The National Institute of Engineering
Mysuru

(An Autonomous College under Visvesvaraya Technological University Belgaum)

RC - (CHARGING AND DISCHARGING)

A report submitted

To the Department of Physics as part of the Experiential Learning

Course: Applied Physics for CSE Stream

Course Code: BPHYS102

Sl. No.	Name	USN	Signature
01	AVANI P SAVALGI	4NI24IS030	Avani
02	AYUSH KUMAR	4NI24IS031	Ayush
03	AYUSH MISHRA	4NI24IS032	[illegible]

Branch: ISE
Semester and Section: Semester - II , ISE - A

Course Instructor: Dr. Sankarshan B M

Assistant professor
Department of Physics
NIE, Mysore

2024-2025

The National Institute of Engineering
Mysuru

(An Autonomous College under Visvesvaraya Technological University Belgaum)

2024-2025

CERTIFICATE

This is to certify that the activity titled **RC-CHARGING DISCHARGING** is a work carried out by Avani P Savalgi (4NI24IS030) , Ayush Kumar(4NI24IS031), Ayush Mishra(4NI24IS032) of 2 n d Semester of ISE-A as a part of Experiential Learning in the course Applied Physics for CSE stream during the year 2024-25.

Date: 20/05/2025

Place: MYSURU

Signature of the Examiner 1 Sathaksha B.M.

Signature of the Examiner 2

The National Institute of Engineering
Mysuru

(An Autonomous College under Visvesvaraya Technological University Belgaum)

Title:

Sl. No.	Name	USN	Signature
01	AVANI P SAVALGI	4NI24IS030	Avani
02	AYUSH KUMAR	4NI24IS031	Ayush
03	AYUSH MISHRA	4NI24IS032	Ayush

Marks awarded for Experiential Learning

Sl. No.	Evaluation Components	Max. Marks	Marks Obtained
1.	Report	20	
2.	~~Presentation~~	~~10~~	
3.	Tools used for ~~presentation~~ and report	5	28 30
4.	Conclusions/ Innovative ideas on the topic	5	
5.	~~Viva~~	~~10~~	
	Total	30	

Marks awarded in words:

Zero	two	Eight.

	Examiner 1	Examiner 2
Signature with date	Sankarsha B.M.	[signature]
Name	Dr. Sankarshan B.M.	Dr Vinay Kumar. P.C

RC Charging and Discharging

Introduction to Experiment (Including Literary survey):

The RC (resistor-capacitor) circuit experiment aims to study the charging and discharging behavior of a capacitor through a resistor. This fundamental experiment helps in understanding the transient response in electrical circuits, which is crucial in various electronic applications.

RC circuits, consisting of a resistor (R) and a capacitor (C) connected in series or parallel, are fundamental components in electronics. These circuits are widely used to store and manage electrical energy and are vital for understanding time-dependent electrical behavior.

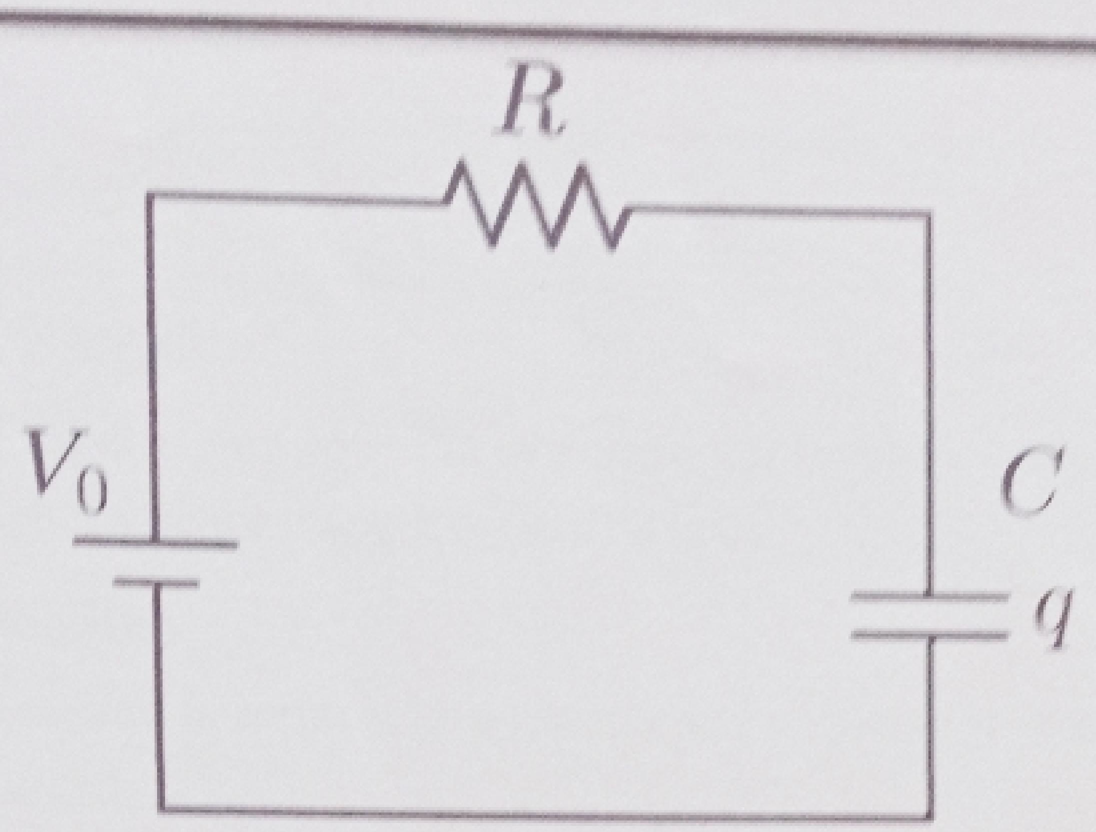
In an RC circuit, the charging and discharging processes describe how a capacitor stores and releases electrical energy over time. This behavior is governed by the interaction between the resistor and the capacitor and is characterized by an exponential change in voltage and current. The resistor controls the rate of charging or discharging, while the capacitor acts as the storage element.

Early research by pioneers like Georg Simon Ohm and Michael Faraday laid the groundwork for the analysis of resistors and capacitors, leading to the mathematical modelling of exponential growth and decay in circuits. This experiment provides practical insight into time constants, energy storage, and dissipation, which are essential in designing filters, timers, and memory circuits.

Literature Survey –

The study of RC circuits has long been fundamental to electrical engineering, physics, and electronics. Classic texts such as Electronic Devices and Circuit Theory by Boylestad and Nashelsky (1996) and Integrated Electronics by Millman and Halkias (1967) provide detailed theoretical frameworks for understanding first-order circuits. These sources explain that the charging and discharging behavior of capacitors is governed by first-order differential equations, which yield exponential voltage-time relationships.

