Physics Laboratory Report

Lab Number and Title: Lab 217: RC Circuits

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Course & section number: Physics 121A-010 **Instructor's Name:** Kai Qian

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Introduction:

In Lab 205, the objective was to learn to observe and analyze the voltage across a capacitor Vc as a function of time t in a circuit containing a resistor and capacitor connected in series. The theories we had to know were the discharge of a capacitor and the charging of a capacitor.

Experimental Procedure:

For Part I, we had to discharge a capacitor and for discharging a capacitor, when t is less than 0, the switch is in position A and the voltage on the capacitor, Vo, and since Vo= Vc, there is no current in the charging capacitor. When the switch is suddenly moved to position B, the capacitor discharges through the resistor R. When the switch was flipped we measure the voltage drop every 10 seconds. For part II, in the scenario when charging the capacitor, the switch is in position B rather than A and the voltage on the capacitor is 0. When the switch is moved to position A, the voltage Vo is applied to the RC circuit. Hence, the capacitor is being charged through the resistor R. Similar to part I, we measured the voltage every 10 seconds.

Results:

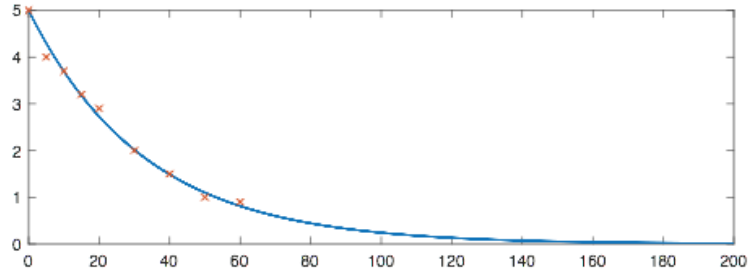
Part A

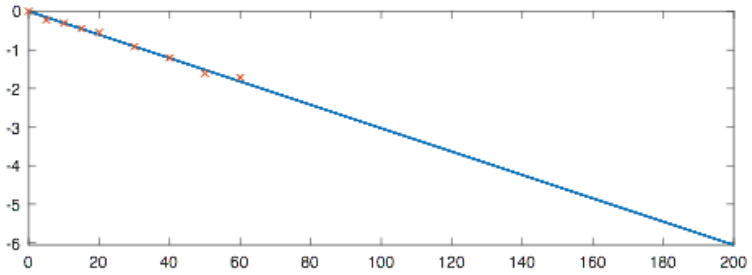
Part I

Texp [s]	0	5	10	15	20	30	40	50	60
Vexp [V]	4.398	3.702	3.147	2.659	2.288	1.684	1.259	0.934	0.694

MATLAB code outcome

Theoretical time constant (tau) [s]	33
Experimental time constant (tauexp) [s]	33.7560
Percent error (error) [%]	2.2908



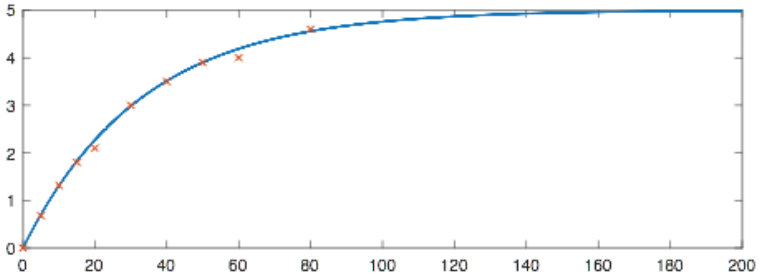


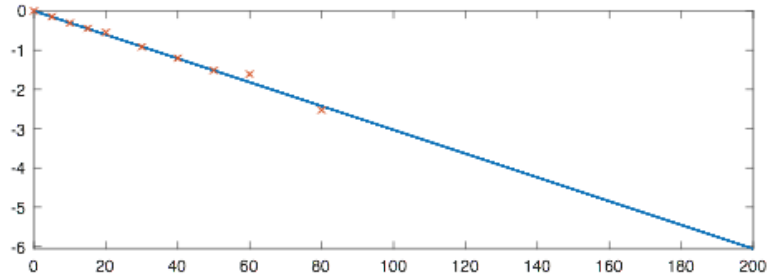
Part II

Texp [s]	0	5	10	15	20	30	40	50	60	70
Vexp [V]	0.003	0.720	1.297	1.839	2.290	2.999	3.510	3.890	4.173	4.380

