AMERICAN INTERNATIONAL UNIVERSITY-BANGLADESH

Faculty of Engineering

Lab Report

Experiment # 09

Experiment Title: Implementation of a motor control system using Arduino: Digital input, outputs, and PWM.

Date of Perform:	18 May 2025	**Date of Submission:**	1 June 2025
Course Title:	Microprocessor and Embedded Systems Lab		
Course Code:	EE4103	**Section:**	G
Semester:	Spring 2024-25	**Degree Program:**	BSc in CSE
Course Teacher:	**Prof. Dr. Engr. Muhibul Haque Bhuyan**		

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4	MD TOYEB ALI	23-51819-2	BSc in CSE	

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FACULTY COMMENTS	**Marks Obtained**	
	Total Marks	

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Marking Rubrics (to be filled by Faculty):

Level Category	Excellent [5]	Proficient [4]	Good [3]	Acceptable [2]	Unacceptable [1]	No Response [0]
Title and Objectives	Able to clarify the understanding of the lab, no issues are missing and formatting is good.	Able to clarify the understanding of the lab experiment, no issues are missing but its formatting is not good.	Able to clarify the understanding of the lab experiment, but a few issues are wrong, and its formatting is bad.	Able to clarify the understanding of the lab experiment, but it lacks a few important issues of the experiment without maintaining the format.	Unable to clarify the understanding of the lab experiment.	No Response/ copied from others/ identical submissions with gross errors/image file printed
Codes and Methods	Able to explain the experimental codes and simulation methods using Proteus very well.	Able to explain the experimental codes and simulation methods using Proteus but is not formatted well.	Able to explain the experimental codes but simulation method using Proteus is not explained well.	Presents the experimental codes but didn't explain simulation methods using Proteus clearly.	Presents the experimental codes but didn't explain simulation methods using Proteus.	
Results	Key results and images are there. Figures/Tables have all identifications and refer to them properly in the texts.	Key results and images are there. Figures/Tables have all identifications, such as the axis labels, numbers, and captions with a few minor errors; the texts refer them.	Key results and images are there. Figures/Tables lack a few identifications, such as the axis labels, numbers, and captions; the texts refer them.	Misses several key results and images. Figures/Tables lack identification, such as the axis labels, numbers, and captions; the texts don't refer them.	Major results, such as experimental and simulation results' images are not included. Figures and tables are poorly constructed or not presented.	
Discussion and Conclusion	Proper interpretation of results and summarizes the results to draw a conclusion, discusses its applications in real-life situations to connect with the report's conclusion.	Proper interpretation of results and summarizes the results to draw a conclusion but didn't discuss its applications in real-life situations to connect with the conclusion of the report.	Interpretation of results is presented. However, there is a disconnect between the results and discussion.	Misses the interpretation of key results. There is little connection between the results and discussion.	Very poor interpretation of the results. No connection between results and discussions.	
Question and Answer	Able to produce all questions' answers correctly maintaining the lab report format.	Able to produce all questions' answers but didn't maintain the lab report format.	Able to produce all questions' answers but wrong answers to a few questions.	Able to produce all questions' answers but wrong/missing answers to multiple questions.	Unable to produce all questions' answers and completely wrong answers.	
Comments						**Total Marks (25)**

Objectives:

The objectives of this experiment are to-

1. Familiarize the students with the PWM signals generated by the Arduino.
2. Control the speed of a DC motor using the PWM signals generated by the Arduino.
3. Change the direction of rotation of a DC motor using the input push switch.

Equipment List:

1) Arduino Uno Board
2) L298N Driver
3) 12 V High Torque DC Motor with Fan Blades connected to it.
4) Potentiometer, push switch, and a resistor of 10 k□
5) A DC Power Supply
6) Breadboard
7) Jumper Wires

Circuit Diagram:

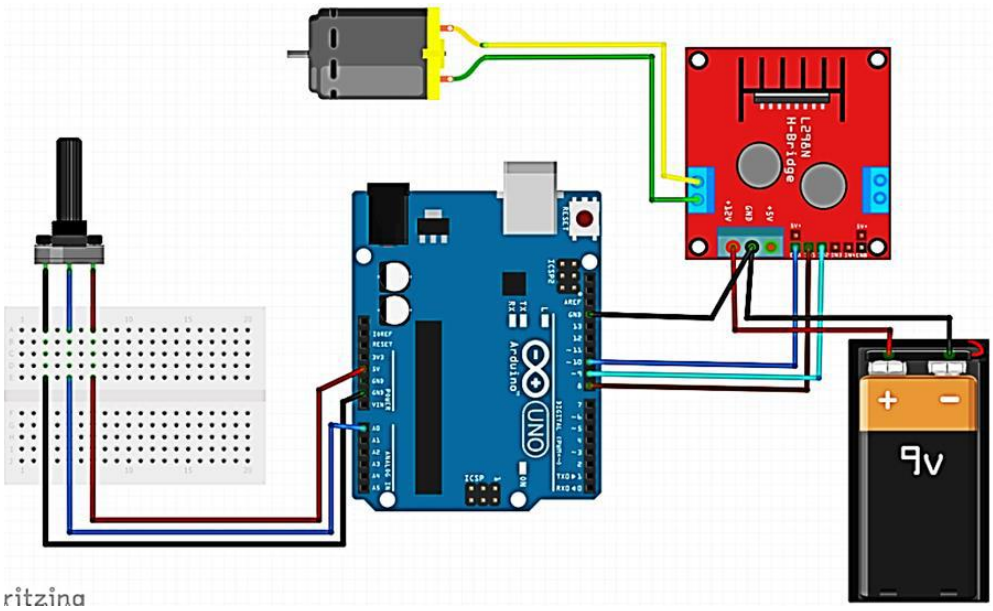

Figure 1: An Arduino microcontroller controls a DC motor's speed through a dual H-bridge.

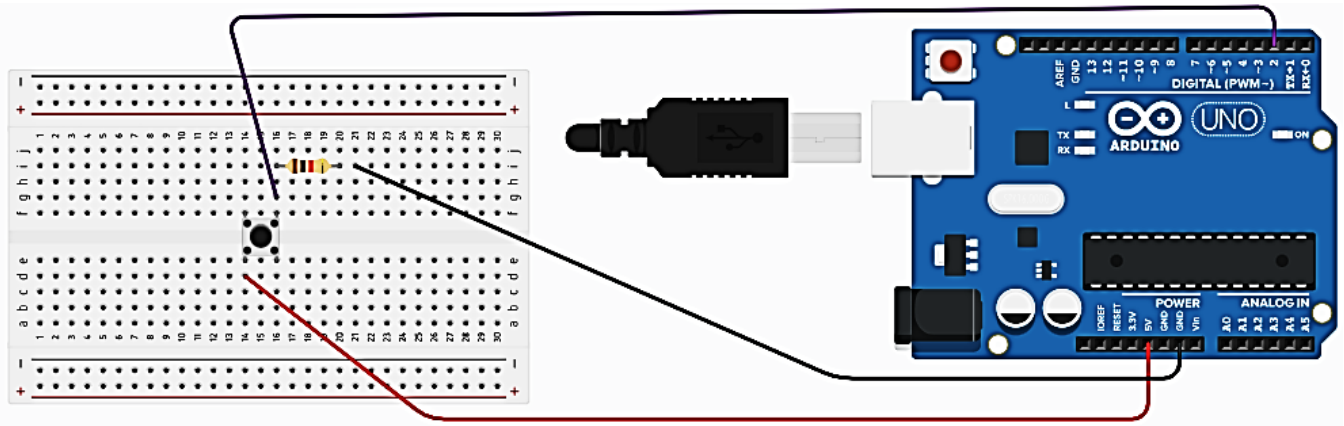

Figure 2: Arduino board's pin connections with a push button switch.

Experimental Output Results:

Here are the output results of a motor control system using Arduino. The Arduino was used to control the motor direction and speed. The circuit was designed following the circuit diagram and the code was copied from the lab manual and complied with Arduino IDE for this experiment. The Arduino pin 2 was configured as Input pin to detect the switch pressed and change the direction of the motor and pin 8, 9, 10 was configured as Output pin to set the direction in the motor driver and set the PWM value. After uploading the code into the Arduino UNO board, the motor was running successfully. The switch and POT were also functional. The speed of the motor was able to control using the POT.

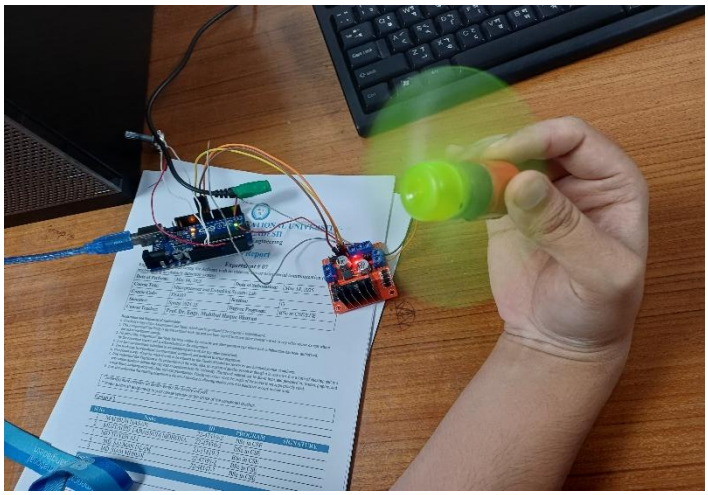

Figure 3: Experimental result of motor running in the clockwise direction.

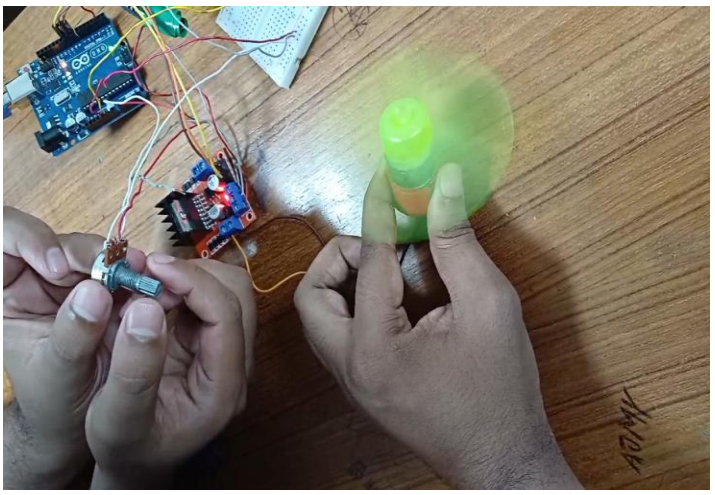

Figure 4: Experimental result of motor running in the anticlockwise direction.

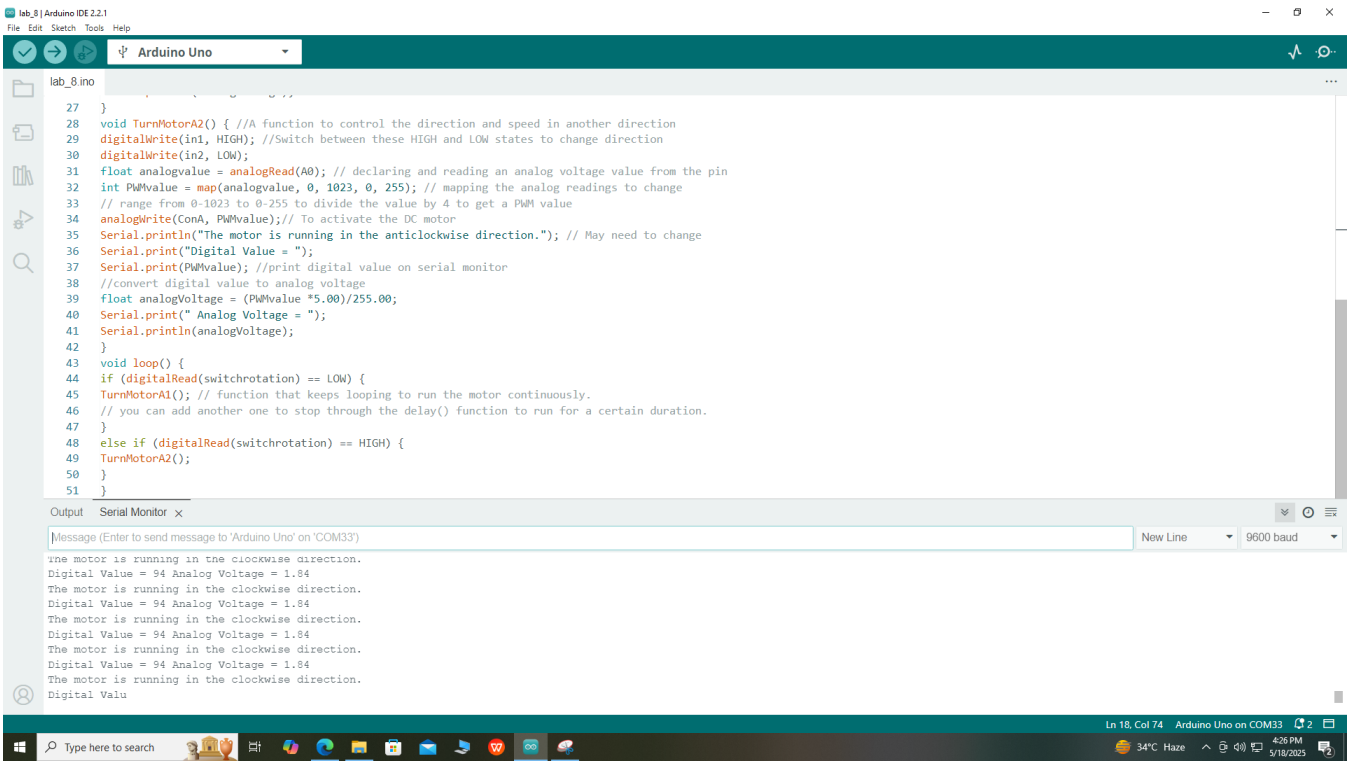

Figure 5: Showing the serial monitor that motor was running in the clockwise direction with low voltage (1.84V).

