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Review Article

A Review Paper on the Study of Charging and Discharging the Capacitor

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Abstract: This review paper was conducted to compare theoretical value with experimental one to provide the charging and discharging capacitor using different value of capacitance, voltage and resistance. Thus on the experiment part was conducted by me and the theoretical one is on the literature part, what if after doing this experiment, When charging capacitor voltage and charge are increase and current are decrease exponentially, where as in discharging capacitor current decrease and similarly voltage and charge are decrease exponentially. This results that experimental value is almost agree with the theoretical one.

Keywords: Capacitance, Charging, Discharging

1. Introduction

1.1. Back Ground of the Study

It is known that, the capacitor, sometimes referred to us condenser is a simple passive device that used to store electricity. Our standard capacitors contains, two metal plates separating by insulating dielectrics. The dielectric can be made out of all sorts of insulating materials like paper, glass, rubbers, ceramics, plastics or any things that will impede the flow of currents. Capacitors can stores energy. So, often found in a power supplied form [1]. A capacitor may be used with a resistor to produce a times. Sometimes it is used to smooth a current in a circuit as they can prevent false triggering of other components such as relay. A capacitor bank is a group of several capacitor of the same rating that is connected in series and parallel with each other to store electrical energy. The resulting bank is then used to counter act Or correct power factor lag or phase shift in an alternating current (AC) power supply [2].

Since it takes predictable amounts of times to reach a specific voltage can be used time electronics switching, the time on and the time off are set by the capacitor and two resistors in the timing circuit. Again, since the store charge they can be used as a part of system to convert ac to dc. A capacitor clicks on the arrows to select various combinations of dielectrics, plate areas and distances. The capacity of capacitor is affected by the area of the plates, the distance between plates and ability of dielectrics to support electrostatics forces [3].

1.2. Statement of the Problem

This review paper is done for the reason that in order to solve the limitation of physics students in our country for experimental aspects like that of theoretical one, and also answer the following question

i. How capacitor charging and discharging?
ii. In order to distinguish the difference between charging and discharging of capacitor?
iii. What is the role of capacitor either charging or discharging?

1.3. Objective of the Study

1.3.1. General Objectives

The general objective of this review paper is to study charging and discharging of capacitor by measuring the charging current over time.

1.3.2. Specific Objectives

The specific objectives of this study are;

a. To understand the characteristics or property of capacitor as they charge and discharge

b. To explain how charge, voltage and current vary with time
c. To visualized and qualitatively expressed the charging and discharging decay graph of capacitors
d. To determine time constants

1.4. Significance of the Study

The significance of the study is

i. To understand how to apply the experimental concepts for human needs
ii. To provide a deeply understanding of a practical phenomenon in the charging and dis charging of capacitor on students through their learning
iii. Used us initiating tool or motivation in the study of charging and discharging capacitors

2. Theory and Literature Review

2.1. Capacitor

A Capacitor is a passive electronic device that stores energy in its Electric Field and returns this energy to the circuit whenever required. It consists of two Conducting Plates separated by an Insulating Material or Dielectric. Figure 1a and Figure 1b are the basic structure and the schematic symbol of the Capacitor respectively [4].

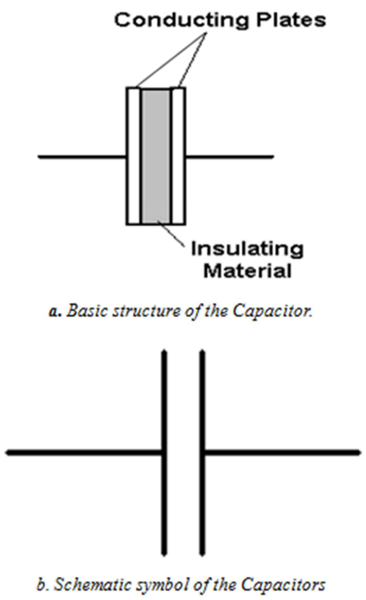


Figure 1. *Basic structure of the Capacitor and Schematic symbol of the Capacitors [4].*