MATLAB code outcome

Theoretical time constant (tau) [s]	33
Experimental time constant (tauexp) [s]	33.0548
Percent error (error) [%]	0.1662





Part B:

	Voltage [V]	Time [s]	Time Changing [s]	Half-life [s]
Initial time (t0)	3.89850	(t0) = 0.12490	NA	NA
Half-life (t1)	1.94925	(t1) = 0.12800	(t1-t0) = 0.0031	tau1 = (t1-t0) = 0.0031
Two half-lives (t2)	0.98318	(t2) = 0.13110	(t2-t0) = 0.0062	tau2 = (t2-t0)/2 = 0.0031
Three half-lives (t3)	0.49502	(t3) = 0.13420	(t3-t0) = 0.0093	tau3 = (t3-t0)/3 = 0.0031
Averaged half-life [s]				(tau1+tau2+tau3)/3 = 0.0031
Experimental time constant [s]				(tau1+tau2+tau3)/(3*ln2) = 0.004472355
Theoretical time constant [s]				R*C =0.0047
Percent Difference [%]				4.96372%

Measure the slopes and calculate relative time constants

Slope of Graph 1	-212.76
Time constant 1 [s]	0.0047
Slope of Graph 2	-212.75
Time constant 2 [s]	0.0047

$$Slope = -(\frac{1}{RC})$$

Percent difference compare with theoretical time constant in Analysis 1

Time constant 1	0%
Time constant 2	0%

Analysis (Results):

Max: T = 0.12490 s V = 3.89850 V

Half Life: T = 0.12800 s V = 1.94925 V

Time-difference: 0.12800 - 0.12490 = 0.0033 s

Half-Life: $\frac{0.12800 - 0.12490}{1} = 0.0033\ s$

¼ of max: T = 0.13110 s V = 0.98318 V

Time-difference: 0.13110 - 0.12490 = 0.0062 s

Half-Life: $\frac{0.13110 - 0.12490}{2} = 0.0033\ s$

⅛ of max: T= 0.13420 s V= 0.49502 V

Time-difference: 0.13420 - 0.12490 = 0.0093 s

Half-Life: $\frac{0.13420 - 0.12490}{3} = 0.0033\ s$

Average half-life: $\frac{0.0033+0.0033+0.0033}{3} = 0.0033\ s$

Experimental time constant: $\frac{0.0033+0.0033+0.0033}{3*ln(2)} = 0.004472355\ s$

Theoretical Time Constant: (10*1000)*(0.47*10^-6) = 0.0047 s

% Difference: $\frac{|0.0047 - 0.004472355|}{\frac{0.0047 + 0.004472355}{2}} * 100 = 4.96\%$

Time Constant 1: $\frac{-1}{-212.76} = 0.0047\ s$

Time Constant 2: $\frac{-1}{-212.75} = 0.0047\ s$

% Difference for time constant 1: $\frac{|0.0047 - 0.0047|}{\frac{0.0047 + 0.0047}{2}} * 100 = 0.007\%$

% Difference for time constant 2: $\frac{|0.0047 - 0.0047|}{\frac{0.0047 + 0.0047}{2}} * 100 = 0.007\%$

Conclusion:

Overall, this lab further reinforced the topics we had learned in Physics lecture. For instance, we had learned about the concepts of discharging and charging a capacitor. Additionally, we learned that charging and discharging of the capacitor happens with an exponential ratio which is shown on the graphs.