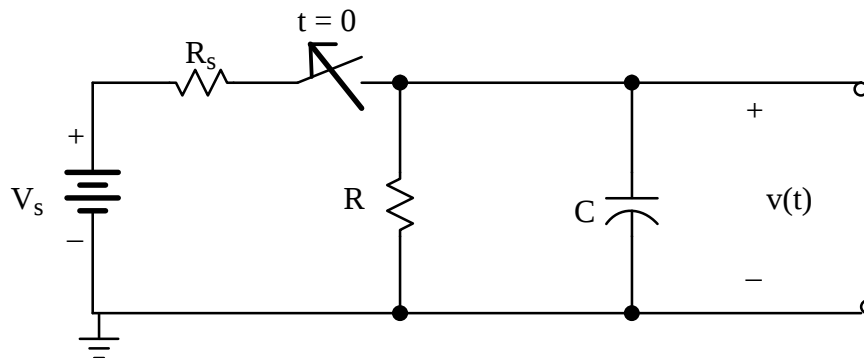


LABORATORY 6

RC Circuits, Time Constants, and Oscilloscopes

In this lab, we will learn about time constants of RC circuits. We will also learn how to measure time constants using the oscilloscopes in room 348.

We will work with the circuit shown below. The purpose of the R_s resistor is to prevent a surge of current into the capacitor when the switch is closed. We will use $C = 1\mu F$ and $V_s = 12$ volts.



Pre-Lab Questions: Please answer the following in your notebook before lab.

1. If the switch has been closed for a long time so that the capacitor is fully charged, what is the voltage $v(t)$ across the capacitor? (Hint: No current flows into the capacitor when it is charged, so does the rest of the circuit look familiar?)
2. Suppose that the switch opens at time $t = 0$ seconds. Analyze the circuit and find an equation describing the voltage $v(t)$.
3. What is the *time constant* for this circuit, in terms of R_s , R , and C ? Make a sketch of $v(t)$, indicating the value of $v(t)$ after 1, 2, 3, 4, and 5 time constants.
4. You should be able to see from your plot where the following two facts and “rules of thumb” about time constants come from:
 - The response decays to 36.8% of its original value after one time constant.
 - The response has decayed to “zero” after 5 time constants, since the amplitude is less than 1% of the original value.
5. What value of R should be used to obtain a time constant of 1 msec?

More Questions: Try to answer these before lab, but help will be provided during lab.

1. Suppose that the switch has been opened for a long time, so that the capacitor is fully discharged. What is the voltage $v(t)$?
2. Now suppose that the switch is *closed* at time $t = 0$. Analyze the circuit to determine an expression for the voltage $v(t)$.
3. What is the time constant for the charging capacitor? Is it different from the time constant of the discharging capacitor considered above?
4. What value does $v(t)$ approach after a long time? Your answer should agree with question 1 above!