Capacitor has many properties like

a. They can store the energy and it can dissipate this energy to the circuits whenever required.
b. They can block DC and allows AC to flows through it and this can couple one part of the circuits with each other.
c. Circuits with capacitor on the frequency so can be used to amplify certain frequencies.
d. As the capacitors when applied with AC Input, the current lead the voltage and thus in power application it increase the pay lead power and move it more economically.
e. It allows high frequency and so it can be used as a filter either to filter low frequency or to collect high frequencies.
f. As the reactant and frequency of a capacitor are inversely related this can be used to increase or decrease the circuit impedance at certain frequencies and can be used as filter.

2.2. Charging Curve of Capacitor

When a Capacitor is connected to a circuit with Direct Current (DC) source, two processes, which are called "charging" and "discharging" the Capacitor, will happen in specific conditions.

Large-value capacitors are required for this experiment to produce time constants slow enough to track with a voltmeter and stopwatch. Be warned that most large capacitors are of the “electrolytic” type, and they are *polarity sensitive*! One terminal of each capacitor should be marked with a definite polarity sign. Usually capacitors of the size specified have a negative (-) marking or series of negative markings pointing toward the negative terminal. Very large capacitors are often polarity-labeled by a positive (+) marking next to one terminal. Failure to heed proper polarity will almost surely result in capacitor failure, even with a source voltage as low as 6 volts. When electrolytic capacitors fail, they typically explode, spewing caustic chemicals and emitting foul odors [5].

It is important to study what happens while a capacitor is charging and discharging. It is the ability to control and predict the rate at which a capacitor charges and discharges that makes capacitors really useful in electronic timing circuits. When a voltage is placed across the capacitor the potential cannot rise to the applied value instantaneously. As the charge on the terminals builds up to its final value it tends to repel the addition of further charge. The rate at which a capacitor can be charged or discharged depends on: (a) the capacitance of the capacitor) and (b) the resistance of the circuit through which it is being charged or is discharging.

This fact makes the capacitor a very useful if not vital component in the timing circuits ofmanydevices from clocks to computers. In the section headed Capacitors 1 we compared a charged capacitor to a bucket with water in it. Now, if a hole is made in the bottom of the bucket the water will run out. Similarly, if the capacitor plates are connected together via an external resistor, electrons will flow round the circuit neutralize some of the charge on the other plate and reduce the potential difference across the plates. The same ideas also apply to charging the capacitor. During charging electrons flow from the negative terminal of the power supply to one plate of the capacitor and from the other plate to the positive terminal of the power supply. When the switch is closed, and charging starts, the rate of flow of charge is large (i.e. a big current) and this decreases as time goes by and the plates become more charged so "resisting" any further charging. You should realize that the addition of a resistor in the circuit in series with the capacitor only affects the time it takes for the capacitor to become fully charge and not the eventual potential difference across it – this is always the same and equal to the potential difference across the supply. Those of you who have a flash lamp built into your camera will know that it takes a few seconds to charge - this is because the energy for the flash is being transferred to, and stored in, the capacitor inside the flash unit and this takes time to become fully charged. If we consider the example of a capacitor connected to an indicator lamp you should realize that if a capacitor was used to light it then the lamp would get slowly dimmer as the capacitor discharges as the potential difference across it falls and the current flowing gets less [3].

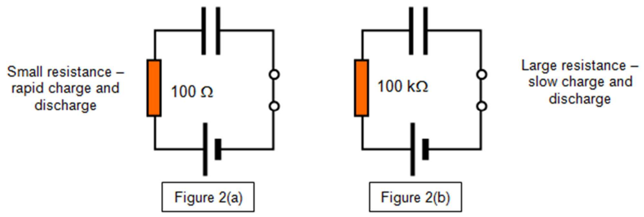


Figure 2. *Schematic diagram for charging and discharging capacitor [3].*

2.2.1. Charging Capacitor

As soon as the switch is closed in position 1 the battery is connected across the capacitor, current flows and the potential difference across the capacitor begins to rise but, as more and more charge builds up on the capacitor plates, the current and the rate of rise of potential difference both fall. (See Figure 3). Finally no further current will flow when the potential difference across the capacitor equals that of the supply voltage V_o. The capacitor is then fully charged. [1].

