Lab 3: Capacitors in Series and Parallel

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1 Purpose

The purpose of this lab is to gain a working understanding of the real-world behavior of capacitors, and experimentally finding the equivalent capacitance of various combinations of series and parallel capacitors.

2 Theory

The following formula for percent difference was used throughout the lab:

$$\% \text{ difference} = \frac{|C_{eq}\text{measured} - C_{eq}\text{calculated}|}{\frac{1}{2}|C_{eq}\text{measured} + C_{eq}\text{calculated}|} \times 100$$

3 Experiment Analysis

4 Procedure

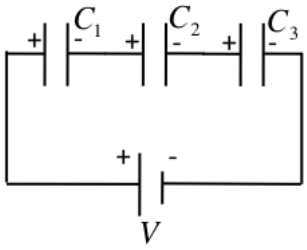
4.1 Measurement of Capacitance Using a Multi-Meter

Not using the breadboard to hold the capacitors in place, our group measured the capacitance of each capacitor while laying on the table. We then proceeded to fill out the values and calculate the percent errors in table 5.1.

4.2 Measurement of Equivalent Capacitance in Series

Beginning by assembling the capacitor circuit with backwards polarity to the example photo, our group proceeded to calculate and measure the values in table 5.2.

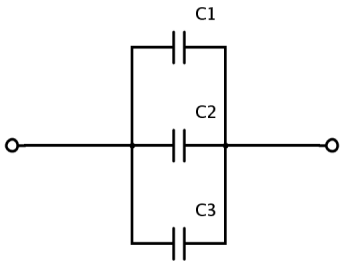
Part 2 Circuit Diagram



4.3 Measurement of Equivalent Capacitance in Parallel

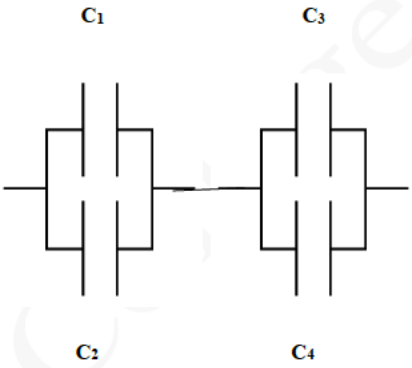
After assembling the capacitors in parallel as shown in the figure below, our group collected the equivalent capacitance and calculated the percent difference shown in table 5.3.

Part 3 Circuit Diagram



4.4 Measurement of Equivalent Capacitance for Both Series and Parallel

Part 4 Circuit Diagram



5 Data and Graphs

5.1 Part 1

[**Table 5.1**] Stated Value Versus Actual Value of Capacitors

	Stated Value of Capacitance	**Experimental Value Measured**	**Percent Error**
C_1	$5\mu F$	$5.62\mu F$	12.4%
C_2	$8\mu F$	$9.96\mu F$	24.5%
C_3	$10\mu F$	$11.2\mu F$	12%
C_4	$15\mu F$	$16.8\mu F$	12%
C_5	$25\mu F$	$28.6\mu F$	14.4%

5.2 Part 2-5

5.3 Part 6

	$C_{eq(measured)}$	$C_{eq(calculated)}$	**Percent Error**
Part 2	$2.71\mu F$	$2.72\mu F$	0.37%
Part 3	$26.8\mu F$	$26.78\mu F$	0.075%
Part 4	$10.87\mu F$	$10.89\mu F$	0.184%
Part 5	$21.4\mu F$	$21.38\mu F$	0.093%

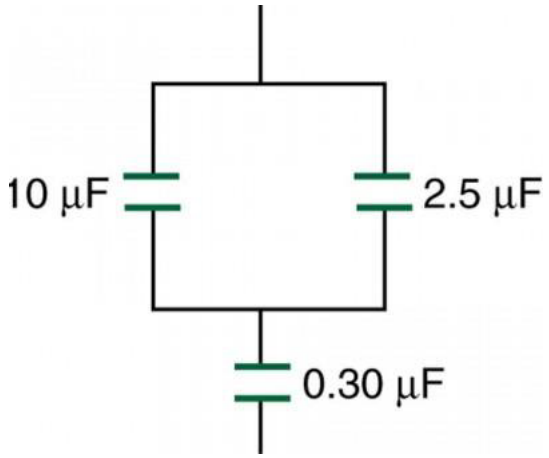
	Nominal Capacitance Value	Measured Voltage	Charge (μC))	Electric Potential Energy(μJ)
C_1	$5\mu F$	3.967V	19.8	39.3
C_2	$10\mu F$	3.968V	39.7	78.7
C_3	$8\mu F$	3.967	31.7	62.9

6 Calculations and Results

7 Questions

7.1 Circuit 1

Figure 1: Circuit diagram for question 1

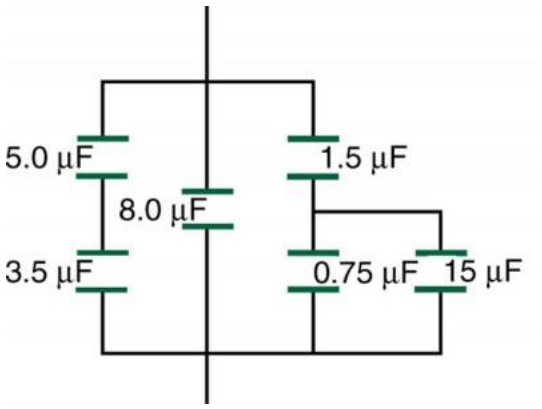


7.2 Circuit 2

Calculations for finding $\mathbf{C_{eq}}$

$$\left(\frac{1}{0.75\mu F + 15\mu F} + \frac{1}{1.5\mu F}\right)^{-1} + \left(\frac{1}{3.5\mu F} + \frac{1}{5\mu F}\right)^{-1} + 8\mu F = 11.4\mu F$$

Figure 2: Circuit diagram for question 2



8 Conclusion

This was a very quick and informative lab. Our group was able to verify our calculations with very low percent differences, aside from the capacitors initially being quite off from their rated capacitances.