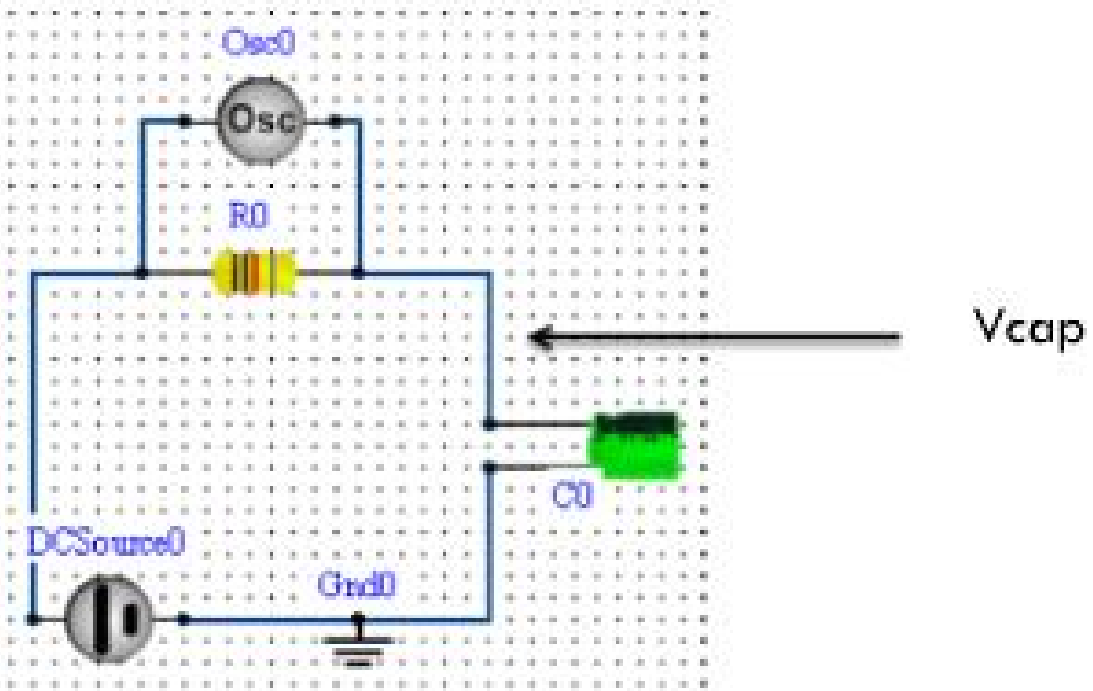
RC CIRCUITS

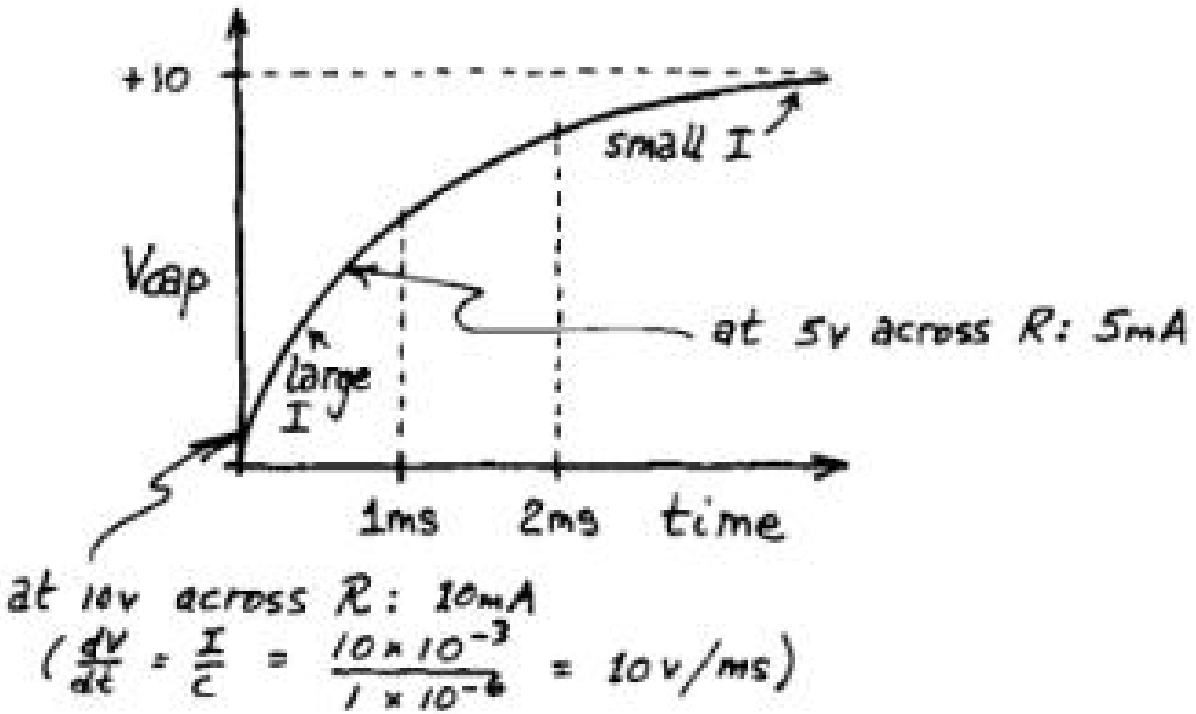
Time Domain Response

Charging with DC Source



Consider the circuit shown above where a DC source of 10V is applied to a Resistor of 1KOhms and a capacitor of 1 uF. Assume Vcap is the voltage across the capacitor.

Charging with DC Source



The Voltage across the capacitor approaches the applied voltage - but at a rate that diminishes towards zero as Vcap approaches the applied voltage. It starts out strongly charging at 10mA but as it is 1V away it has slowed to 1/10 its rate.

Question ?

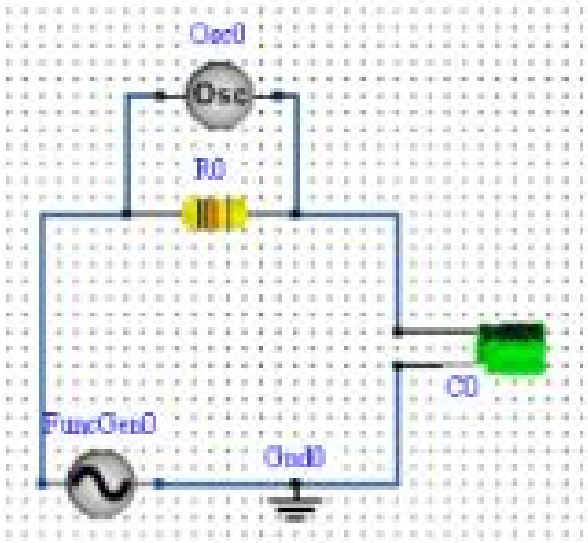
Does Vcap ever reach the applied Voltage of 10 V ?

Square Wave Response – slow change

Since we have seen that a time of 5T where T = R*C is needed for the capacitor to charge fully, let us first take a time period of the square wave large enough to charge the capacitor. So we take Time period of Square wave $>>$ RC. So in effect, this square wave is changing slowly.

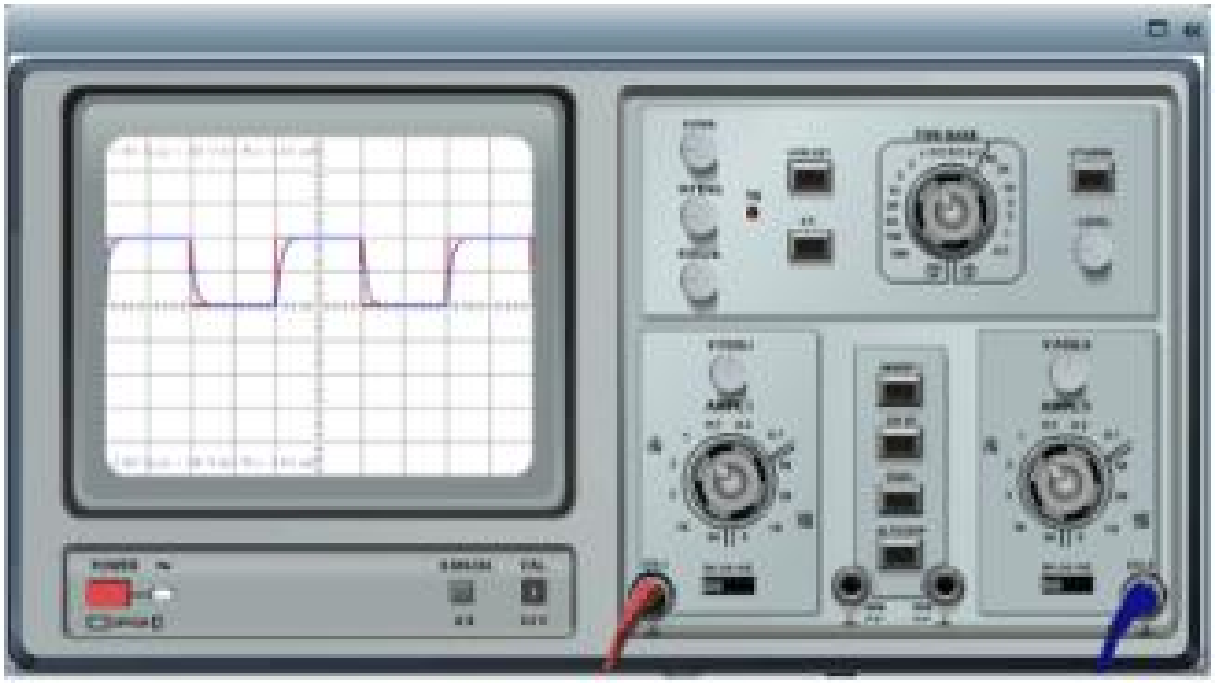
Square Wave Response – slow change

Construct the circuit as below with R = 1 Kohm and C= 0.1 uF. Time Constant ,RC = 100 µS. For the function generator select square wave, let us take Freq = 250 Hz (time period = 4 ms), Amplitude = 2 V. Hook up the Oscilloscope as indicated, run simulation and see the results as shown below.



Square Wave Response – slow change

View the results in the Oscilloscope. Notice that the output across the capacitor is nearly same as the input as we allow the capacitor enough time to charge or discharge fully.

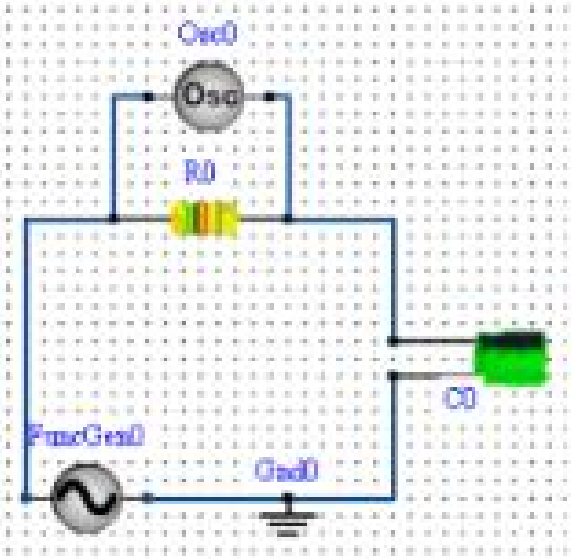


Square Wave Response – fast change

Since we have taken a source which changes slowly and allows the capacitor to charge/discharge fully, let us first take a time period of the square wave the changes fast now. So we take Time period of Square wave << RC. Let us construct the circuit and observe its changes to this fast changing signal.

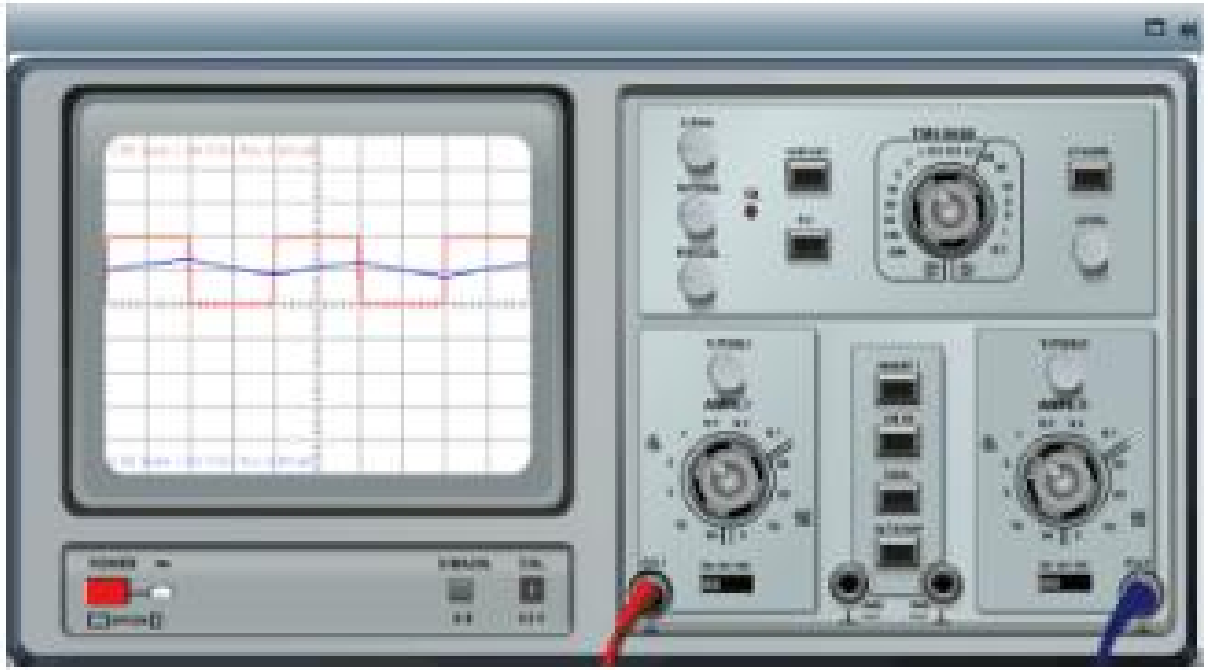
Square Wave Response – fast change

Construct the circuit as below take R = 5.1 Kohm and C= 0.9 uF. Time Constant , RC = 4.5 mS . For the function generator select square wave, let us take Freq = 250 Hz (time period = 4 ms), Amplitude = 2 V. Hook up the Oscilloscope as indicated, run simulation and see the results as shown below.



Square Wave Response – fast change

View the results in the oscilloscope. Notice the we **don't** allow the capacitor enough time to charge or discharge fully in this case thus we have the resultant waveform.

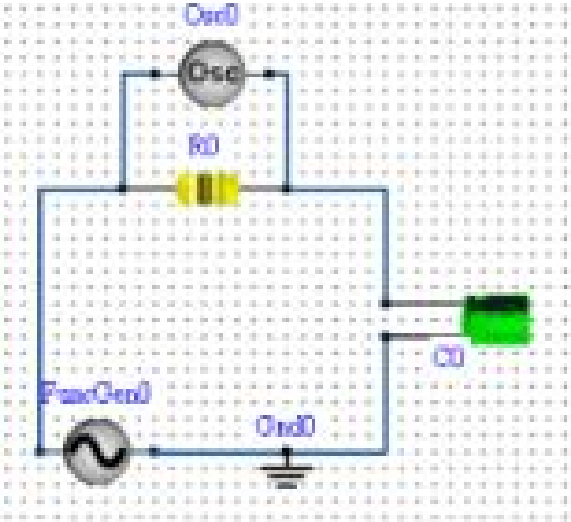


Square Wave Response – Medium change

Since we have seen both cases where we apply a fast changing signal and a slow changing signal, we now apply a signal which is neither changing fast nor changing slowly. So we take Time period of Square wave $>$ RC. Let us construct the circuit and observe the behavior.

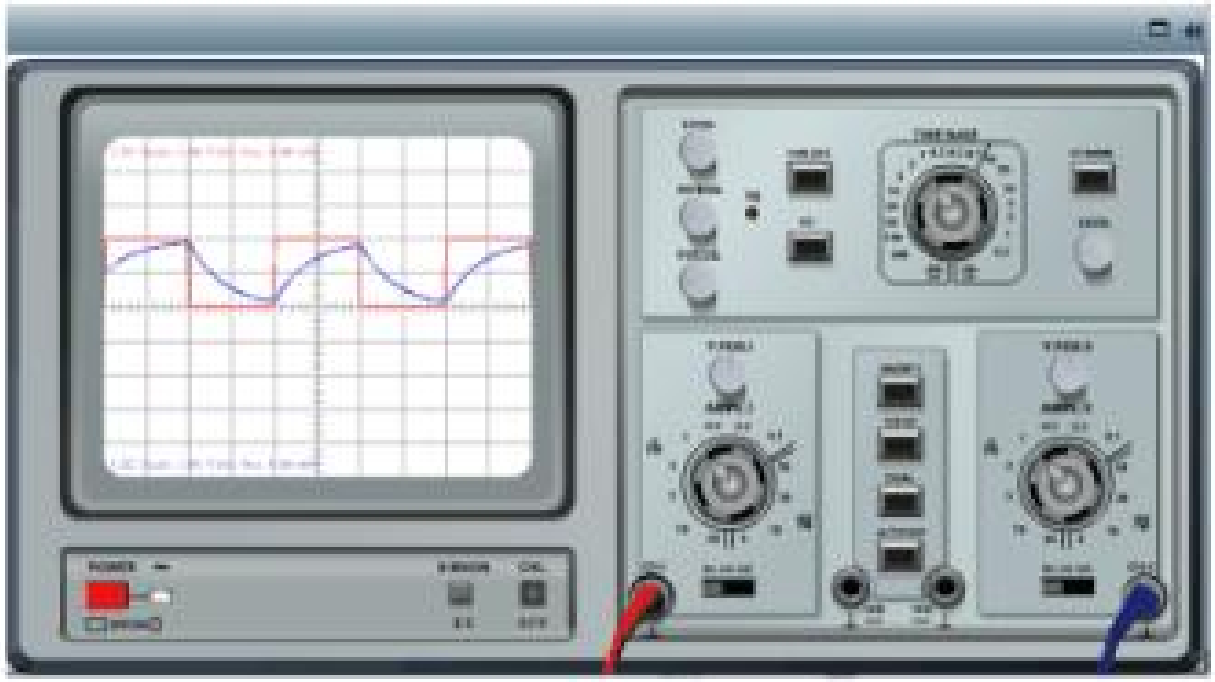
Square Wave Response – Medium change

Construct the circuit as below with Take R = 910 Ohms and C= 0.9 uF. Time Constant, RC = 900 µS. For the function generator select square wave, let us take Freq = 250 Hz (time period = 4 ms), Amplitude = 2 V . Hook up the Oscilloscope as indicated, run simulation and see the results as shown below.



Square Wave Response – medium change

View the results in the oscilloscope. Notice the we **just** allowed the capacitor to have enough time to charge or discharge fully in this case thus we have the resultant waveform.

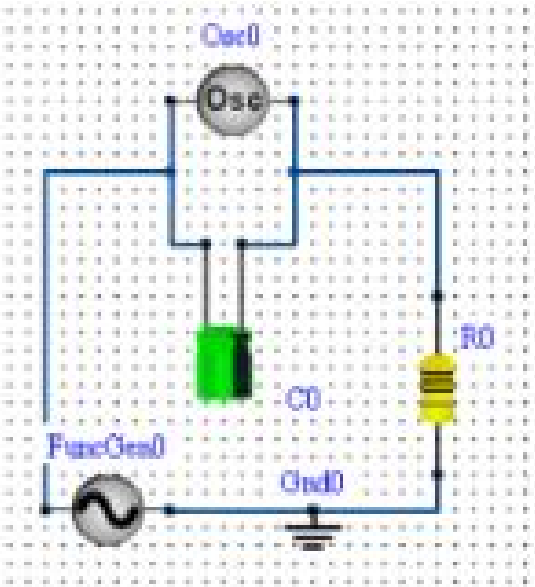


Integrators and Differentiators

RC Circuit as Differentiator

RC as differentiator – Circuit construction

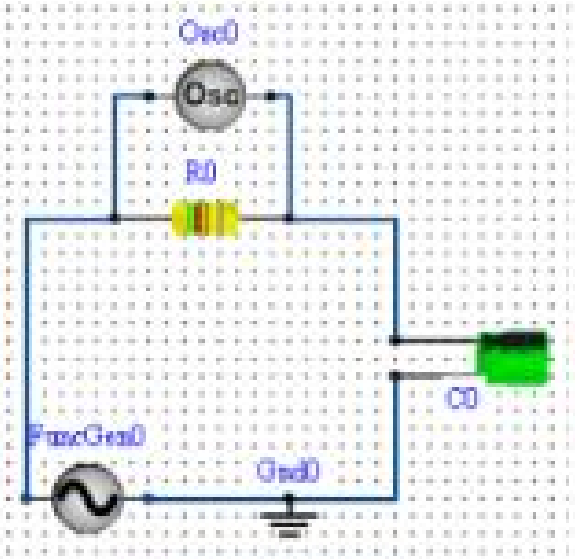
Construct the circuit as below. Take R_0= 0.1 Kohm and C_0= 1 uF. RC = 100 µS. For the function generator select square wave, of 500Hz and 1V. Hook up the Oscilloscope as indicated, run simulation and see the results as shown below.



RC Circuit as Integrator

RC as Integrator

Construct the circuit as below take R = 5.1 Kohm and C= 0.9 uF. Time Constant , RC = 4.5 mS . For the function generator select square wave, let us take Freq = 250 Hz (time period = 4 ms), Amplitude = 2 V. Hook up the Oscilloscope as indicated, run simulation and see the results as shown below.



RC as integrator

View the results in the oscilloscope. Notice the we **don't** allow the capacitor enough time to charge or discharge fully in this case thus we have the resultant waveform.