

# Assignment-1: Smart Multimeter Using Arduino

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**Project:** Smart Multimeter Using Microcontroller Systems

## ◆ TASK-1: Voltage Measurement (Voltage Divider)

### Aim:

To measure voltage using a voltage divider and Arduino.

### Theory:

A voltage divider is made by connecting two resistors in series. The voltage at the middle point is less than the input voltage. Arduino reads this voltage using an analog pin.

### Circuit Description:

Two resistors are connected in series between 5V and ground. The middle point is connected to Arduino pin A0.

### Arduino Code:

```
void setup() {  
    Serial.begin(9600); // start serial communication  
}  
  
void loop() {  
    int adc = analogRead(A0); // read A0  
    float voltage = adc * 5.0 / 1023.0;  
    Serial.println(voltage); // print voltage  
    delay(500);}
```

### Observation Table:

Parameter	Value
Input Voltage	5 V
Resistor R1	10 kΩ
Resistor R2	10 kΩ
Calculated Voltage	2.50v
Measured Voltage	2.48v

### Result

The measured voltage is almost equal to the calculated value.

## TASK-2: Capacitance Measurement (RC Time Constant)

### Aim:

To measure capacitance using RC time constant method.

### Theory:

A capacitor takes some time to charge through a resistor. The time taken to reach 63% of the supply voltage is called time constant.

### Circuit Description:

A resistor and capacitor are connected in series. The capacitor voltage is measured using Arduino pin A0.

### Arduino Code:

```
// Task 2: Capacitance Measurement using RC Time Constant
```

Parameter	Value
-----------	-------

// Smart Multimeter – Assignment 1

// Resistor = 10k ohm

// Capacitor is charged via digital pin and voltage is sensed using A0

```
int sensePin = A0; // Analog pin to read capacitor voltage
```

```
int chargePin = 8; // Digital pin to charge capacitor
```

```
float R = 10000.0; // Resistance value in ohms (10kΩ)
```

```
float Vcc = 5.0; // Supply voltage
```

```
void setup() {
```

```
  Serial.begin(9600);
```

```
  pinMode(chargePin, OUTPUT);
```

```
}
```

```
void loop() {
```

```
  // Step 1: Discharge the capacitor
```

```
  pinMode(sensePin, OUTPUT);
```

```
  digitalWrite(sensePin, LOW);
```

```
  delay(500);
```

```
  // Step 2: Start charging the capacitor
```

```
  pinMode(sensePin, INPUT);
```

```
  digitalWrite(chargePin, HIGH);
```

Parameter	Value
<b>unsigned long startTime = millis();</b>	
<b>int adcValue = 0;</b>	
<b>// Step 3: Wait until voltage reaches 63% of Vcc</b>	
<b>while (adcValue &lt; (0.63 * 1023)) {</b>	
<b>    adcValue = analogRead(sensePin);</b>	
<b>}</b>	
<b>unsigned long elapsedTime = millis() - startTime;</b>	
<b>// Step 4: Calculate capacitance using <math>\tau = R \times C</math></b>	
<b>float capacitance = (elapsedTime / 1000.0) / R;</b>	
<b>// Display results</b>	
<b>Serial.print("Time Constant (s): ");</b>	
<b>Serial.print(elapsedTime / 1000.0);</b>	
<b>Serial.print(" Capacitance (F): ");</b>	
<b>Serial.println(capacitance);</b>	
<b>digitalWrite(chargePin, LOW);</b>	
<b>delay(3000);</b>	
<b>}</b>	

Parameter	Value
-----------	-------

### Observation Table:

Parameter	Value
Supply Voltage	5 V
Resistor Value	10 kΩ
Time Constant ( $\tau$ )	1.02 s
Calculated Capacitance	0.000102 F
Actual Capacitance	0.0001 F

### Result:

The calculated capacitance is close to the actual value.

## ◇ TASK-3: Resistance Measurement (Ohmmeter)

### Aim:

To measure unknown resistance using Arduino.

### Theory:

A known and unknown resistor are connected in series. The voltage at the middle point is measured and resistance is calculated.

### Circuit Description:

Two resistors are connected between 5V and ground. The middle point is connected to A0.

### Arduino Code:

```
// Task 3: Ohmmeter using Voltage Divider
```

Parameter	Value
-----------	-------

## // Smart Multimeter – Assignment 1

```
int sensePin = A0;      // Analog pin
float Vcc = 5.0;        // Supply voltage
float R_known = 10000.0; // Known resistor (10k ohm)

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

void loop() {
    int adcValue = analogRead(sensePin);
    float Vout = (adcValue * Vcc) / 1023.0;

    float R_unknown = R_known * (Vout / (Vcc - Vout));

    Serial.print("Measured Resistance (Ohms): ");
    Serial.println(R_unknown);

    delay(2000);
}
```

Parameter	Value
-----------	-------

### Observation Table:

Parameter	Value
Supply Voltage	5 V
Known Resistance	10 kΩ
Measured Voltage	1.60 V
Calculated Resistance	4700 Ω
Actual Resistance	4700 Ω

### Result:

The measured resistance is almost equal to the actual resistance.