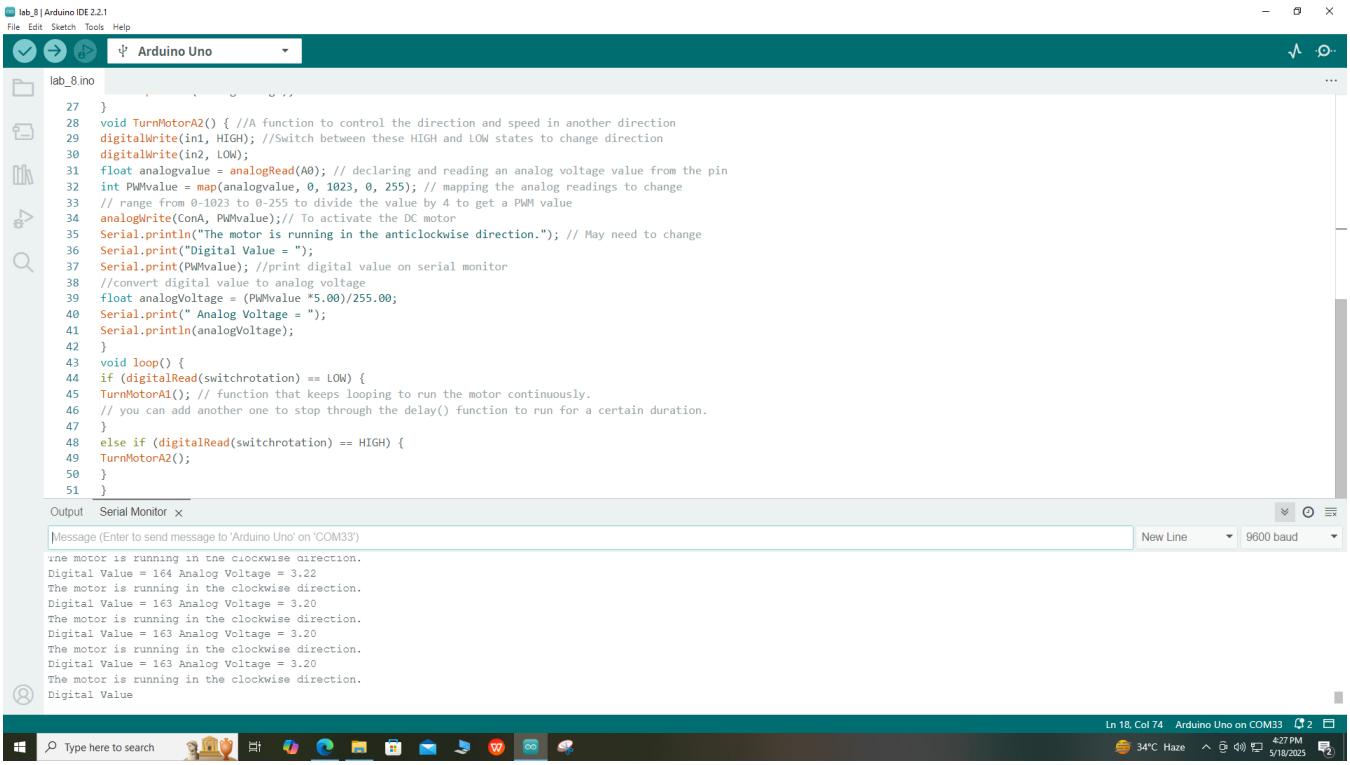

Figure 6: Showing the serial monitor that motor was running in the clockwise direction with medium voltage (3.20V).

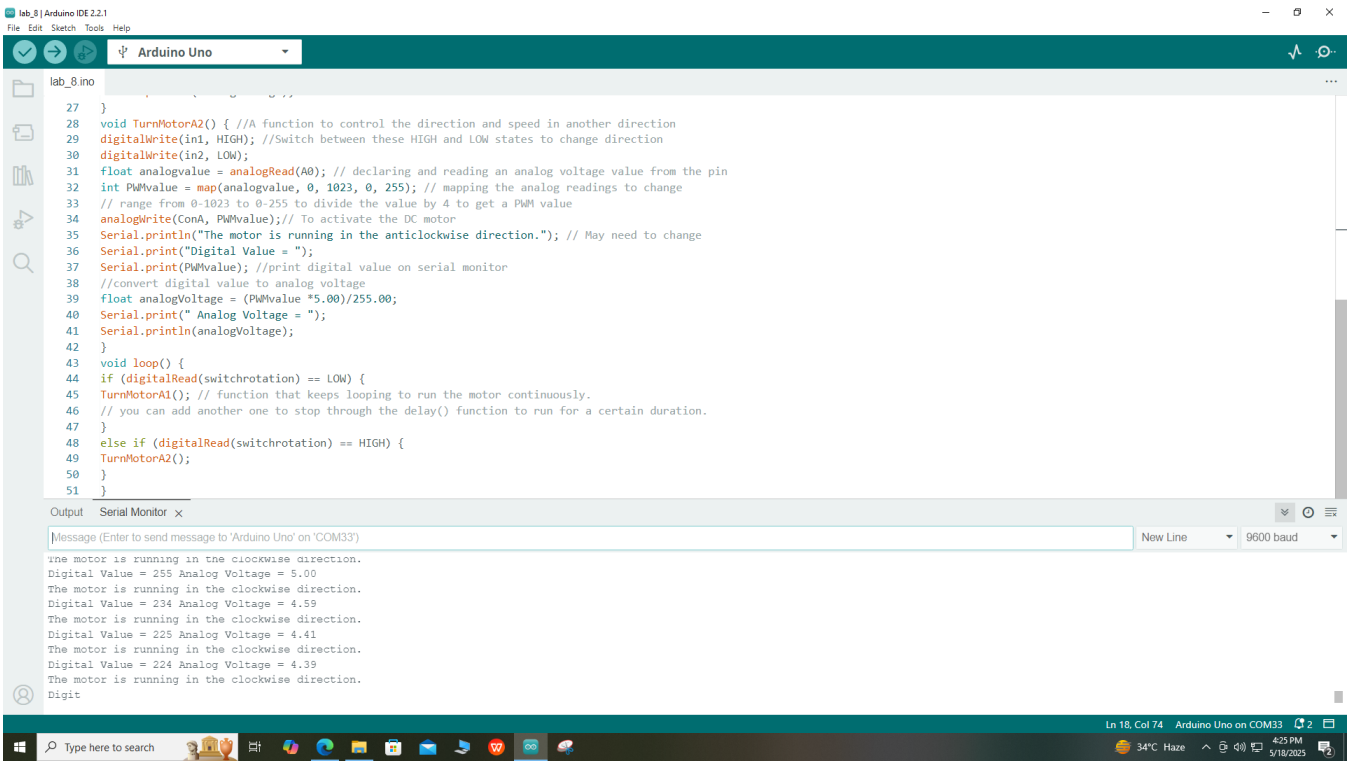

Figure 7: Showing the serial monitor that motor was running in the clockwise direction with high voltage (5V).

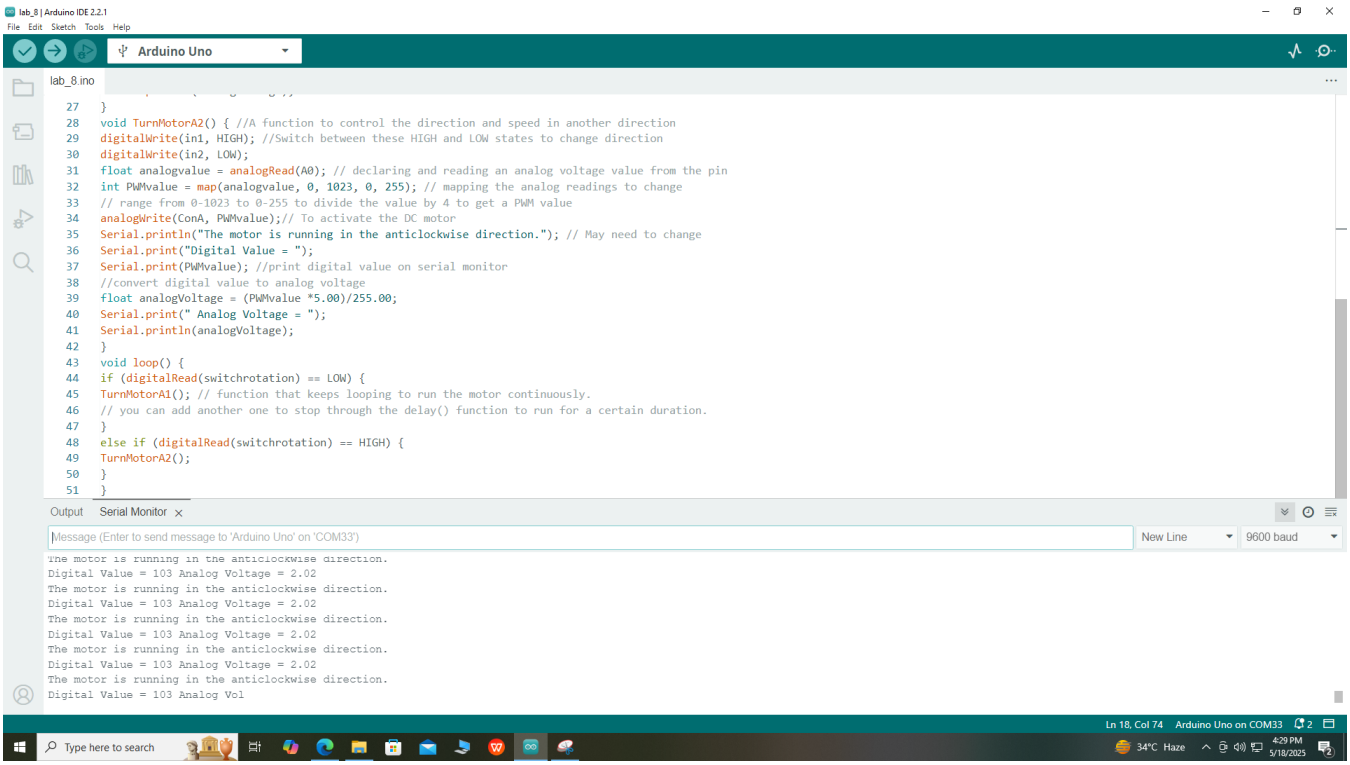

Figure 8: Showing the serial monitor that motor was running in the anticlockwise direction with low voltage (2.02V).

