Lab Experiment #6:

RC Circuit Discharge

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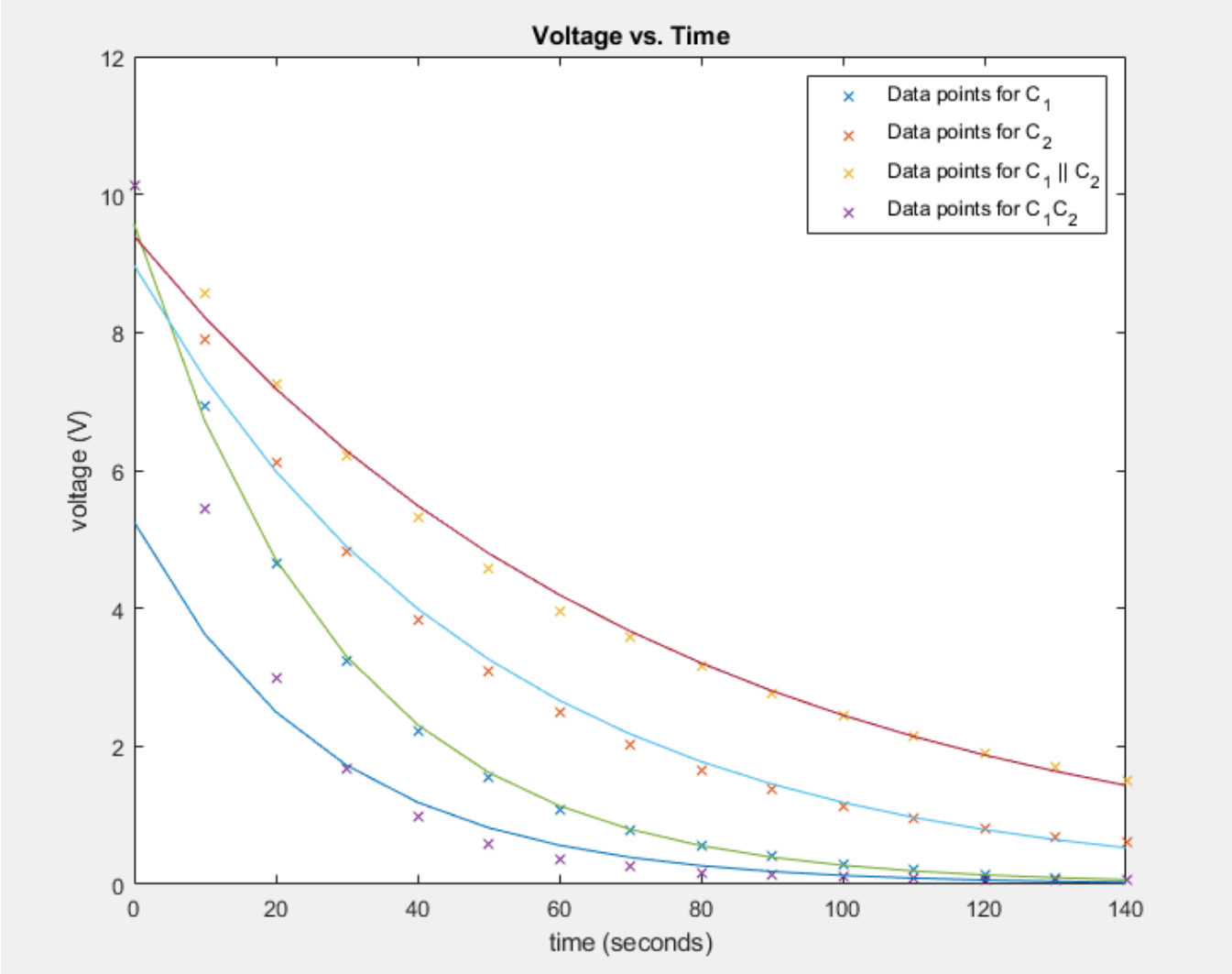
PHYS 200BL
10/18/2021