Horowitz and Hill (1980), in The Art of Electronics, provide practical applications and emphasize the significance of time constants in circuit design, including filters, waveform generators, and pulse-shaping circuits. Additionally, educational research (Maloney et al., 2001) has shown that hands-on experiments with RC circuits reinforce theoretical learning and enhance conceptual understanding, especially in undergraduate labs.



Recent advancements also explore RC circuits in energy storage, power electronics, and biomedical devices, where understanding transient behavior is critical. Thus, this experiment remains highly relevant for both theoretical study and practical applications.

Objectives :

- To construct a simple RC circuit using resistors, capacitors, and a DC power supply.
- To observe the voltage across the capacitor during the charging phase when connected to a DC voltage source.
- To observe the voltage across the capacitor during the discharging phase when the source is removed or switched.
- To record the voltage values at regular time intervals and plot voltage vs. time graphs.
- To analyze the nature of the voltage curve and verify its exponential behavior.
- To determine the time constant $\tau = RC$ experimentally from the plotted graphs.
- To compare the experimental time constant with the theoretical value and analyze any deviations.
- To understand the influence of resistance and capacitance values on the time constant and overall behavior of the circuit.
- To appreciate the application of RC circuits in real-world systems such as filters, timers, and analog signal processing.

AIM: To Determine the Dielectric Constant of a material by charging and discharging of the material.

Theoretical Background:

Charging of a Capacitor

The derivation of the charging equation of a capacitor involves analyzing the process of charging through a resistor using Kirchhoff's laws.

Circuit Configuration

A capacitor is connected in series with a resistor and a voltage source. Initially, the capacitor is uncharged.

Steps

1. **Applying Kirchhoff's Voltage Law (KVL) :**

   By KVL, the sum of potential differences in the loop equals zero:

   $V_0 - V_R - V_C = 0$

   Where:

   - V_0: Source voltage
   - $V_R = iR$:Voltage across the resistor
   - $V_C = \frac{q}{C}$: Voltage across the capacitor

   Substituting: $V_0 - iR - \frac{q}{C} = 0$

2. **Current-Charge Relationship :**

   Current is the rate of change of charge: $i = \frac{dq}{dt}$

   Substituting: $V_0 - R\frac{dq}{dt} - \frac{q}{C} = 0$

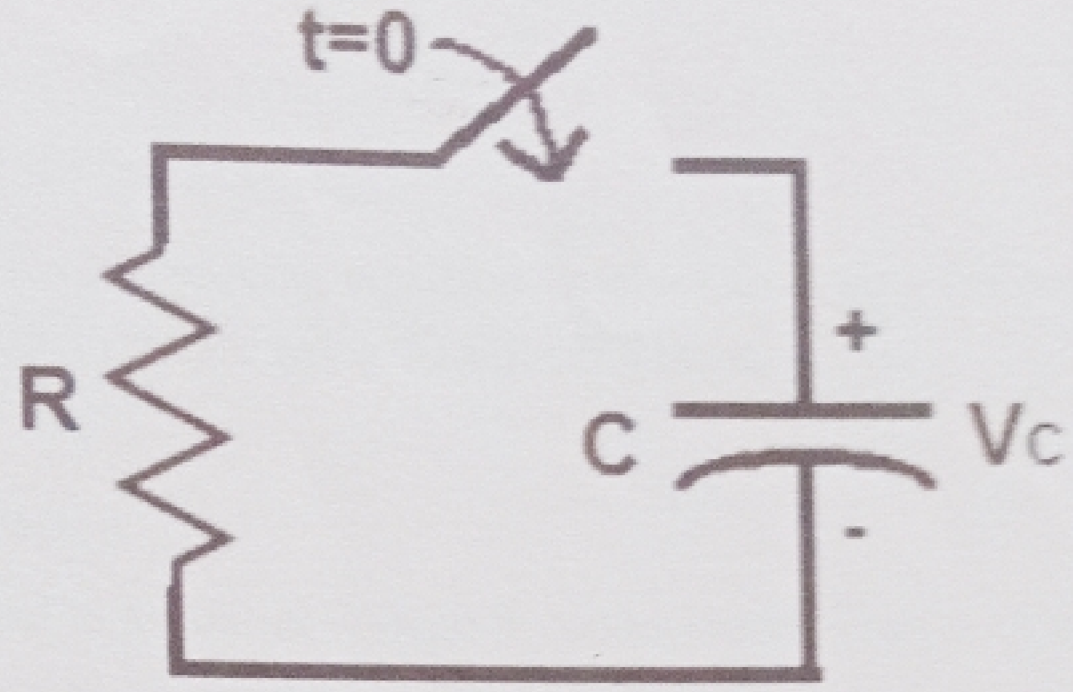
3. **Rearranging the Equation :**

   $$R\frac{dq}{dt} = V_0 - \frac{q}{C} \quad \Rightarrow \quad \frac{dq}{dt} = \frac{1}{R}\left(V_0 - \frac{q}{C}\right)$$

4. **Separate Variables :** $\frac{dq}{V_0 - \frac{q}{C}} = \frac{1}{R}dt$

5. **Simplify the Denominator :**

   $$V_0 - \frac{q}{C} = \frac{CV_0 - q}{C} \Rightarrow \frac{C\,dq}{CV_0 - q} = \frac{1}{R}dt$$



6. **Integrate Both Sides :**

Let u $= CV_0 - q$, then $du = -dq$:

$$-C\int \frac{1}{u}du = \int \frac{1}{R}dt \Rightarrow -C\ \ln|u| = \frac{t}{R} + k$$

Substituting back:

$$-C\ \ln|CV_0 - q| = \frac{t}{R} + k$$

7. **Solve for q :**

Exponentiate both sides: $CV_0 - q = Ae^{-t/RC}$

Using initial condition q = 0 at t = 0: (where , $A = CV_0$)

$$\Rightarrow CV_0 - q = CV_0 e^{-t/RC}$$
$$\Rightarrow q(t) = CV_0\left(1 - e^{-t/RC}\right)$$

8. **Express Current I(t) :**

$$i(t) = \frac{dq}{dt} = \frac{V_0}{R}e^{-t/RC}$$

Final Results

- Charge on the Capacitor: $q(t) = CV_0\left(1 - e^{-t/RC}\right)$
- Current through the Circuit: $i(t) = \frac{V_0}{R}e^{-t/RC}$

Discharging of a Capacitor

The derivation of the discharging equation involves analyzing the process of discharging through a resistor using Kirchhoff's laws.

Circuit Configuration

A capacitor charged to an initial voltage is connected in series with a resistor. The circuit is closed and the capacitor discharges over time.

