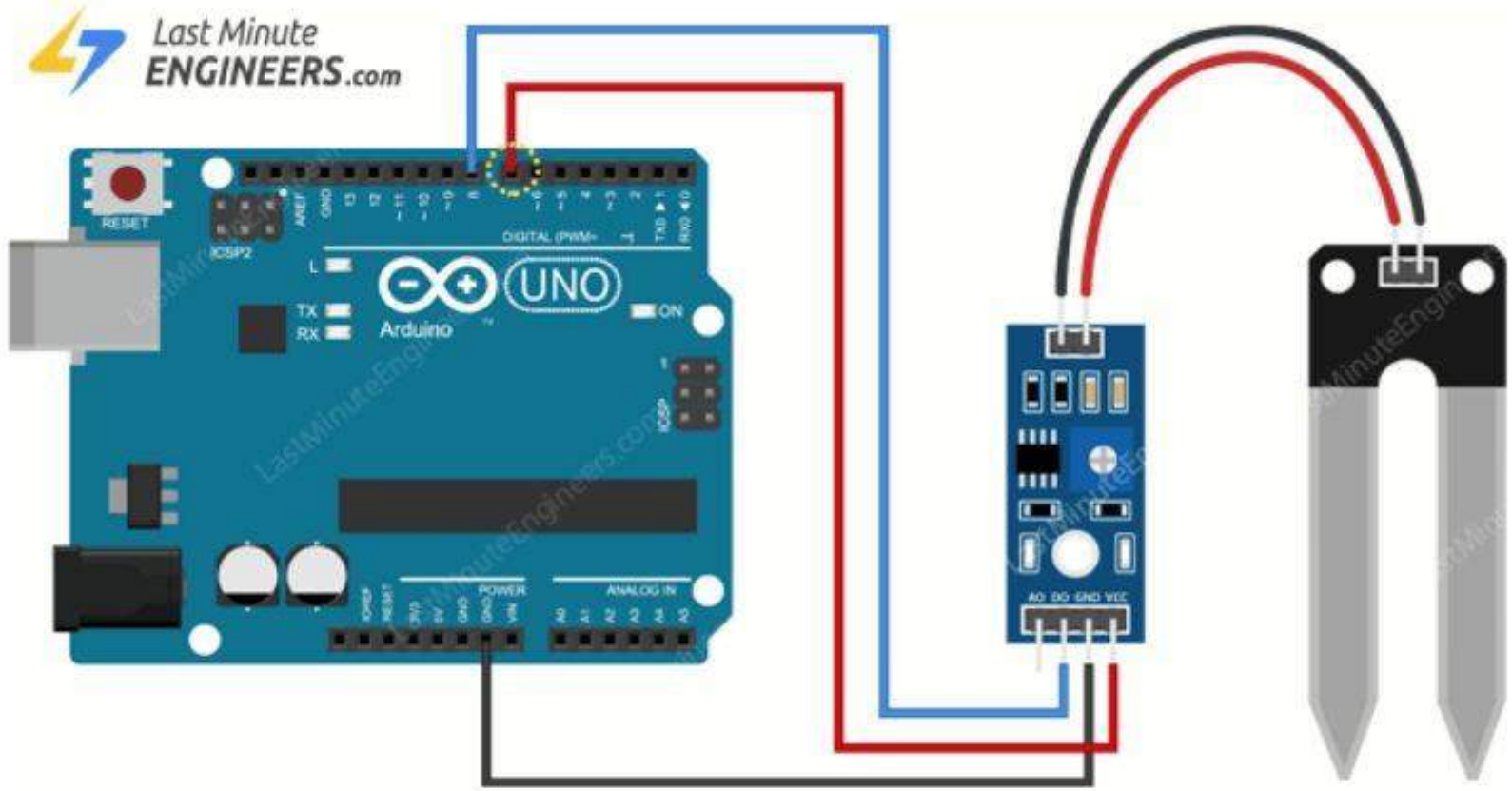
Components Required

Keyboard: It is used to enter various inputs according to our requirement.