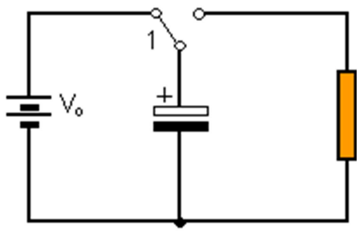


Figure 3. *Charging of capacitorcircuit.*

2.2.2. Discharging Capacitor

As soon as the switch is put in position 2 a 'large' current starts to flow and the potential difference across the capacitor drops. (Figure4). As charge flows from one plate to the other through the resistor the charge is neutralized and so the current falls and the rate of decrease of Potential difference also falls. Eventually the charge on the plates is zero and the current and potential differences are also zero - the capacitor is fully discharged. Note that the value of the resistor does not affect the final potential difference across the capacitor – only the time that it takes to reach that value [1].

The discharging circuit provides the same kind of changing capacitor voltage, except this time the voltage jumps to full battery voltage when the switch closes and slowly falls when the switch is opened. Experiment once again with different combinations of resistors and capacitors, making sure as always that the capacitor's polarity is correct [3].

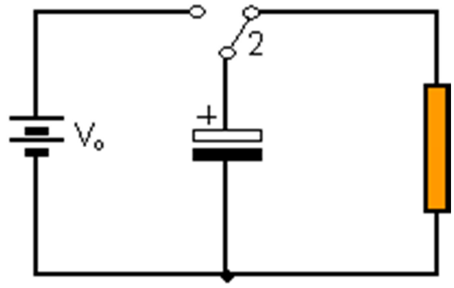


Figure 4. *Discharging of capacitor circuit [1].*

2.2.3. Time Constant

All Electrical or Electronic circuits or systems suffer from some form of "time-delay" between its input and output, when a signal or voltage, either continuous, (DC) or alternating (AC) is firstly applied to it. This delay his generally known as the time delay or Time Constant of the circuit and it is the time response of the circuit when a step voltage or signal is firstly applied. The resultant time constant of any electronic circuit or system will mainly depend upon the reactive components either capacitive or inductive connected to it and is a measurement of the response time with units of, Tau – τ [6].

When an increasing DC voltage is applied to a discharged capacitor the capacitor draws a charging current and "charges up", and when the voltage is reduced, the capacitor discharges in the opposite direction. Because capacitors are able to store electrical energy they act like small batteries and can store or release the energy as required [7].

The charge on the plates of the capacitor is given as: $Q = CV$. This charging (storage) and discharging (release) of a capacitors energy is never instant but takes a certain amount of time to occur with the time taken for the capacitor to charge or discharge to within a certain percentage of its maximum supply value being known as its Time Constant (τ). [6].

If a resistor is connected in series with the capacitor forming an RC circuit, the capacitor will charge up gradually through the resistor until the voltage across the capacitor reaches that of the supply voltage. The time also called the transient response, required for the capacitor to fully charge is equivalent to about 5 time constants or $5T$. This transient response time T, is measured in terms of $\tau = RxC$, in seconds, where R is the value of the resistor in ohms and C is the value of the capacitor in Farads. This then forms the basis of an RC charging circuit were 5T can also be thought of as "$5xRC$" [7]

The product of Resistance R and Capacitance C is called the Time Constant, τ, which characterizes the rate of charging and discharging of a Capacitor. The smaller the Resistance or the Capacitance, the smaller the Time Constant, the faster the charging and the discharging rate of the Capacitor, and vice versa [7].

2.2.4. Half Life

The decay of charge in a capacitor is similar to the decay of radioactive nuclide, it is exponential decay. If we discharge a capacitor we find that the charge decreased by halves in every fixed time interval just like the radio nuclide activity halves in every half-life [2].

