California State University, Fresno
Department of Electrical and Computer Engineering

ECE 90L Principles of Electronic Circuits Laboratory

Experiment No. 9: Driven *RC* and *RL* Circuits

Objective

The objective of this laboratory is to study the responses when forcing functions of various types are applied to *RC* and *RL* circuits.

Prelab

1.) Draw a series *RC* circuit with a voltage supply, as shown in Figure 1. Calculate the voltage across the capacitor as a function of time assuming that $v_C(0)$ = 0 V, and the voltage supply is turned on at time $t = 0$ such that $V = -10$ u(t) V. Assume a resistance of 100 Ω and a capacitance of 0.1 μF for your circuit. Plot your results as a function of time for $-10\ \tau \leq t \leq 10\ \tau$.

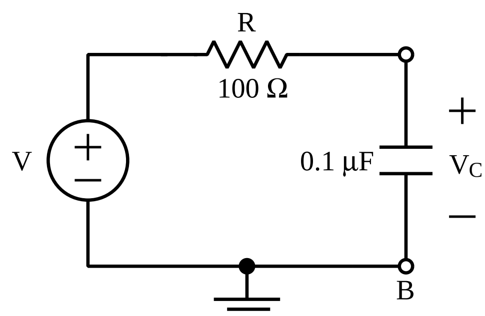

Figure 1: A Series RC Circuit

2.) Repeat your calculations when the forcing function is $V = 10\,$u(t) V. Plot your results between $-10\ \tau \leq t \leq 10\ \tau$.

Procedure

1.) Using the oscilloscope, adjust the function generator for a square wave output of 10 V_{pp} at 10 kHz with a 0 DC offset. Check the period of the waveform using the time base calibration of the oscilloscope. Measure the output resistance of the function generator.

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

2.) Obtain a decade capacitor and use it as the load for the circuit shown in Figure 2. Use capacitance values of 0.1 μF, 0.5 μF, and 1.0 μF, starting with 0.1 μF. Connect the circuit, using a resistance *R* equal to the output resistance of the function generator.

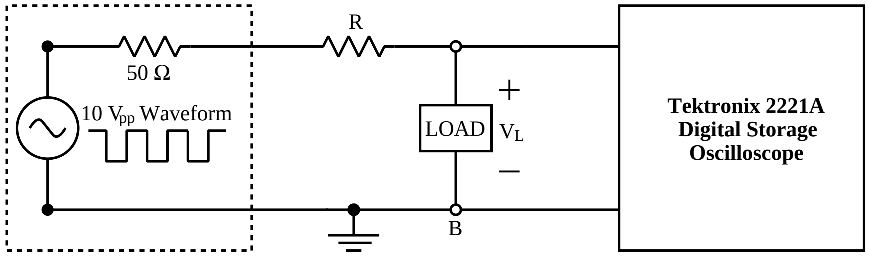

Figure 2: Generic Test Circuit

2.1 Observe, tabulate, and sketch the waveforms of the capacitor voltage for $C = 0.1$ μF. Show the waveforms for one complete cycle of the square wave and indicate values of voltage and time on your graph, as appropriate. Explain the behavior of the measured voltage qualitatively. Then switch the physical locations of the resistor and capacitor, so that the resistor becomes the new load. Observe, tabulate, and sketch the resistor voltage. Explain the behavior of the measured voltage.

2.2 For capacitance values of 0.5 μF and 1.0 μF, draw the capacitor waveform only. Explain the behavior of the circuit. Why are the results different compared to when you used the 0.1 μF capacitor?

3.) Repeat Part 2 with the 0.1 μF, 0.5 μF, and 1.0 μF capacitors replaced by 10 mH, 50 mH, and 100 mH inductors, respectively. Change the frequency of the function generator to 1 kHz before taking your measurements, and be sure to measure the resistances of the inductors. How does the resistance affect the time constant of the system?

4.) Set the function generator to a triangular waveform with a 10 kHz frequency. Using a 0.1 μF capacitor as the test element, observe and draw the capacitor voltage waveform. Repeat if a 10 mH inductor is used as the test element, with the frequency set to 1 kHz.

5.) Repeat Part 4 with the function generator set to a sinusoidal input.

Conclusion

What conclusions can you draw about the forced responses of *RC* and *RL* circuits? What differences (if any) did you observe between the RC circuit and an RL circuit? How does the time constant affect the circuit's operation, especially with regard to the frequency of the applied forcing function?

Group Report

1.) Theoretically determine and tabulate the six time constants corresponding to the various values of capacitance and inductance used in the circuit in Part 2 and 3 of the Procedure. Explain the behavior of each of the circuits, especially with respect to the frequency of the function generator.

2.) Graphically sum the voltage waveforms of Parts 2.1 and 3.1 of the Procedure to verify that Kirchhoff's Voltage Law is satisfied.

3.) For Parts 4 and 5 of the Procedure, account for the shape of the waveforms that were obtained.