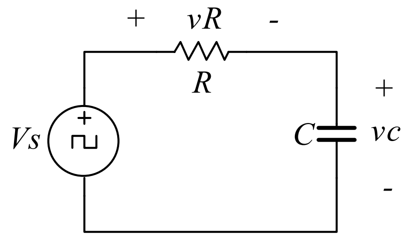
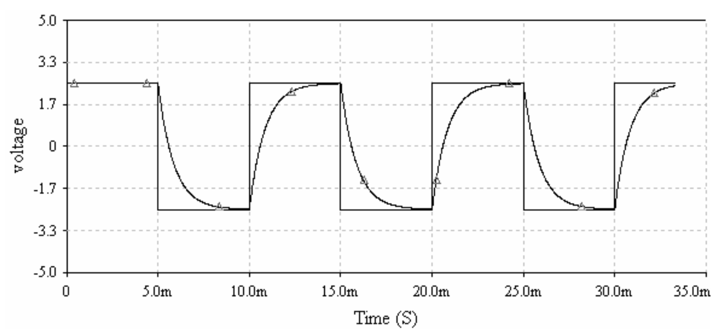
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
22.071/6.071 Introduction to Electronics, Signals and Measurement
Spring 2006

Laboratory 15. Transients

Exercise 1.
Let's start by investigating the behavior of the simple *RC* circuit shown below.
Start by constructing the circuit using a 47nF capacitor and your 20kΩ variable resistor.
For the voltage source *Vs* use the function generator set to the square wave mode.



Start with a square wave of frequency 100 Hz and amplitude *Vp=2.5* Volts.
Using your oscilloscope, measure the voltages *vc.* Adjust your variable resistor until you get a response that looks like



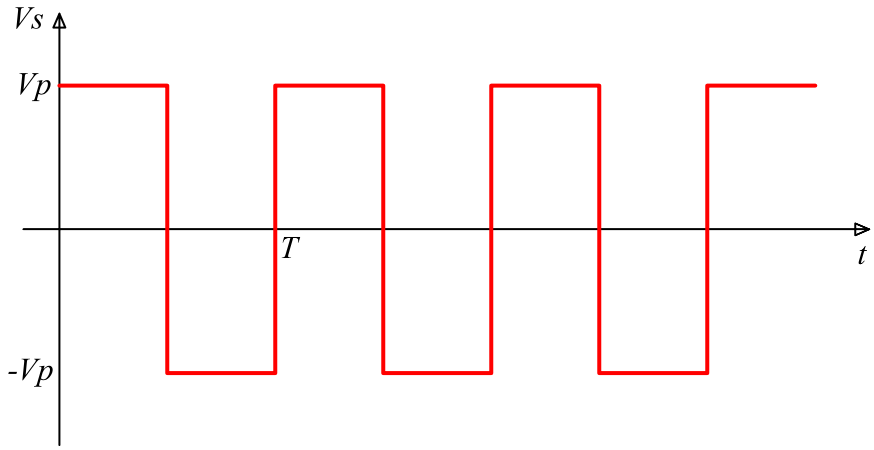
From the shape of the response measure the time constant for this circuit and thus deduce the value of your variable resistor that produced this result.

Now use your digital multimeter and measure the value of the resistor.

Comment on your results.

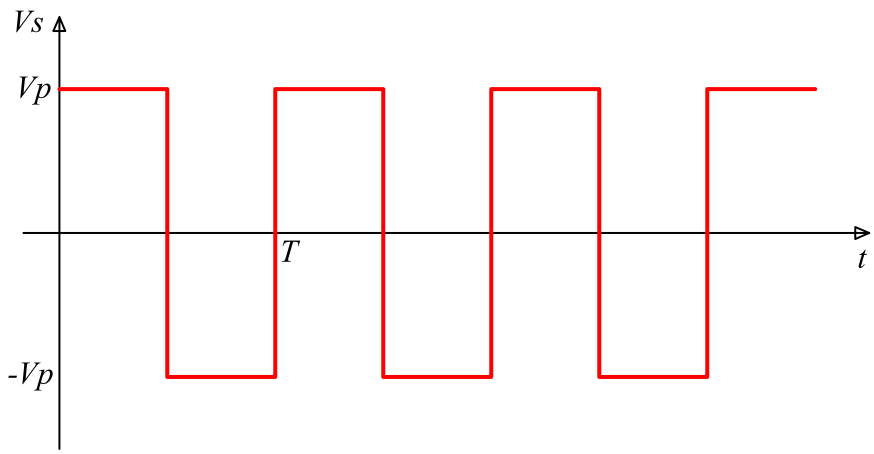
Now measure the voltage *vc* and *vR* simultaneously with the oscilloscope.

In the figure below indicate the form of *vc* and *vR*.



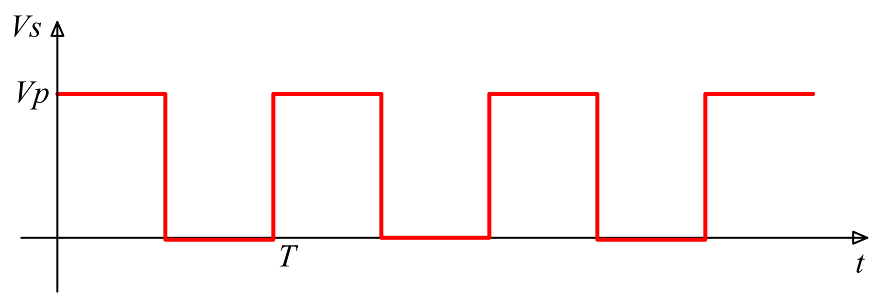
Provide an analytical relationship between *vc* and *vR*.

Now change the frequency of your square wave to 5kHz. Measure *vc* and show its form on the figure below.



Adjust the form of the square wave to vary between 0 Volts and 5 Volts and repeat the experiment for various signal frequencies.

What is the average value of the response signal *vc*?

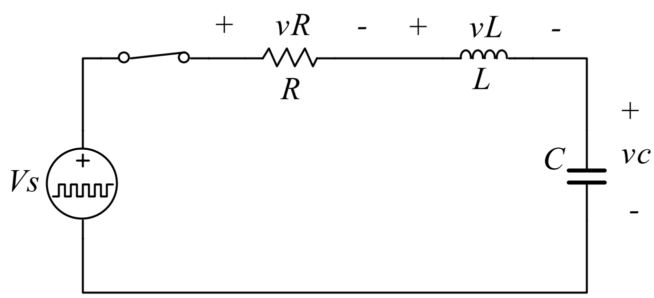


For a square wave signal of 1kHz what is the variation (ripple) of the response signal.

Exercise 2.

Here we will investigate the response of the series *RLC* circuit shown below.

Build the circuit using *L=47mH, C=47nF* and your *20kΩ* variable resistor. For *Vs* use a square wave varying from 0 to 5 Volts and having a frequency of 1kHz.



Calculate the natural frequency ω_o of the circuit.

Calculate the value of α for which the system becomes critically damped.

What is the corresponding value of *R* for critical damping. (R_{crit})

Using R_{crit} observe the response of the system.
Draw the response on the figure below for $R = R_{crit}$, $R < R_{crit}$ and $R > R_{crit}$