Steps

1. **Kirchhoff's Voltage Law (KVL) :**

$$V_R + V_C = 0 \Rightarrow iR + \frac{q}{C} = 0$$

2. **Current-Charge Relationship :**

$$i = \frac{dq}{dt}. \qquad \Rightarrow R\frac{dq}{dt} + \frac{q}{C} = 0$$

3. **Rearranging the Equation :** $\frac{dq}{dt} = -\frac{q}{RC}$

4. **Separate Variables :** $\frac{dq}{q} = -\frac{1}{RC}dt$

5. **Integrate Both Sides :**

$$\int \frac{1}{q}dq = -\frac{1}{RC}\int dt. \quad \Rightarrow \ln|q| = -\frac{t}{RC} + k$$

6. **Solve for q :**

$$q = e^{-t/RC+k} = Q_0 e^{-t/RC}$$

Where $Q_0 = CV_0$ is the initial charge.

7. **Substitute Initial Conditions**

$$q(t) = CV_0 e^{-t/RC}$$

8. Express Current i(t)

$$i(t) = \frac{dq}{dt} = -\frac{V_0}{R}e^{-t/RC}$$

(Negative sign indicates current flows in the direction of discharge)

Final Results

- Charge on the Capacitor : $q(t) = CV_0e^{-t/RC}$
- Voltage across the Capacitor: $V_C(t) = V_0e^{-t/RC}$
- Current through the Circuit: $i(t) = -\frac{V_0}{R}e^{-t/RC}$

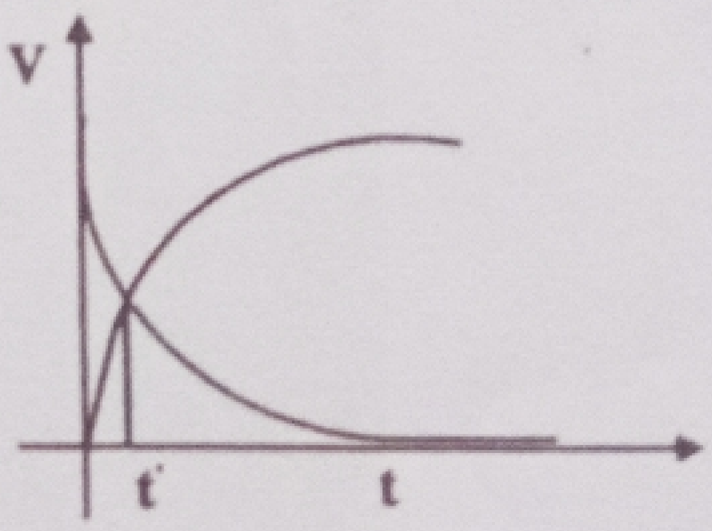
Derivation of Dielectric constant :

The charging of capacitor is not instant as the capacitor have i-v characteristics which depends upon time (t).

The charging and discharging of a capacitor in an RC circuit are governed by the time constant (τ), defined as $\tau = RC$, where R is the resistance and C is the capacitance. During charging, the voltage across the capacitor increases exponentially, while during discharging, it decreases exponentially.

The voltage V(t) across the capacitor at any time t is given by $V_C(t) = V_0\left(1 - e^{-t/RC}\right)$ for charging and $V_C(t) = V_0e^{-t/RC}$ for discharging, where V_0 is the initial voltage. , R is the resistance, C is the capacitance, and τ=RC is the time constant, which determines the rate of charging and discharging.

The theory highlights the exponential nature of voltage change and energy dissipation.



If the two curves are drawn at the same graph the intersect at a particular time.

At t = t', Both the equation of charging and discharging are equal. Hence :-

$$V_0\left(1 - e^{-t'/RC}\right) = V_0e^{-t'/RC} => 2e^{-t'/RC} = 1$$

$$=> e^{\frac{-t}{RC}} = \frac{1}{2}$$

=> $\frac{t'}{RC} = \log_e 2$ *hence* $C = \frac{t'}{R \log_e 2}$ i.e.,

using $C = \varepsilon_0 \varepsilon_r \frac{A}{d}$. => $C = \frac{t'}{0.693R}$ $\quad \varepsilon_r = \frac{t'}{0.693R\varepsilon_0}\left(\frac{d}{A}\right)$

The value of dielectric constant ; $\varepsilon_r = \frac{t'}{0.693R\varepsilon_0}\left(\frac{d}{A}\right)$ where, ($\frac{d}{A}$=0.63*10^{-7}).

The objective of this experiment is to measure the time constant of an RC circuit and compare it with theoretical predictions, as well as to observe the voltage change across the capacitor during the charging and discharging processes.

Apparatus:

The apparatus required for this experiment includes:

1.a resistor (100kΩ)

2.a capacitor (C_3)

