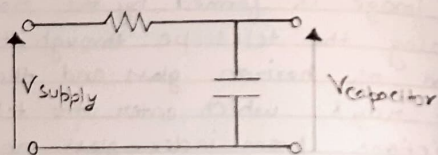


## Diagram:-



## Experiment No.

**Object:-** To determine the time constant and to study the charging and discharging of capacitor.

**Apparatus:-** Resistance of various values, capacitors of different capacities, millimeter, voltmeter, keys, battery, and stop watch etc.

**Theory and Formula:-** When capacitor is connected to a source of potential difference, the charge on it starts to grow and so does its potential difference. However, at subsequent time the charge existing on the capacitor opposes the addition of charge. Therefore, charge as well as voltage on the capacitor grows exponentially. If capacitor gets maximum charge  $Q_0$  after infinite time then, charge  $Q$  on it at any time  $t$  is given by

$$Q = Q_0 (1 - e^{-t/RC})$$

And

$$I = I_0 e^{-t/RC}$$

where,  $I_0 = \frac{Q_0}{RC}$

during charging of a condenser charge and voltage increases exponentially with time while the current decrease exponentially.

At time

$$\tau_c = RC$$

where  $R$  = Resistance

$C$  = Capacitance

$$Q = Q_0(1 - e^{-t}) = 0.63 Q_0$$

and

$$I = I_0 e^{-t} = 0.37 I_0$$

Where  $Q_0$  and  $I_0$  are the maximum value of charge and current during charging of condenser during discharging of a condenser charge decrease exponentially with time while the current increases exponentially on negative side.

Observation:-

1.  $R = \underline{50 \text{ k}\Omega}$

2.  $C = \underline{1000 \mu\text{F}}$

Theoretical value of time constant

$$\tau_{re} = RC = \underline{50 \text{ sec}}$$

$$LC = 0.02$$

$$\text{Reading} = 0.02 \times \text{No. of line}$$



## Calculation:-

### For Charging

$$V = 63\% \text{ of max.}$$

$$= \frac{63}{100} \times 0.86$$

$$V = 0.54 \text{ V}$$

### For Discharging

$$V = 37\% \text{ of max}$$

$$= \frac{37}{100} \times 1$$

$$V = 0.37 \text{ V}$$

time according to

graph

$$= 20 \text{ sec}$$

## Percentage error

### Charging

$$\% \text{ error} = \frac{\text{Calculated} - \text{Graphical}}{\text{Calculated}} \times 100$$

