More Questions: Try to answer the following before March 1, but we will help you in lab. (Hint: This is a first–order circuit!)

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!

Measurements

Please choose R to achieve a time constant of approximately 1 msec, and choose R_S so that most of the 12 volts appears across the R–C parallel combination when the switch is closed. Consider the case of *opening* the switch at time t = 0. We will use the oscilloscope to *measure* the time constant of the circuit.

Please set up the circuit from page 1 on your protoboard. The lab assistant and I will help you to use the scopes in order to measure the time constant. Record notes in your lab notebook so you can refer to them in the future when we use the scopes.

An outline of the procedure that you can use to measure the time constant is as follows. The scopes are *digital* instruments, so they can be programmed to perform a lot of useful functions. The steps below allow a single ‘‘trace’’ of the capacitor discharge to be displayed on the oscilloscope. Measurements can then be performed on the trace.

1. Adjust the horizontal (time) axis scaling and the vertical (voltage) scaling to values that are appropriate for the value of V_S and the time constant.
2. Open and close the switch a few times. Make sure the v(t) you observe on the scope matches the sketch you made earlier.
3. Use the MODE key on the scope to set it to record a *single* trace when you open the switch. Also set the scope to *trigger* at a level just below v(0), and set the scope to trigger on a negative slope.
4. Use the STOP, RUN, and ERASE keys to record a trace of v(t) after you open the switch.
5. Use the *cursors* on the oscilloscope screen to measure and compute the time constant. If you use the ‘‘%’’ option in a clever way, then you can get the scope to do all the computations for you in checking the time constant.

Below are some specific activities and measurements to make.

1. Measure the time constant of the circuit using the oscilloscope. Compare the measured value with the expected value based on the R and C component values.
2. Modify the circuit to achieve a time constant on the order of one second. Use the oscilloscope to verify that the time constant is indeed about one second.
3. Consider the case in which the switch is initially opened and then closed to charge the capacitor. Use the oscilloscope to capture one trace of the charging capacitor. Note that the procedure needs to be modified slightly to capture this trace. Compare the measured time constant with the expected value that you determined in the “More Questions” section above.