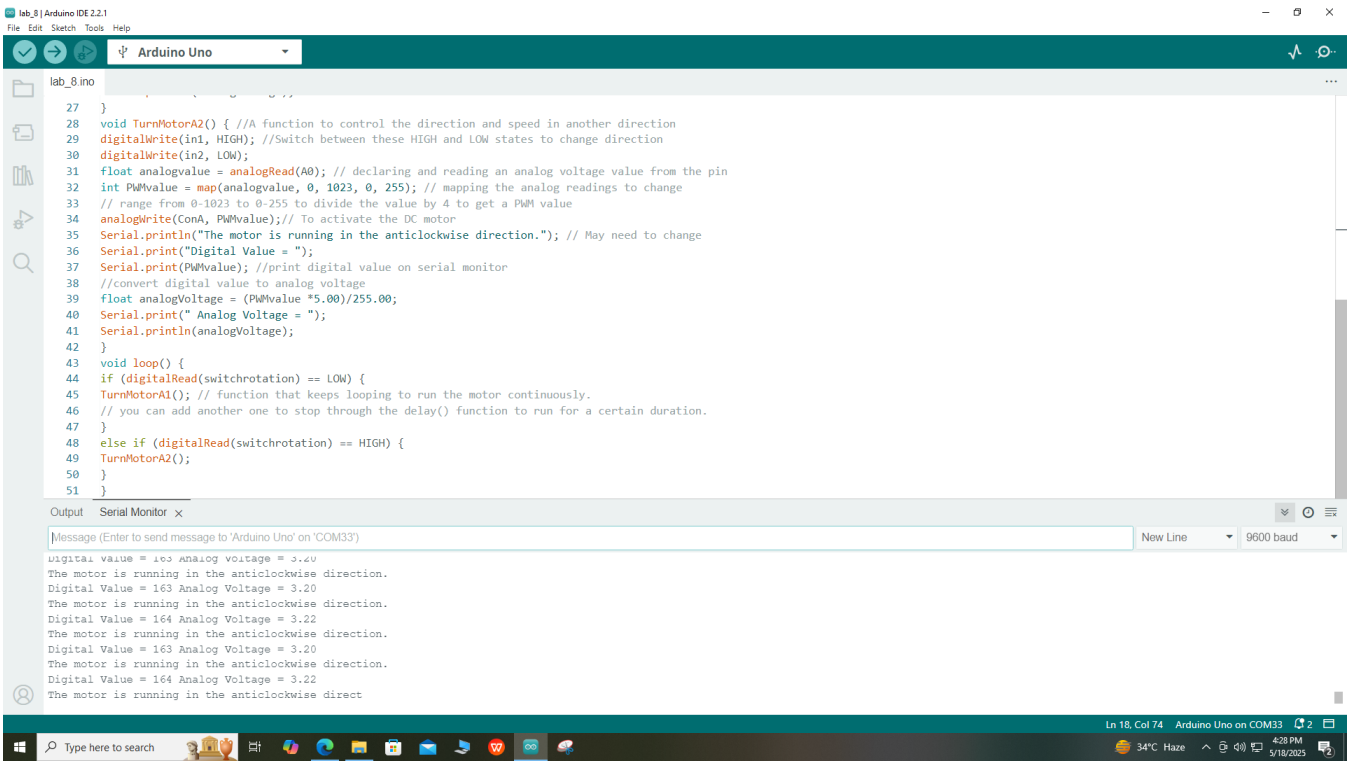

Figure 9: Showing the serial monitor that motor was running in the anticlockwise direction with medium voltage (3.22V).

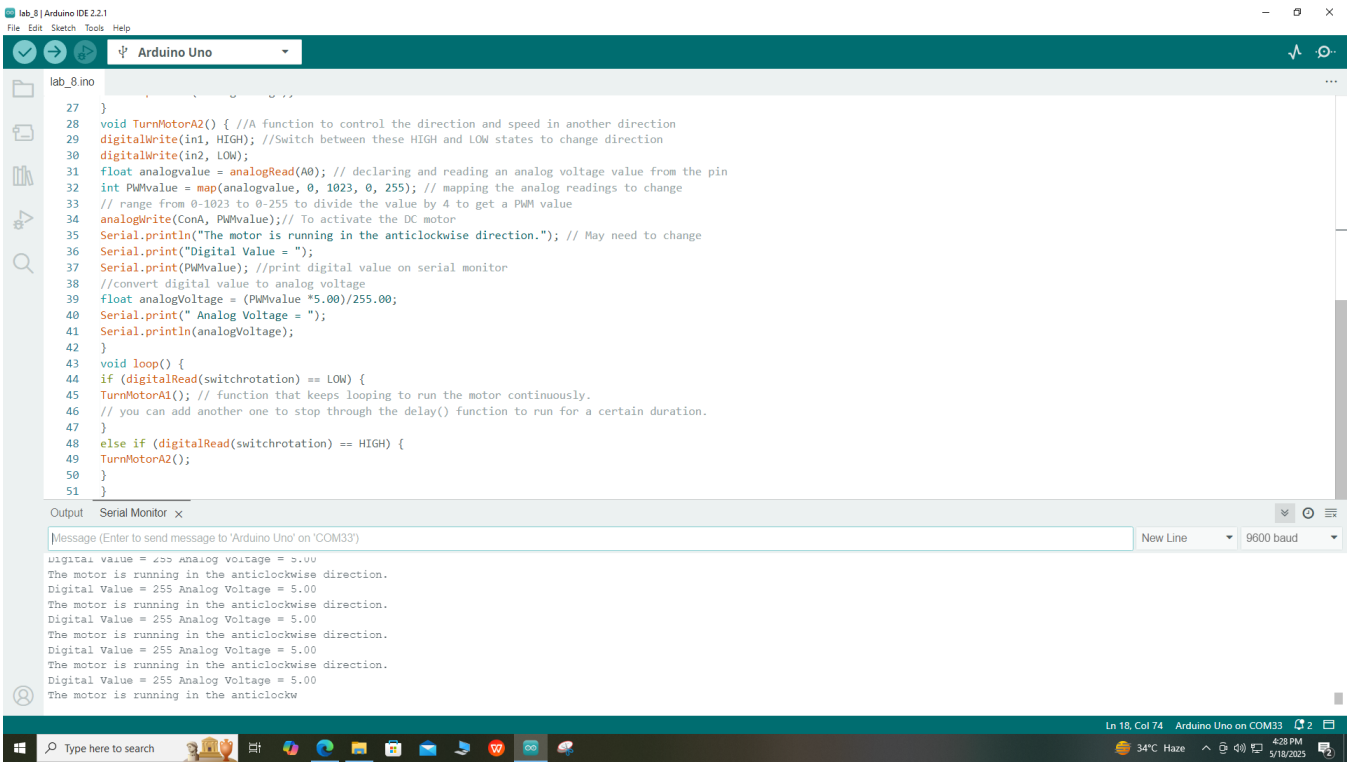

Figure 10: Showing the serial monitor that motor was running in the anticlockwise direction with high voltage (5.00V).

Simulation Output Results (Proteus):

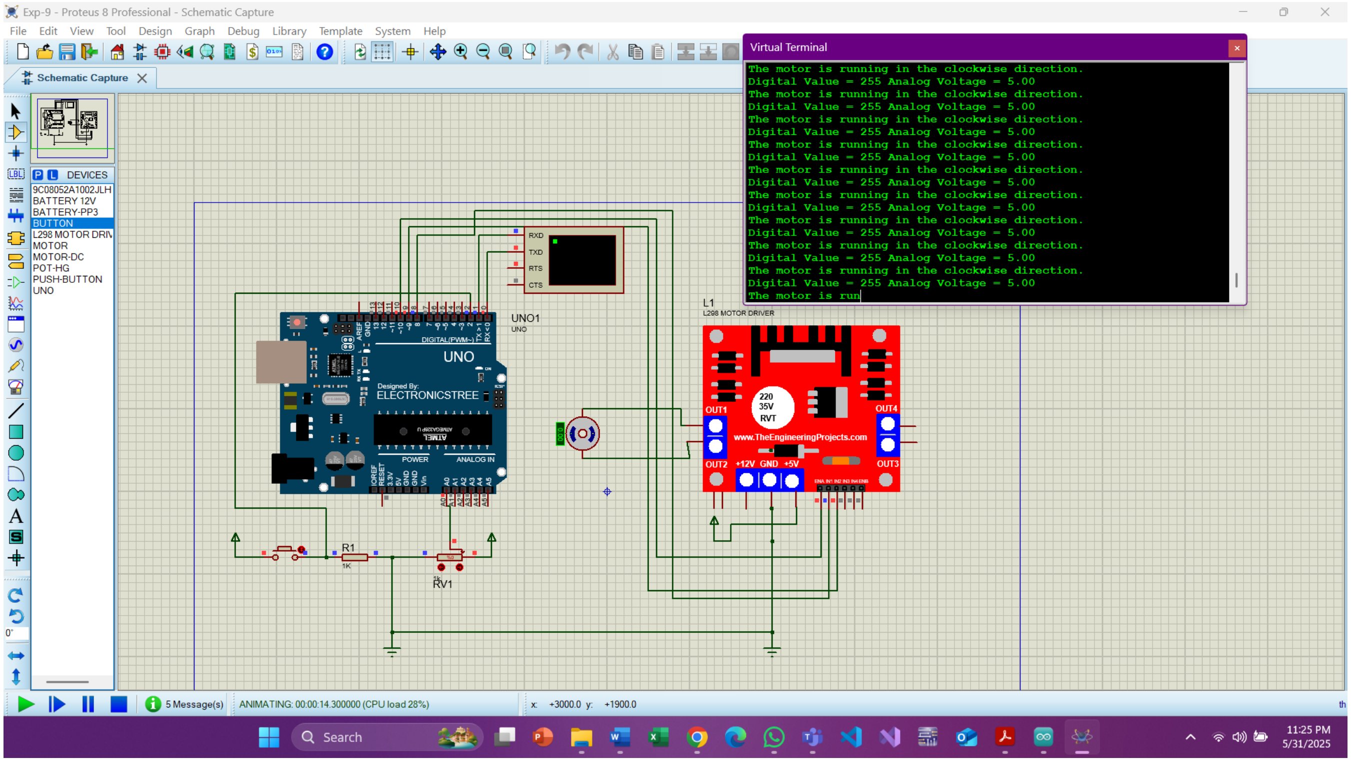

Figure 11: Motor is running clockwise at high speed (5V).

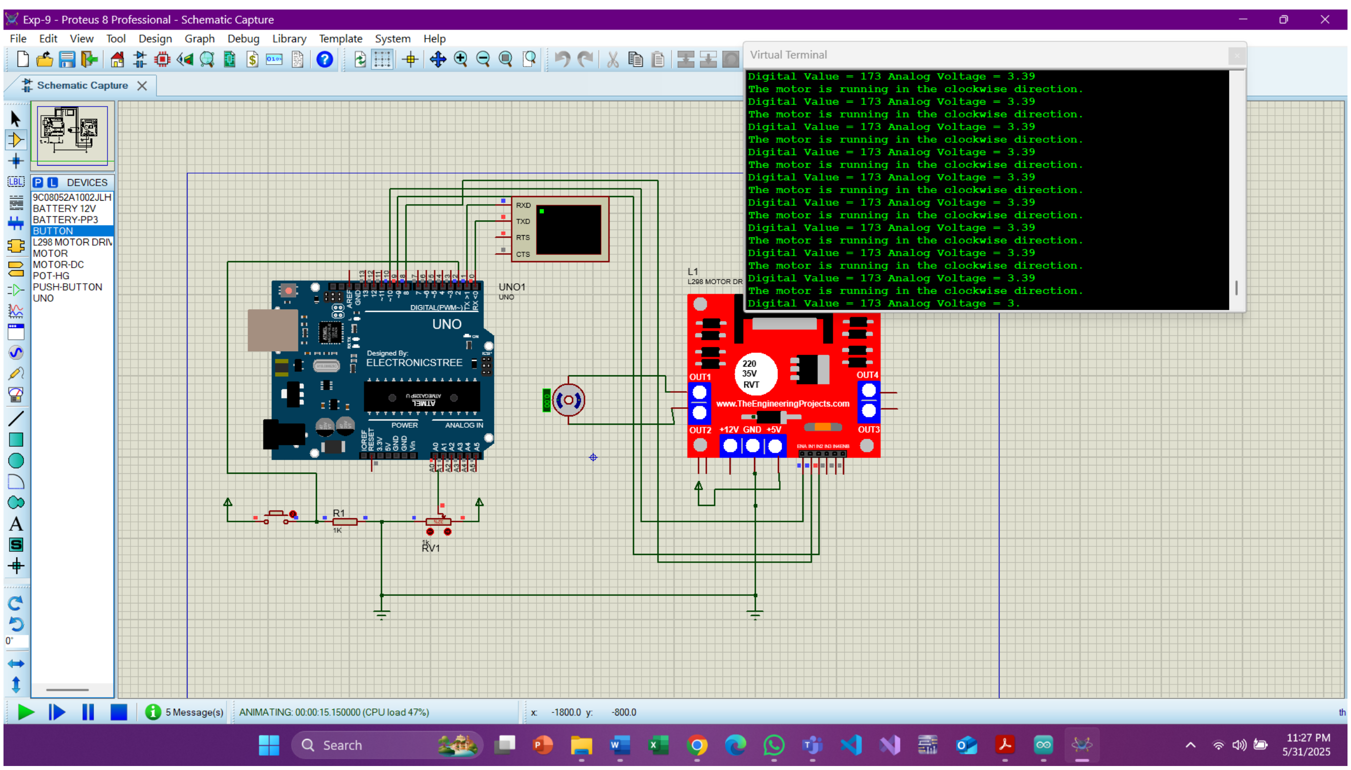

Figure 12: Motor is running clockwise at medium speed (3.39V).

