California State University, Fresno
Department of Electrical and Computer Engineering

ECE 90L Principles of Electronic Circuits Laboratory

Experiment No. 12: Currents and Voltages in AC Circuits

Objective

The objective of this laboratory is to measure voltages in series and parallel AC circuits, and to calculate component values from such measurements.

Prelab

1.) Calculate the theoretical impedances of R, L, and C in Figure 1.

2.) Calculate the theoretical impedances of R, L, C_1, and C_2 in Figure 2.

Procedure

1.) Connect the circuit shown in Figure 2, omitting C_x. Set the function generator output to a 10 V_{pp} sinewave at 500 Hz. Using digital multi-meter (DMM), measure the input voltage, the input current, and the voltages across R, L, and C. Then, use the oscilloscope to measure the phase difference of the voltage between the function generator and R, L, and C. To do this, first measure the phase difference of the voltage between the capacitor C and the input at points V_B and V_A, respectively. Then swap the positions of the inductor and capacitor so that the voltages at V_B and V_A provide you with the voltage phase difference between the inductor and the input. Finally, repeat the process for the resistor. What is the phase of the current?

NOTE: *All measurements in this laboratory must be made using RMS values.*

Now add C_x to the circuit and measure the input voltage, the input current, and the voltages across R, L, and C using the DMM. Then use the oscilloscope to measure the phase difference of the voltage between the function generator and R, L, and C, using the same process as before. What is the phase of the current through the resistor and inductor? From this information, can you determine the phase of the current through each capacitor? How, and what is it?

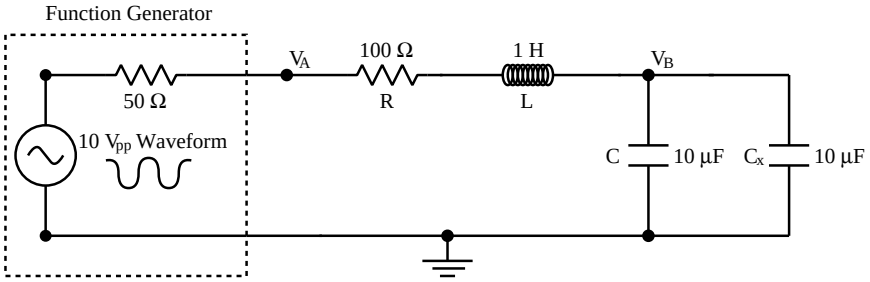

Figure 1: A Series RLC Circuit

2.) Connect the circuit shown in Figure 2, and set the function generator output to an 10 V_{pp} sinewave at 500 Hz. Measure the input voltage, the input current, and the currents through R, L, and C, and the voltage across each capacitor

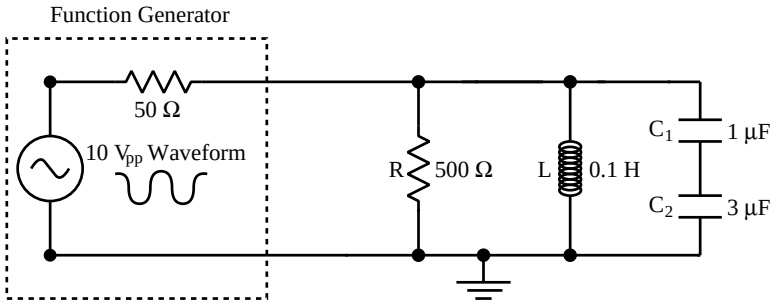

Figure 2: A Parallel RLC Circuit

using the DMM. Using the oscilloscope, measure the phase of the voltage across each of the elements. Is this what you expect? From this information, what is the phase of the current though the resistor? What about the phase of the current through the inductor and the capacitors? Can you figure out a way of measuring the phase of the current through the inductor and capacitors experimentally?

Conclusion

What conclusions can you draw about voltage, current, and phase measurements in AC circuits? Do the circuits behave as expected? If not, why?

Group Report

1.) From the data obtained in Part 1 of the Procedure:

(a) Use the measured values of voltage and current to calculate the impedances of R, L, C, C_x, and the parallel combination of C and C_x.

(b) Calculate the exact value of C and compare this value with the marked value.

(c) Calculate the value of C_x using the impedance of the parallel combination of C and C_x and the calculated value of C. Compare this value with the value calculated directly from the impedance of C_x.

(d) Using complex notation ($R(\omega) + jX(\omega)$), show that the measured branch voltages and the source voltage satisfy KVL.

2.) From the data obtained in Part 2 of the Procedure:

(a) Use the measured values of voltage and current to calculate the impedances of R, L, C_1, and C_2, and the series combination of C_1 and C_2. Compare these values of impedance with the values obtained using the given element values and frequency.

(b) Using complex notation ($R(\omega) + jX(\omega)$), show that the measured branch currents and the input current satisfy KCL.