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Simulator time: 00:00:24

Code Stop Simulation Send To

Components Basic

Search

Resistor LED Pushbutton

Potentiomet... Capacitor Slideswitch

9V Battery Coin Cell 3V Battery 1.5V Battery

Breadboard Small micro:bit Arduino Uno R3

ENG IN 22:39:31 15-12-2025

The screenshot shows a breadboard setup connected to an Arduino Uno. The breadboard has two red power rails and a central ground rail. A 9V battery is connected across the top rail. Two resistors are connected in series between the top rail and an Arduino digital pin (pin 13). The Arduino is connected to a USB cable. The breadboard has labels for pins 1 through 30 along its edges.

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Simulator time: 00:00:32

Code Stop Simulation Send To

1 (Arduino Uno R3)

void setup() {  
 Serial.begin(9600); // start serial communication  
}  
  
void loop() {  
 int adc = analogRead(A0); // read A0  
 float voltage = adc \* 5.0 / 1023.0;  
 Serial.println(voltage); // print voltage  
 delay(500);  
}

Serial Monitor

2.50  
2.50  
2.50  
2.50  
2.50  
2.50  
2.50

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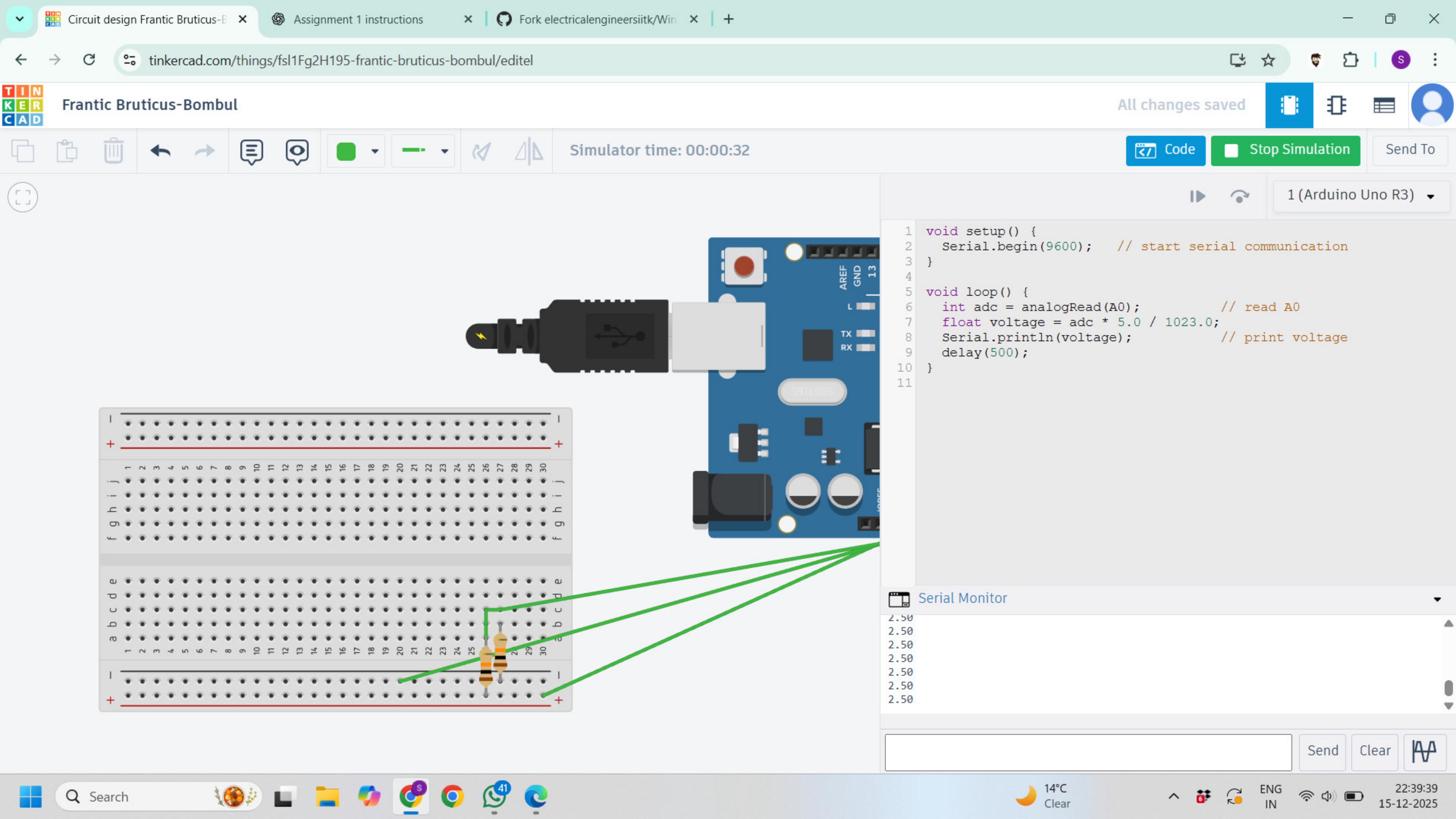
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Simulator time: 00:00:14