2.2.5. Exponential Function

A capacitor is a dynamic element, which doesn't allow sudden changes in its terminal voltage, when energized. Also by $Q = C \times V$, its voltage depends on Q/C ratio; C -capacitance is usually considered to be constant, as its two conductors are of constant cross section & are separated by a constant distance. So, V will be directly proportional to Q. That is, capacitor won't allow sudden change its charge accumulation. So charge wont built up on it instantly. It follows an exponential order or charging, decided by the value of $R \times C$, R being the value of externally connected resistor in series with it. The reason behind this the dynamic nature of it. So, its voltage rise or charge accumulation is considered as a state variable.

Graphs of charge versus time and current versus time for charging capacitors are shown below. Mathematically, both of these graphs are exponential functions - current is an exponential decay, while charge is an exponential growth. [6].

i. The time varying charge

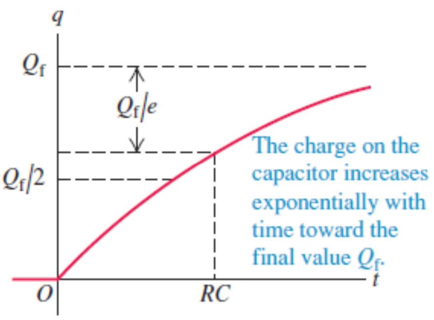
$$Q(t) = CE(1 - e^{-\frac{t}{Rc}}) \quad (1)$$

ii. The time varying voltage

$$v(t) = E(1 - e^{-t}/RC) \quad (2)$$

iii. The time varying current

$$I(t = \frac{E}{R}(1 - e^{-\frac{t}{RC}}) \quad (3)$$



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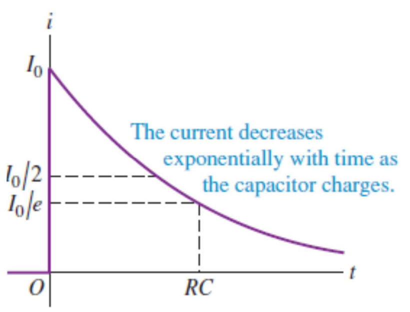
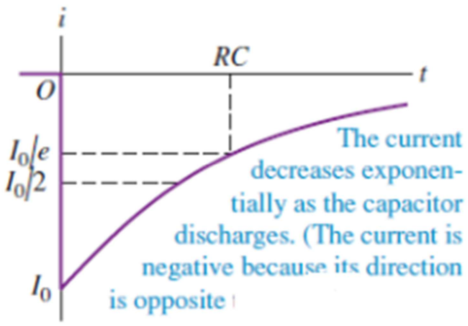


B

Figure 5. *A. Graph of charge versus time for charging capacitor [4]; B. Graph of current versus time for charging capacitor.*

i. Graphs of current versus time and charge versus time will both be decay functions since the current flowing through the resistor will fall off according to the flow of charge off of the capacitor's plates.



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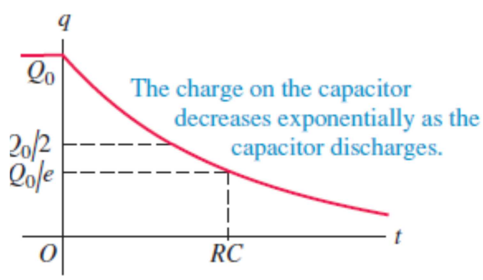

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Figure 6. *A. Graph of current versus time for a discharging capacitor. [4]; B. Graph of charge versus time for a discharging capacitor.*

2.6. Application

Capacitors have many uses in electronic and electrical systems. They are so ubiquitous that it is rare that an electrical product does not include at least one for some purpose. Few of these are: Energy storage, Pulsed power and weapons, power conditioning, power factor correction, suppression and coupling, signal coupling, Decoupling, High pass and low pass filters, Noise Filter, signal processing, tuned circuits, sensing, changing the dielectrics, changing the distance between the plates, changing the effective area of the plates and as oscillator [7].

