Bangladesh University of Engineering and Technology

Department of Electrical and Electronic Technology

EEE 428

Measurement and Instrumentation Laboratory

Experiment 2
High Resistance Measured by Loss of Charge Method

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Measurement and Instrumentation Laboratory
EEE 428
Experiment No :02
Experiment Title : High Resistance Measured by Loss of Charge Method

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Objective of the experiment

Using the Loss of charge method to determine the high resistance values.

Experimental Setup:

The following circuit was implemented in Tinkercad for the experimentation.

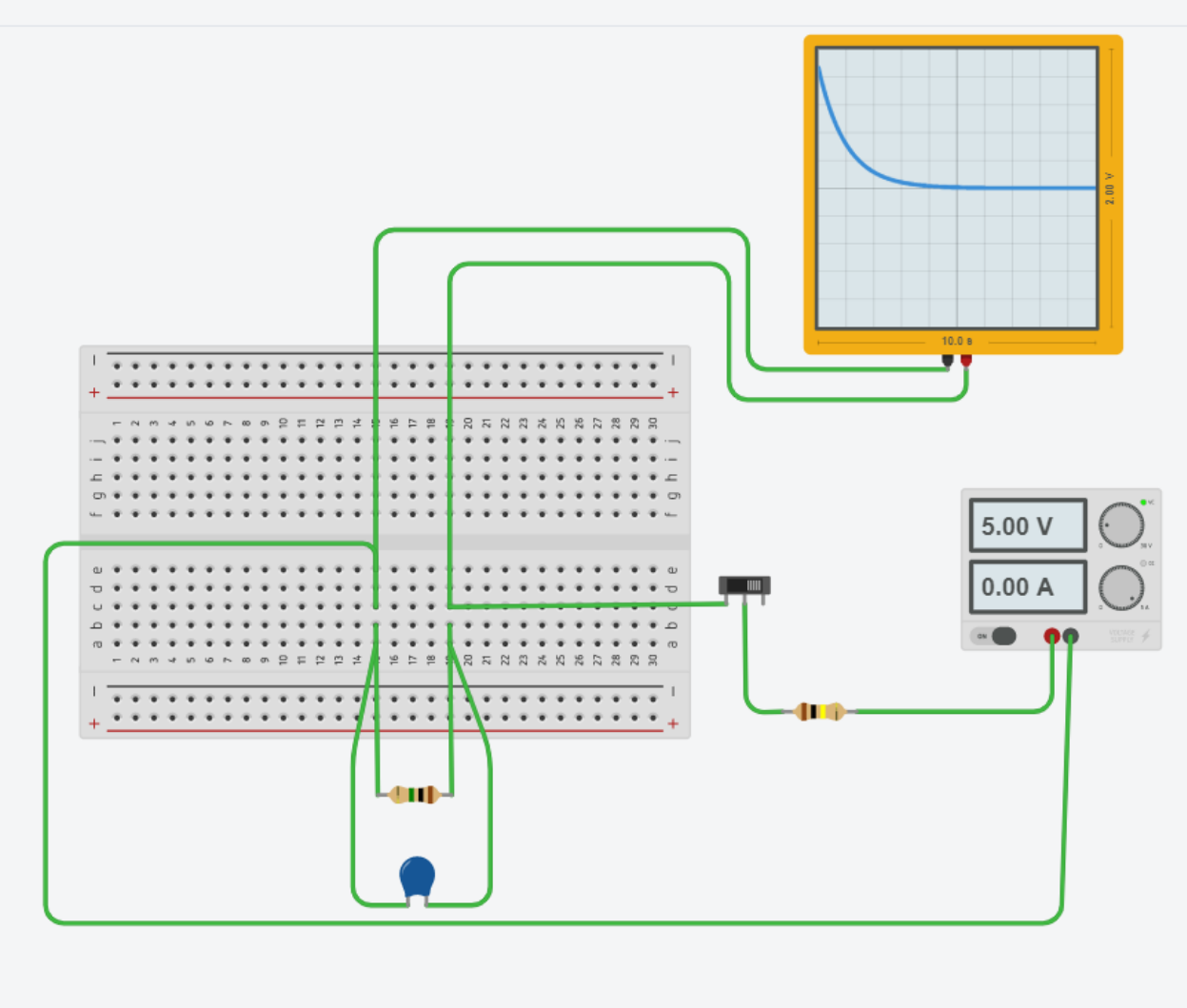


Figure 1 Tinkercad Implementation

Here, instead of a normal multimeter, we used a oscilloscope as that shows the time of voltage discharge, which is crucial for out calculation.