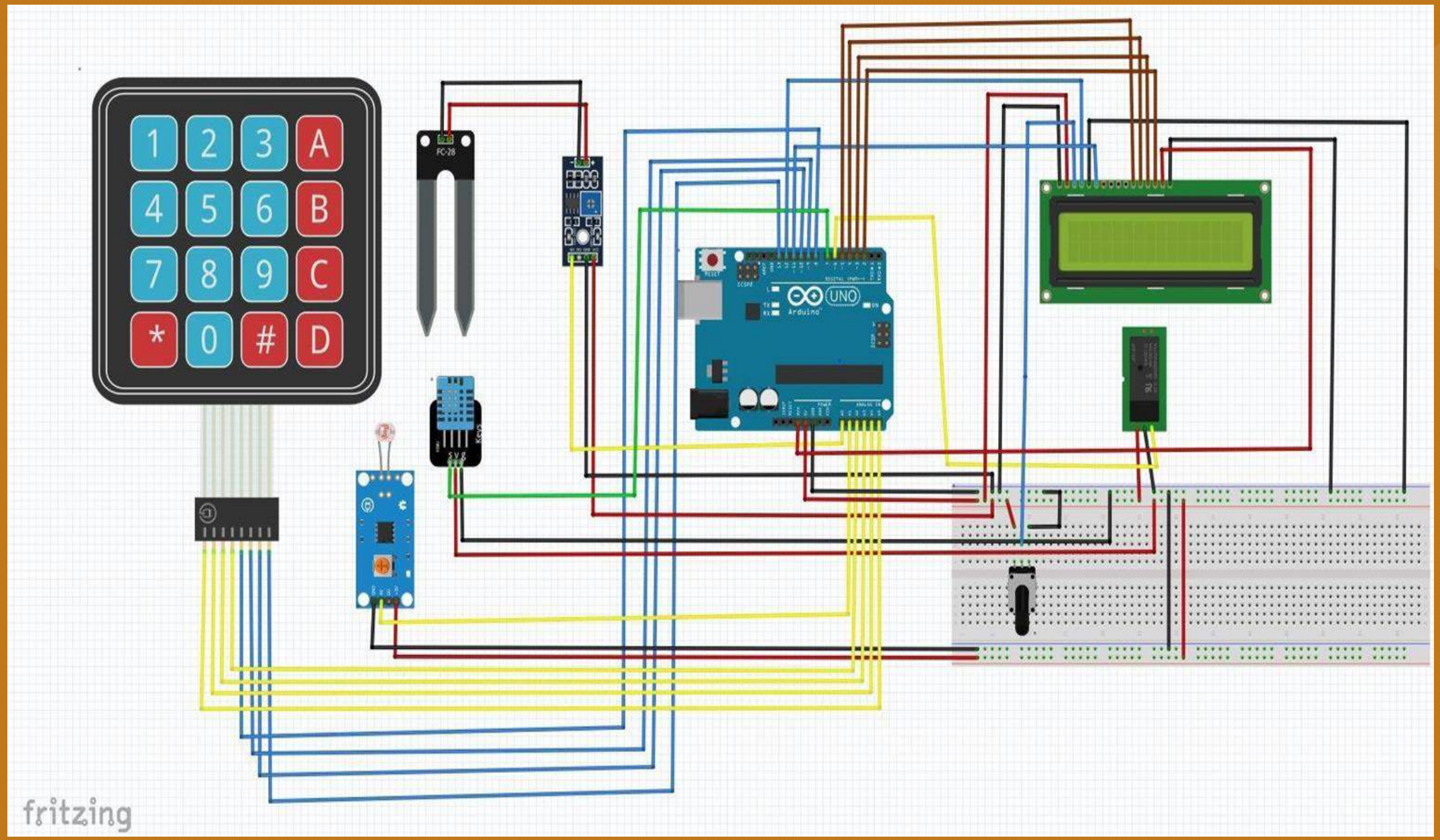
* - Take the circuit to next process

1 – Soil Moisture Content

- 1 – Sandy Soil
- 2 – Bentonite Soil
- 3 – Fly Ash



Power the sensor off a digital pin, only when you take a reading to reduce corrosion rate.


1 2 3 A
4 5 6 B
7 8 9 C
* 0 # D
FC-28
UNO
Arduino
fritzing

Calibration

Calibration of soil moisture sensor module

For the calibration of the moisture sensor module, We have used air and water. After connection and writing some necessary code on Arduino Uno, we have kept the probe in air and noted the analog value that was being displayed in laptop. After air , we dipped the probe in water and noted its reading too. This is basically done for establishing the minimum (air)and maximum(water) range.

Then we used three types of soil samples with varying properties and varying water content. We took 50 gm of each type of soil that is of sandy soil, Bentonite soil, and fly ash. Now taking the water content of 15%, 20% of the weight of the soil sample.