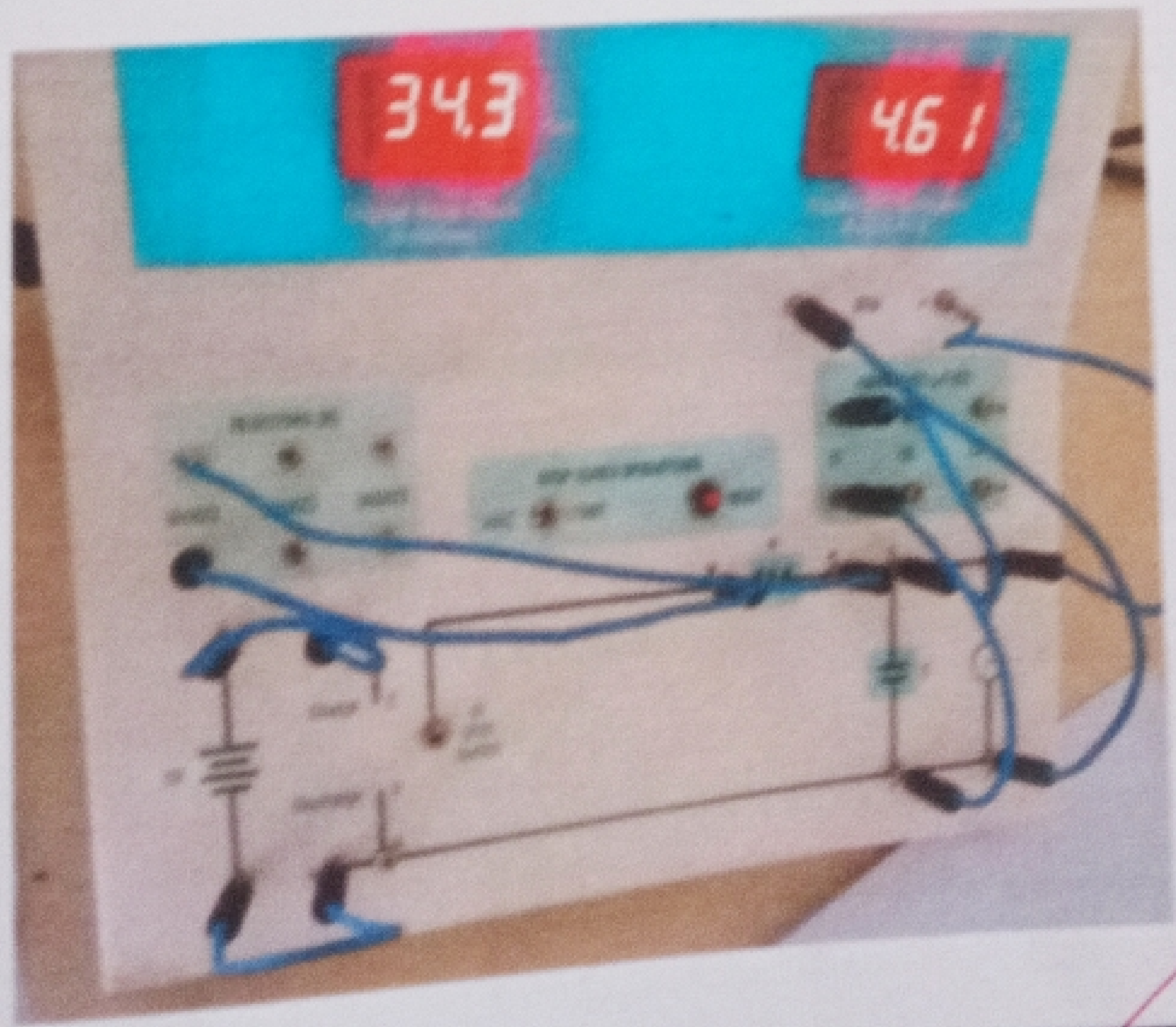
3.a DC power supply

4.a digital multimeter or oscilloscope

5.connecting wires

6.a stopwatch or timer.

This setup is often referred to as an RC circuit, where "R" represents the resistor and "C" represents the capacitor



4.Methodology/ Procedure –

- **Charging**

When a capacitor is connected to a direct current (DC) source, electrons flow onto one plate and off the other, creating a potential difference across the plates. The capacitor stores energy as an electric field. The rate at which a capacitor charges depends on the capacitance, the voltage applied, and the resistance of the circuit.

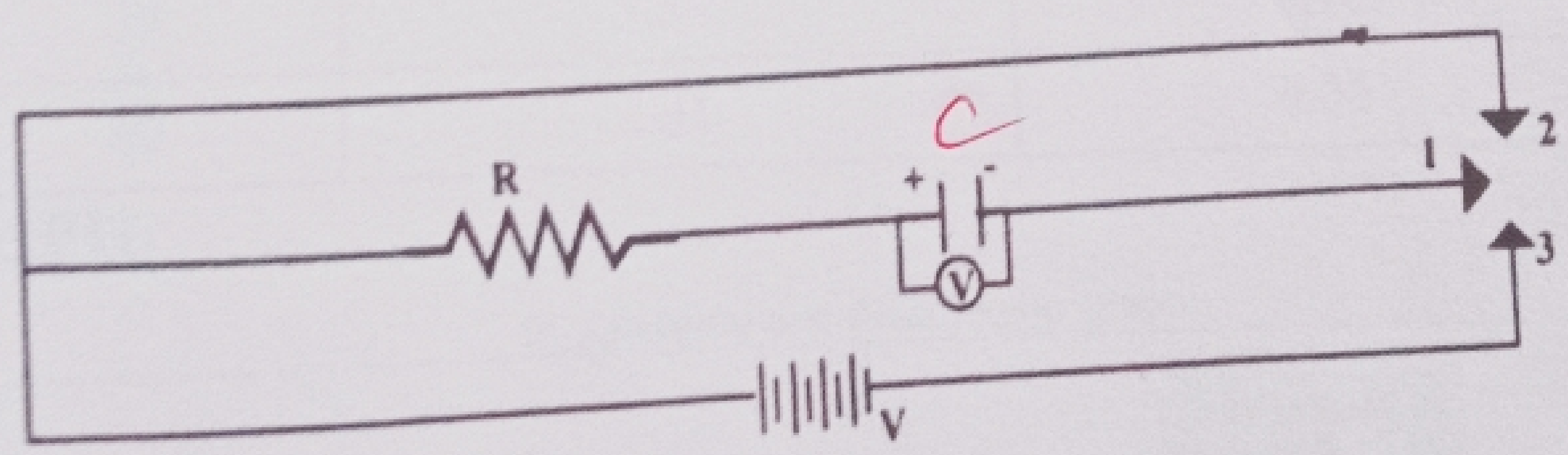
The stop clock is switched on. At a particular "tick", 1 and 3 are connected (1 and 2 are kept open). The potential developed across the capacitor is continuously recorded at the end of every 10 seconds, using a multi meter or a Voltmeter (whose internal resistance should be low) up to 80 seconds.

- **Discharging**

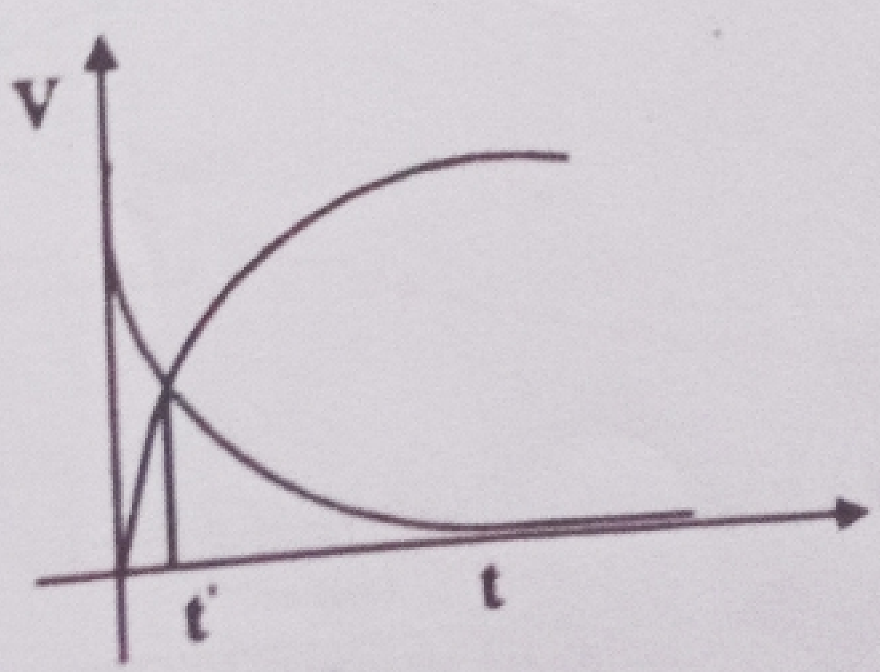
When the power supply is removed from the capacitor, the stored electrical energy is released. The charge flows from one plate to the other, and the voltage across the capacitor decreases until it reaches zero.

Now again at a particular "tick" of the stop clock, 1 and 3 are disconnected and simultaneously 1 and 2 are connected. Again the potential across the capacitor is continuously recorded at the end of every 10 seconds up to 80 seconds.

