MULTISIM DEMO 5.2: TRANSIENT ANALYSIS AND FIRST ORDER CIRCUITS

As we saw in the last demo, we can easily model a switch turning on and then off (or vice versa) in Multisim using the Time Delay Switch TD_SW1. This switch, however, will only operate in Interactive Simulations. It WILL NOT work in a Transient Analysis. Go ahead and try it, if you don't believe it.

As a result, we need to find something that *will* work in the Transient Analysis because it would be nice to take advantage of the all the nice cursors and variable manipulation which Transient Analysis provides us. The answer to our problems is the VOLTAGE_CONTROLLED_SWITCH in conjunction with a PULSE_VOLTAGE. To access these components go to:

Group: Sources Family: SIGNAL_VOLTAGE_SOURCES Component: PULSE_VOLTAGE

Group: Basic Family: SWITCH Component: VOLTAGE_CONTROLLED_SWITCH

Let's incorporate these components into the circuit shown in Fig. 5.2.1 below and then run a Transient Analysis to see the voltage across the capacitor as a function of time.



Connect everything as shown in Fig. 5.2.2 on the next page. The PULSE_VOLTAGE component will cause the VOLTAGE_CONTROLLED_SWITCH to turn on and off in accordance with its pulses.



To change the frequency of the switching double click on the PULSE_VOLTAGE source to bring up the window shown in Fig. 5.2.3 below.

- 1. Set the Initial value to 1V.
- 2. Set the Pulsed value to 0 V.
- 3. Set the Period to 1 sec.
- 4. Set the Pulse Width to 0.5 sec.

So what we've just done is set everything up so that the switch J1 will switch on for half a second and off for half a second repeatedly.

	PULSE_VOLTAGE		×	
	Label Display Value Fault Pins	User Fields		
	Initial Value:	1 V		
	Pulsed Value:	0	÷	
	Delay Time:	0 sec	•	
	Rise Time:	0 psec	÷	
	Fall Time:	0 psec	÷	
	Pulse Width:	0.5 sec	÷	
	Period:	1 sec	<u>.</u>	
	AC Analysis Magnitude:	1 V	<u>.</u>	
	AC Analysis Phase:	0 °		
	Distortion Frequency 1 Magnitude:	0 V	÷	
	Distortion Frequency 1 Phase:	0 •		
	Distortion Frequency 2 Magnitude:	0 V	÷	
	Distortion Frequency 2 Phase:	•		
	Tolerance:	0 %		
	Replace OK	Cancel Info	Help	
				1
Figure 5.2.3 PULSE_VOLTAGE control panel with adjusted values.				

Now it's time to set up the Transient Analysis. Once you have the window brought up, set it to the values shown in Fig. 5.2.4 below. Set the start time to 0 Seconds, the End time to 5 Seconds, and set the Maximum time step to 0.0001 Seconds; this may take a little bit of time depending on the speed of your computer so you can adjust it if you'd like. Make sure the output is set to measure the voltage across the capacitor. Using the node numbering found in Fig. 5.2.3, this corresponds to V(3).

-	* Transient Analysis					
Analysis Parameters Output Analysis Options Summary						
	Initial Conditions					
	Automatically determine initial conditions					
	Parameters Start time (TSTART) 0 Sec					
	End time (TSTOP) 5 Sec					
	✓ Maximum time step settings (TMAX)					
	C Minimum number of time points 99					
	Maximum time step (TMAX) 0.0001 Sec					
	C Generate time steps automatically					
More options						
	Set initial time step (TSTEP) 1e-005 Sec					
Estimate maximum time step based on net list (TMAX)						
Simulate OK Cancel Help						
	Figure 5.2.4 Settings for the Transient Analysis.					



Now when we take a look at this output plot, we can see that the voltage just barely gets to 0 V before the capacitor charges up immediately again.

What if we want to adjust the pulse so that the capacitor has more time to decay? We can do this several ways. One way is to simply decrease the frequency (increase the period.) We can also change the pulse length while maintain the length of the period. For our circuit here, this effectively increases the percentage of time that the circuit is spent decaying and decreases the amount of time in which the capacitor is kept fully charged.

In the PULSE_VOLTAGE control window, change the pulse length to 0.8 seconds. The RC circuit now has 0.8 seconds to decay instead of the 0.5 seconds it had originally. In looking at the output in Fig. 5.2.6. We can see that the signal more fully reaches 0 V under these new conditions.



Now let's do the opposite. Decrease the pulse length (the time allowed for voltage decay) to 0.2 s. This will decrease the amount of time the RC circuit has to decay, and as a result, the voltage doesn't even come close to 0 V. There just isn't enough time to reach it. The result is shown in Fig. 5.2.7 on the next page.

