Assignment-1

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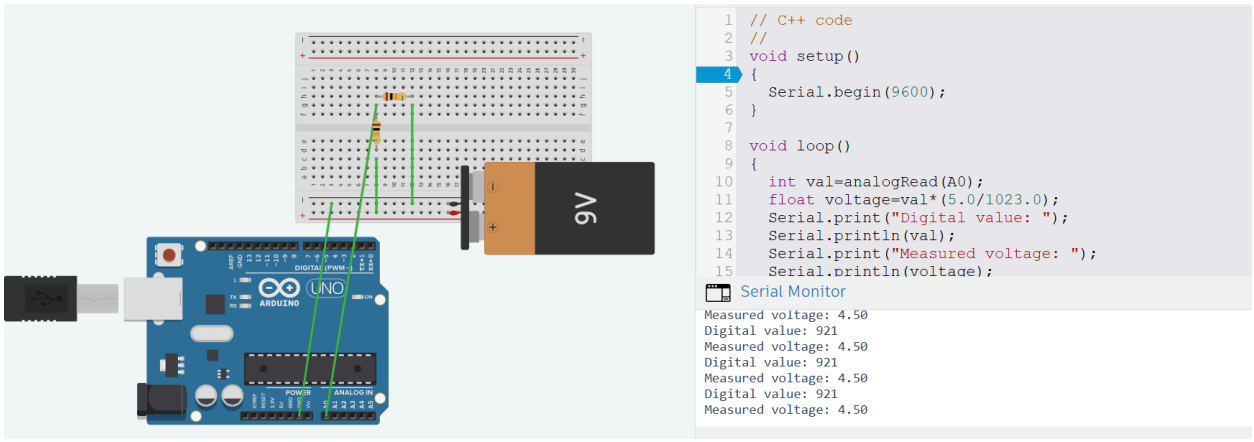
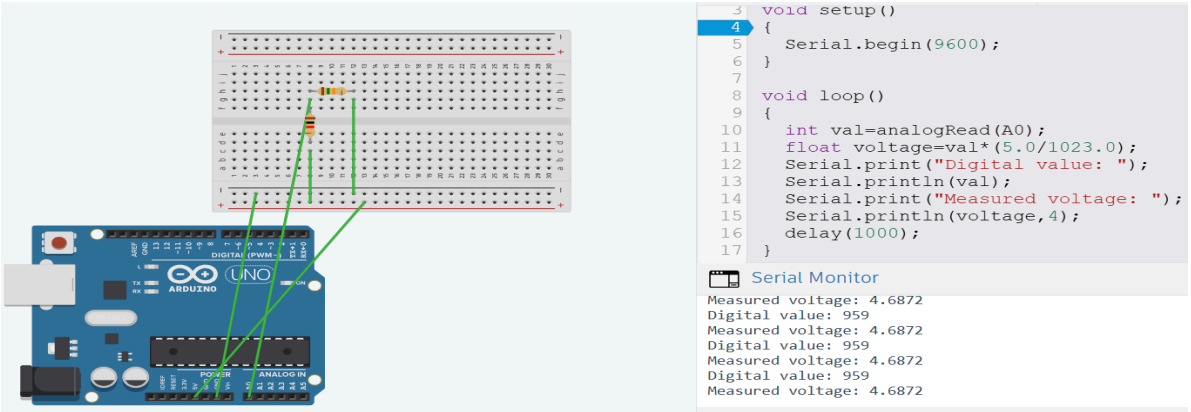
Task A:-

1) The purpose of voltage divider circuits is to scale down the voltage to be measured, since modern measurement devices can only handle low voltages, typically in the range of 0 to 5V.
2) The formula used to convert the reading by the arduino into voltage is: adc_value * (5/1023.0)
    a) Arduino has an inbuilt ADC that converts the continuous voltage into a discrete values.
    b) It uses a 10 bit analog-to-digital convertor, and so maps the voltages of 0 to 5V to values from 0 to 2^{10}-1 (1023)
3) When the input voltage is 9V, in the case of R_1=10kΩ, and R_2=10kΩ,
    a) The theoretical and measured value of V_{out} match, and are equal to 4.50V.
    b)



4) When the input voltage is 5V, and R_1=1kΩ, and R2=15kΩ,
    a) The theoretical value is 5.6875V, while the measured value is 5.6872V.
    b) Reason for the error: least count of the analog port of the arduino is 5/1023 = **0.00488V**, so when converting the voltage to digital, 4.6875/5 * 1023 = 959.7. But the ADC output has to be integral, so 959.7 is rounded off to 959, which when converted back to voltage, it comes out to be slightly less than the actual voltage.
    c) The input voltage in this part was changed since the analog pin of the arudino can correctly measure only voltages from range 0 to 5V.