Circuit Diagram:



Nature of graph :



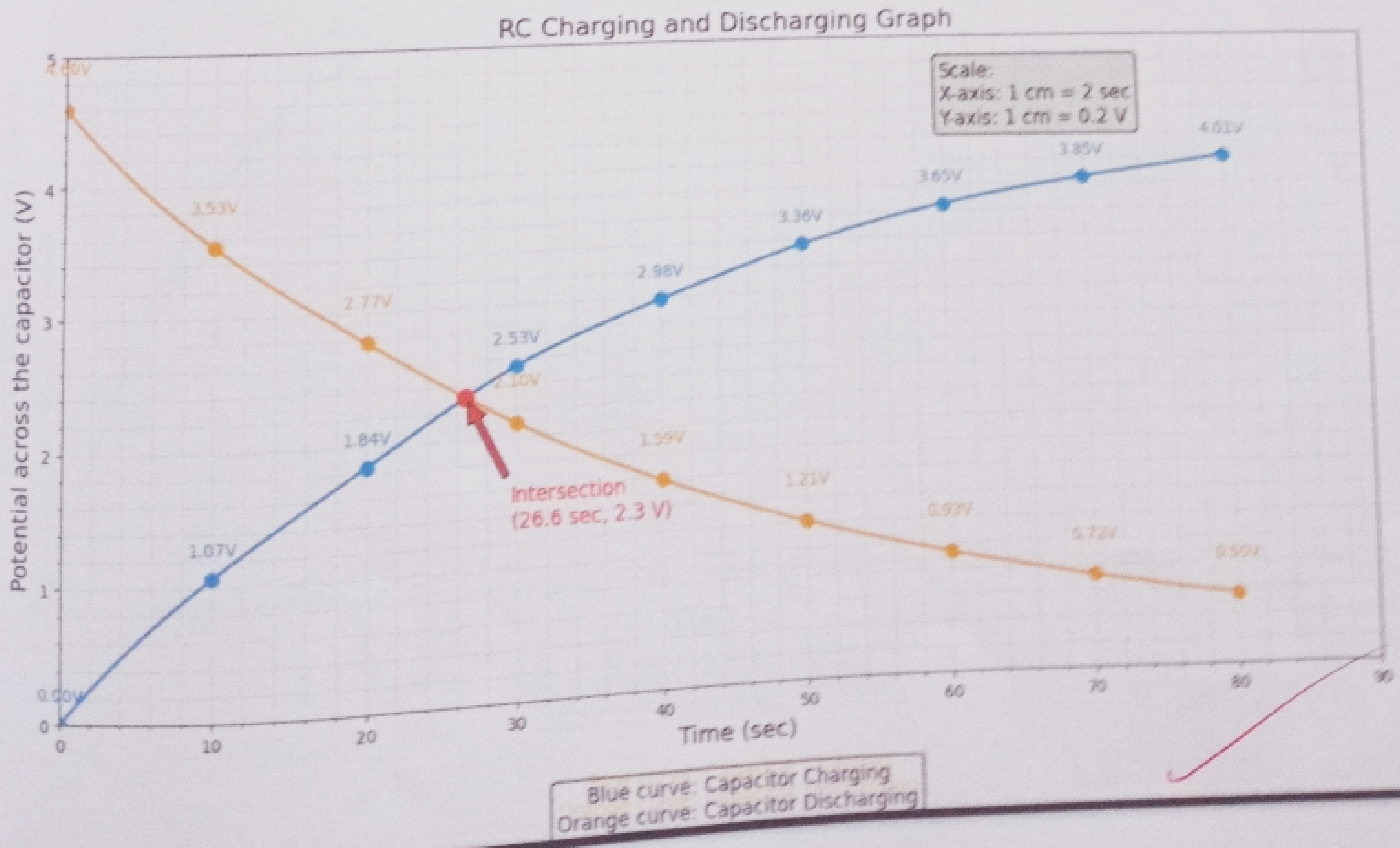
Observation Table for Different Capacitor Across R = 100 K ohms:

Below is a sample observation table for recording the voltage across the capacitor at different times:

A. WITH C3 (Our Experimental Data):

Time (in sec)	Potential Across the Capacitor (C_3) (in V)	
	Charging	Discharging
	R = 100 K ohms	R = 100 K ohms
00	0.00	4.60
10	1.07	3.53
20	1.84	2.77
30	2.53	2.10
40	2.98	1.59
50	3.36	1.21
60	3.65	0.93
70	3.85	0.72
80	4.01	0.55

GRAPH:

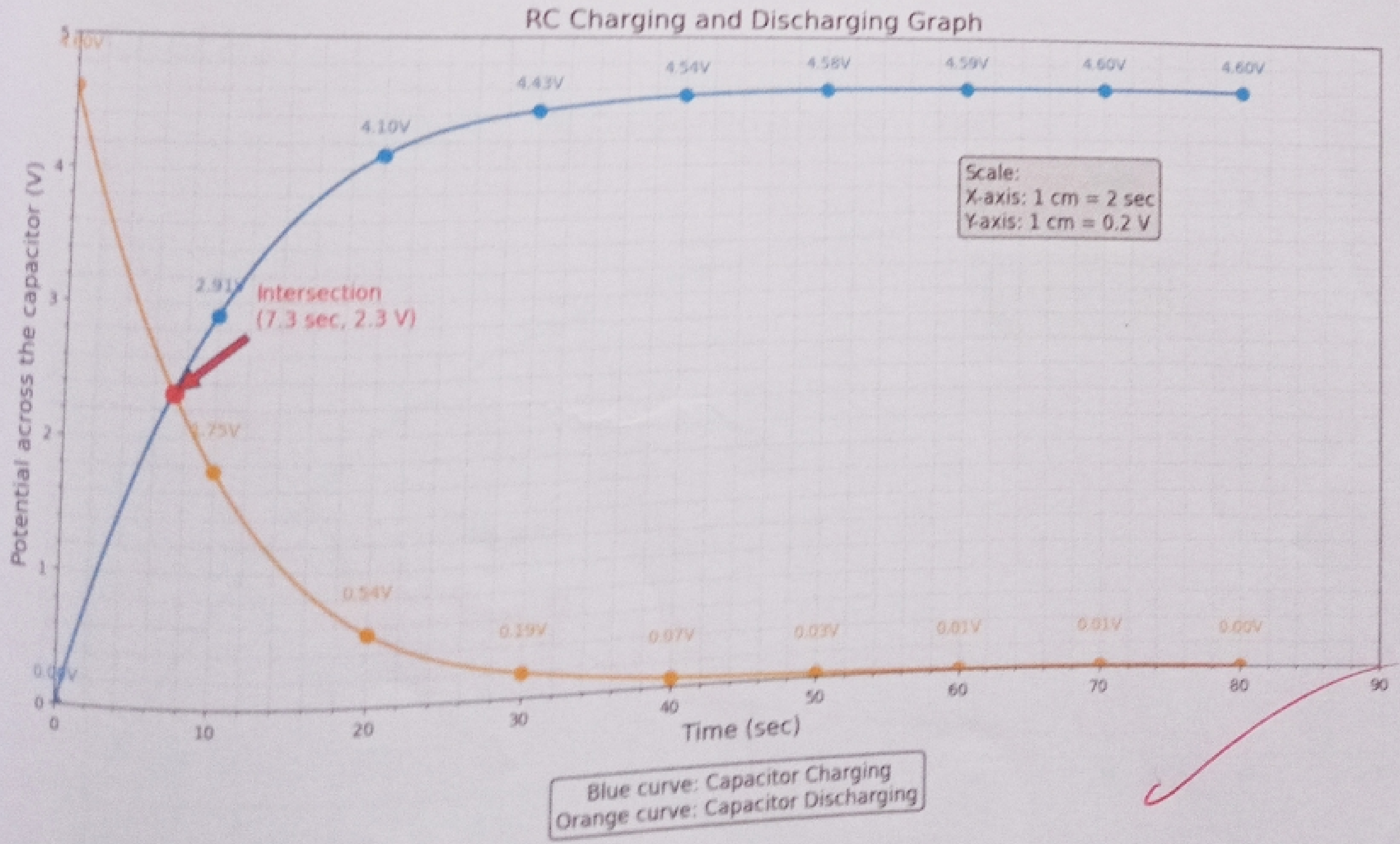


Blue curve: Capacitor Charging
Orange curve: Capacitor Discharging

B. With C1

Time (in sec)	Potential Across the Capacitor (C_1) (in V)	
	Charging	Discharging
	R = 100 K ohms	R = 100 K ohms
00	0.00	4.60
10	2.91	1.75
20	4.10	0.54
30	4.43	0.19
40	4.54	0.07
50	4.58	0.03
60	4.59	0.01
70	4.60	0.01
80	4.60	0.00

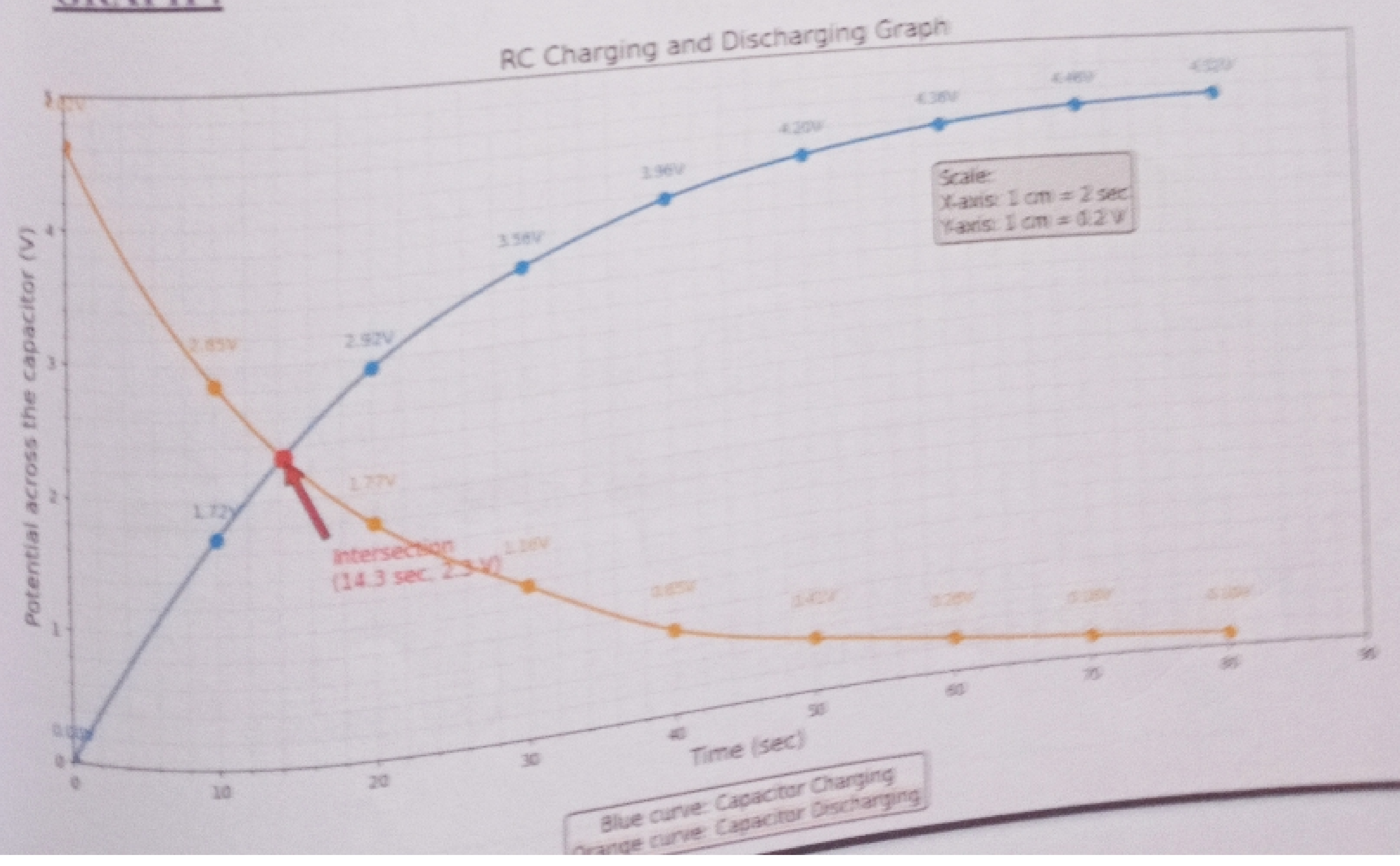
GRAPH :



3. With C2 :

Time (in sec)	Potential Across the Capacitor (C_2) (in V)	
	Charging	Discharging
	R = 100 K ohms	R = 100 K ohms
00	0.00	4.62
10	1.72	2.85
20	2.92	1.77
30	3.56	1.16
40	3.96	0.65
50	4.20	0.41
60	4.36	0.26
70	4.46	0.16
80	4.52	0.10

GRAPH :



CALCULATIONS :

Using the Equation for dielectric constant : $\varepsilon_r = \frac{t'}{0.693R\varepsilon_0}\left(\frac{d}{A}\right)$

For C_1 :

$$\varepsilon_r = \frac{t'}{0.693R\varepsilon_0}\left(\frac{d}{A}\right)$$; Here the value of $\left(\frac{d}{A}\right) = 3.2*10^{-7}$ /m

The Value of t' from the graph = 7.3 sec

Now , $\varepsilon_r = \frac{t'}{0.693R\varepsilon_0}\left(\frac{d}{A}\right) \Rightarrow \varepsilon_r = \frac{7.3 \times 3.2 \times 10^{-7}}{0.693 \times 100 \times 1000 \times 8.85 \times 10^{-12}} = 3.80$

For C_2 :

$$\varepsilon_r = \frac{t'}{0.693R\varepsilon_0}\left(\frac{d}{A}\right)$$; Here the value of $\left(\frac{d}{A}\right) = 1.4*10^{-7}$ /m

The Value of t' from the graph = 14.3 sec

Now , $\varepsilon_r = \frac{t'}{0.693R\varepsilon_0}\left(\frac{d}{A}\right) \Rightarrow \varepsilon_r = \frac{14.3 \times 1.4 \times 10^{-7}}{0.693 \times 100 \times 1000 \times 8.85 \times 10^{-12}} = 3.26$

For C_3 :

$$\varepsilon_r = \frac{t'}{0.693R\varepsilon_0}\left(\frac{d}{A}\right)$$; Here the value of $\left(\frac{d}{A}\right) = 0.68*10^{-7}$ /m

The Value of t' from the graph = 26.6 sec

Now , $\varepsilon_r = \frac{t'}{0.693R\varepsilon_0}\left(\frac{d}{A}\right) \Rightarrow \varepsilon_r = \frac{26.6 \times 0.68 \times 10^{-7}}{0.693 \times 100 \times 1000 \times 8.85 \times 10^{-12}} = 2.94$

ε_r for different values of R, C and t':

Sl.no.	R	C	t'(sec)	ε_r
01	100k ohm	C_1	7.30	3.808
02	100k ohm	C_2	14.3	3.264
03	100k ohm	C_3	26.6	2.945
04	220k ohm	C_1	13.2	3.135
05	220k ohm	C_2	31.0	3.214
06	220k ohm	C_3	52.0	2.705

Result:

From the observations, the dielectric constant (k) of the material by charging and discharging of capacitor calculated for different Capactiors is (Taking mean value for the Capacitors):

- For C_1 : $\varepsilon_r = 3.4715$
- For C_2 : $\varepsilon_r = 3.239$
- For C_3 : $\varepsilon_r = 2.945$

The Two different value of Resistors giving similar value of the dielectric constant for C1 , C2 and C3 confirms that the Theoritical/ Actual value of the dielectric for the respective capacitor will be closer / similar to the experimental values keeping all forms of errors in mind .

Special Attention on Variation of t' and Er from our Observation :

According to the derived formula: $\varepsilon_r = \frac{t'}{0.693R\varepsilon_0}\left(\frac{d}{A}\right)$ where ,

εr is directly proportional to t', provided R, ε_0, d, and A are constant.
So, longer time constants (t') indicate higher effective permittivity, if the capacitor geometry and resistance remain the same.

This experiment successfully validated the theoritical principles governing RC circuits and dielectric materials through practical observations. Our Finding are summarized as follows:

1. Relationship between R & t'.

when capacitance C is kept constant, we observed that the time constant t' increases proportionally with resistance R. This also aligns with the Formula $t' = R \cdot C$, confirming that increasing Resistance for Loger t'.

2. Relation between C & t'.

when resistance R is constant, increasing the capacitance C results in proportional increase in t'. This again supports the equation $t' = RC$ demostrating that longer to charge and discharge in Larger capacitors.

3. Variation of Dielectric constant (ε_r)

since, $C = \varepsilon_0 \varepsilon_r \left(\frac{A}{d}\right)$. this could be implied as

$\boxed{C \propto \varepsilon_r}$ and $\boxed{C \propto \left(\frac{A}{d}\right)}$.

$\because$ $C \propto \varepsilon_r$ this means that if C decreases ε_r will also decrease. This could be seen in our table too. ε_r value is decreasing as C changes. Hence can be verified $C_1 > C_2 > C_3$.

also, $C \propto \left(\frac{A}{d}\right)$ means Capacitance increases if $\frac{A}{d}$ increases. This implies $C \propto \varepsilon_r \left(\frac{A}{d}\right)$

also, $\boxed{\varepsilon_r = \frac{t'}{0.693 R \varepsilon_0} \cdot \frac{d}{A}}$ $\Rightarrow$ $\boxed{\varepsilon_r \propto \frac{t'}{R} \cdot \left(\frac{d}{A}\right)}$

This could be observed from our table data. As the C is changed ε_r will also change. This change will also depend upon the Area of the capacitor plate & distance between the two plates.

validated the theoritical
cuits and dielectric mate-
bservations. Our finding
ws:

between R & t'.
ept constant, we observed
' increases proportionally
is also aligns with the
rming that increasing
t'.

between C & t'.
is constant, increasing
ults in proportional increase
supports the equation that
onger to charge and disch
rs.

of Dielectric constant (ε_r)
$\frac{A}{d}$) . this could be impl
and $\boxed{C \propto \left(\frac{A}{d}\right)}$.
means that if C decrease
decrease. This could be
o. ε_r value is decreasing
Hence can be verified

3.
means Capacitance increase
This implies $C \propto \varepsilon_r \left(\frac{A}{d}\right)$
$\boxed{\frac{t'}{.693 R\varepsilon_0} \cdot \frac{d}{A}}$ $\Rightarrow$ $\boxed{\varepsilon_r \propto \frac{t'}{R}\left(\frac{d}{A}\right)}$

observed from our table
C is changed ε_r will also
change will also depend
a of the capacitor plate & distance
two plates.

From our observations:

C	t'(sec)	ε_r	d(*10^{-7})
C_1	7.30	3.808	3.2
C_2	14.3	3.264	1.4
C_3	26.6	2.945	0.68

Although t' increases from C1 to C3, εr decreases. This appears counterintuitive at first glance.

Explanation: The thickness (d) of the dielectric layer decreases from C1 to C3. Since εr also depends on the ratio $\frac{d}{A}$, a smaller thickness d counterbalances the effect of larger t', leading to a net decrease in εr.

Interesting point: This reveals a subtle but important insight — material geometry can dominate the electrical behavior, reminding us that experimental analysis must consider physical dimensions carefully.

In our conclusion, we noted that using different resistors still yielded similar εr values for the same capacitor. This confirms:

- The validity of the mathematical model,
- And that εr is an intrinsic property of the dielectric material, independent of R.

Conclusion:

1. **Demonstration of Exponential Behavior:**
   - The experiment clearly verified the exponential nature of voltage variation during the charging and discharging cycles of an RC circuit.
2. **Accurate Determination of Time Constants (τ = RC):**
   - Time constants were accurately determined by analyzing voltage vs. time graphs for different resistor-capacitor combinations.
3. **Estimation of Dielectric Constants:**
   - Dielectric constants of the materials were successfully calculated using the time constants, and the results showed close agreement with standard values.
4. **Validation of Theoretical Concepts:**
   - The experimental data aligned well with theoretical models, confirming the mathematical framework governing RC circuit behavior.

5. **Insight into Transient Response:**

- The role of resistance and capacitance in determining the speed of voltage change was clearly observed, reinforcing the importance of the RC time constant.

6. **Application Relevance:**

- The experiment demonstrated the practical utility of RC circuits in electronic systems such as filters, pulse shaping, delay circuits, and timing mechanisms.

