Experiment 8: Capacitors in Circuits

EQUIPMENT NEEDED:

– AC/DC Electronics Lab Board: Capacitors, Resistors, Wire Leads
– D-cell Battery
– Stopwatch or timer with 0.1 sec resolution.
– Vacuum Tube Voltmeter (VTVM) or Electrometer (ES-9054B) or Digital Multimeter (DMM) that has an input impedance of 10 MΩ or greater.

Purpose

The purpose of this lab will be to determine how capacitors behave in R-C circuits. The manner in which capacitors combine will also be studied.

Procedure

① Connect the circuit shown in Figure 8.1, using a 100 kΩ resistor and a 100 μF capacitor. Connect the circuit as shown in Figure 8.1. Connect the VTVM so the black "ground" lead is on the side of the capacitor that connects to the negative terminal of the battery and set it so that it reads to a maximum of 1.5 V DC.

② Start with no voltage on the capacitor and the switch off. If there is remaining voltage on the capacitor, use a piece of wire to "short" the two leads together, draining any remaining charge. (Touch the ends of the wire to points **B** and **C** as shown in Figure 8.1 to discharge the capacitor.)

③ Now close the switch by pushing and holding the button down. Observe the voltage readings on the VTVM, the voltage across the capacitor. How would you describe the manner in which the voltage changes?

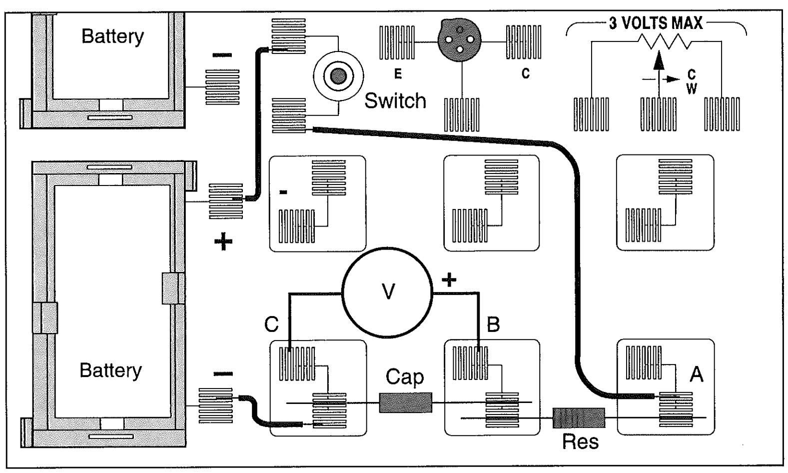

Figure 8.1

④ If you now open the switch by releasing the button, the capacitor should remain at its present voltage with a very slow drop over time. This indicates that the charge you placed on the capacitor has no way to move back to neutralize the excess charges on the two plates.

⑤ Connect a wire between points **A** and **C** in the circuit, allowing the charge to drain back through the resistor. Observe the voltage readings on the VTVM as the charge flows back. How would you describe the manner in which the voltage falls? (It would be reasonable to sketch a graph showing the manner in which the voltage rose over time as well as the manner in which it fell over time.)

⑥ Repeat steps 3-5 until you have a good feeling for the process of charging and discharging of a capacitor through a resistance.

⑦ Now repeat steps 3-5, this time recording the time taken to move from 0.0 volts to 0.95 volts while charging, $\mathbf{t_C}$, and the time taken to move from 1.5 volts to 0.55 volts while discharging, $\mathbf{t_D}$. Record your times along with the resistance and capacitance values in Table 8.1 at the top of the back page.

Table 8.1

Trial	Resistance	Capacitance	t_C	t_D
1				
2				
3				
4				
5				
6				
7				
8				

⑧ Replace the 100 μF capacitor with a 330 μF capacitor. Repeat step 7, recording the charging and discharging times in Table 8.1. If a third value is available, include it in the data table, too.

⑨ Return to the original 100 μF capacitor, but put a 220 kΩ resistor in the circuit. Repeat step 7, recording your data in Table 8.1. If a third resistor is provided, use it in the circuit, recording the data.

➤ **NOTE:**

① What is the effect on charging and discharging times if the capacitance is increased? What mathematical relationship exists between your times and the capacitance?

② What is the effect on charging and discharging times if the resistance of the circuit is increased? What mathematical relationship exists between your times and the resistance?

⑩ Return to the original 100 kΩ resistor, but use the 100 μF capacitor in series with the 330 μF capacitor. Repeat step 7, recording your results in Table 8.2.

⑪ Now repeat step 7, but with the 100 μF and the 330 μF capacitors in parallel.

$R =$ ________ $C_1 =$ ________ $C_2 =$ ________

Table 8.2

Type of Circuit	t_C	t_D
Series		
Parallel		

➤ **NOTE:** What is the effect on the total capacitance if capacitors are combined in series? What if they are combined in parallel? (Refer to Table 8.2).