

# California State University, Fresno

## Department of Electrical and Computer Engineering

### ECE 90L Principles of Electronic Circuits Laboratory

#### Experiment No. 8: Natural Response of $RC$ and $RL$ Circuits

### Objective

The objective of this laboratory is to study the natural response of simple  $RC$  and  $RL$  circuits.

### Prelab

1.) Derive the theoretical expressions for the voltage versus time in Parts 1, 2, and 3. Plot the results on graph paper. There should be five final expressions plotted, each on a separate page.

### Procedure

1.) Set-up the  $RC$  circuit shown in Figure 1 and adjust the power supply so that the capacitor voltage is 10 V. With  $R_C = 100\text{ k}\Omega$ , close the switch and observe, tabulate, and sketch the capacitor voltage waveform. Use the storage capabilities of the 2221A digital oscilloscopes to help you with your data collection. Repeat the experiment when  $R_C = 10\text{ k}\Omega$ .

**Note:** In all waveform sketches, label all scales and indicate all pertinent values.

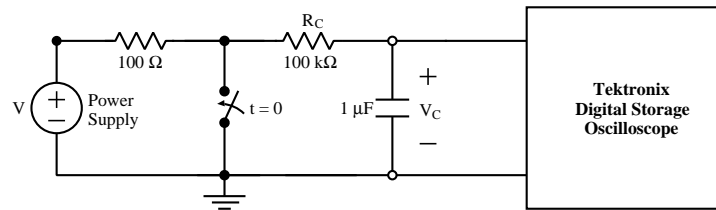


Figure 1:  $RC$  Circuit

2.) Measure the resistance of the inductor to be used in the circuit shown in Figure 2 before setting it up. Adjust the power supply so that 1 V appears across  $R_L$ . Close the switch and observe, tabulate, and sketch the waveform of the voltage across  $R_L$ . Repeat when  $R_L = 100\ \Omega$ . Why are you measuring the voltage across the resistor when you care about the current through the inductor?

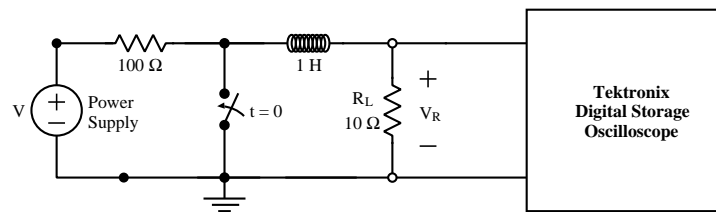


Figure 2:  $RL$  Circuit

3.) Connect the circuit shown in Figure 3 and adjust the power supply so that 14 V appears across the switch. Close the switch and observe, tabulate, and sketch the waveform of the voltage across the 60 kΩ resistor.

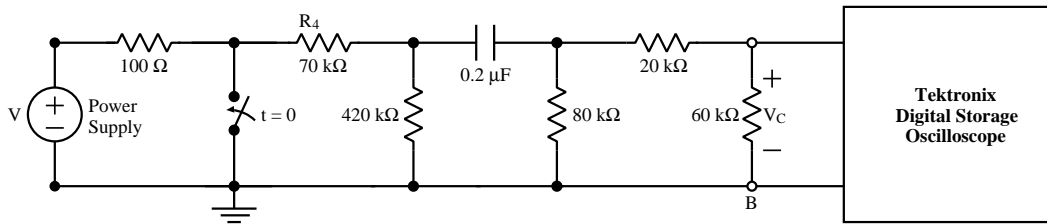


Figure 3: RC Ladder Circuit

4.) Connect the circuit shown in Figure 4. Measure and record actual resistor and capacitor values. With  $S_1$  closed and  $S_2$  open, adjust the power supply so that 10 V appear across  $C_1$ . Now open  $S_1$  and immediately close  $S_2$ . Observe, tabulate, and sketch the waveform of the voltage across  $C_2$ .

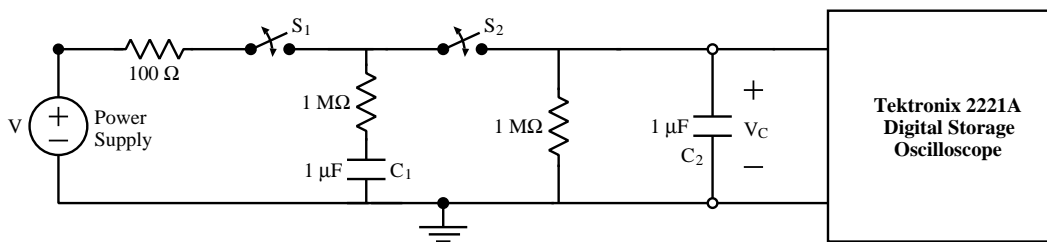


Figure 4: Multiple Time Constant RC Circuit

## Conclusion

What conclusions can you draw about the natural responses of RC and RL circuits? What differences (if any) did you observe between an RC circuit and an RL circuit? How does the time constant affect the circuit's operation, especially with regard to Part 4 of the Procedure?

## Group Report

- 1.) On the same paper that you used to graph your theoretical expressions in the Prelab, plot the empirical data obtained in Parts 1, 2, and 3. The graphs should show the voltage before, during, and after the transient. Compare and explain any differences between your theoretical and experimental results.
- 2.) Account for the shape of the waveform obtained in Part 4 of the procedure by explaining the physical behavior of the circuit.