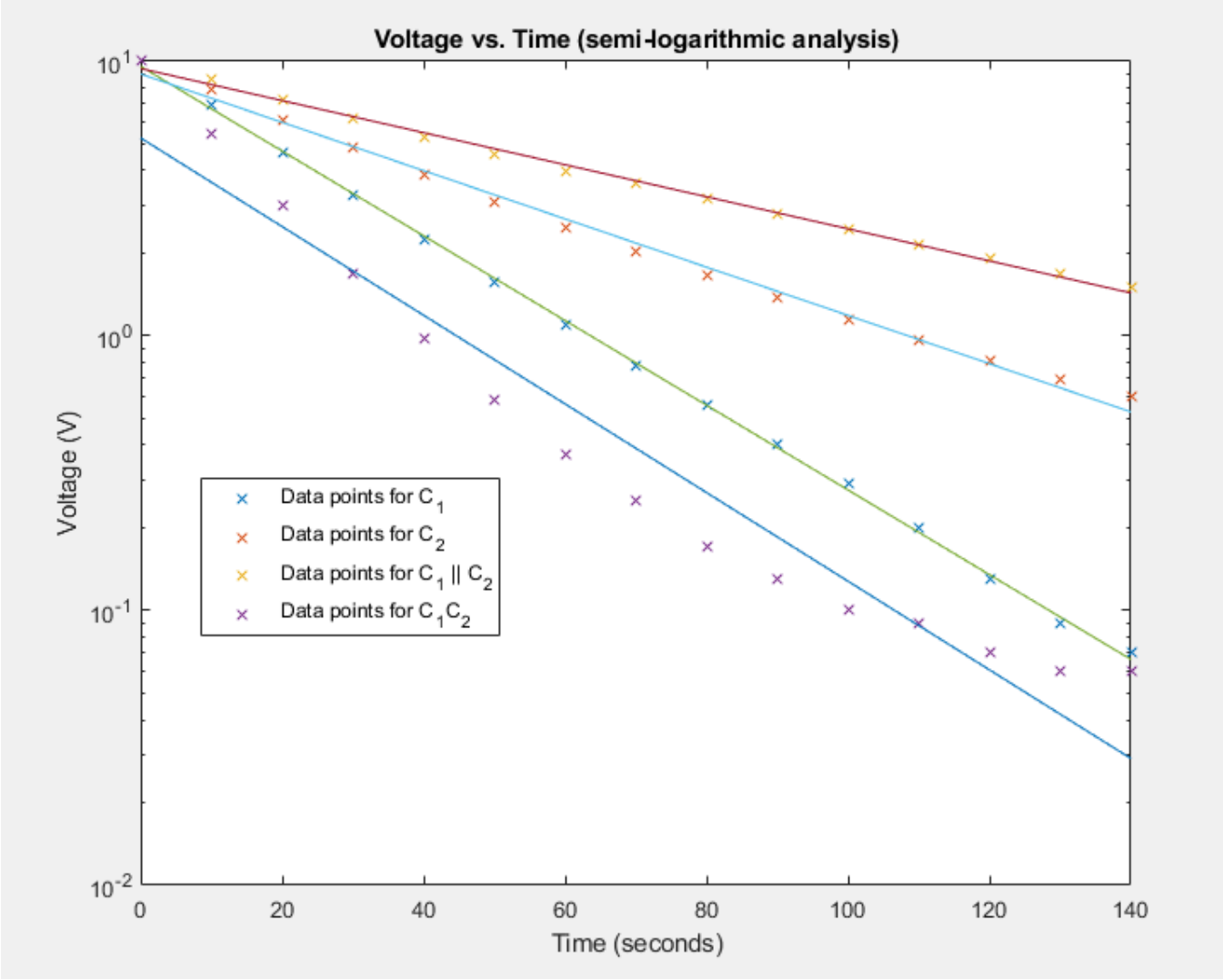
Data

Voltages V of various capacitors as a function of time

t (seconds)	V_{C_1} (Volts)	V_{C_2} (Volts)	$V_{C_1 \| C_2}$ (Volts)	$V_{C_1 C_2}$ (Volts)
0 s	10.12 V	10.12 V	10.12 V	10.12 V
10 s	6.92 V	7.90 V	8.57 V	5.45 V
20 s	4.66 V	6.12 V	7.24 V	2.98 V
30 s	3.24 V	4.83 V	6.21 V	1.68 V
40 s	2.23 V	3.84 V	5.31 V	0.98 V
50 s	1.56 V	3.08 V	4.58 V	0.58 V
60 s	1.09 V	2.48 V	3.95 V	0.37 V
70 s	0.78 V	2.02 V	3.58 V	0.25 V
80 s	0.56 V	1.66 V	3.15 V	0.17 V
90 s	0.40 V	1.37 V	2.76 V	0.13 V
100 s	0.29 V	1.14 V	2.43 V	0.10 V

t (seconds)	V_{C_1} (Volts)	V_{C_2} (Volts)	$V_{C_1 \| C_2}$ (Volts)	$V_{C_1 C_2}$ (Volts)
110 s	0.20 V	0.96 V	2.15 V	0.09 V
120 s	0.13 V	0.81 V	1.90 V	0.07 V
130 s	0.09 V	0.69 V	1.69 V	0.06 V
140 s	0.07 V	0.60 V	1.50 V	0.06 V