Task B:-

1) The time constant is the product of the Resistance and Capacitance connected in series. The time taken by the capacitor voltage to reach 63% of its maximum value is equal to 1 time constant, ie, RC.
2) Measured vs theoretical time values for 2 values of capacitance :-

Capacitor value (R=10kΩ)	Measured time to reach 63% of source voltage (ms)	Theoretical time (ms)
1 μF	10.020	10.0
23 μF	229.864	230.0

3) The sources of error are the ADC resolution of the arduino, the tolerances of capacitor and resistor.
4) capacitance is calculated by dividing the time taken to charge the capacitor to 63% of its maximum value.
5) **Code**:

```
// C++ code
const int discharge = 13, meas = A0;
const float R=10000;

void setup() {
  Serial.begin(9600);
  pinMode(discharge, OUTPUT);
}

void loop() {
  digitalWrite(discharge, LOW);          //to make sure capacitor is discharged
  delay(2000);
```

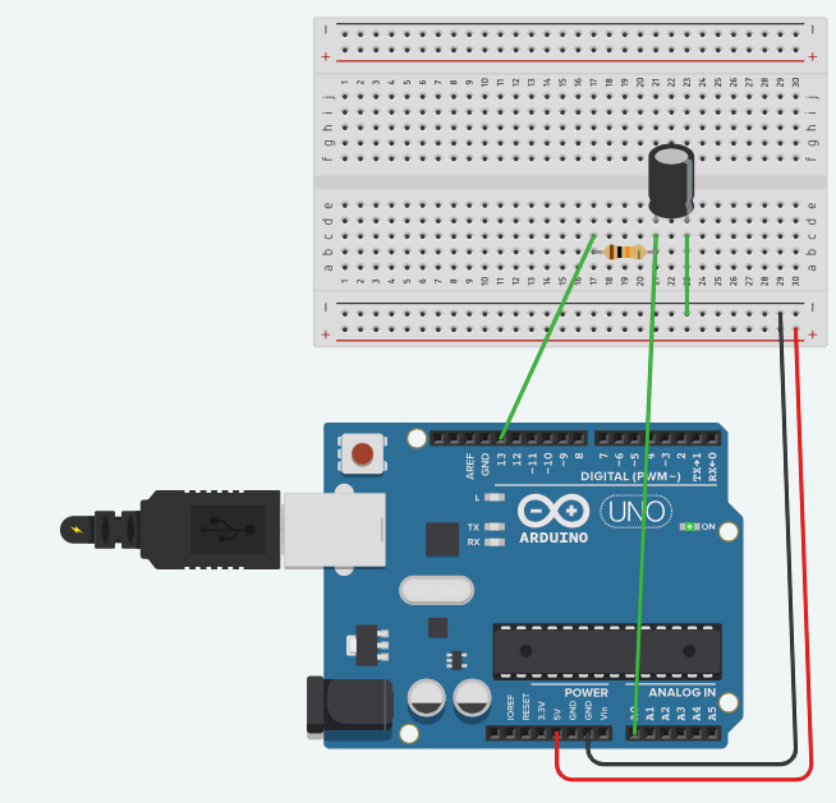
```
  long int starttime=micros();
  digitalWrite(discharge, HIGH);          //starting the charging

  int adcvalue;
  do {
    adcvalue=analogRead(meas);
  } while(adcvalue<645);

  long int t = micros() - starttime;
  Serial.print("t: ");
  Serial.println(t);

  float c=t/R;
  Serial.print("C: ");
  Serial.println(c, 6);
}
```

6) **Circuit**:



Task C:-

1) In the voltage divider circuit,
   $V_{out}=(R_{unknown} V_{in}) / (R_{unknown} + R_{known})$
   $R_{unknown} = (R_{known} * V_{in}) / (V_{in} - V_{out})$

2) In this

Known resistance (Ω)	Theoretical value (Ω)	Measured value (Ω)
10,000	1000	1000
10,000	15000	15012.22
10,000	4700	4698.28

3) The error is again due to the ADC resolution (0.00488V), tolerance of the resistor values, etc
4) Code:

```
const float Vin=5;
const float R=10000;
void setup()
{
        Serial.begin(9600);
}

void loop()
{
  int adc=analogRead(A0);
  float voltage=adc * (5.0/1023);

  float unknown = (R*voltage)/(Vin-voltage);
  Serial.print("Unknown resistance: ");
  Serial.println(unknown);

  delay(1000); // Wait for 1000 milliseconds
}
```

5) Circuit: