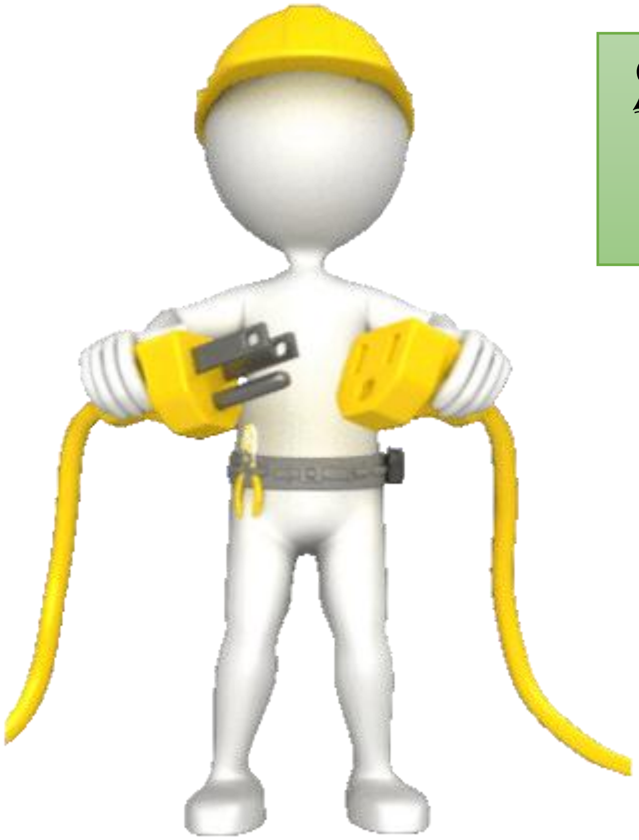
GANPAT UNIVERSITY

U. V. PATEL COLLEGE OF ENGINEERING

DEPARTMENT OF ELECTRICAL ENGINEERING



SUBJECT: 2ES103 BASIC ELECTRICAL ENGINEERING (BEE)

BASIC ELECTRICAL ENGINEERING LABORATORY

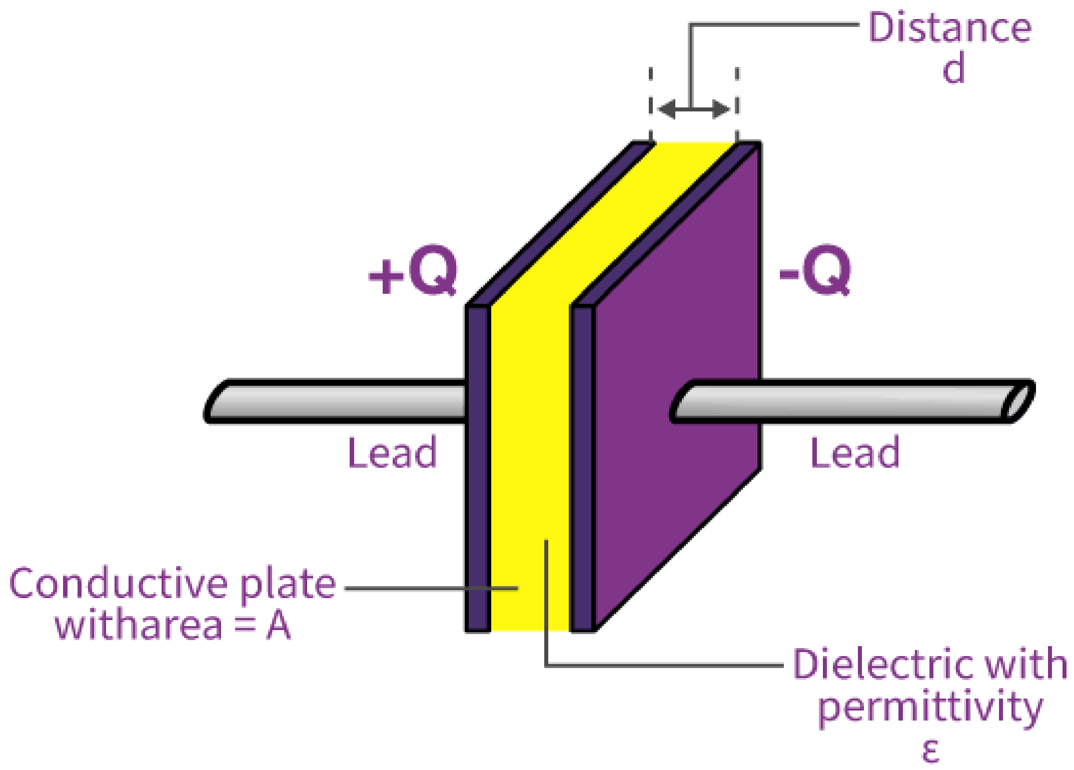
Experiment 8

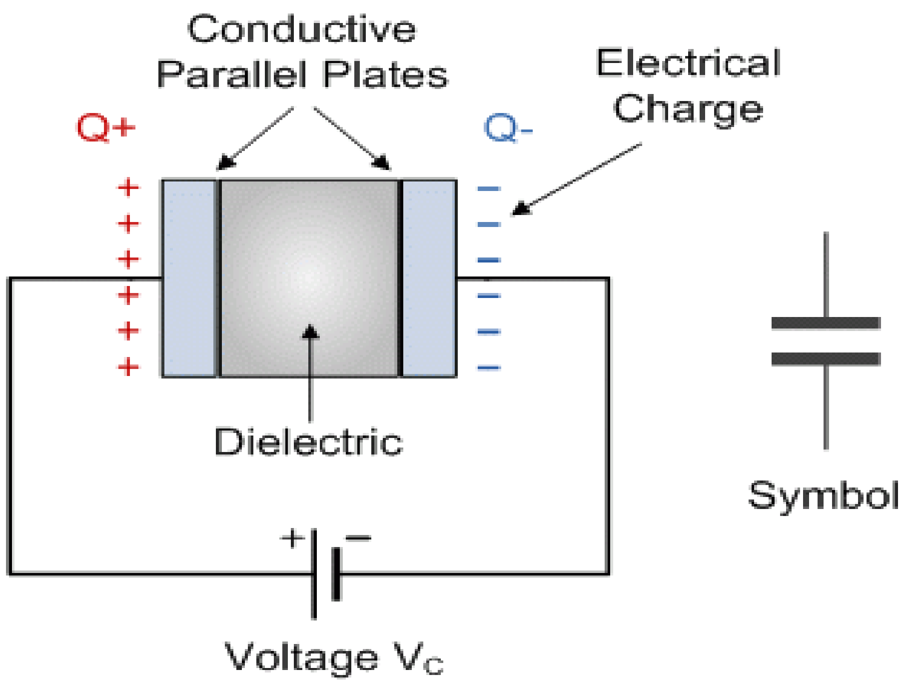
AIM: **To study charging and discharging phenomena of a Capacitor and determine time constant.**

THEORETICAL BACKGROUND:

❖ **<u>The Capacitor:</u>** A capacitor is a device that can store electrical charge.

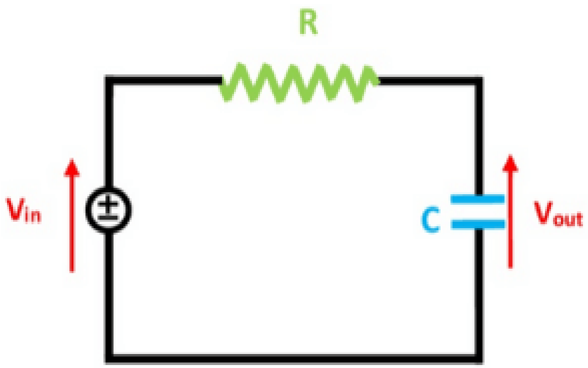
- The simplest kind is a "parallel plate" capacitor that consists of two metal plates that are separated by an insulating material such as dry air, plastic or ceramic. Such a device is shown schematically below figure.



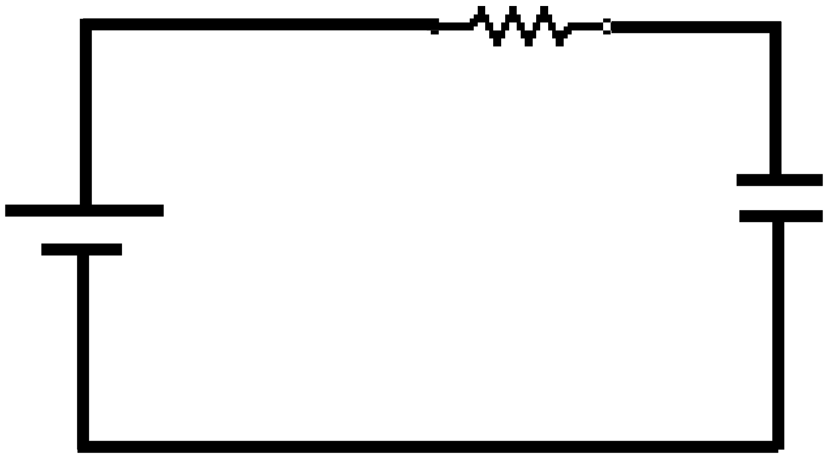


- If we connect the two plates to each other with a battery in the circuit, as shown in the figure above, the battery will drive charge around the circuit as an electric current.
- But when the charges reach the plates they can't go any further because of the insulating gap; they collect on the plates, one plate becoming positively charged and the other negatively charged.
- The voltage across the plates due to the electric charges is opposite in sign to the voltage of the battery.
- As the charge on the plates builds up, this back-voltage increases, opposing the action of the battery.
- As a consequence, the current flowing in the circuit decays, falling to zero when the back-voltage is exactly equal and opposite to the battery voltage.
- If we quickly remove the wires without touching the plates, the charge remains on the plates. Because the two plates have different charge, there is a net electric field between the two plates.

- Hence, there is a voltage difference between the plates.
- If, sometime later, we connect the plates again, this time with a light bulb in place of the battery, the plates will discharge: the electrons on the negatively charged plate will move around the circuit to the positive plate until all the charges are equalized.
- During this short discharge period a current is flowing and the bulb will light. The capacitor stored electrical energy from its original charge up by the battery until it could discharge through the light bulb.
- The speed with which the discharge (and conversely the charging process) can take place is limited by the resistance of the circuit connecting the plates and by the capacitance of the capacitor (a measure of its ability to hold charge).

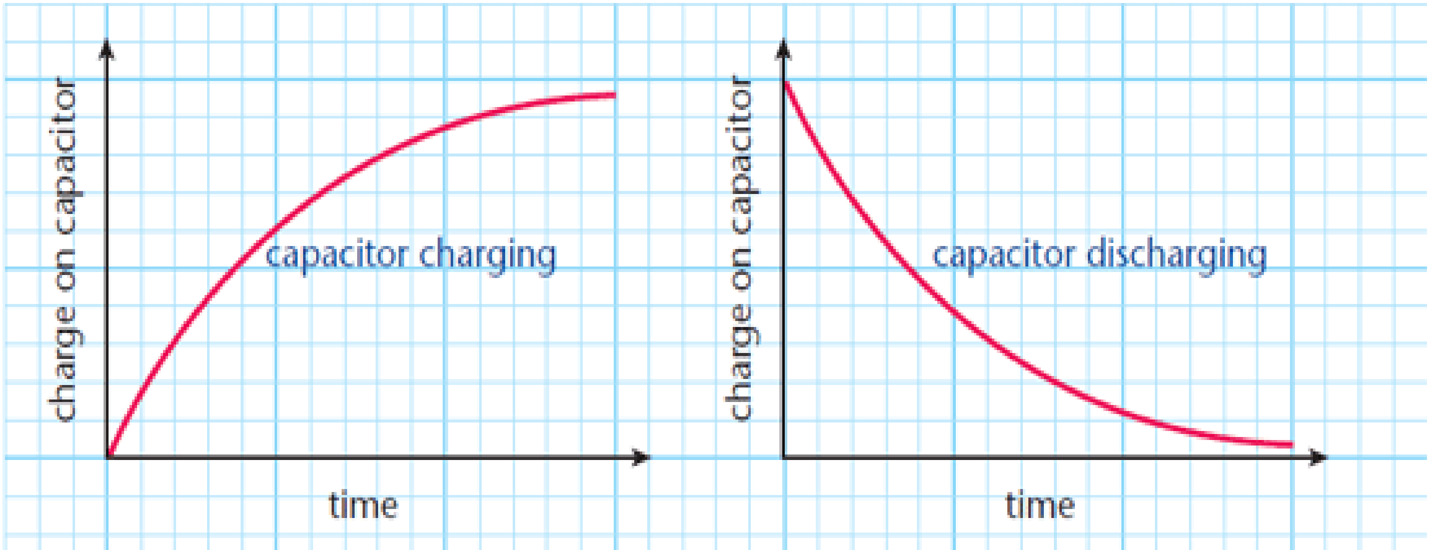


- An RC circuit is simply a circuit with a voltage source (battery) connected in series with a resistor and a capacitor.
- A battery connected in series with a resistor will produce a constant current.



- The same battery in series with a capacitor will produce a time varying current, which decays gradually to zero.
- If the battery is removed and the circuit reconnected without the battery, a current will flow (for a short time) in the opposite direction as the capacitor "discharges".
- A measure of how long these transient currents last in a given circuit is given by the "time constant", τ.
- The time it takes for these transient currents to decay depends on the resistance and capacitance. The resistor resists the flow of current slows down the decay. The capacitance measures capacity to hold charge.

- Thus, the "time constant" of the circuit gets larger for larger R and C. In detail:
- τ(seconds) = R(Ohms) C(Farads)

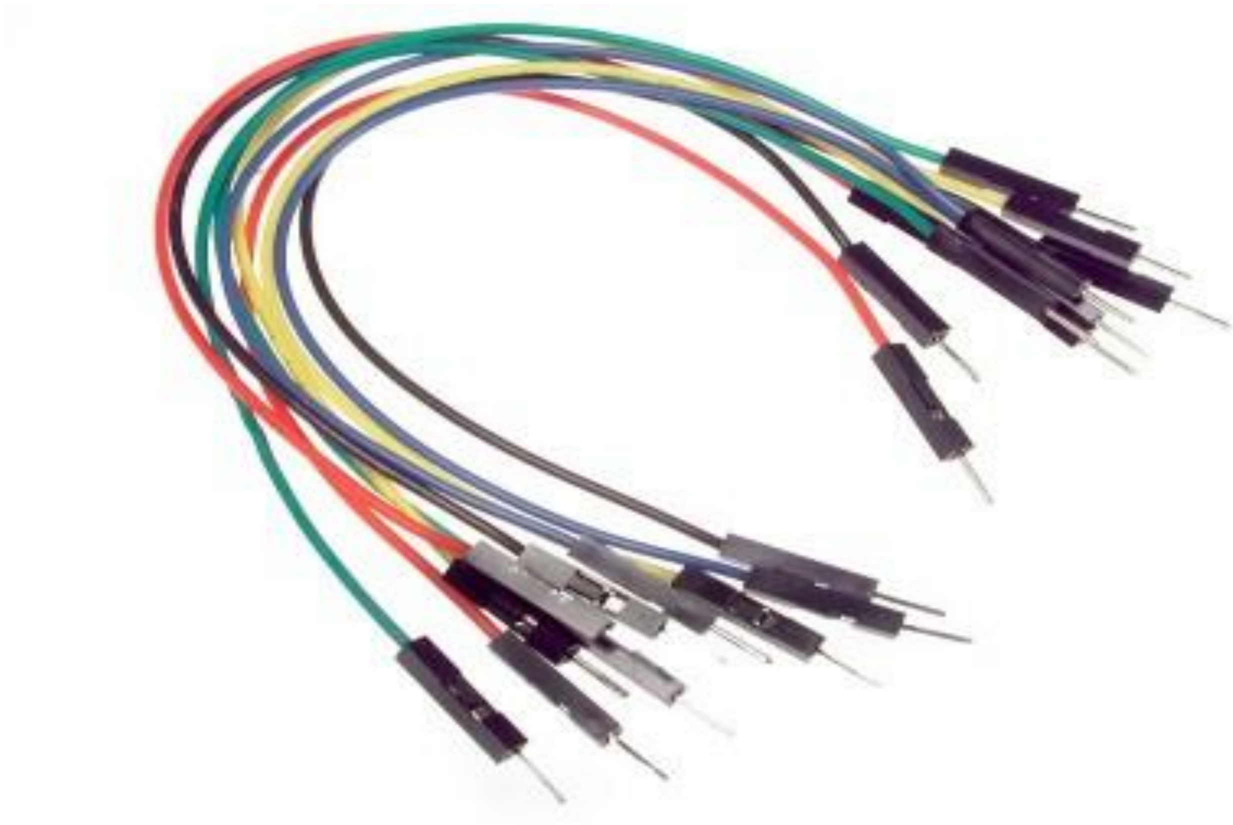


The charge on a capacitor during charging and discharging

Apparatus:

(1) Capacitor Charging & Discharging Trainer Kit

(2) Connecting wires



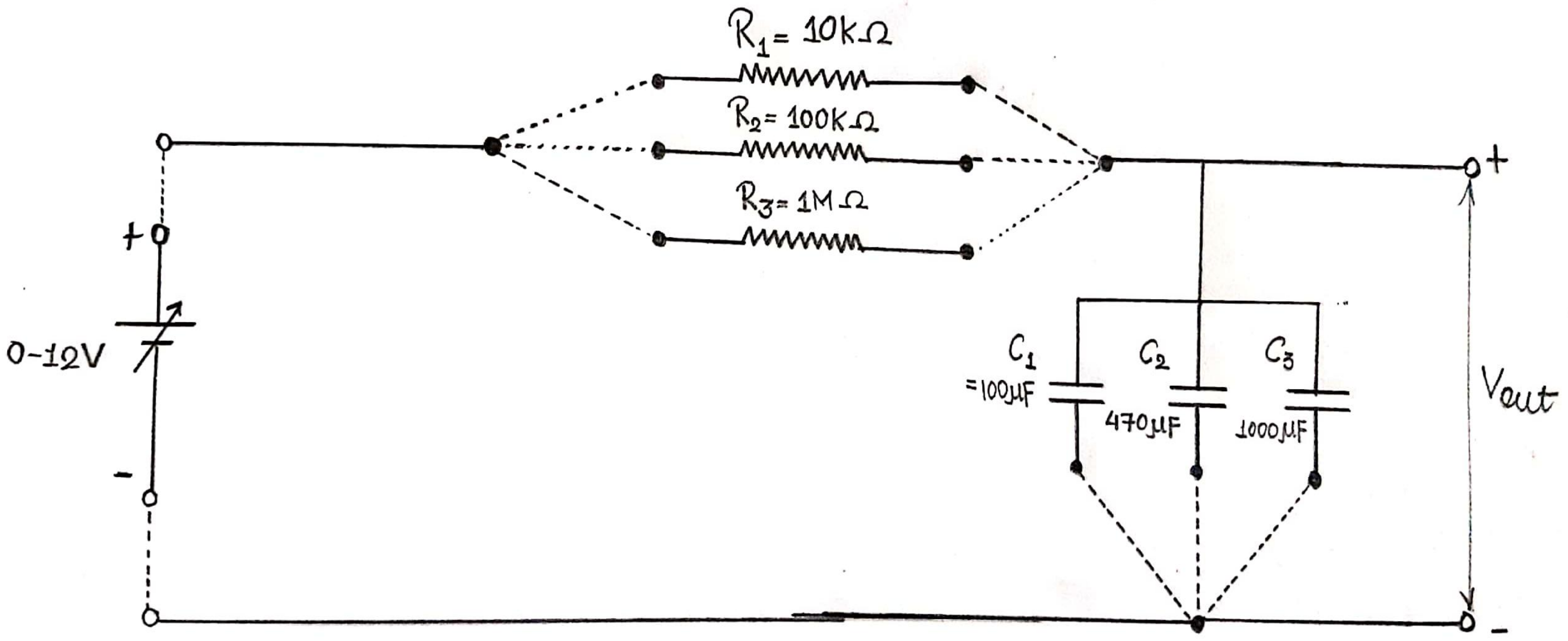
(3) Stop Watch


MODE
START
STOP
SPLIT
RESET
ACCUSPLIT
SPLIT STOP
1/100
MIN.
SEC.
PRO SURVIVOR
601X
3V.1

Procedure:

1. Connect the circuit as shown in figure.
    - Connect +ve end of DC power supply to one end of switch.
    - Connect centre terminal of switch to resistor.
    - Connect other end of resistor to +ve end of capacitor.
    - Connect –ve terminals of DC power supply and capacitor with each other.
2. Switch "On" the trainer board.
3. Put the toggle switch in "Off" condition, if there is some remaining voltage on the capacitor, use a piece of wire to short the two leads together draining any remaining charge, i.e. discharge the capacitor.
4. Now if you put the toggle switch in ON condition you can observe voltmeter that the capacitor is charging very fast but after few second the rate of charging is slow.
5. Now put the toggle switch in „Off‟ condition and connect a wire from 1st end of resistor to 2nd end of capacitor. Here we can observe the charge is flowing back. In start it discharges very fast but after few seconds discharging is slow.
6. You can record the time of charging t_c and voltage across capacitor V_c
7. Draw plot between V_c and t_c
8. Similarly, You can record time of discharging t_d and voltage across capacitor V_c
9. Draw plot between V_c and $t_{d.}$

Circuit Diagram:



Time Constant $\tau = RC$

OBSERVATION TABLE:

R = 10 kΩ

C = 100μF

Charging of Capacitor		
Sr. No.	Voltage across capacitor	Charging time
1	0.5	0.05
2	1.5	0.02
3	2.5	0.2
4	3.5	0.4
5	4.5	0.6
6	5.5	1.4
7	8.5	2.5
8	9.7	4.7
9	9.8	5.3
10	9.9	5.8
11		
12		
13		
14		
15		

Discharging of Capacitor		
Sr. No.	Voltage across capacitor	Charging time
1	9.0	0.02
2	9.5	0.03
3	8.5	0.04
4	6.5	0.05
5	5.5	1.2
6	3.5	2.0
7	2.5	2.8
8	1	3.3
9	0.9	3.5
10	0.4	4.4
11		
12		
13		
14		
15		

- **Time Constant: $\tau = RC$**

$= 10\ k\Omega \times 100\ \mu F$

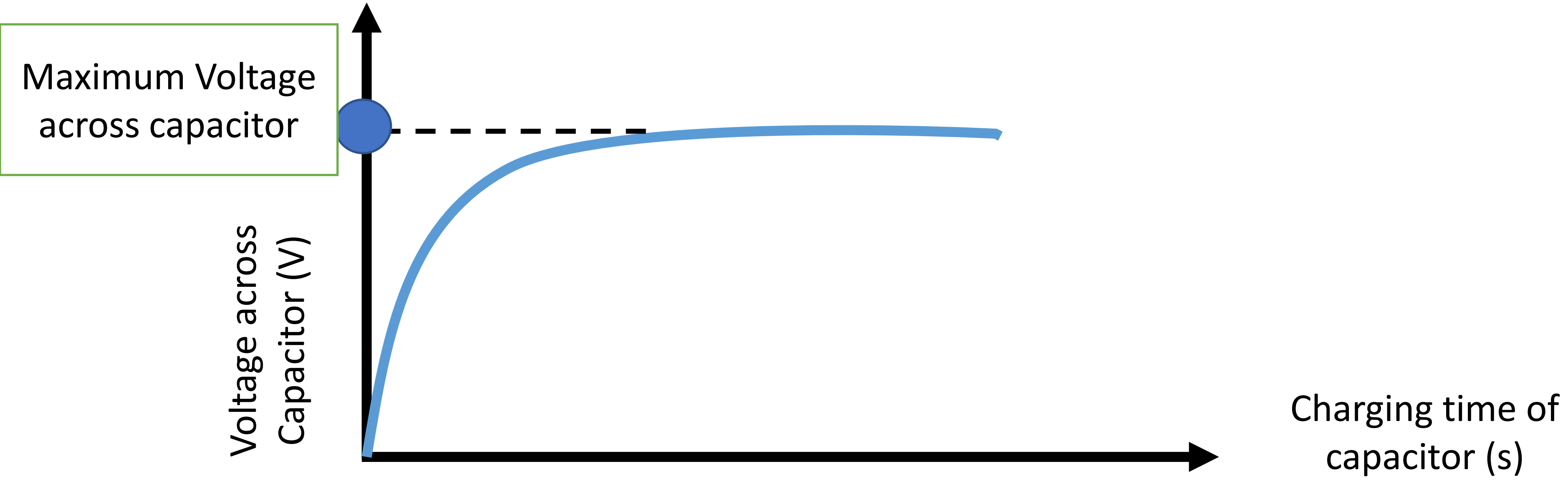
$= 10 \times 1000 \times 100 \times 10^{-6}$

$= 10\ s$

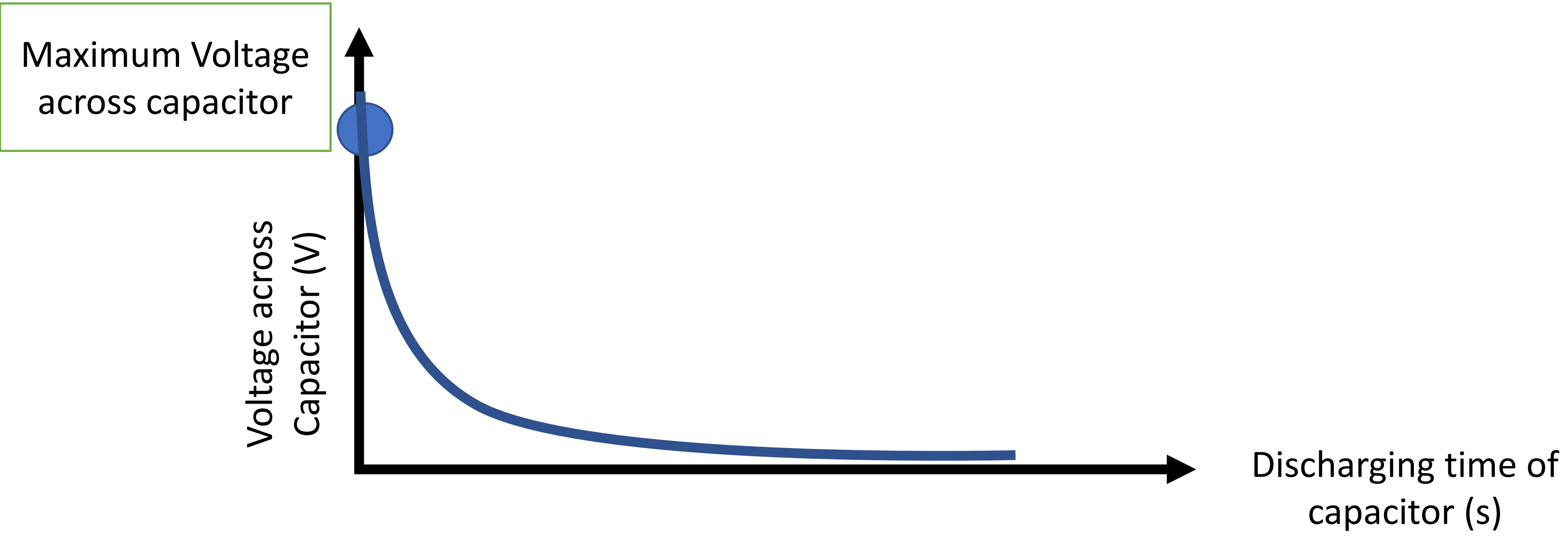
GRAPHS:

Plot the graph for charging & discharging of capacitor:

a) **Charging of Capacitor:**



b) Discharging of Capacitor:



Conclusion: From this experiment we understood how capacitor charges and discharges.