7. **Material Characterization:**

- The approach proved effective not only for circuit analysis but also for indirectly characterizing dielectric materials through electrical measurements.

8. **Skill Development:**

- The experiment helped develop critical skills in data acquisition, curve fitting, and analysis of exponential functions using graphical and numerical methods.

9. **Error Analysis and Precision:**

- Minor deviations from theoretical values were attributed to practical limitations such as measurement inaccuracies and component tolerances, providing valuable experience in real-world experimental analysis.

10. **Broader Educational Impact:**

- Beyond confirming textbook concepts, the experiment encouraged analytical thinking, precision in measurement, and a deeper appreciation of how fundamental circuit principles are applied in advanced technologies.

Application of it:

RC circuits are widely used in electronic devices for filtering, timing applications, and in analog signal processing. Understanding the behavior of RC circuits is essential for designing circuits in audio equipment, communication systems, and various other electronic applications.

1. Active Filter Design with RC Networks

- **Idea**: Design a tunable active filter using an RC circuit integrated with operational amplifiers (Op-Amps) and variable resistors or capacitors.
- **Application**: This can be used in audio systems to adjust the frequency response (e.g., low-pass, high-pass, or band-pass filters). The use of variable components could allow real-time adjustment of the filter characteristics.

2. RC Oscillator with Frequency Modulation

- **Idea**: Create a frequency-modulated oscillator using an RC circuit combined with a variable resistor (potentiometer) to change the timing and output frequency in real time.
- **Application**: This can be used in communication systems, audio generation (e.g., for tone generation or sound synthesis), and even in educational tools to visualize.

3. Capacitor-Based Energy Harvesting Circuit

- **Idea**: Develop an RC circuit that stores energy from a small energy source (like solar cells or kinetic energy) in the capacitor and then releases it in a controlled manner.
- **Application**: This concept can be used in small-scale energy harvesting applications, such as powering sensors, IoT devices, or low-power electronics.

4. RC Low-Power Signal Processing for Wearables

- **Idea**: Design a low-power, high-efficiency RC circuit for signal conditioning and filtering for wearable health devices like heart rate monitors or step counters.
- **Application**: The RC circuit could help filter out noise from sensors and ensure accurate signal processing without draining the battery, which is crucial for wearable .

5. RC Circuit in Analog Computing

- **Idea**: Use an RC network to simulate complex mathematical operations like integration, differentiation, or even solving differential equations.
- **Application**: Analog computing methods, using resistors and capacitors, are ideal for high-speed computations in signal processing or for real-time control systems in robotics or drones.

6. Time-Delay Circuits with Smart Capacitors

- **Idea**: Create a time delay circuit using a combination of RC elements and controlled variable capacitors or switches (e.g., MOSFETs) that can alter the timing dynamically.
- **Application**: This could be used in various time-sensitive applications like generating delays in digital systems, LED blinkers, or controlling the timing of motors or actuators.

7. RC Circuit for Noise Reduction in Power Supplies

- **Idea**: Incorporate an RC low-pass filter in power supply circuits to reduce high-frequency noise and ripple in power lines, enhancing the stability of power-hungry electronic systems.

- **Application**: This is crucial for sensitive electronic devices like audio equipment, medical devices, or any system requiring high-quality, clean power input.

8. Pulse Shaping with RC Networks

- **Idea**: Use an RC network to modify the shape of pulses in digital circuits to improve signal integrity and reduce electromagnetic interference.
- **Application**: Pulse shaping in communication systems or signal processing applications, such as in data transmission and high-speed digital circuits.

ACKNOWLEDGEMENTS:

We would like to extend our heartfelt gratitude to the Department of Physics at The National Institute of Engineering, Mysuru, for giving us the opportunity to undertake and complete this experiment on RC Charging and Discharging as a part of the Applied Physics course (BPHYS202). This practical exposure significantly enhanced our understanding of fundamental electrical concepts and their applications in real-world electronics.

We are deeply thankful to our course instructor, Dr. Sankarshan B M, whose guidance, mentorship, and constant encouragement were instrumental throughout the course of this project. Their clarity in explaining complex concepts and their timely feedback helped us gain both theoretical insights and practical skills related to RC circuits and transient electrical phenomena.

We would also like to acknowledge the support of the laboratory staff, who were always available to help with the setup. And the institute for providing a well-equipped laboratory environment that enabled us to perform this experiment efficiently.

We would like to thank our classmates performing the same experiment with different set of data for sharing their experimental values that helped us to arrive at a solid conclusion .

Lastly, a special thanks to our fellow group members for their dedication, teamwork, and collaborative spirit. Each member contributed meaningfully to the project, whether it was data collection, analysis, or documentation. Working together not only made the process efficient but also enjoyable and intellectually rewarding.

REFERENCES:

1. MILLMAN, J., & HALKIAS, C. C. (1967). INTEGRATED ELECTRONICS: ANALOG AND DIGITAL CIRCUITS AND SYSTEMS. MCGRAW-HILL

2. USE OF AI PLATFORMS LIKE OPENAI'S CHATGPT, GOOGLE'S GEMINI AND MICROSOFT'S COPILOT.

3. MALONEY, D. P., O'KUMA, T. L., HIEGGELKE, C. J., & VAN HEUVELEN, A. (2001). RANKING TASK EXERCISES IN PHYSICS. PEARSON EDUCATION.

4. SERWAY, R. A., & JEWETT, J. W. (2013). PHYSICS FOR SCIENTISTS AND ENGINEERS (9TH ED.). CENGAGE LEARNING.

5. ALEXANDER, C. K., & SADIKU, M. N. O. (2012). FUNDAMENTALS OF ELECTRIC CIRCUITS (5TH ED.). MCGRAW-HILL.

6. NILSSON, J. W., & RIEDEL, S. A. (2015). ELECTRIC CIRCUITS (10TH ED.). PEARSON.

7. OPENSTAX. (2016). UNIVERSITY PHYSICS VOLUME 2. OPENSTAX, RICE UNIVERSITY. RETRIEVED FROM https://openstax.org/books/university-physics-volume-2/pages/1-introduction

8. LECTURE NOTES ON RC CIRCUITS. DEPARTMENT OF PHYSICS, THE NATIONAL INSTITUTE OF ENGINEERING, MYSURU.

9. KHAN ACADEMY. (N.D.). CAPACITOR AND RC CIRCUITS. RETRIEVED FROM https://www.khanacademy.org/science/physics/circuits-topic/circuits-resistance/v/capacitors

10. ALLABOUTCIRCUITS. (N.D.). RC TIME CONSTANT. RETRIEVED FROM https://www.allaboutcircuits.com/textbook/direct-current/chpt-13/rc-time-constant/

11. USE OF **NUMPY** LIBRARIES LIKE MATPLOTLIB AND PLATFORMS LIKE JUPYTER NOTEBOOK AND GOOGLE COLLAB FOR DRAWING PRECISE AND FINE GRAPHS