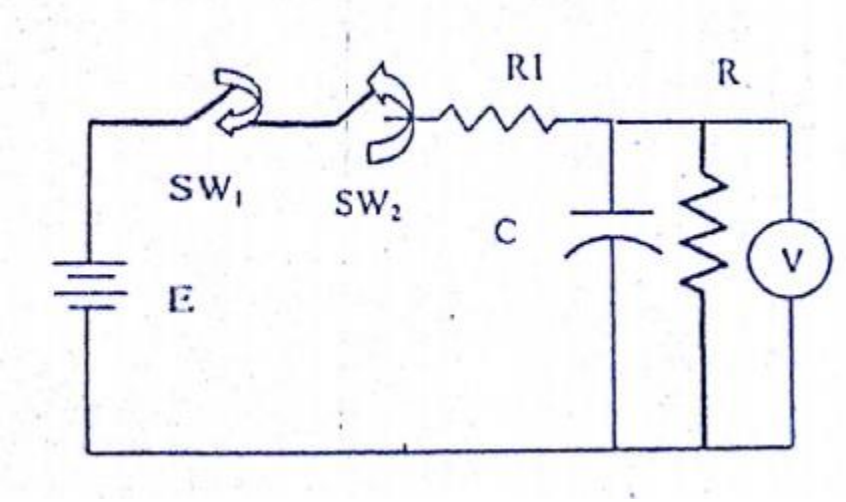


Figure 2 Schematic diagram

In our tinkercad simulation,
at first we observed the output for the following parameters :
C= 1uF
R = 1M Ohm
R1 = 100 kOhm

Then, we observed the performance for the following parameters :

C = 10uF

Then we changed the resistance to :

R = 2, 4, 10 M ohm

The following Observations were obtained :

CASE 1 (1 uF , R = 1M Ohm, R1 = 100 k Ohm)

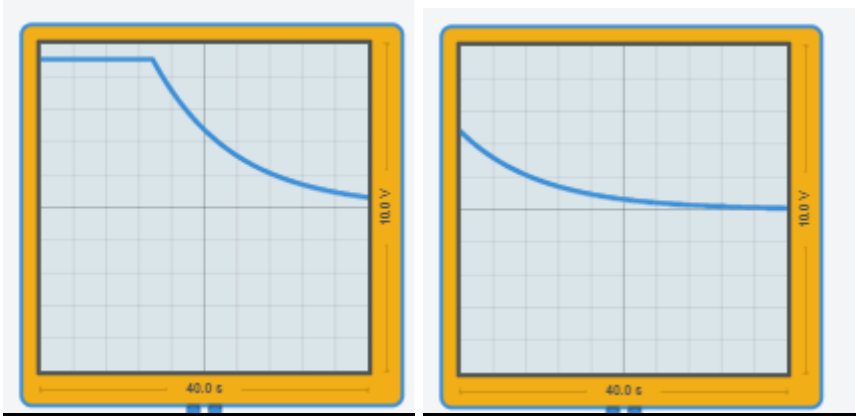
The Capacitor took almost 5s to discharge .

The following table was obtained :

Time	Voltage across C
t=0s	4.54 V
1s	1.5 V
2s	0.75 V
3s	0.25V
4s	0.05 V
5s	0.2 mV

Calculating, R = t / [c log (E/V)]
= 1.147 M Ohm

CASE 2 (10uF , R = 1M Ohm, R1 = 100 k Ohm)

