Laboratory Application Assignment

In this lab application assignment you will examine *RC* differentiators and integrators. In each type of circuit you will measure the resistor and capacitor voltage waveforms and draw them in the proper time relation with respect to the input voltage applied. For both the differentiator and integrator, pay close attention to how the *RC* time constant relates to the pulse time, t_p, of the applied voltage.

Equipment: Obtain the following items from your instructor.

- Function generator
- Oscilloscope
- 10-kΩ carbon-film resistor
- 0.01-μF and 0.1-μF capacitors
- DMM

RC Differentiator

In Fig. 22–23*a*, calculate and record the *RC* time constant. *RC* = _____ Is this value long or short with respect to the pulse time, t_p, of the applied voltage? _____. Calculate and record the t_p/RC ratio: _____/_____ Will this ratio provide proper differentiation? _____

Construct the *RC* differentiator in Fig. 22–23*a*. Connect channel 1 of your oscilloscope to the input side of the circuit, and leave it there. Set the channel 1 input coupling switch to dc. Next, adjust the dc offset, amplitude, and frequency controls of the function generator to produce the input waveform shown at the top of Fig. 22–23*b*. Have your instructor verify that the input waveform is indeed a 0- to +10-V square wave with a frequency of 500 Hz.

Connect channel 2 of your oscilloscope across the resistor, *R*, which is the output of the differentiator. Set the channel 2 input coupling switch to dc. Draw this waveform in Fig. 22–23*b* in the space allocated for V_R. Next, use the differential measurement capabilities of your oscilloscope to measure the voltage across the capacitor, *C*. Draw this waveform in Fig. 22–23*b* in the space allocated for V_C. Be certain that V_R and V_C are both drawn in proper time relation with respect to V_{IN}. Include all voltage values for both the V_R and V_C waveforms.

Using your DMM, measure and record the dc value of the applied voltage, V_{IN}. $V_{IN(dc)}$ = _____
Next, measure and record the dc voltage across *R* and *C*.
$V_{C(dc)}$ = _____, $V_{R(dc)}$ = _____
What's significant about these dc voltage measurements? _____

RC Integrator

In Fig. 22–24*a*, calculate and record the *RC* time constant. *RC* = _____ Is this value long or short with respect to the pulse time, t_p, of the applied voltage? _____. Calculate and record the t_p/RC ratio: _____/_____ Will this ratio provide proper integration? _____

Construct the *RC* integrator in Fig. 22–24*a*. Connect channel 1 of your oscilloscope to the input side of the circuit, and leave it there. Set the channel 1 input coupling switch to dc. Next, adjust the dc offset, amplitude, and frequency controls of the function generator to produce the input waveform shown at the top of Fig. 22–24*b*. Have your instructor verify that the input waveform is indeed a 0- to +10-V square wave with a frequency of 5 kHz.

Connect channel 2 of your oscilloscope across the capacitor, *C*, which is the output of the integrator. Set the channel 2 input coupling switch to dc. Draw this waveform in Fig. 22–24*b* in the space allocated for V_C. Next, use the differential measurement