3. Material and Method of Study

Under this part I was able to investigate about all used material, methods and list of all data recorded. By focusing on the situation we use the data to get the result of the experiments. It may be in mathematical expression or in theoretical expression.

3.1. Materials

In order to illustrate my experiment I have used the following materials

a. Cables
b. Resisters of 1.0 mega ohms

c. Capacitors of 100 micro farads
d. Digital voltmeter
e. Digital ammeter
f. Stop watch
g. Power supply

3.2. Methods of the Study

In order to charging and discharging capacitor "C" through a resister "R". I have used these steps respectively. First I have connected the circuit as shown in the figure above.

Secondly, I have arranged the power supply in 16 volts, resister, $R = 1.0 megaohms$ and the capacitance, $C = 100 microfarad$.

After this, I have connected the capacitor correctly that is its positive terminal to the positive terminal of the power supply and its negative terminals to the negative terminal of the power supply. Then for the switch see the diagram above it can be set to position 1 or position 2 just by using connecting wire. Initially, I connected that wire in position one.

Thirdly, I have used a digital multimeter by connecting it into a capacitor. In order to measure the voltage I connected of the multimeter parallel to the capacitor, That is I connected the lead next to the negative sign of capacitor to COM of the multimeter and the lead next to the positive sign of the capacitor to $V\Omega$ of the capacitor, I read the voltage directly on the screen of the multimeter.

Finally, I set the stop watch to zero and before I charged the capacitor by connecting the wire across the two plats of the capacitor and I discharge it automatically until the voltmeter should read zero. Then I started charging $'C'$ by moving the switch from position 1 to position 2 and also I started the stop watch at the same time then after I recorded the initial $voltage = 0$, at time $t = 0$, next to this I $recorded the voltage \in every 15 seconds for the next 5 minutes$.

At $time$ t=5minutes Immediately moved the switch from position 2 back to position 1 the capacitor now discharge through the resister R. Similarly, I continued taking of V and t in every 15 seconds for further $5 minutes$, then I switched the multimeter off when I have finished.

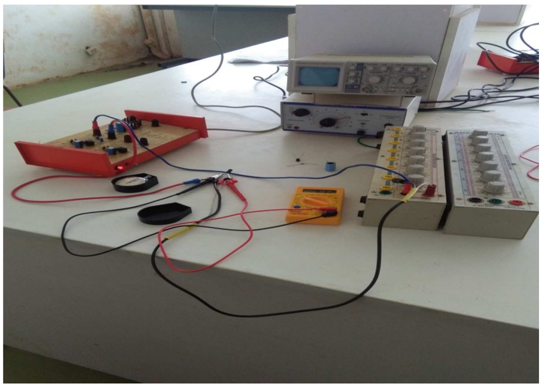

Figure 7. *photographed circuit for charging and discharging during experiments By using the above I performed such types of diagram.*

3.3. Data Recorded

When I was done the experiment I have obtained the following data. When the capacitor charging and discharging as shown in the table below.

Table 1. *Recorded data from experiments.*

Number	Charging Capacitor		Discharging Capacitor	
	Time in second	Voltage in volts	Time in seconds	Voltage in volts
0	0	0	0	12.85
1	15	3.013	15	11.01
2	30	4.335	30	10.251
3	45	6.02	45	8.05
4	60	7.32	60	6.72
5	75	8.451	75	6.01
6	90	9.12	90	5.645
7	105	9.801	105	4.88
8	120	10.525	120	4.223
9	135	10.99	135	3.783
10	150	11.112	150	3.267
11	165	11.502	165	2.912
12	180	11.74	180	2.511
13	195	11.81	195	2.215
14	210	11.99	210	1.965
15	225	12.203	225	1.421
16	240	12.32	240	1.01
17	255	12.405	255	0.99
18	270	12.57	270	0.84
19	285	12.76	285	0.72
20	300	12.85	300	0.61

To calculate the above data we can calculate the amount of charges, currents and voltages. When the capacitor is charging and discharging either experimentally or theoretically by using mathematical relation that is expressed in the previous chapter and use tables to put the evaluated data and also we can calculate the time constants which detects how the capacitor charging fast rate.