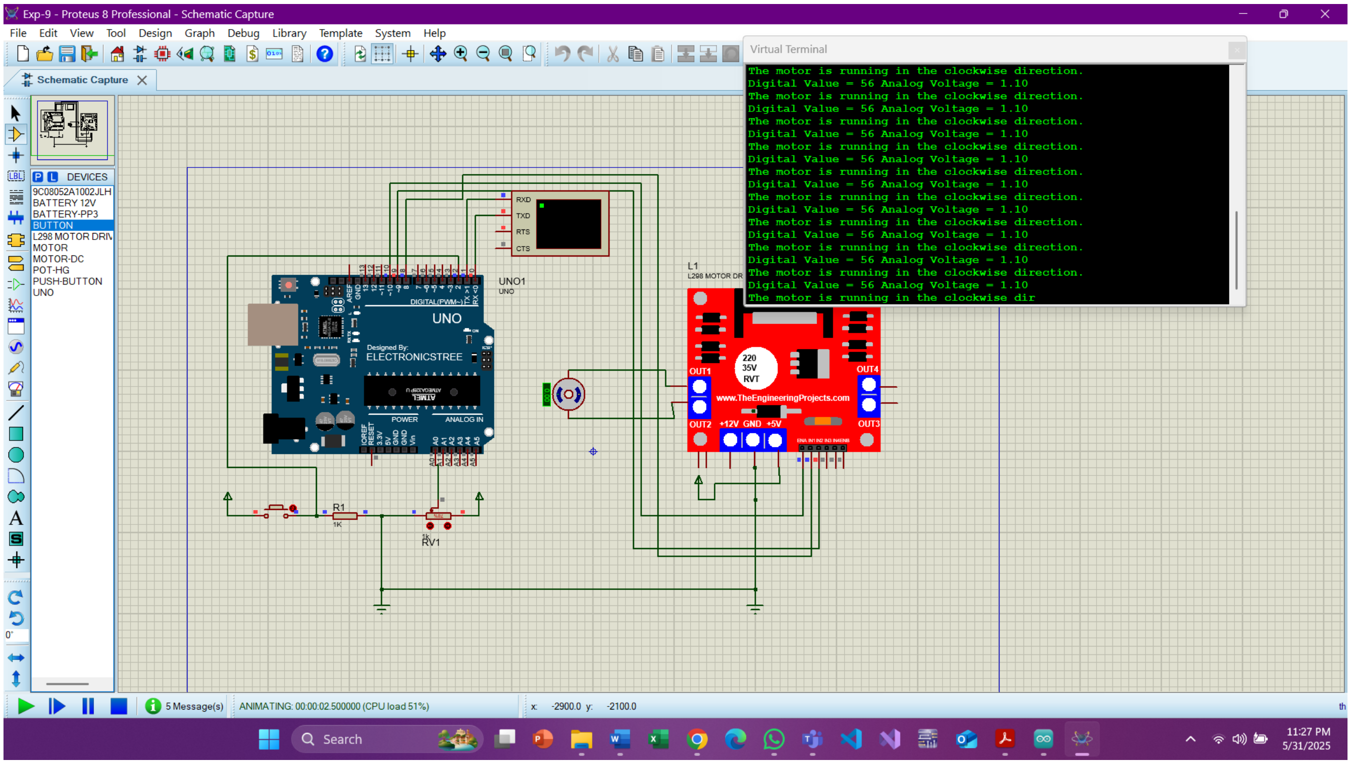

Figure 13: Motor is running clockwise at low speed (1.1V).

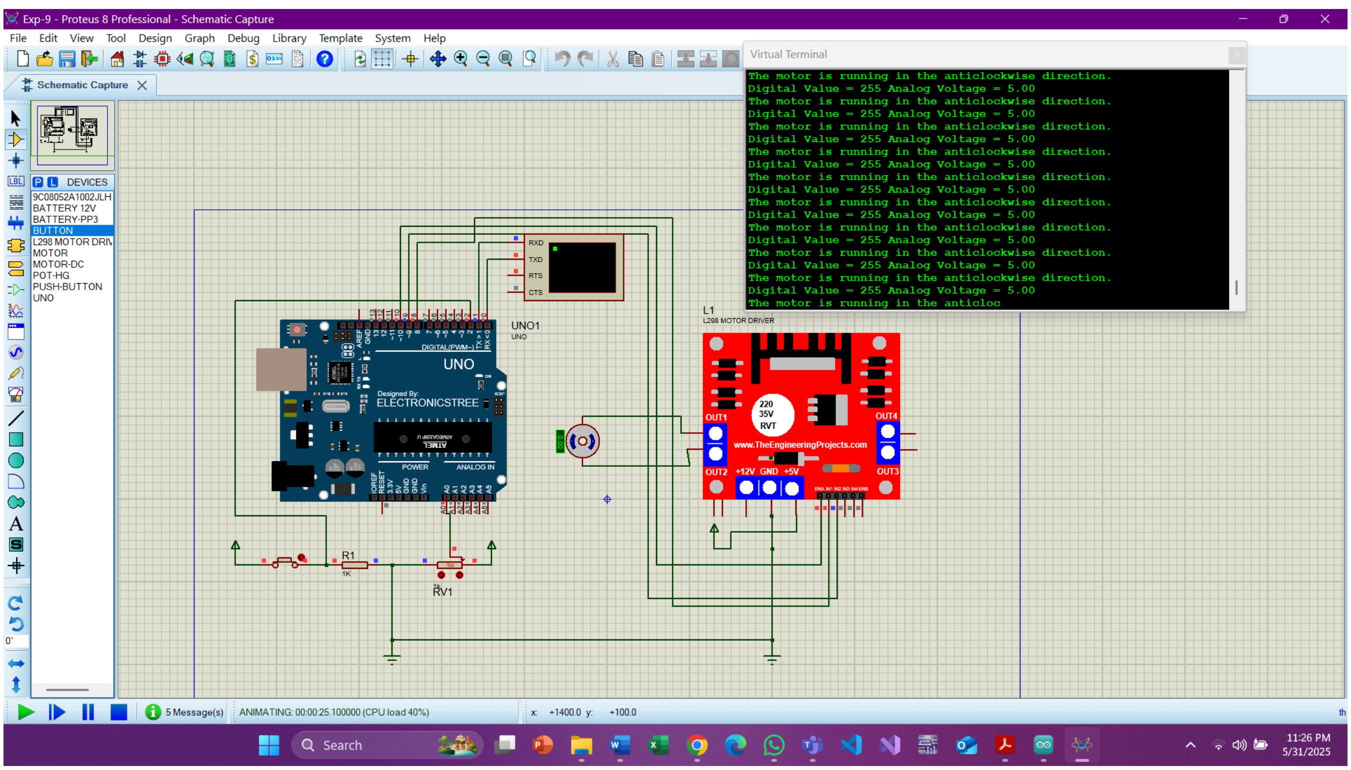

Figure 14: Motor is running anticlockwise at high speed (5V).

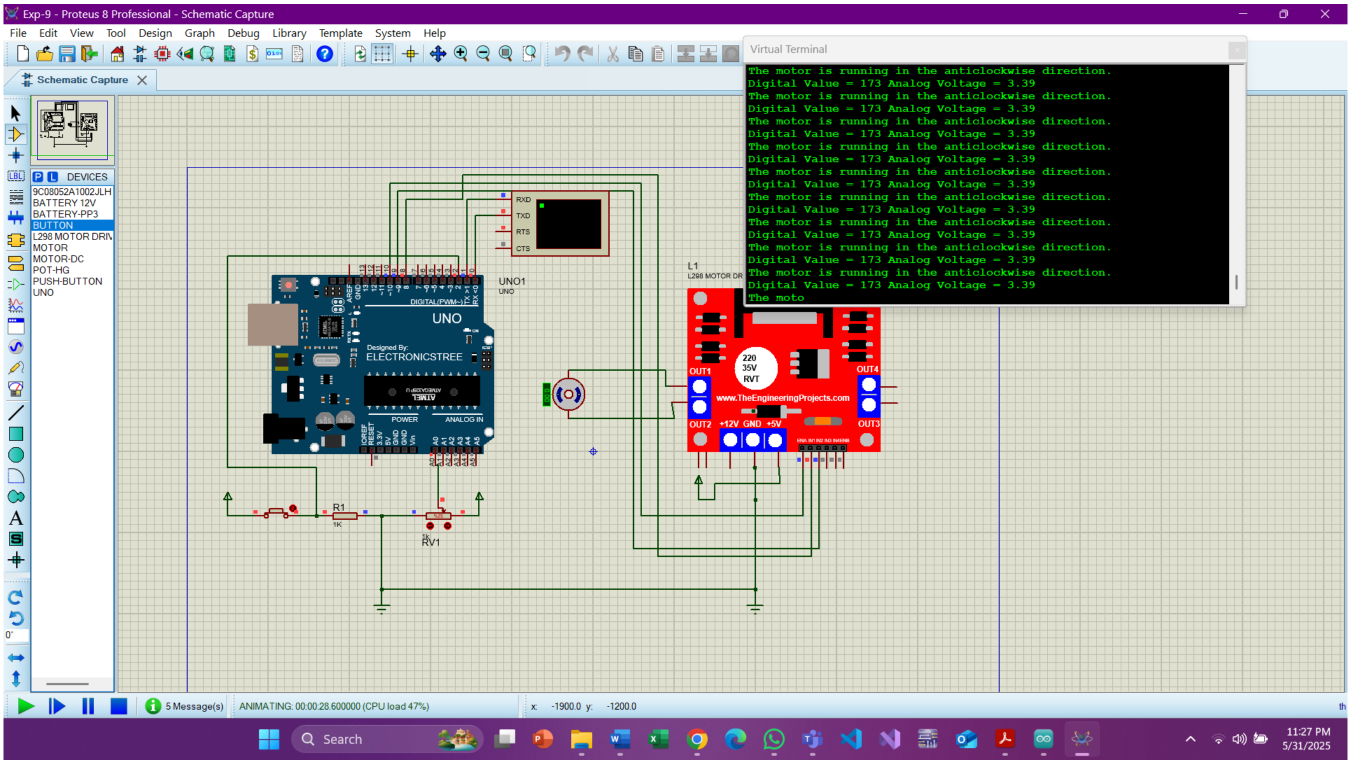

Figure 15: Motor is running anticlockwise at medium speed (3.39V).

