LABORATORY 5
RC Circuits, Time Constants, and Oscilloscopes

D/A Converter Circuit

First, every student should demonstrate their implementation of the R–2R ladder D/A converter circuit from Lab 4. We can spend some time debugging your circuits during lab, but try to arrive with your circuit wired and operating. However, I know that circuit problems are sometimes difficult to track down, so don't spend an excessive amount of time if your circuit is not working!

** Remember that lab notebooks will be collected on February 22 for grading of Labs 1–4.

Capacitor Circuits

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 continue these lab activities next week (March 1).

Begin by reading the following E–Lessons (the path to E–Lessons is given in Lab 2):

• Elements –> Capacitors, and the three lessons under this category (You may skip the problems.)

• Basic Concepts –> Measurements –> Using an Oscilloscope, up to "Simple Oscilloscope Experiments – 4". (We did this in Lab 1, but please pay attention to the information on "triggering".)

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.
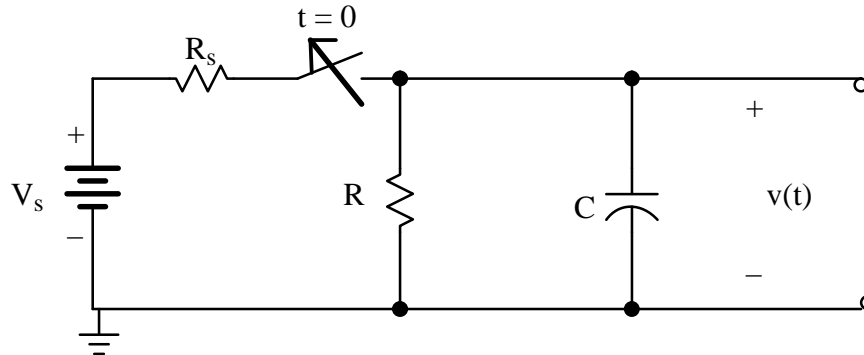
Questions: Please answer the following, and bring your written answers to lab on March 1.

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?