Table 2. *The time varying charge, voltage, current and time constant when the capacitor is charged (theoretical values).*

Number	Time in second	Charge in coulombs	Voltage in volts	Current in amperes	Time constant in second
0	0	0	0	0	0
1	15	$3.22 x10^{-4}$	3.22	$6.1576x10^{-5}$	100
2	30	$4.51x10^{-4}$	4.51	$1.40x10^{-5}$	100.01
3	45	$6.32x10^{-4}$	6.32	$1.16x10^{-5}$	100.03
4	60	$7.45x10^{-4}$	7.45	$8.74x10^{-6}$	100
5	75	$8.56x10^{-4}$	8.56	$7.62x10^{-6}$	100.04
6	90	$9.87x10^{-4}$	9.87	$6.69x10^{-6}$	100.07
7	105	$9.99x10^{-4}$	9.99	$6.65x10^{-6}$	100.04
8	120	$20.63x10^{-4}$	10.65	$5.65x10^{-6}$	100.06
9	135	$11.03x10^{-4}$	11.03	$4.901x10^{-6}$	99.7
10	150	$11.41x10^{-4}$	11.41	$4.73x10^{-6}$	100.05
11	165	$11.603x10^{-4}$	11.603	$4.623x10^{-6}$	99.7
12	180	$11.85x10^{-4}$	11.85	$4.16x10^{-6}$	100
13	195	$12.04x10^{-4}$	12.04	$3.967x10^{-6}$	104
14	210	$12.42x10^{-4}$	12.42	$3.53x10^{-6}$	104
15	225	$12.59x10^{-4}$	12.59	$3.20x10^{-6}$	105.07
16	240	$12.64x10^{-4}$	12.64	$3.09x10^{-6}$	99.27
17	255	$13.33x10^{-4}$	13.33	$2.62x10^{-6}$	100.02
18	270	$14.38x10^{-4}$	14.38	$1.50x10^{-6}$	99.13
19	285	$15.08x10^{-4}$	15.08	$0.09243x10^{-6}$	100.089
20	300	$15.86x10^{-4}$	15.86	$0.05864x10^{-6}$	100.5

The above data obtained from the relation in chapter two that is in the form of

1. $Q\ (t) = \ CE\ \left(1 - e^{-\frac{t}{RC}}\right)\ at\ time\ varying\ charges.$
2. $V\ (t) = \ E\ \left(1 - e^{-\frac{t}{RC}}\right) at\ time\ varying\ voltages.$
3. $I\ (t) = \frac{E}{R}\left(1 - e^{-\frac{t}{RC}}\right) at\ time\ varying\ currents.$

Table 3. *Time varying charge, current and time constant obtained from the experiment.*

Number	Time in second	Charge in coulomb	Current in ampere	Time constants in second
0	0	0	$22x10^{-6}$	0
1	15	$3.013x10^{-4}$	$20.1x10^{-6}$	108.01
2	30	$4.335x10^{-4}$	$14.5x10^{-6}$	109.86
3	45	$6.02x10^{-4}$	$13.4x10^{-6}$	110
4	60	$7.32x10^{-4}$	$12x10^{-6}$	115.05
5	75	$8.451x10^{-4}$	$11x10^{-6}$	117
6	90	$9.12x10^{-4}$	$10x10^{-6}$	121
7	105	$9.80x10^{-4}$	$9x10^{-6}$	128.01
8	120	$10.525x10^{-4}$	$8.8x10^{-6}$	132
9	135	$10.99x10^{-4}$	$8x10^{-6}$	134.9
10	150	$11.112x10^{-4}$	$7.4x10^{-6}$	143
11	165	$11.502x10^{-4}$	$7x10^{-6}$	146.9
12	180	$11.74x10^{-4}$	$6.5x10^{-6}$	156.9
13	195	$11.81x10^{-4}$	$6.01x10^{-6}$	157.8
14	210	$11.99x10^{-4}$	$5.71x10^{-6}$	163
15	225	$12.203x10^{-4}$	$5.4x10^{-6}$	168.1
16	240	$12.32x10^{-4}$	$5.1x10^{-6}$	172
17	255	$12.405x10^{-4}$	$4.8x10^{-6}$	179.04
18	270	$12.57x10^{-4}$	$4.66x10^{-6}$	184.04
19	285	$12.76x10^{-4}$	$4.48x10^{-6}$	193.72
20	300	$12.85x10^{-4}$	$4.28x10^{-6}$	196.7