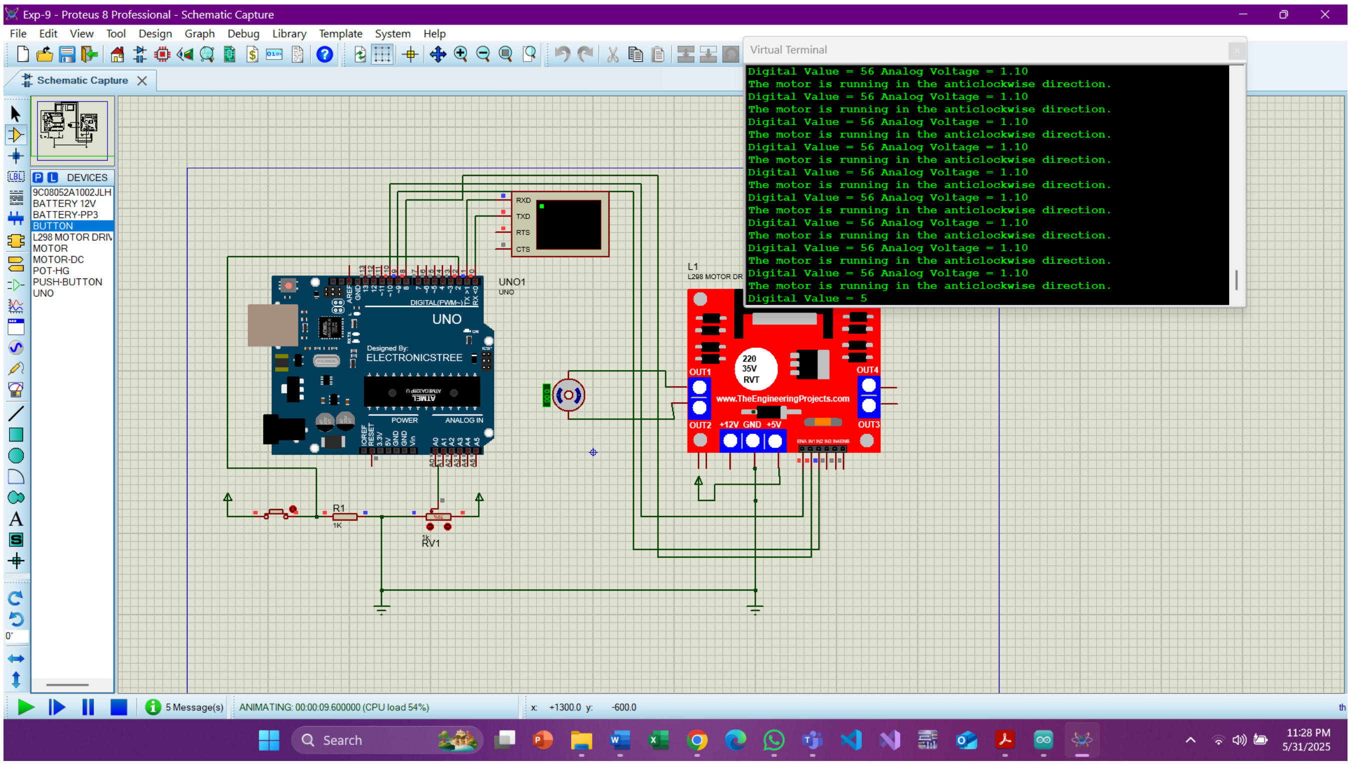

Figure 16: Motor is running anticlockwise at low speed (1.1V).

Simulation Methodologies (Proteus):

At first necessary parts were inserted into the proteus such as Arduino Uno, DC motor, motor driver, potentiometer, push button, 10k resistor and virtual monitor. Arduino pin 8, pin 9 and pin 10 were connected to the motor driver In1, In2 and ENA pin respectively. On the other hand, pin 2 of Arduino was connected to the push button one terminal with a 10k resistor connected to ground. Another terminal of push button was connected to VCC. The Wiper (middle pin) of the POT was connected to Arduino A0 pin and two other terminals were connected to the VCC and ground. A DC motor was connected to OUT1 and OUT2 of the motor driver and a virtual terminal was used which TX was connected to RX and vice versa. Then the code associated with this experiment was compiled using Arduino IDE and generated the hex file. The .hex file was uploaded to the UNO on the proteus. Then the simulation was run, and it was running successfully.

Simulation Methodologies (TinkerCad):

First open the TinkerCad website and select circuit. Then Select the necessary components from the components section and place it on the canvas. Here all the components were available except the L298N motor driver. So, L293D motor driver IC was used instead of the L298N motor driver. The fundamentals of these drivers are almost the same, just L298N driver has more motor current and extra heating protection. All the circuit connections were the same as proteus. The Enable 1&2 pin of L293D was connected to PD10 and Input 1 and Input 2 pin were connected to PD8 and PD9 respectively. The Output 1 and Output 2 of L293D were connected to the 2 terminals of the motor. The code was written in the code section after selecting the code type in text. Then press the start simulation button to simulate it.

Simulation Output (Tinker CAD):

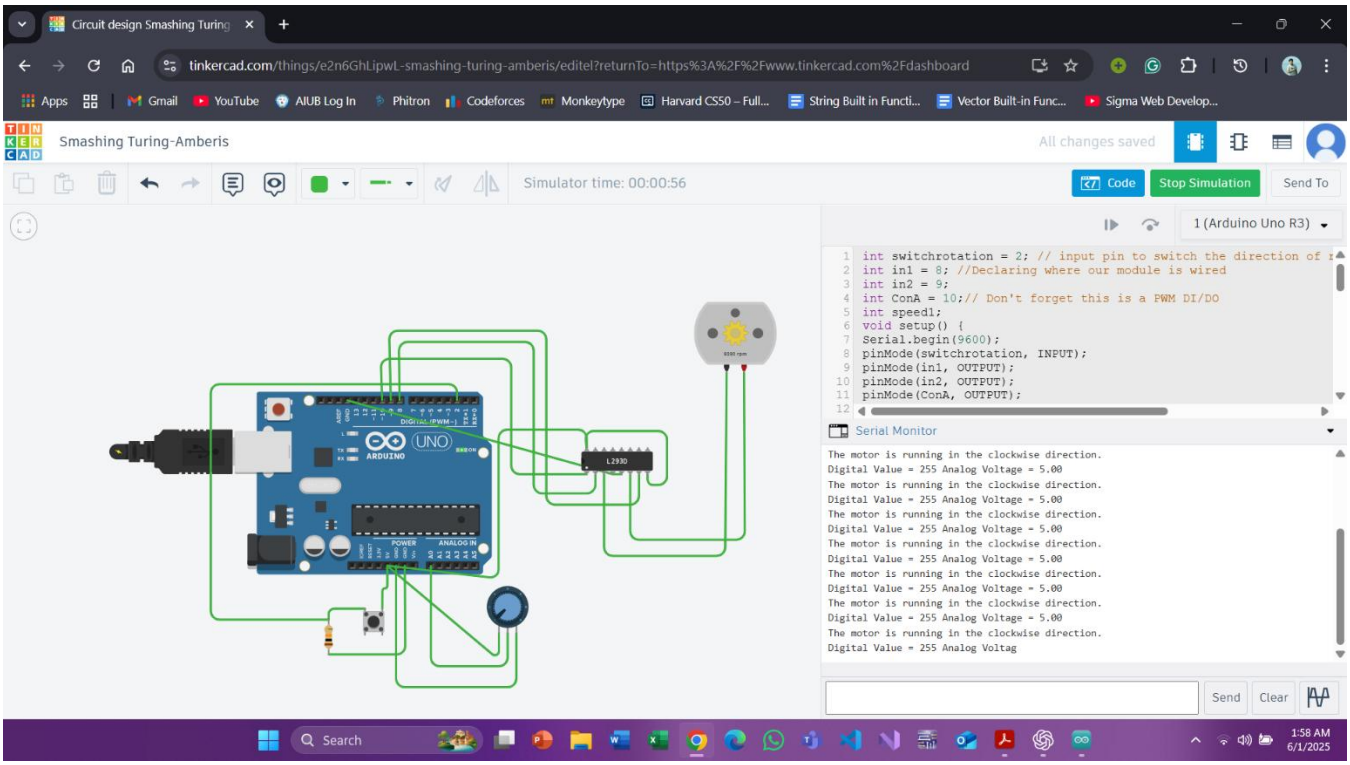

Figure 17: Motor is running clockwise at high speed (5V).

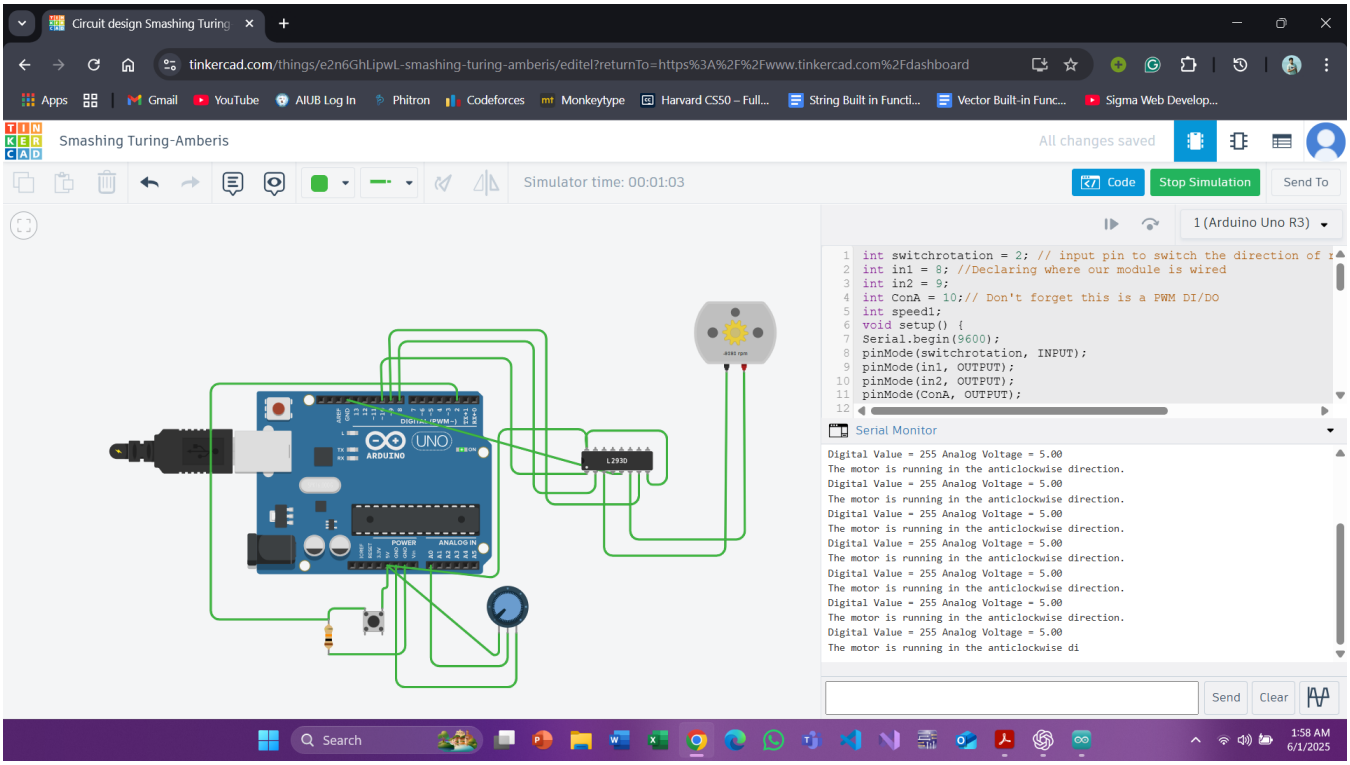

Figure 18: Motor is running anticlockwise at high speed (5V).

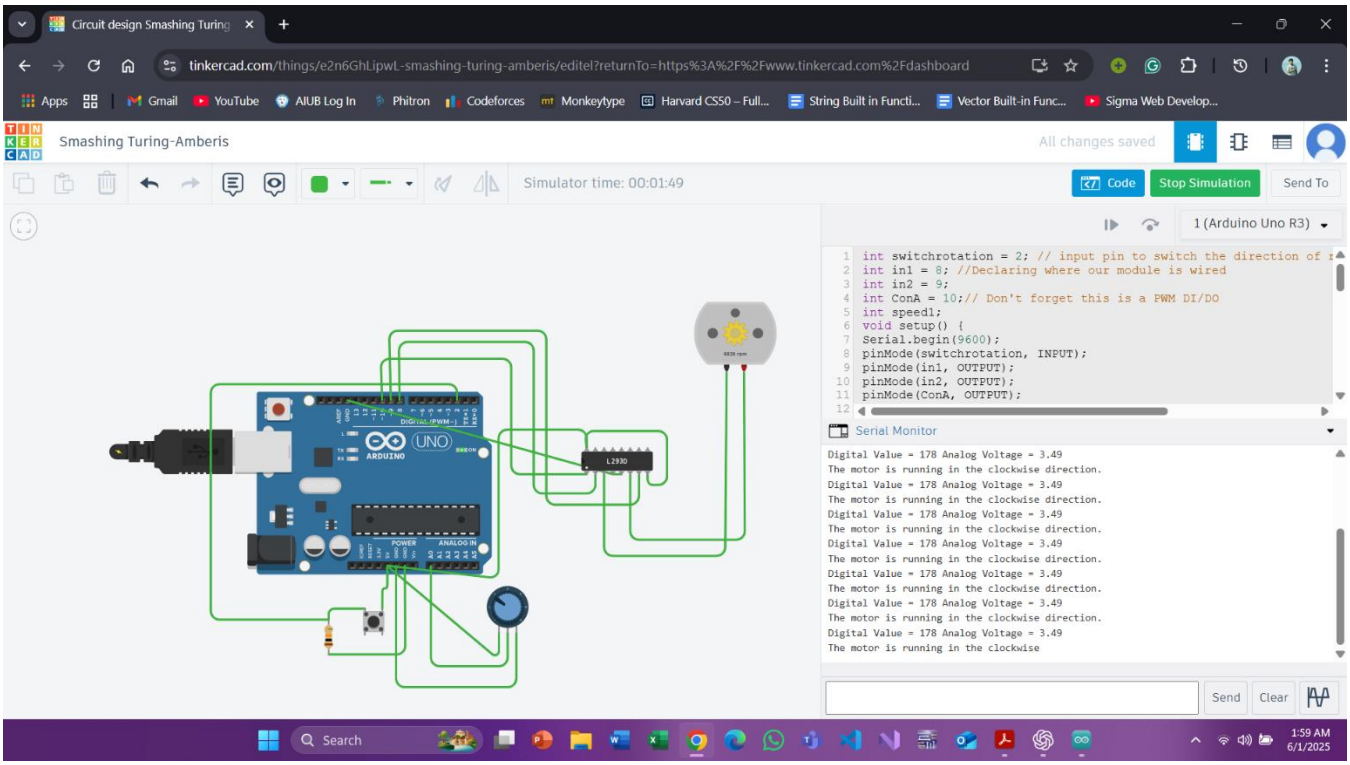

Figure 19: Motor is running clockwise at medium speed (3.49V).