Calibration

We get the analog outputs on the Arduino IDE on the computer. But we transformed the analog output to percentage using some code. The following given data are the code and the output and the calibration curves and tables for each of the soil sample.

Soil Sample taken:

1. Sandy soil
2. Bentonite soil
3. Fly Ash

1.

2.

3.

sketch_nov13a | Arduino IDE 2.2.1

File Edit Sketch Tools Help

Arduino Uno

sketch_nov13a.ino

```
int sensor_pin = A1;

void setup()
{
  Serial.begin(9600);
  pinMode(sensor_pin, INPUT);
}

void loop()
{
  int sensor_data = analogRead(sensor_pin);
  Serial.print("Sensor_data:");
  Serial.println(sensor_data);
  delay(1000);
}
```

Serial Monitor Output

```
Sketch uses 2038 bytes (6%) of program storage space. Maximum is 32256 bytes.
```

Ln 16, Col 3 Arduino Uno on COM5 [not connected] 1

24°C Haze

Search

6:42 PM 11/13/2023

Soil_Moisture | Arduino IDE 2.2.1

File Edit Sketch Tools Help

Arduino Uno

Soil_Moisture.ino

```ino

int sensorPin = A1;     // Soil Moisture Sensor Pin
int sensorValue = 0;    // Initialize sensor reading value
int percentValue;       // Store percentage sensor value
const int dryValue = 1023;  // Replace with your dry calibration value //in air
const int wetValue = 269;  // Replace with your wet calibration value //in water

void setup() {
  Serial.begin(9600);   // Initialize serial communication
}

void loop() {
  sensorValue = analogRead(sensorPin); // Read the sensor value

  // Calculate moisture percentage manually
  percentValue = ((sensorValue - dryValue) * 100) / (wetValue - dryValue); //can also use map function
  percentValue = constrain(percentValue, 0, 100); // Ensure it's within the valid range

  Serial.print("Moisture Percentage: ");
  Serial.print(percentValue);
  Serial.println("%");

  delay(1000); // Delay between readings
}