Table 4. *The amount of charge and current when the capacitor discharge, this data obtained from the experiments.*

Number	Time in second	Charge in coulomb	Current in ampere
0	0	$12.85x10^{-4}$	
1	15	$11.01x10^{-4}$	$7.34x10^{-5}$
2	30	$10.25x10^{-4}$	$3.417x10^{-5}$
3	45	$8.05x10^{-4}$	$1.79x10^{-5}$
4	60	$6.72x10^{-4}$	$1.12x10^{-6}$
5	75	$6.01x10^{-4}$	$8.01x10^{-6}$
6	90	$5.645x10^{-4}$	$6.278x10^{-6}$
7	105	$4.88x10^{-4}$	$4.649x10^{-6}$
8	120	$4.223x10^{-4}$	$3.52x10^{-6}$
9	135	$3.783x10^{-4}$	$2.8x10^{-6}$
10	150	$3.267x10^{-4}$	$2.178x10^{-6}$
11	165	$2.912x10^{-4}$	$1.76\ x10^{-6}$
12	180	$2.511x10^{-4}$	$1.395x10^{-6}$
13	195	$2.215x10^{-4}$	$1.136x10^{-6}$
14	210	$1.961x10^{-4}$	$9.36x10^{--7}$
15	225	$1.421x10^{-4}$	$6.32x10^{-7}$
16	240	$1.01x10^{-4}$	$4.21x10^{-7}$
17	255	$0.99x10^{-4}$	$3.725x10^{-7}$
18	270	$0.84x10^{-4}$	$3.11x10^{-7}$
19	285	$0.72x10^{-4}$	$2.53x10^{-7}$
20	300	$o.62x10^{-4}$	$2.06x10^{-7}$

4. Result and Discussion

4.1. Result

Under this chapter I am going to compare and contrast the theoretical values and experimental value of the review paper with also the experimental findings, which obtained from in the previous chapters.

First let me compare the theoretical values which obtained from the product of R and C and the values that obtained in the calculation in table 2 of time constants.

To show the unit of time constants by starting from the relation

$$Resistance = Voltage/current \tag{4}$$

and

$$Capacitance = Charge/Voltages \tag{5}$$

$$Timeconstant = RC \tag{6}$$

So by substituting Equation (4) and Equation (5) in to Equation (6), we obtained

$$Timeconstants = Charge/Voltage \tag{7}$$

Then from Equation (7) the unit of time constant is second.

Let me compare and contrast the value of charge current and voltage by using evaluated data from theoretically and the data obtained from the experiments.

At time $t = 0$ the charge $q = 0$ as shown tables 2 the theoretical values and at time $t = 0$, $q = 0$ as shown table 3 the experimental values, this shows that the theoretical values and experimental the charge stored is the capacitors are the same values at $t = 0$.

In general table 2 and table 3 describes that the practical and the theoretical values of charges, currents and voltages are the same but they are not exactly equal because there is some source of error that arises from during the measurements either personal error or instrumental errors, and also from table three we have seen that the time constants is increases when time is increases. Similarly, in table 2 the time constant is nearly constant and equal to the theoretical values of time constants that is the product of resistor and capacitor. So this time constants tell us how charging and discharging will occurs.