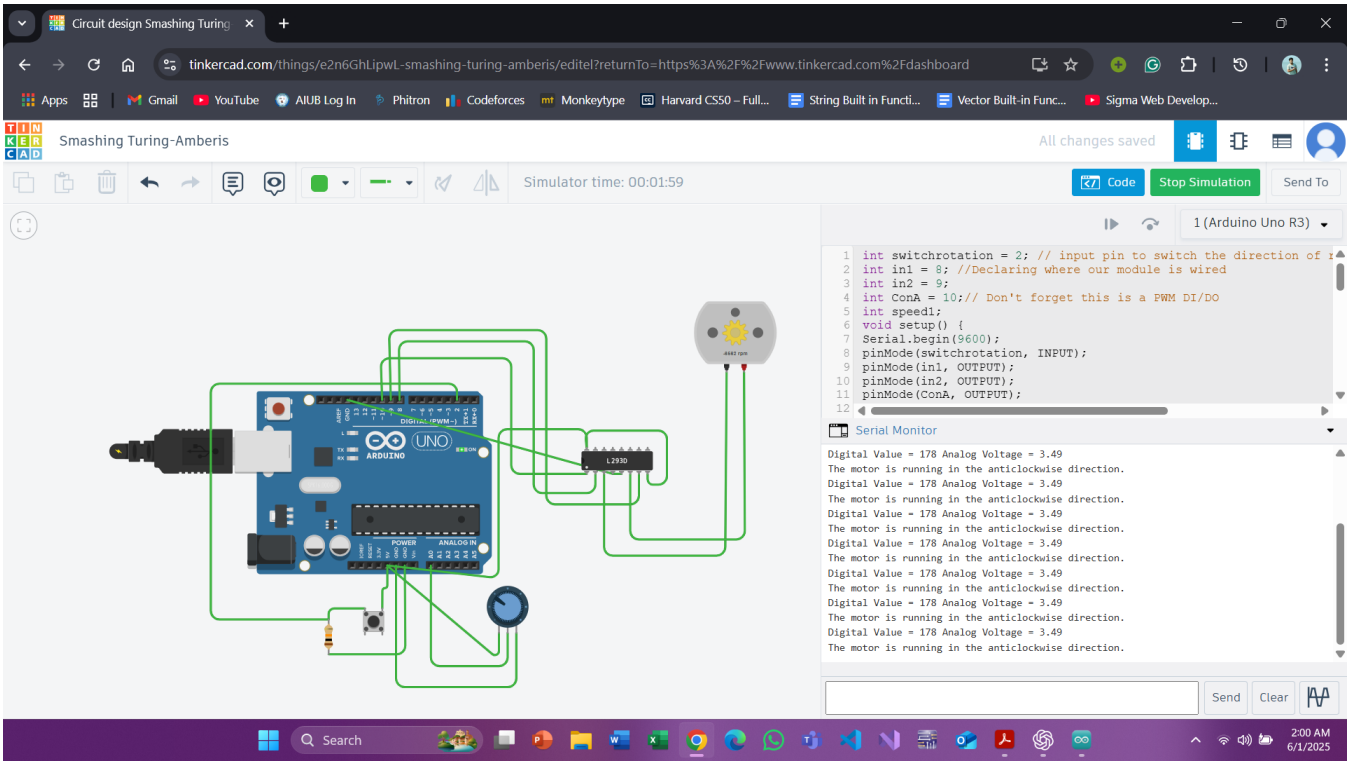

Figure 20: Motor is running anticlockwise at medium speed (3.49V).

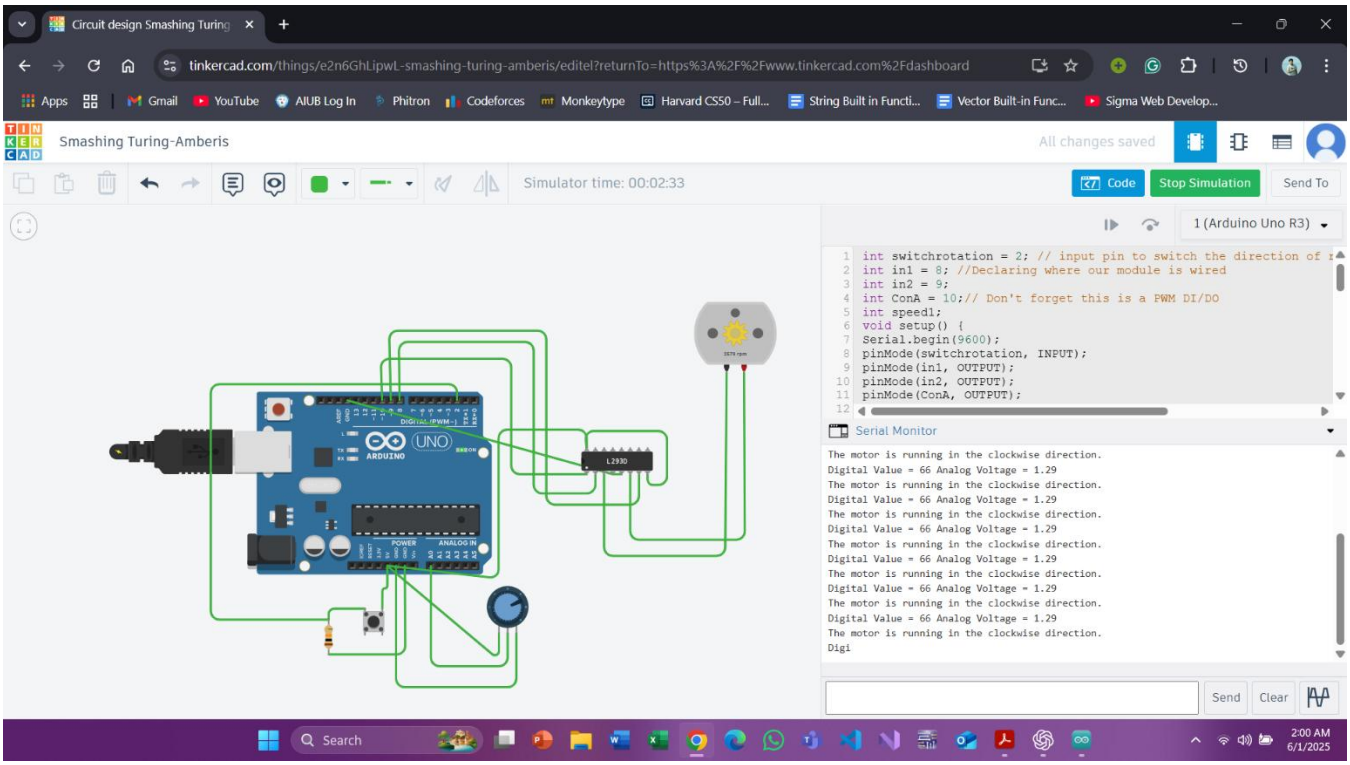

Figure 21: Motor is running clockwise at low speed (1.29V).

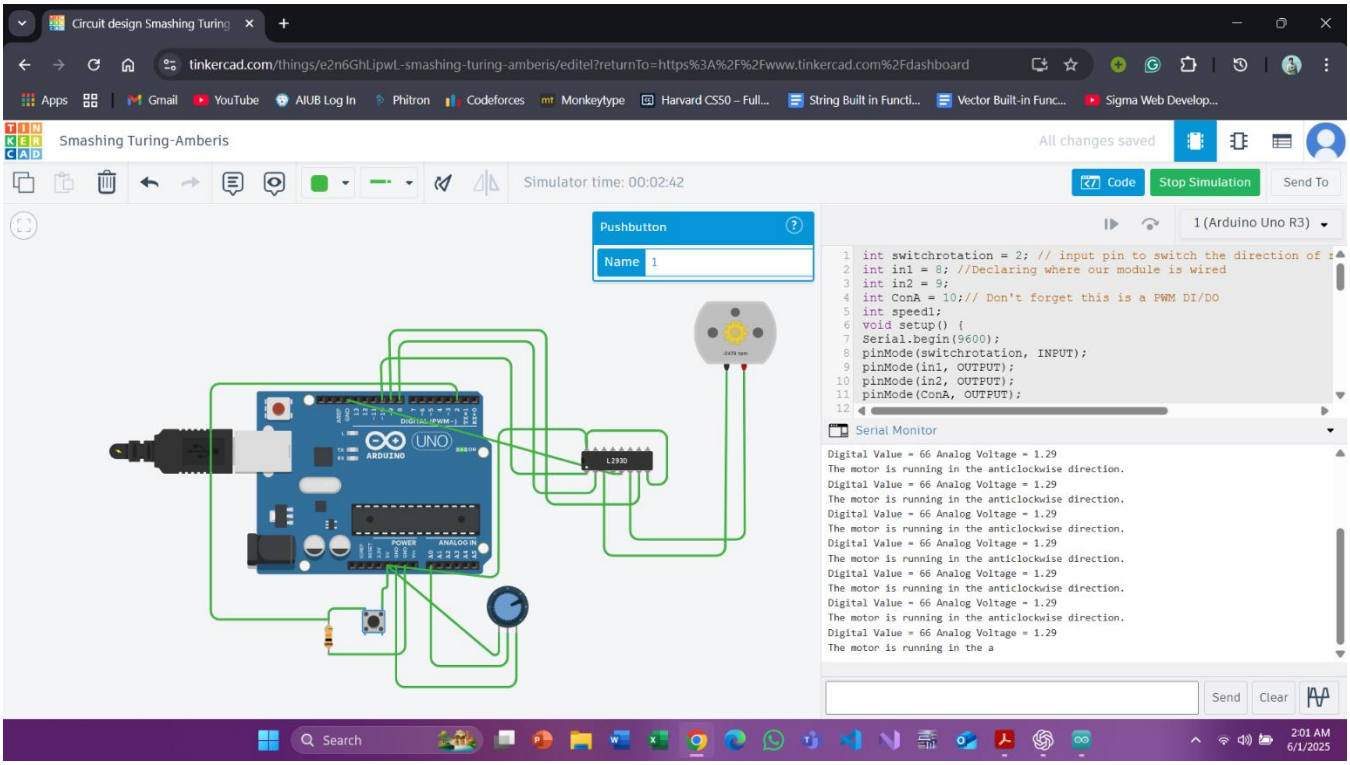

Figure 22: Motor is running anticlockwise at low speed (1.29V)

Answers to the Questions in the Lab Manual:

1. Code for the motor control system:

```
int switchrotation = 2;
int in1 = 8;
int in2 = 9;
int ConA = 10;
int speed1;
void setup() {
Serial.begin(9600);
pinMode(switchrotation, INPUT);
pinMode(in1, OUTPUT);
pinMode(in2, OUTPUT);
pinMode(ConA, OUTPUT);
}
void TurnMotorA1() {
digitalWrite(in1, LOW);
digitalWrite(in2, HIGH);
float analogvalue = analogRead(A0);
int PWMvalue = map(analogvalue, 0, 1023, 0, 255);
analogWrite(ConA, PWMvalue);
Serial.println("The motor is running in the clockwise direction.");
Serial.print("Digital Value = ");
Serial.print(PWMvalue);
float analogVoltage = (PWMvalue *5.00)/255.00;
Serial.print(" Analog Voltage = ");
Serial.println(analogVoltage);
}
void TurnMotorA2() {
digitalWrite(in1, HIGH);
digitalWrite(in2, LOW);
float analogvalue = analogRead(A0);
int PWMvalue = map(analogvalue, 0, 1023, 0, 255);
```

```
analogWrite(ConA, PWMvalue);
Serial.println("The motor is running in the anticlockwise direction.");
Serial.print("Digital Value = ");
Serial.print(PWMvalue);
float analogVoltage = (PWMvalue *5.00)/255.00;
Serial.print(" Analog Voltage = ");
Serial.println(analogVoltage);
}
void loop() {
if (digitalRead(switchrotation) == LOW) {
TurnMotorA1();
}
else if (digitalRead(switchrotation) == HIGH) {
TurnMotorA2();
}
}
```

3. My ID is 23-51819-2 compared with XY-PQABC-Z, here P = 5, Q = 1, A = 8, B = 1 and C = 9. That means In1, In2, switchrotation and ConA will be 5,1,8,1 respectively. Since my Q = B the In2 and ConA will be the same pin, so I am considering C = 9 as ConA. After applying these changes the program and output will be,

```
int switchrotation = 8;
int in1 = 5;
int in2 = 1;
int ConA = 9;
int speed1;
void setup() {
Serial.begin(9600);
pinMode(switchrotation, INPUT);
pinMode(in1, OUTPUT);
pinMode(in2, OUTPUT);
pinMode(ConA, OUTPUT);
```

```
}
void TurnMotorA1() {
digitalWrite(in1, LOW);
digitalWrite(in2, HIGH);
float analogvalue = analogRead(A0);
int PWMvalue = map(analogvalue, 0, 1023, 0, 255);
analogWrite(ConA, PWMvalue);
Serial.println("The motor is running in the clockwise direction.");
Serial.print("Digital Value = ");
Serial.print(PWMvalue);
float analogVoltage = (PWMvalue *5.00)/255.00;
Serial.print(" Analog Voltage = ");
Serial.println(analogVoltage);
}
void TurnMotorA2() {
digitalWrite(in1, HIGH);
digitalWrite(in2, LOW);
float analogvalue = analogRead(A0);
int PWMvalue = map(analogvalue, 0, 1023, 0, 255);
analogWrite(ConA, PWMvalue);
Serial.println("The motor is running in the anticlockwise direction.");
Serial.print("Digital Value = ");
Serial.print(PWMvalue);
float analogVoltage = (PWMvalue *5.00)/255.00;
Serial.print(" Analog Voltage = ");
Serial.println(analogVoltage);
}
void loop() {
if (digitalRead(switchrotation) == LOW) {
TurnMotorA1();
}
else if (digitalRead(switchrotation) == HIGH) {
```

```
TurnMotorA2();
}
```

The Simulation result is,

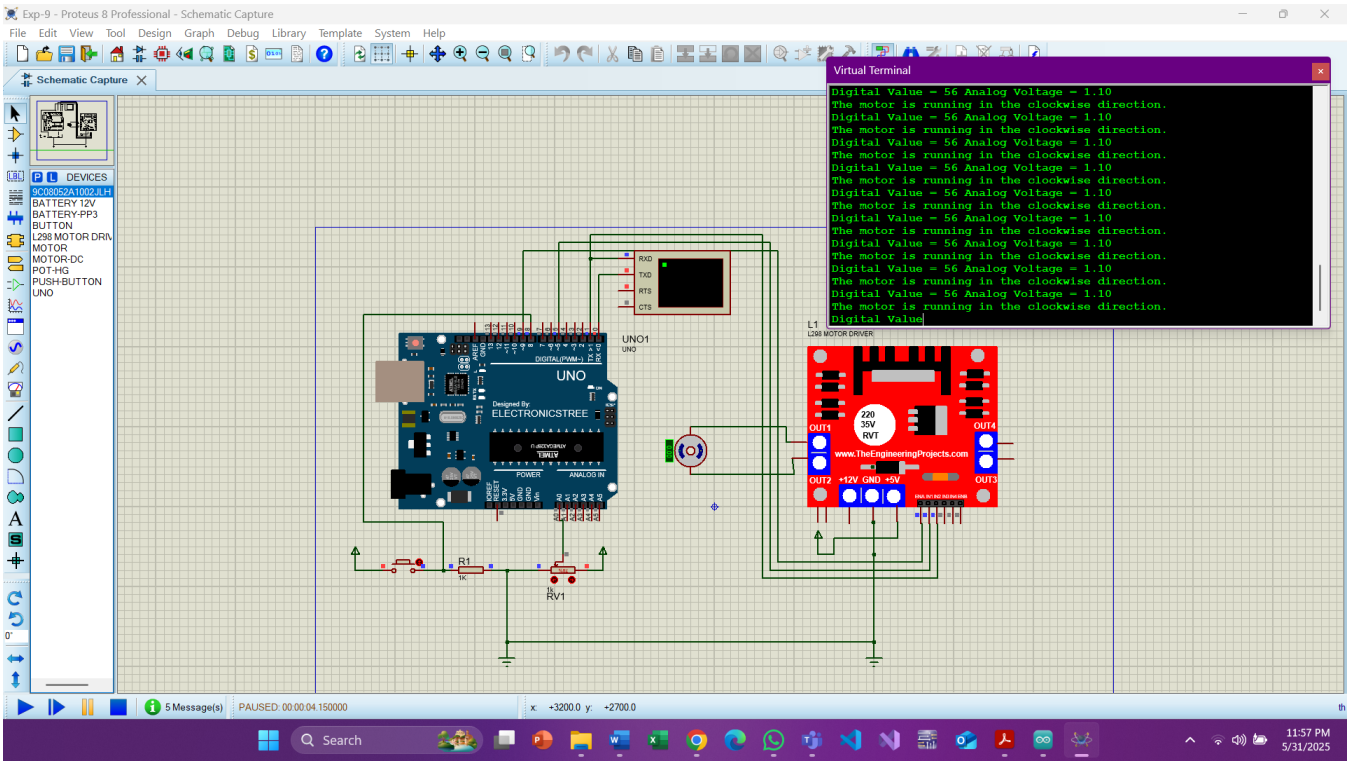

Figure 23: Motor is running clockwise in low voltage (1.1V).

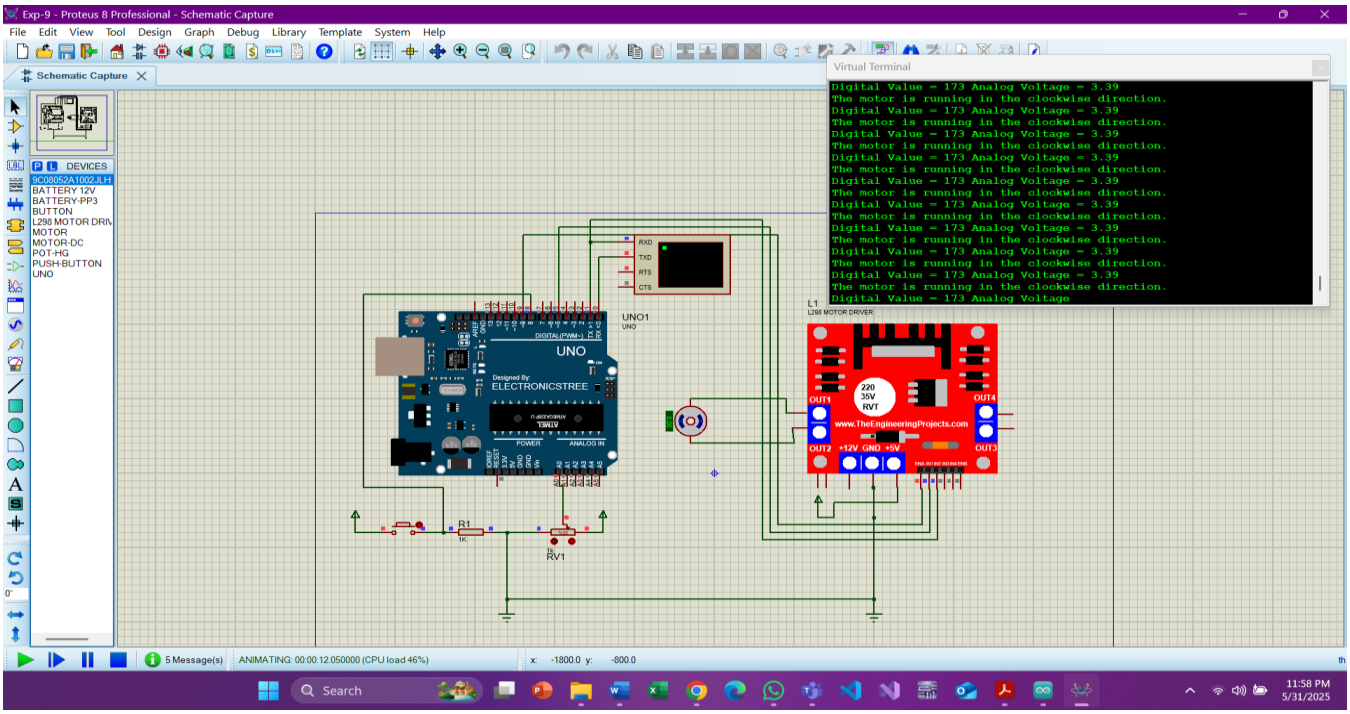

Figure 24: Motor is running clockwise in medium voltage (3.39V).

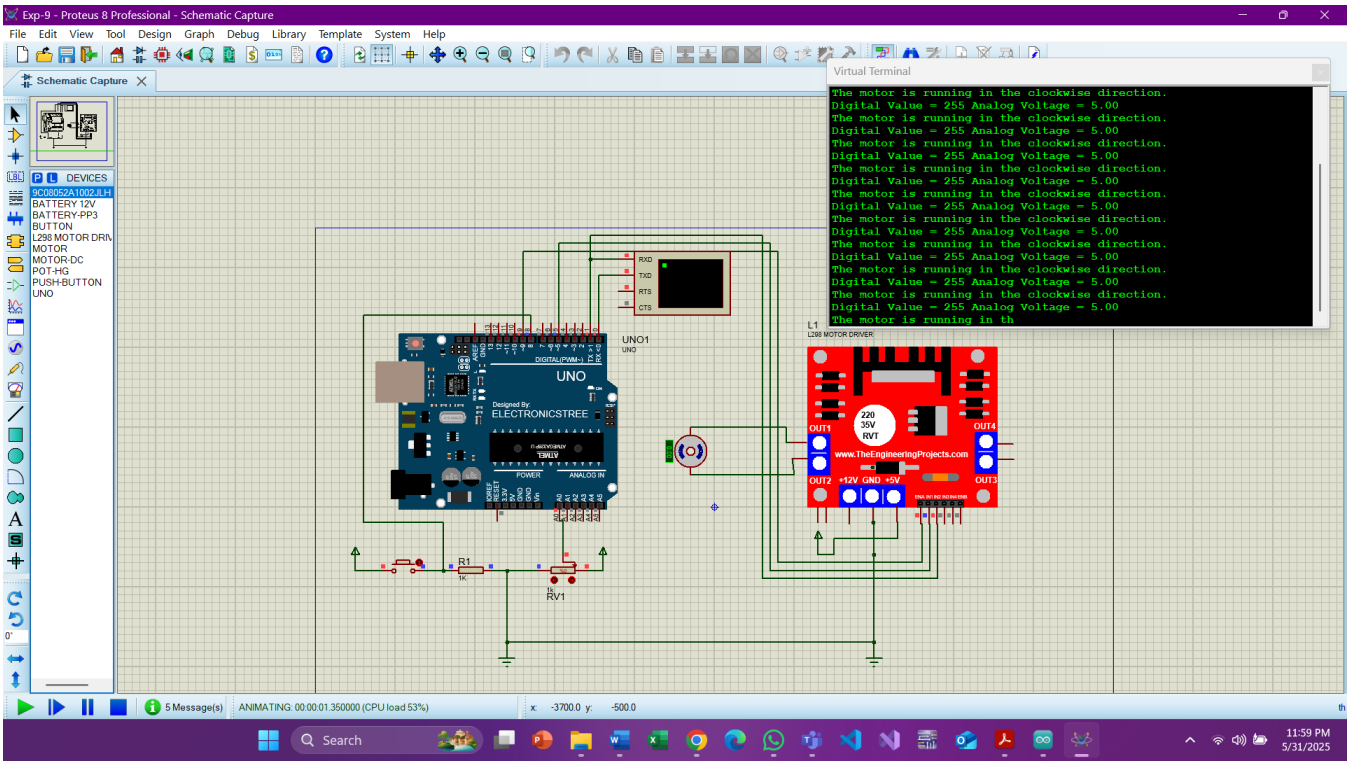

Figure 25: Motor is running clockwise in high voltage (5V).