Extracted values for time constant τ:

- C_1 : 28.2 seconds
- C_2 : 49.4 seconds
- $C_1 \parallel C_2$: 74.4 seconds
- C_1C_2 : 26.9 seconds

Capacitor	C from slope	Theoretical value of C	% difference
C_1	1.41×10^{-6}	XXX	XXX
C_2	2.47×10^{-6}	XXX	XXX
$C_1 \parallel C_2$	3.72×10^{-6}	3.88×10^{-6}	4.21%
C_1C_2	1.35×10^{-6}	8.98×10^{-7}	40.2%

Lab Questions

1. The voltage drop across the capacitor in the "power source/capacitor" Kirschoff loop must be 20 Volts, as the total provided by the power source is also 20 volts. Thus, the voltage drop over the resitors in series in the "capacitor/resistor" loop must also equal 20 volts. The total resistance of the resistors in series is the product of the resistance of the multimeter and the resistor, so it stands to reason that the resistor would provide half of the resistance; the multimeter, then, is measuring the voltage from the resistor to the negative terminal, which is 1/2 * 20 volts = 10 volts.
2. Because the ratio of capacitance $C = \frac{Q}{V}$ doesn't change, and the resistors are both of equal magnitude, we again only need to know one value of R to determine the total voltage at any point RC.
3. a. The total resistance would be inverted, for an approximate value of 5×10^{-8}.
   b. The experiment would take many orders of magnitude more time to complete, with the given voltage. This would not be practical when Landon has to study for an exam after class.

Data sheet + Quiz

6.7 Data sheet

Name: David McNeary	Date: 10/12/21	Instructor's initials:
Partner: Glendy Lara	Group No:	

Data

Voltages V of various capacitors as a function of time

t (s)	Voltage of C_1 (V)	Voltage of C_2 (V)	V of $C_1 \parallel C_2$ (V)	V of C_1C_2 in series (V)
0	10.12 V	10.12V	10.12V	10.12 V
10	6.92V	7.90V	8.57V	5.45V
20	4.66V	6.12V	7.24V	2.98V
30	3.24V	4.83V	6.21V	1.68V
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Calculations

1. In a single plot, plot voltage as a function of time for all capacitors using regular graph paper or graphing software.

2. In a single plot, plot voltage (on logarithmic axis) vs. time on a two cycle semi-log graph for all four cases.

3. Make a straight line fit on the semilog plot from 2 for all the four lines. Draw the fits as exponential curves on the linear plots from 1

4. Using equation 6.6 or 6.7, extract the value of capacitance of the 4 different measurements.

5. Calculate the capacitance of the parallel and series combinations using the theory in sections 6.3.2 and 6.3.3.

6. Summarize your calculations in the following table:

Capacitor	C from slope	Theoretical value of C	% difference
C_1	1.41×10^{-6}	XXX	XXX
C_2	2.47×10^{-6}	XXX	XXX
$C_1 \parallel C_2$	3.72×10^{-6}	3.88×10^{-6}	4.21%
C_1, C_2 in series	1.35×10^{-6}	8.98×10^{-7}	40.2%

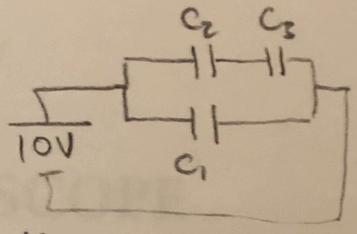
Answers

(Questions 1 – 3)

Quiz

1.) $V = \frac{q}{C}$

2.) a. Parallel
b. Series



4.)

3.) $V(t) = V_0 e^{-t/RC} \rightarrow$

$V = IR \rightarrow$

$IR = V_0 e^{-t/RC}$

$\frac{IR}{V_0} = e^{-t/RC}$

$\ln\left(\frac{IR}{V_0}\right) = -t/RC$

$\frac{-t}{R \ln\left(\frac{IR}{V_0}\right)} = C$

$C = -t\left(R \ln \frac{IR}{V_0}\right)^{-1}$

$= \frac{t \ln \frac{IR}{V_0}}{R}$

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