4.2. Discussion

From this experiment I have discussed that charging and discharging capacitor creates an exponential function. When charging capacitor voltage versus time graph is an exponentially increased and in charging capacitor again the charge versus time graph is an exponentially increasing on the contrary current versus time graph is decreasing.

In discharging capacitor voltage versus time graph is an exponentially decreasing. Similarly, charge verses time graph is exponentially decreasing whereas current versus time graph is an exponentially increasing.

An also at maximum voltage that is $V_{max} = 12.85volts$ this is the capacitor begin to discharging and$V_i = 0$ is the beginning of charging capacitor in my experiments. When we doing the experiment if the applied if the applied voltage to the capacitor that is greater than the voltage stored in the capacitor the voltage reverse and the capacitor starts charging to the higher voltages.

5. Summery and Conclusion

5.1. Summery

A capacitor is a passive electronic device that stores energy in the form of an electrostatics field. It can store charges: a positive charge $(+q)$ on one plate equally large negative charges $(-q)$ on the other plate. Its capacitance c is the ratio of charge, Q to voltage, V that was needed to store it (and there exist between the plates when it has been stored): $C = Q/V$. For any given capacitor is a constant so Q is proportional to$V$.

When the capacitor is charged, charge flows to the plates: Q and V are increases. Similarly when it is discharge, $Q$and V decreases.

When a capacitor (with capacitances$C$) is discharge the charge on its plate changes with time. The rate of discharge is not constant, when charge Q on each plate is large, the capacitor discharge more rapidly than when it is small. Theoretically it can be proved that the charge decrease in the form of exponentially with time.

Theoretically it takes infinitely long whenever capacitance c it has and whatever capacitance c it has and whenever he initial charge and voltage may be. But clearly the capacitor may be with small initial capacitance c must discharge very quickly than one with large initial charge and large capacitance must discharged

A detailed theory of the discharging of capacitor predicts that $timeconstant = RC$.

5.2. Conclusion

From this review paper I have concluded that in a charging and discharging capacitor circuit when the voltage is applied to a capacitor the charge grow up and the current decline to zero.

From my project work I have concluded that when capacitor is charging the charge and voltage increased and the current decreased this is shown by using the experimental data as well as by the theoretical calculation using the formula expressed in chapter two. As shown table two and table three both charge and voltage increases but current decreased when the capacitor is charging. When a capacitor is discharging all current, voltage and charge decreased as shown in table three as time constant is to be coming increased as shown in table 4 for the capacitor takes more time to change. As time constant is small the capacitor charges quickly.

5.3. Recommendation

i. Every educated person should an interesting ideas about charging and discharging capacitor, exponential function, half-life, time constant as well as their application in order to understand how capacitor charging and discharging.
ii. To conduct charging curve of capacitor experiment take the following attention. The polarity of a capacitor must be connected in the correct way because they are heated easily if do not connect in the correct polarity.
iii. Do not touch any apparatus without the instruction of the manual and without the permission of the lab assistants. Since the apparatus are broken easily. For example multimeter is delicate instrument, it can easily be damages.
iv. To prevent that from damaging it is important that we always follow the correct procedure for using it. Do not move the material from one place to another place to prevent from damaging.
v. Build the “charging” circuit and measure voltage across the capacitor when the switch is closed. Notice how it increases slowly over time, rather than suddenly as would be the case with a resistor. You can “reset” the capacitor back to a voltage of zero by shorting across its terminals with a piece of wire.
vi. It is educational to plot the voltage of a charging capacitor over time on a sheet of graph paper, to see how the inverse exponential curve develops. In order to plot the action of this circuit, though, we must find a way of slowing it down. A one-second time constant doesn’t provide much time to take voltmeter readings!
vii. The discharging circuit provides the same kind of changing capacitor voltage, except this time the voltage jumps to full battery voltage when the switch closes and slowly falls when the switch is opened. Experiment once again with different combinations of resistors and capacitors, making sure as always that the capacitor’s polarity are correct.

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