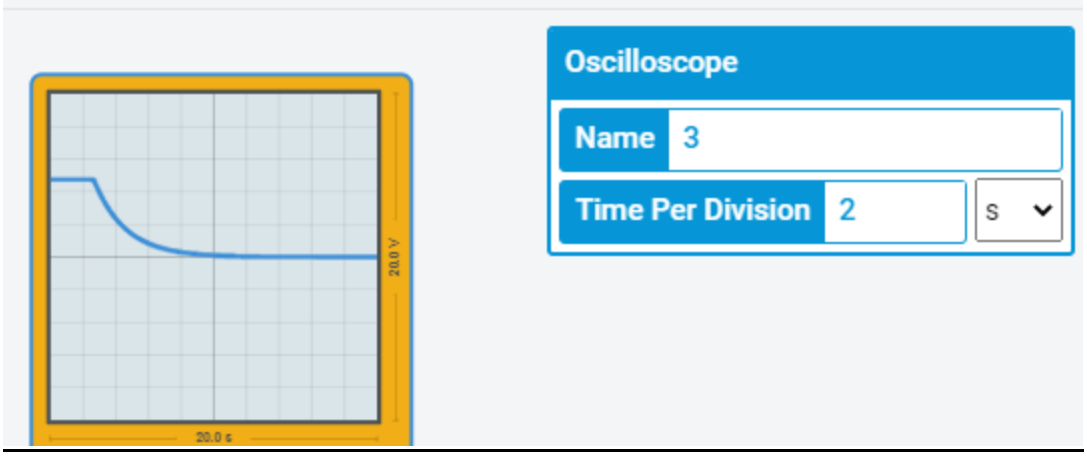


The Capacitor took almost 5s to discharge .
The following table was obtained :

Time	Voltage across C
t=0s	4.54 V
1s	3.5 V
2s	3 V
3s	2.4 V
4s	2 V
5s	1.6V
6s	1.2V
7s	1V
8s	0.8V
9s	0.7V
10s	0.5V

Calculating, R = t / [c log (E/V)]
= 1. 043 M Ohm

CASE 3 (1uF , R = 2M Ohm, R1 = 100 k Ohm)

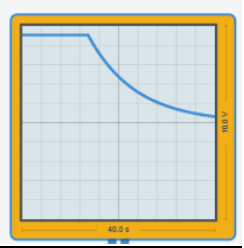
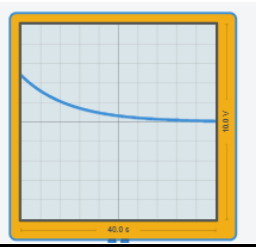


The Capacitor took almost 5s to discharge .
The following table was obtained :

Time	Voltage across C(V)
t=0s	4.54
1s	2.5
2s	1.5
3s	1
4s	0.6
5s	0.4
6s	0.2
7s	0.1
8s	50mV
9s	25mV
10s	0.05mV

Calculating, R = t / [c log (E/V)]
= 2.01 M Ohm

CASE 4 (10uF , R = 2M Ohm, R1 = 100 k Ohm)

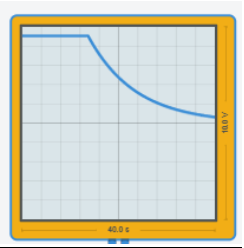
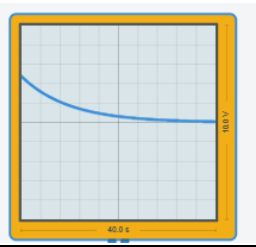



The Capacitor took almost 5s to discharge .
The following table was obtained :

Time	Voltage across C(V)
t=0s	4.54 V
2s	3.5 V
4s	3 V
6s	2.4 V
8s	2 V
10s	1.6V
12s	1.2V
14s	1V
16s	0.8V
18s	0.7V
20s	0.5V

Calculating, R = t / [c log (E/V)]
= 2.086 M Ohm

CASE 5 (1uF , R = 4M Ohm, R1 = 100 k Ohm)

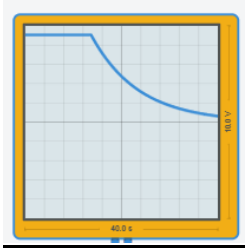
The Capacitor took almost 5s to discharge .
The following table was obtained :

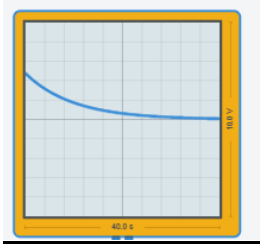
Time	Voltage across C(V)
t=0s	4.54
2s	2.5
4s	1.5
6s	1
8s	0.6
10s	0.4
12s	0.2
14s	0.1
16s	50mV
18s	25mV
20s	0.05mV

Calculating, R = t / [c log (E/V)]
= 4.003M Ohm

as it was more convenient to take the readings with more time per division, we took the reading upto 20 s

CASE 6 (10uF , R = 4M Ohm, R1 = 100 k Ohm)