```

Output

Ln 17, Col 103 Arduino Uno on COM5 [not connected] 2

26°C Near record

Search

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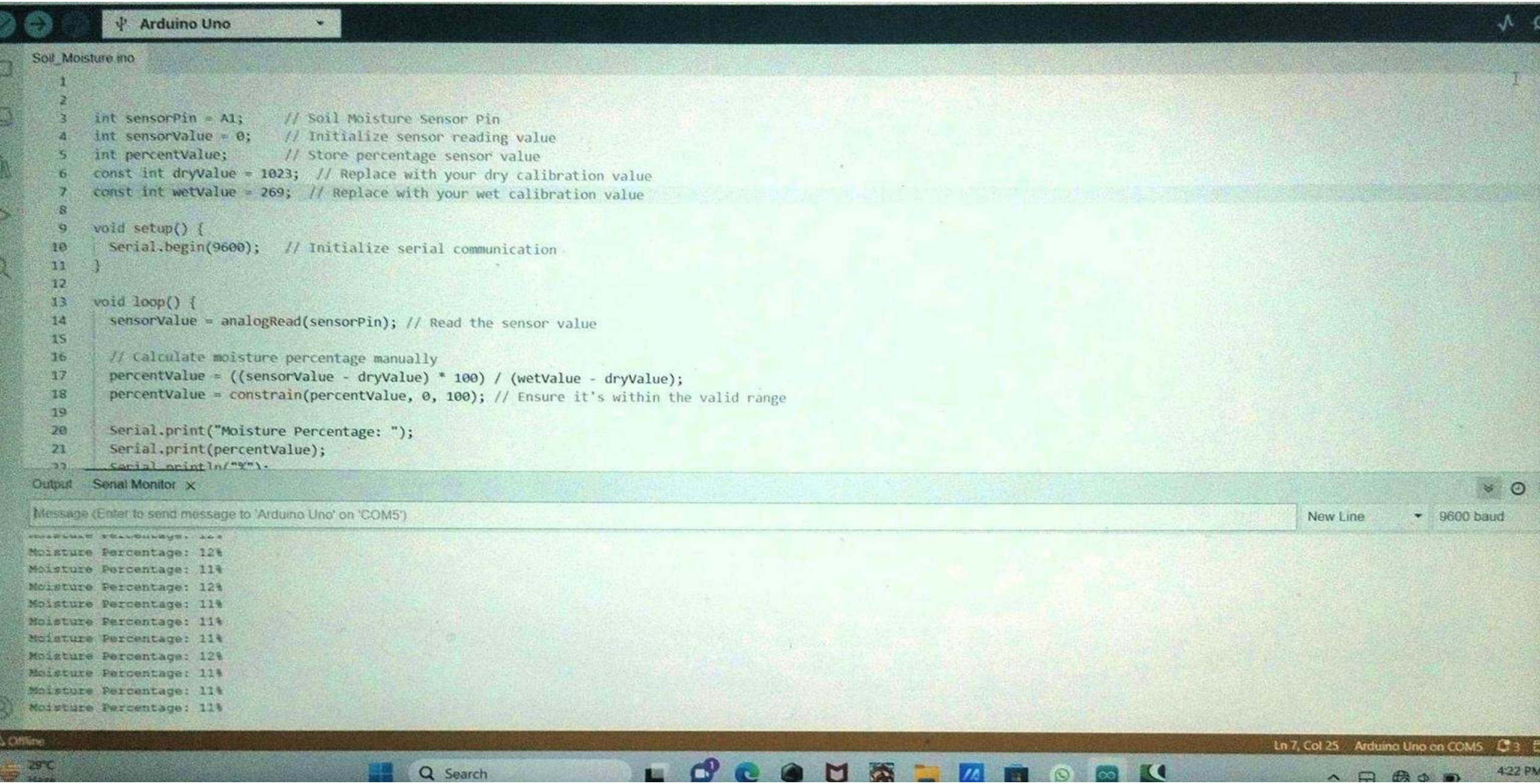
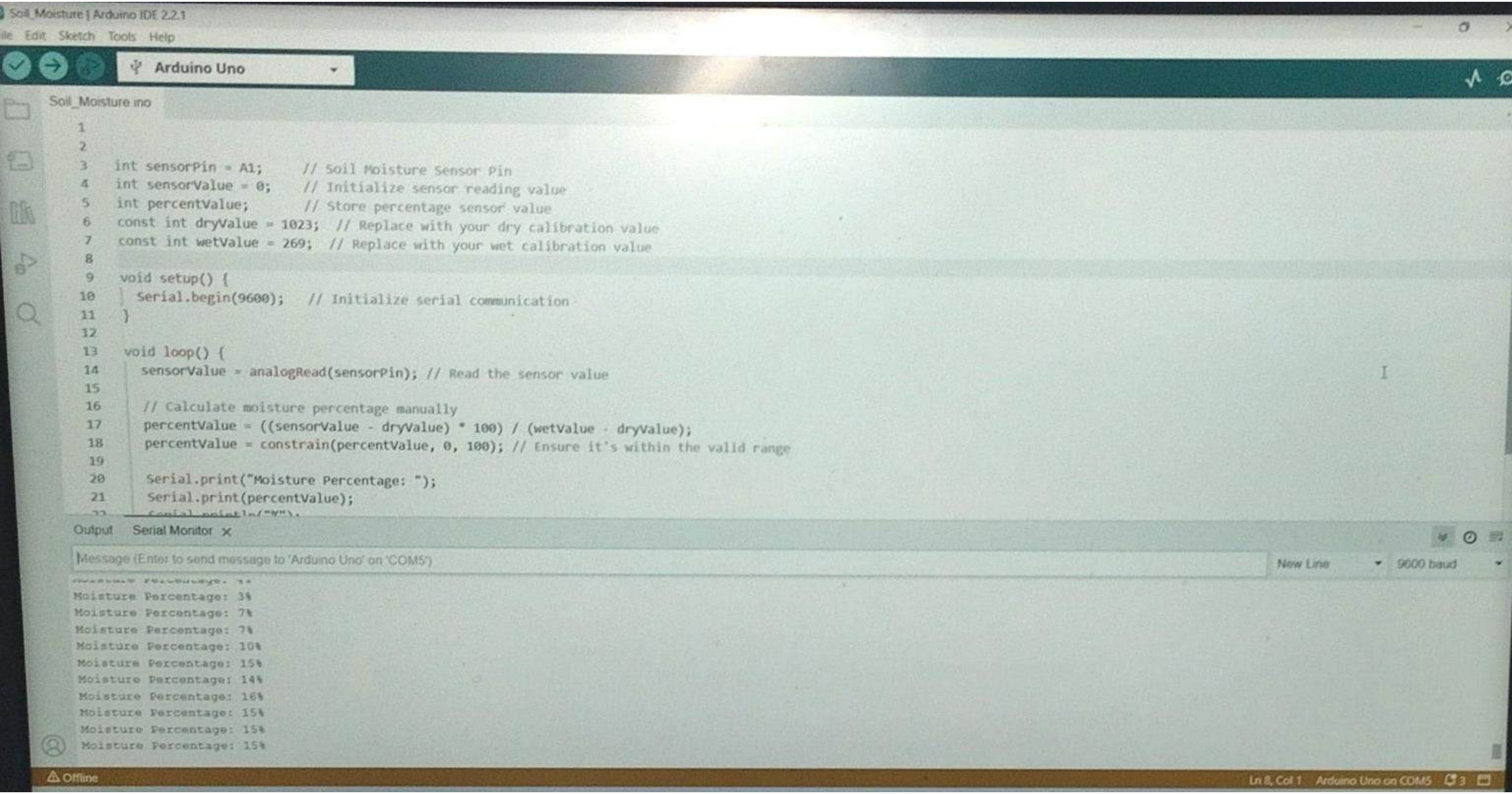
Bentonite Soil(15% water)

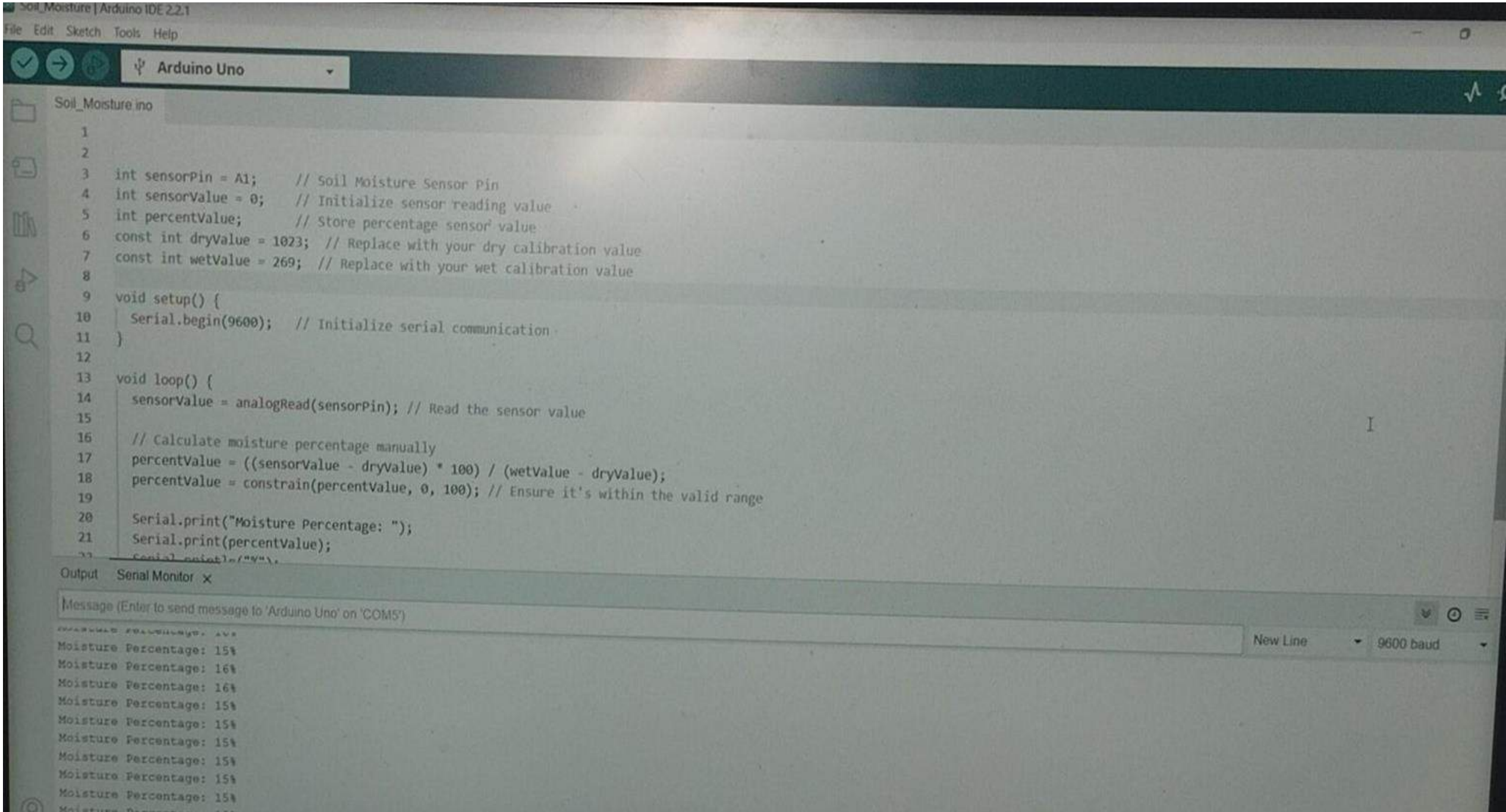


Sandy Soil(15%)

Fly ash(15% water)



Fly Ash(20%)


Soil_Moisture | Arduino IDE 2.2.1
File Edit Sketch Tools Help
Arduino Uno
Soil_Moisture.ino
1
2
3 int sensorPin = A1; // Soil Moisture Sensor Pin
4 int sensorValue = 0; // Initialize sensor reading value
5 int percentValue; // Store percentage sensor value
6 const int dryValue = 1023; // Replace with your dry calibration value
7 const int wetValue = 269; // Replace with your wet calibration value
8
9 void setup() {
10 Serial.begin(9600); // Initialize serial communication
11 }
12
13 void loop() {
14 sensorValue = analogRead(sensorPin); // Read the sensor value
15
16 // Calculate moisture percentage manually
17 percentValue = ((sensorValue - dryValue) * 100) / (wetValue - dryValue);
18 percentValue = constrain(percentValue, 0, 100); // Ensure it's within the valid range
19
20 Serial.print("Moisture Percentage: ");
21 Serial.print(percentValue);
Output Serial Monitor
Message (Enter to send message to 'Arduino Uno' on 'COM5')
New Line
9600 baud
Moisture Percentage: 15%
Moisture Percentage: 16%
Moisture Percentage: 16%
Moisture Percentage: 15%
Moisture Percentage: 15%
Moisture Percentage: 15%
Moisture Percentage: 15%
Moisture Percentage: 15%
Moisture Percentage: 15%
Moisture Percentage: 15%

Bentonite Soil(20%)

```
12
13  void loop() {
14    sensorValue = analogRead(sensorPin); // Read the sensor value
15
16    // Calculate moisture percentage manually
17    percentValue = ((sensorValue - dryValue) * 100) / (wetValue - dryValue);
18    percentValue = constrain(percentValue, 0, 100); // Ensure it's within the valid range
19
20    Serial.print("Moisture Percentage: ");
21    Serial.print(percentValue);
      Serial.println("%");
```

Output Serial Monitor ×

Message (Enter to send message to 'Arduino Uno' on 'COM5')

```
Moisture Percentage: 2%
Moisture Percentage: 1%
Moisture Percentage: 11%
Moisture Percentage: 22%
Moisture Percentage: 24%
Moisture Percentage: 22%
Moisture Percentage: 23%
Moisture Percentage: 22%
Moisture Percentage: 21%
Moisture Percentage: 20%
```

Sandy Soil(20%)

```
13  void loop() {
14    sensorValue = analogRead(sensorPin); // Re   he sensor value
15
16    // Calculate moisture percentage manually
17    percentValue = ((sensorValue - dryValue) * 100) / (wetValue - dryValue);
18    percentValue = constrain(percentValue, 0, 100); // Ensure it's within the valid range
19
20    Serial.print("Moisture Percentage: ");
21    Serial.print(percentValue);
      Serial.println("%");
```