Figure 22–23

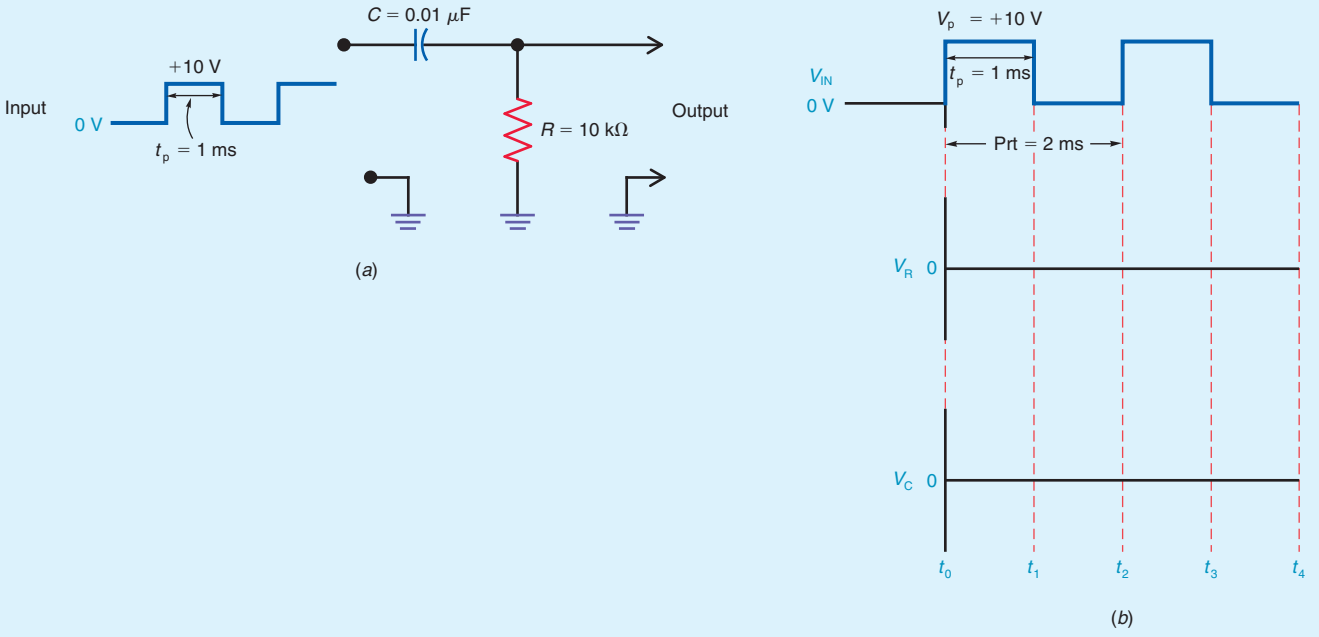
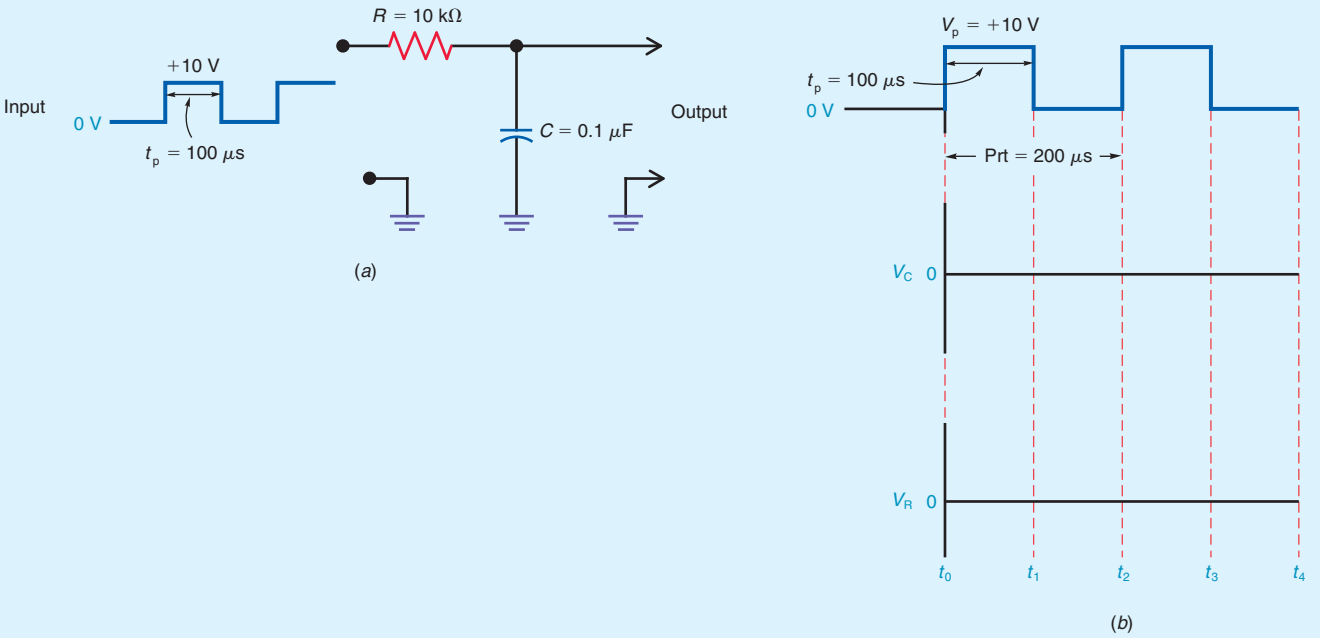


Figure 22–24



capabilities of your oscilloscope to measure the voltage across the resistor, *R*. Draw this waveform in Fig. 22–24*b* in the space allocated for V_R. Be certain that V_C and V_R are both drawn in proper time relation with respect to V_{in}. Include all voltage values for both the V_C and V_R waveforms.

Was the capacitor voltage waveform difficult to view with the channel 2 input coupling switch set to dc?_____
Was it nearly a straight line centered around +5 V?
_____ Move the channel 2 input coupling switch to ac. Reduce the channel 2 volts/div. setting until the capacitor voltage waveform is recognizable as a triangular wave.

Explain the displayed waveform. _____
_____

Using your DMM, measure and record the dc value of the applied voltage, V_{IN}.
$V_{IN(dc)}$ = _____
Next, measure and record the dc voltage across *R* and *C*.
$V_{C(dc)}$ = _____, $V_{R(dc)}$ = _____
What's significant about these voltage measurements? _____
_____
_____