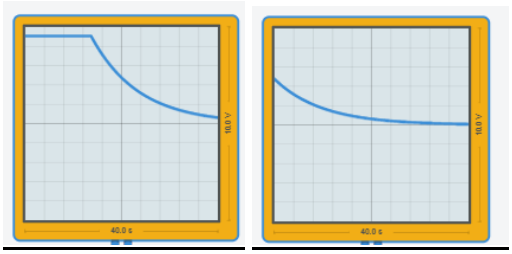
The Capacitor took almost 5s to discharge .
The following table was obtained :

Time	Voltage across C(V)
t=0s	4.54 V
4s	3.5 V
8s	3 V
12s	2.4 V
16s	2 V
20s	1.6V

24s	1.2V
28s	1V
32s	0.8V
36s	0.7V
40s	0.5V

Calculating, R = t / [c log (E/V)]
= 4.0057M Ohm

CASE 7 (1uF , R = 10M Ohm, R1 = 100 k Ohm)



The Capacitor took almost 5s to discharge .
The following table was obtained :

Time	Voltage across C(V)
t=0s	4.54
5s	2.76
10s	1.25
15s	1
20s	0.5
25s	0.33
30s	0.25
35s	0.15
40s	75mV
45s	33mV
50s	0.075mV

Calculating, R = t / [c log (E/V)]
= 10.455M Ohm

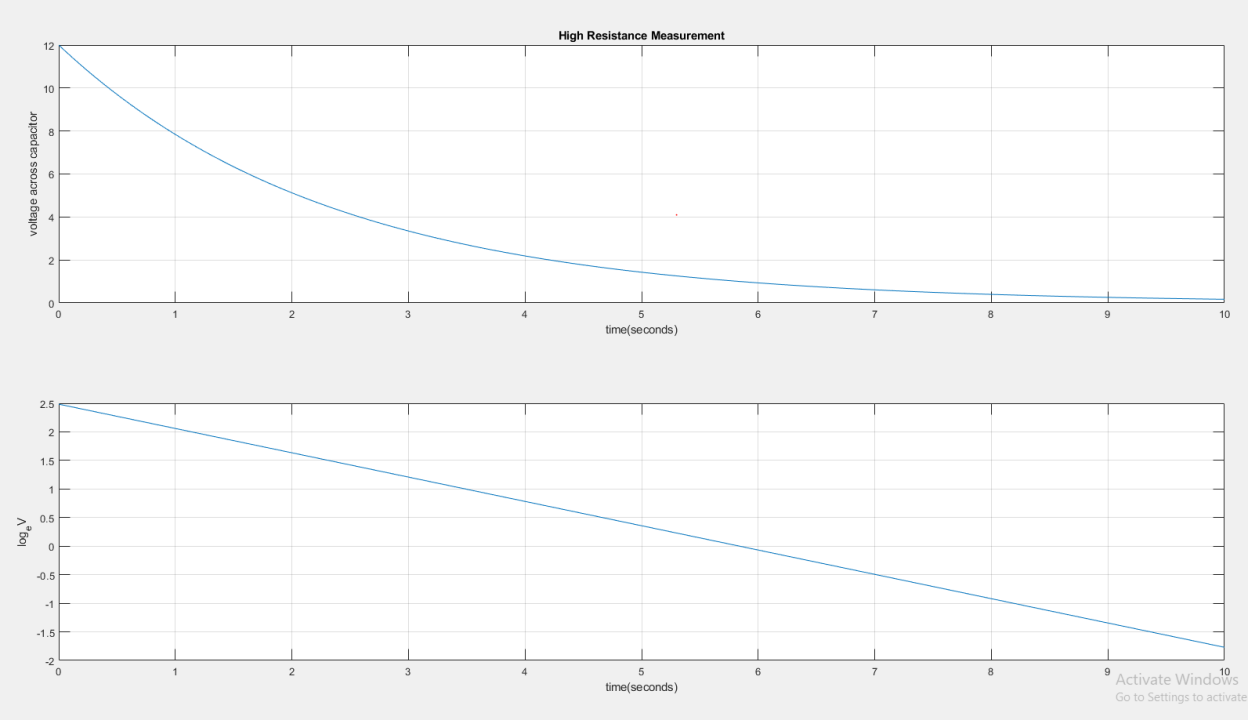
MATLAB CODE SIMULATION:

Code :

```
E = 12;
R = 0.5e+6;
C = 4.7e-6;

RC = R*C;
tmax = 10;
t = 0:0.01:tmax;
N = tmax / 0.01;
V = E*exp(-t/RC);
subplot(2,1,1), plot (t,V);
grid on
title('High Resistance Measurement');
xlabel('time(seconds)');
ylabel('voltage across capacitor');
subplot(2,1,2), plot(t,log(V));
grid on
xlabel('time(seconds)');
ylabel('log_eV')
Rx = 0.01*N/(C*log(E/V(N+1)))
```

Output :

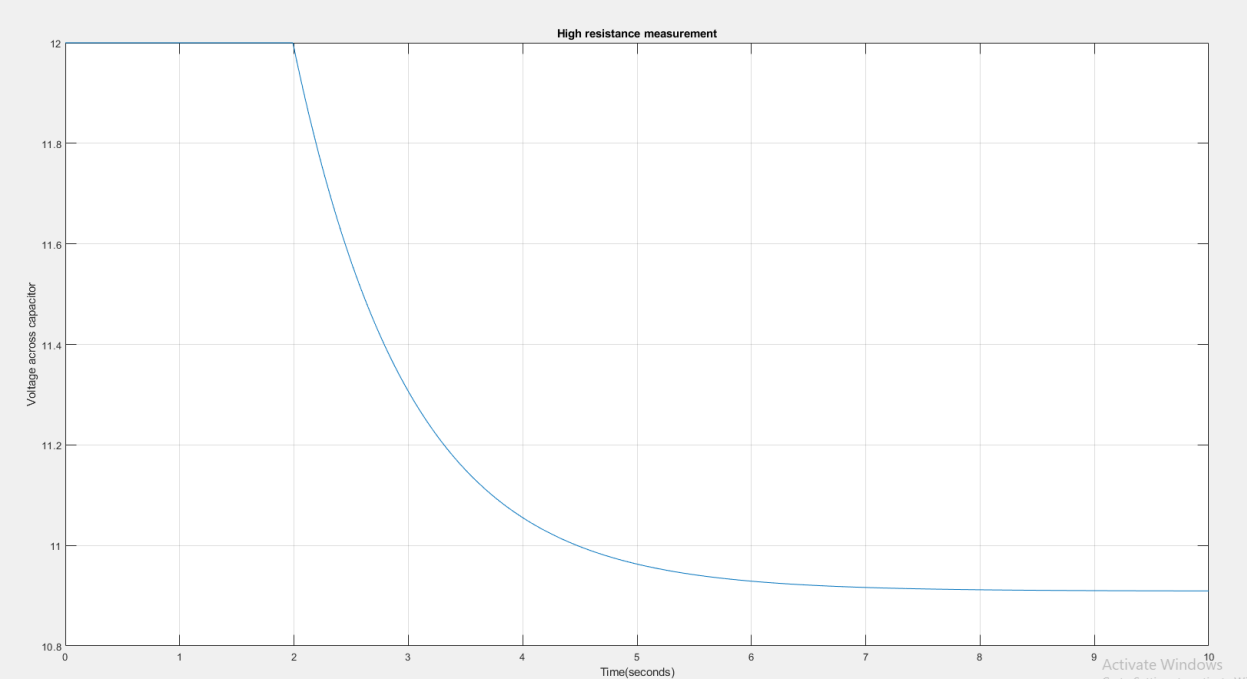


Alternative method Matlab code :

Code :

```
clear all; clc;
t = 0:0.01:10;
N = t(end)/ 0.01;
E = 12;
R = 1e6;
Rsw = 1e5;
C = 1e-6;
RC = R*C;
for i = 1:(N+1)
    if (i <= 2/ 0.01)
        V(i) = E;
    elseif(i> 2/0.01)
        Vinf = (R / (R + Rsw))*E ;
        V(i) = Vinf + (E - Vinf)* exp (-(i - 2/0.01)/ (RC/0.01));
    end
end
plot (t, V)
grid on
title('High resistance measurement');
xlabel('Time(seconds)');
ylabel('Voltage across capacitor');
```

Output :



Discussion :

Observing the voltage discharge through the tinkercad oscilloscope was difficult and somewhat inaccurate. In order to make the process more convenient, as the circuits with greater capacitor values and the circuits with greater resistance values

require more time to descend, and discharge, the readings were taken longer than 10s to improve the accuracy of the system.