Output Serial Monitor ×

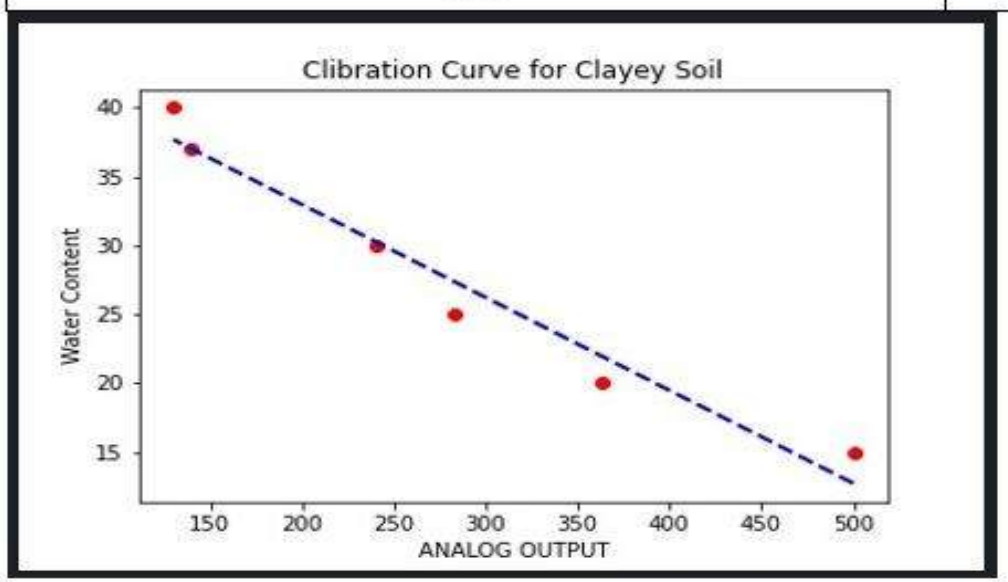
Message (Enter to send message to 'Arduino Uno' on 'COM5')

```
Moisture Percentage: 11%
Moisture Percentage: 22%
Moisture Percentage: 24%
Moisture Percentage: 22%
Moisture Percentage: 23%
Moisture Percentage: 22%
Moisture Percentage: 21%
Moisture Percentage: 20%
Moisture Percentage: 19%
Moisture Percentage: 19%
```

We have converted the analog output to percentage of water content directly by code, but if this was not done, we will get some value and curve like these.

Calibration Table and curve for Clayey Soil:

Water Content	Analog Output
15	500
20	363
25	283
30	240
37	140
40	130



Water content reading using sensor

Procedure

1. Take the sample whose moisture content is to be measured.
2. Insert the nodes of the moisture sensor module into the soil sample(Make sure It should not touch the base of container).
3. We can view the moisture content reading on arduino IDE output that is percentage of moisture content of the sample.

Verification of the sensor readings

We took a sample of known moisture from the laboratory and measured its moisture content using both the oven dry method and with sensor. The soil sample was of clayey type, bentonite, and fly ash. The readings that were using the oven dry method of sample 1, sample 2 and sample 3 are listed below. And the comparison with oven dry method is also shown. Error calculations are done simultaneously.

Sandy Soil	15% water	20% water
Can No:	A2	A4
Weight of can(W1)	17.961	18.056
Weight of can+ wet soil(W2)	28.306	29.512
Wet of can +dry soil(W3)	26.939	27.067

Moisture Content (15%)= 13.22
Moisture Content (20%)= 21.34

Moisture content = (W2 -W3) X 100/(W2 -W1) %

Bentonite Soil	15%	20%
Can No:	A45	A29
Weight of can(W1)	17.336	18.077
Weight of can+ wet soil(W2)	31.762	26.505
Wet of can +dry soil(W3)	30.354	24.879

Moisture Content (15%)= 9.76
Moisture Content (20%)= 19.29

Fly Ash	15%	20%
Can No:	A5	A39
Weight of can(W1)	18.016	18.905
Weight of can+ wet soil(W2)	24.245	24.387
Wet of can +dry soil(W3)	23.705	23.446

Moisture Content (15%)= 8.67
Moisture Content (20%)= 17.16

Feasibility

The oven dry method is time consuming and generally requires a lot of effort both from human and machine side. The oven dry is not possible to conduct in site immediately. These are made possible by using this method.

-high amount energy is required for 24*7(in oven)

-time consuming process.

-oven dry method requires a lab set-up.

SIGNIFICANCE:

A soil moisture sensor is a device designed to measure the moisture content of soil. It's commonly used in agriculture, gardening, and environmental monitoring to assess the water content in the soil, which is crucial for plant health and irrigation management. The sensor provides information about whether the soil is too dry, optimal, or too wet.

TAKEAWAY :

1. Hands-On Learning: Practical insights into electronics, sensors, and microcontroller programming.

2. Real time monitoring of soil moisture content

2. Arduino Programming

3. The saturation levels of the mixture may differ from those of typical soil. Fly ash may saturate differently, and this could impact the sensor's ability to accurately measure moisture content across the range.

Thank you.