Code Stop Simulation Send To

Components Basic

Search

Resistor LED Pushbutton

Potentiomet... Capacitor Slideswitch

9V Battery Coin Cell 3V Battery 1.5V Battery

Breadboard Small micro:bit Arduino Uno R3

ENG IN

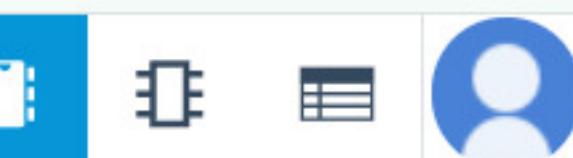
22:58:04 15-12-2025

The screenshot shows a breadboard setup connected to an Arduino Uno. The breadboard has three green wires connecting it to digital pins 24, 26, and 28 of the Arduino. The Arduino is connected to a USB cable and a pushbutton component. The pushbutton is connected between digital pin 24 and ground. The breadboard has a red power rail at the top and a red ground rail at the bottom. The Arduino Uno has its own power and ground rails. The circuit is currently simulated, as indicated by the simulator time of 00:00:14.



## Frantic Bruticus-Bombul

All changes saved



Simulator time: 00:00:29

Code

Stop Simulation

Send To



1 (Arduino Uno R3)

```
23 // Step 2: Start charging the capacitor
24 pinMode(sensePin, INPUT);
25 digitalWrite(chargePin, HIGH);
26
27
28 unsigned long startTime = millis();
29 int adcValue = 0;
30
31 // Step 3: Wait until voltage reaches 63% of Vcc
32 while (adcValue < (0.63 * 1023)) {
33     adcValue = analogRead(sensePin);
34 }
35
36 unsigned long elapsedTime = millis() - startTime;
37
38 // Step 4: Calculate capacitance using τ = R × C
39 float capacitance = (elapsedTime / 1000.0) / R;
40
41 // Display results
42 Serial.print("Time Constant (s): ");
43 Serial.print(elapsedTime / 1000.0);
44 Serial.print(" Capacitance (F): ");
45 Serial.println(capacitance);
46
47 digitalWrite(chargePin, LOW);
48 delay(3000);
49 }
```

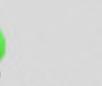
## Serial Monitor

```
Time Constant (s): 0.99 Capacitance (F): 0.00
Time Constant (s): 0.99 Capacitance (F): 0.00
Time Constant (s): 0.99 Capacitance (F): 0.00
```

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Search

16°C  
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Simulator time: 00:00:20

Code Stop Simulation Send To

Components Basic

Search

Resistor LED Pushbutton

Potentiometer Capacitor Slideswitch

9V Battery Coin Cell 3V Battery 1.5V Battery

Breadboard Small micro:bit Arduino Uno R3

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The screenshot shows a breadboard setup connected to an Arduino Uno. The breadboard has three rows of pins labeled a through j. Two resistors are connected between pin 27 and ground. A green wire connects pin 27 to digital pin 13 on the Arduino. The Arduino Uno is connected to a USB cable. The circuit is powered by a 9V battery connected to the breadboard's power rail.

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Simulator time: 00:00:33 Code Stop Simulation Send To

1 (Arduino Uno R3)

```
1 // Task 3: Ohmmeter using Voltage Divider
2 // Smart Multimeter - Assignment 1
3
4 int sensePin = A0;          // Analog pin
5 float Vcc = 5.0;           // Supply voltage
6 float R_known = 10000.0;   // Known resistor (10k ohm)
7
8 void setup() {
9     Serial.begin(9600);
10 }
11
12 void loop() {
13
14     int adcValue = analogRead(sensePin);
15     float Vout = (adcValue * Vcc) / 1023.0;
16
17     float R_unknown = R_known * (Vout / (Vcc - Vout));
18
19     Serial.print("Measured Resistance (Ohms): ");
20     Serial.println(R_unknown);
21
22     delay(2000);
23 }
```

Serial Monitor

```
Measured Resistance (Ohms): 4490.08
Measured Resistance (Ohms): 4490.08
Measured Resistance (Ohms): 4490.08
```

Send Clear

Search

23:07:47 15-12-2025

9+ 16°C Clear