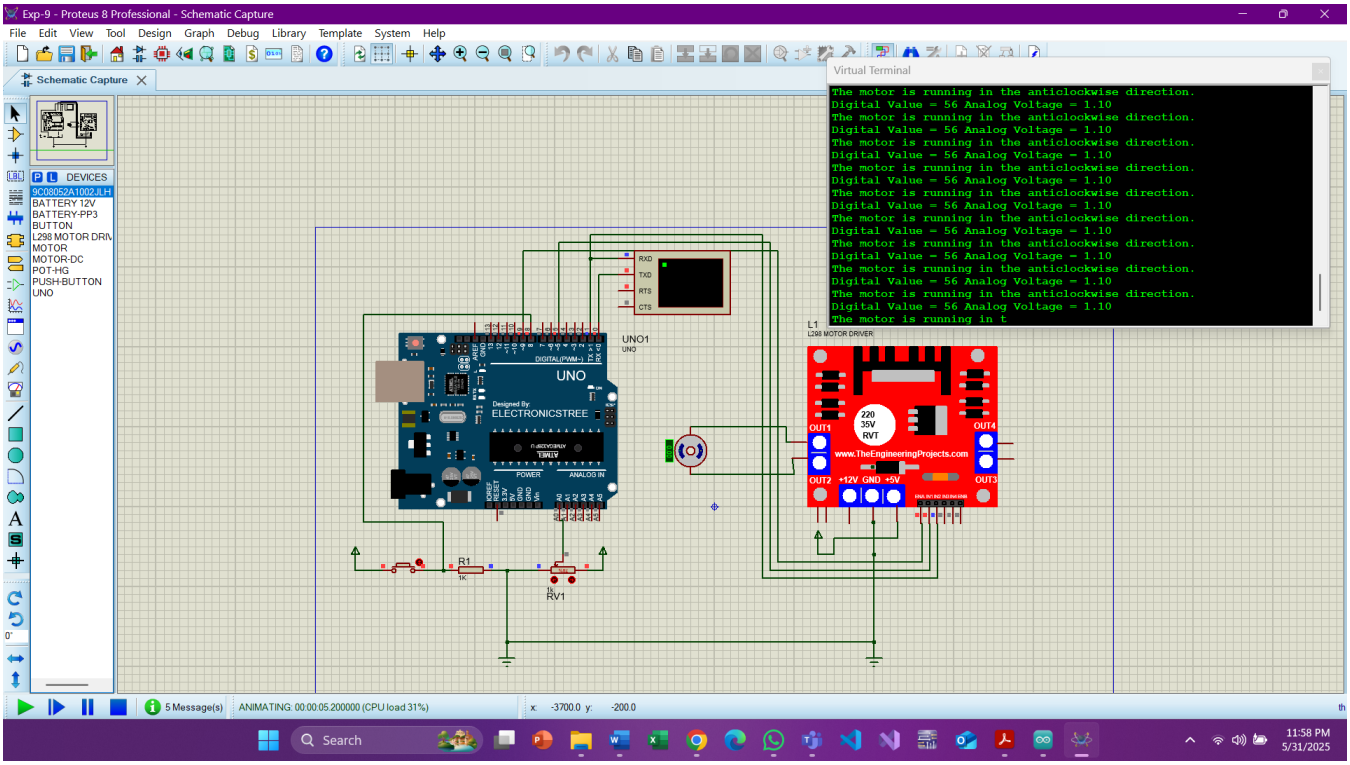

Figure 26: Motor is running anticlockwise in low voltage (1.1V).

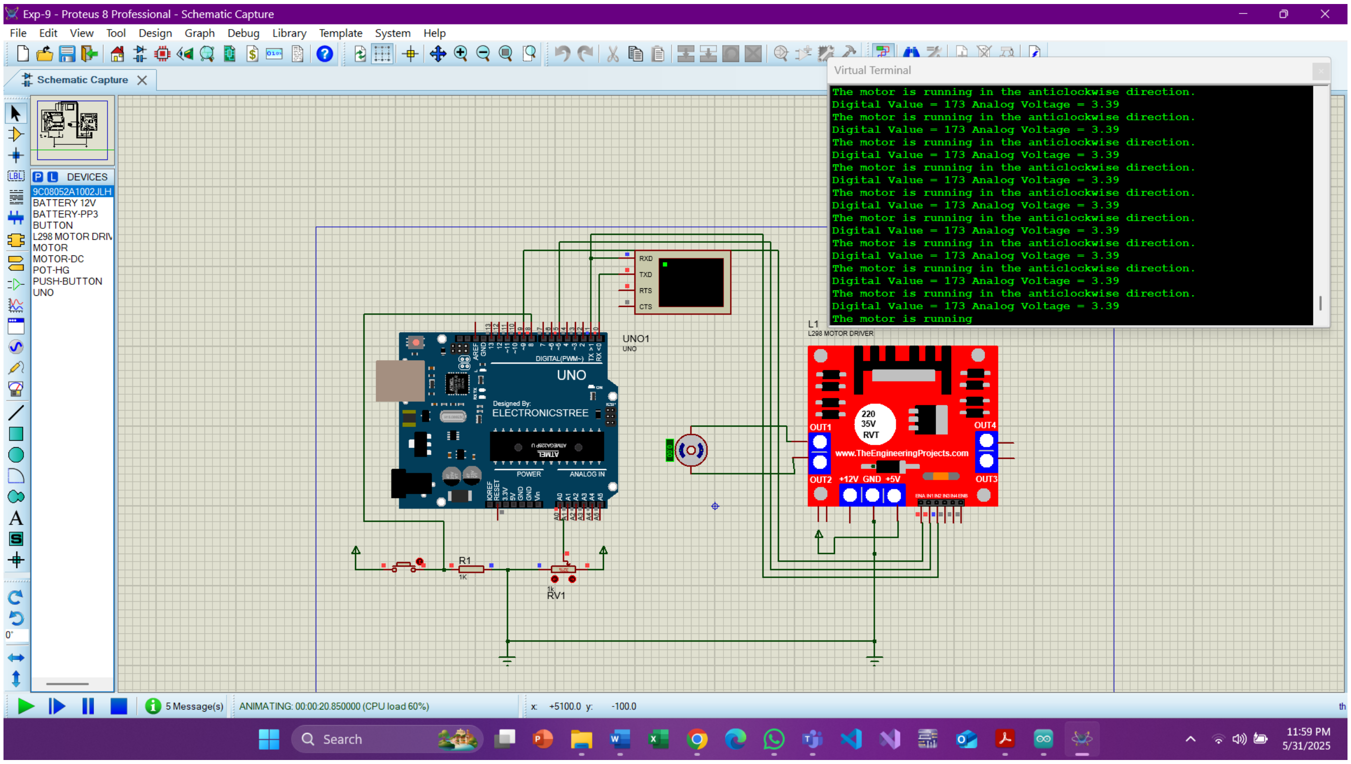

Figure 27: Motor is running anticlockwise in medium voltage (3.39V).

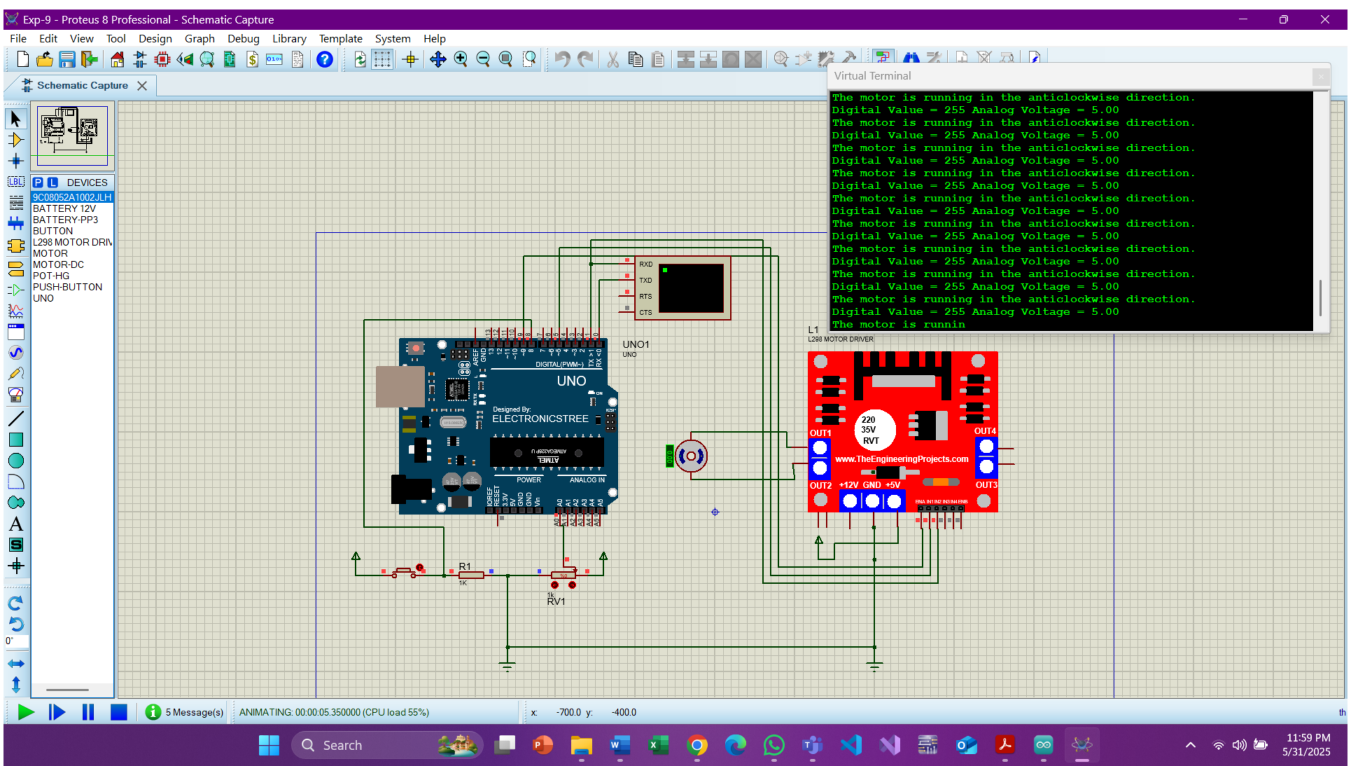

Figure 28: Motor is running anticlockwise in high voltage (5V).

In the simulation result after applying In1, In2, switchrotation, and ConA according to my Id was same as before. It didn't affect the output result. The motor was running properly in both directions with low, medium and high voltage. The switch and potentiometer were working properly. So, it can be concluded that the pin configuration may be changed according to individuals need.

Discussion:

In this experiment, a motor control system was successfully implemented using an Arduino microcontroller. Digital inputs were used to control the motor's behavior, digital outputs were used to monitor or indicate the motor status, and PWM (Pulse Width Modulation) was applied to regulate motor speed. By integrating these components, the direction and speed of a DC motor were controlled in real-time. Through this experiment, hands-on experience was gained in several key areas of embedded systems and control engineering. The generation and manipulation of PWM signals using Arduino were learned, which are essential for motor speed control. Additionally, the use of digital input signals (such as push buttons or sensors) to trigger motor operations was explored, and digital outputs were used to provide visual feedback. This system can be applied in real-life scenarios such as smart fans, robotic vehicles, automated conveyor belts, and home automation systems like smart doors or window blinds. Overall, theoretical knowledge was bridged with practical skills through this experiment. An improved understanding of circuit design, programming logic for control systems, and the real-world application of PWM in controlling motor behavior was achieved.

References:

[1] Arduino IDE, https://www.arduino.cc/en/Main/Software accessed on 2nd July 2023.

[2] https://www.tinkercad.com/things/b6oU31mFyQa-brilliant-snaget/editel?tenant=circuits, accessed on 2nd July 2023.

[3] https://www.youtube.com/watch?v=PVyAcgYkzDs&list=TLPQMzEwNTIwMjXqaAG1Lpeu8w&index=2