$$\% \text{ error} = \frac{50 - 20}{50} \times 100$$

$$\% \text{ error} = 60\%$$

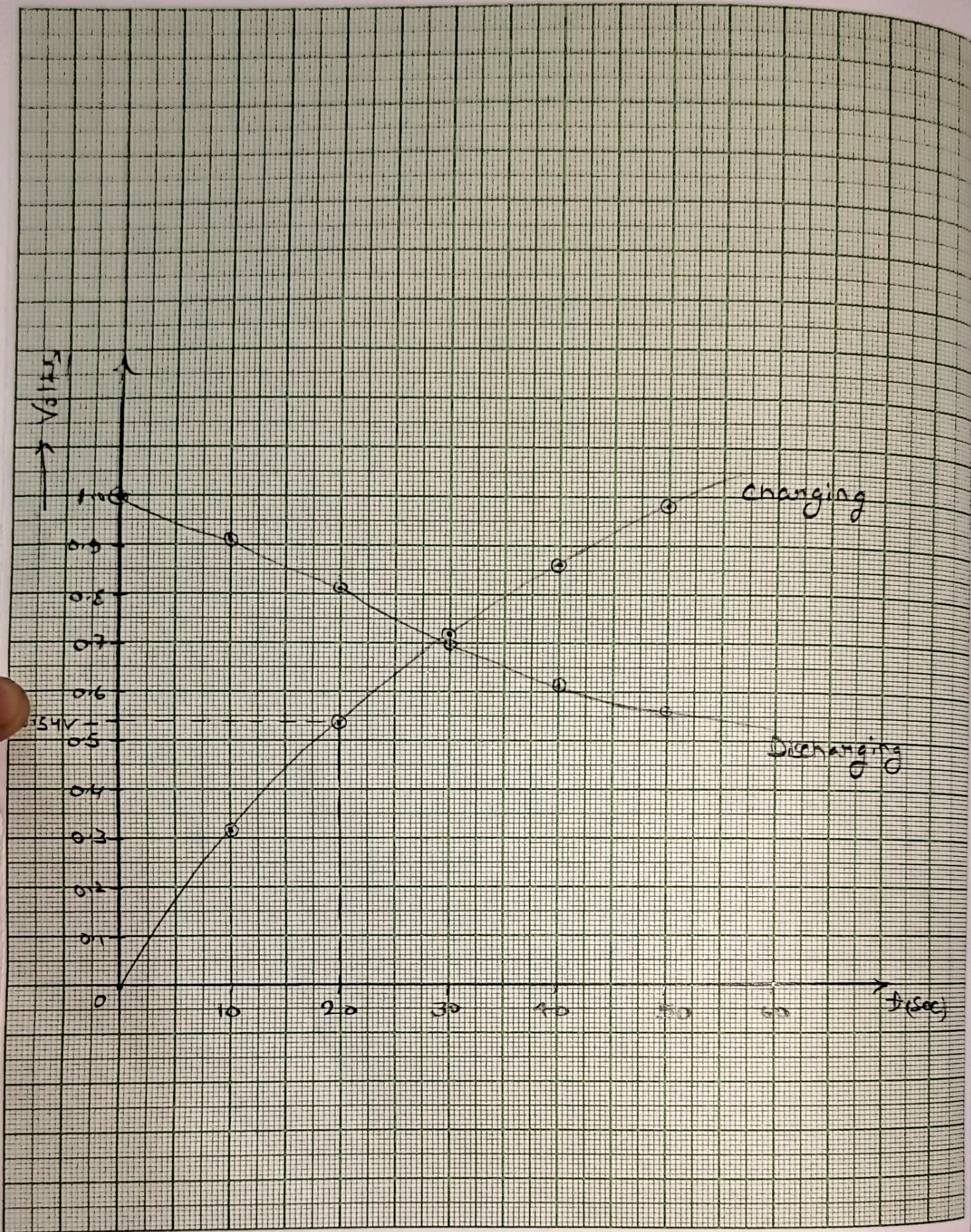
### Discharging

$$\% \text{ error} = \frac{\text{Calculated} - \text{Graphical}}{\text{Calculated}} \times 100$$

$$\% \text{ error} = \frac{50 - 50}{50} \times 100$$

$$\% \text{ error} = -$$







## Observation Table :-

Time Sequence T(sec)	Charge V(Volts)	Discharge V(Volts)
0	0	1
10	0.32	0.92
20	0.54	0.84
30	0.72	0.70
40	0.86	0.62

(Note: keep on taking the readings until the voltage becomes almost constant (both charging and discharging.)

## Result :-

Analyze of observation and graphs carefully.

1. The time constant for charging is 50 sec (Calculated)
2. The time constant for charging is 20 sec (Graphical)
3. The time constant for discharging is 50 sec (Calculated)
4. The time constant for discharging is      (Graphical)
5. % error = 60% and      respective.



### Precautions:-

1. The value of  $R$  and  $C$  must be chosen so that time constant is large say  $\sim 200 \text{ sec}$
2. It is not possible to take readings of voltmeter and ammeter simultaneously. It is taken one after the other.
3. While discharging the condenser, current decrease quite quickly. Therefore note current quickly and accurately.

### Practical application:-

1. Importance in wireless telegraphy.
2. Capacitor due to charge storage properties and extremely useful in power storage devices like inverters.

### Viva Questions with Answers.

Q1 What is capacitor and what are its types?

Ans It is a device that is used to store the charge on the principle of polarization.

Types of capacitor - Paper capacitor,  
Mica capacitor, electrolytic capacitor,  
variable capacitor.



Q2 What is the unit of capacitance?

Ans Coulomb/Volt, farad,  $\mu\text{f}$  (micro farad) and pF (Pico farad).

Q3 On what factor the capacitance of capacitor depends?

Ans It depends on geometry of plates (Area of plates, separation between plates, length and radius of cylinder, radius of sphere) and dielectric constant of material concentration of electrolyte.

Q4 What is Voltmeter?

Ans It is an instrument used to measure the potential difference two points directly in volts, when connected across those points.

Q5 What is mean by charging and discharging?

It is the ability to control and predict the state at which a capacitor charges and discharges that makes capacitors really useful in electronic timing circuits.



Q6: On what factor the rate of charging or discharging of a capacitor depends?

Ans: The rate at which a capacitor can be charged or discharged depends on;

(a) The capacitance of the capacitor.

(b) The resistance of the circuit through which it is being charged or is discharging.

Q7: What is time constant?

Ans: The product  $RC$  (having units of time) has a special significance; it is called the time constant of the circuit. The time constant is the amount of time required for the charge on a charging capacitor to rise to 63% of its final value.

Q8: What is a resistor?

Ans: A passive two-terminal electrical component that implements electrical resistance as a circuit element.

Q9: What is role of resistor in charging and discharging?  
The smaller the resistance or the capacitance, the smaller the time constant, the faster the charging and discharging rate of the capacitor.

Teacher's Signature: \_\_\_\_\_



Q10 How does a capacitor charge and discharge?  
= A capacitor charges ~~negative~~ exponentially and discharges exponentially.

The capacitor's charging or discharging through a capacitor resistor, the current of the circuit always decreases from its maximum to zero.