California State University, Fresno
Department of Electrical and Computer Engineering

ECE 90L Principles of Electronic Circuits Laboratory

Experiment No. 11: Phase Measurements in AC Circuits

Objective

The objective of this laboratory is to observe the phase difference between two sinusoidal voltages, and to study the effect of the variation of element values on phase.

Prelab

1.) Review the Laboratory 1 portion of the Procedure that discusses the difference between the **ADD ALT CHOP** modes when displaying multiple traces. Explain why only the **CHOP** mode is valid when displaying Channels 1 and 2 simultaneously to measure the phase difference between two sinusoids.

2.) Explain how the phase difference between two sinusoids can be measured using the oscilloscope. Provide/draw oscilloscope "diagrams" to help you explain your procedure.

Procedure

1.) Connect the circuit shown in Figure 1 and adjust the function generator to provide a 10 V_{pp} sinewave at 5 kHz. Vary the capacitance from 0.001 μF to 0.010 μF in steps of 0.001 μF and record the phase difference between V_B and V_A (i.e., the phase of V_B - the phase of V_A) for each value of the capacitance. Observe both voltage waveforms on the oscilloscope as C is varied.

NOTE: Please remember that the only valid mode for measuring the phase difference between two waveforms when displaying waveforms on Channel 1 and 2 simultaneously is through the **CHOP** mode. Refer back to Laboratory 1 (*The Tektronix 2221A Digital Oscilloscope*) to review the fundamental reasons for this. Explain.

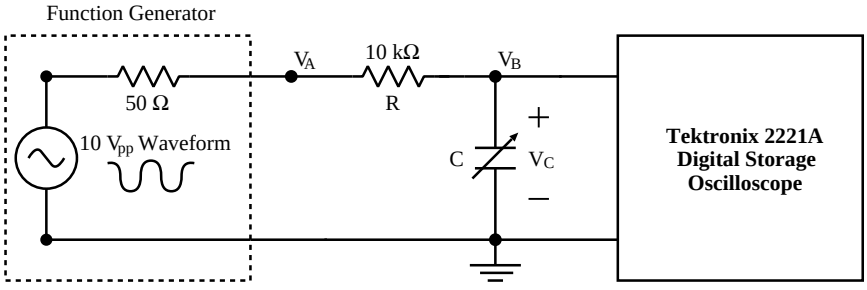

Figure 1: A Series RC Circuit

2.) For the circuit shown in Figure 2, observe and record the phase difference between V_B and V_A as the inductance is varied between 0.1 H to 1 H using steps of 0.1 H.

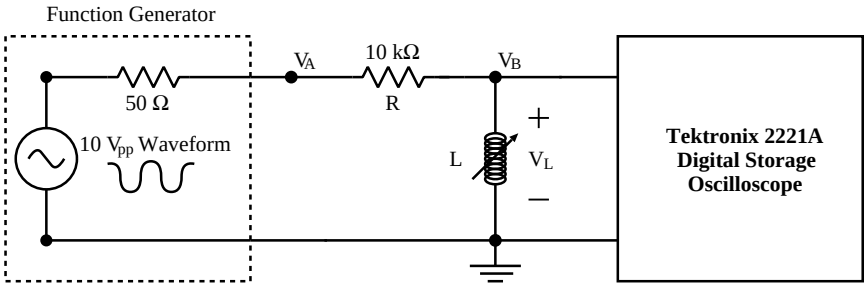

Figure 2: A Series RL Circuit

3.) For the circuit shown in Figure 3, observe and record the phase difference between V_B and V_A as the capacitance is varied from 0.001 μF to 0.010 μF in steps of 0.001 μF.

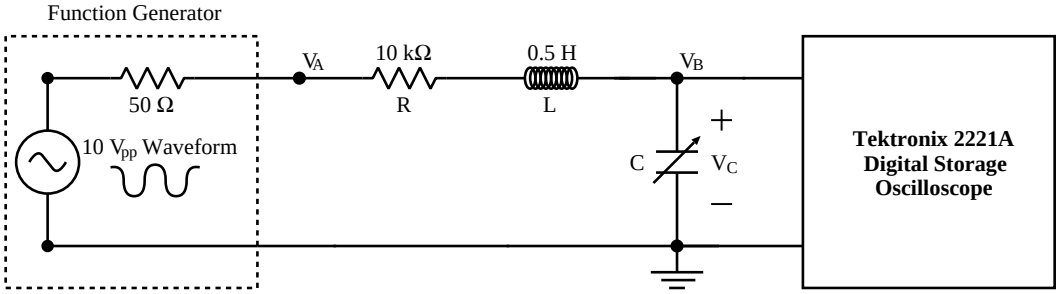

Figure 3: A Series RLC Circuit

4.) Using the circuit in Part 3 of the Procedure, let the capacitance be 0.005 μF, and observe and record the phase difference between V_B and V_A as the frequency is varied from 1 kHz to 10 kHz in steps of 1 kHz.

Conclusion

What conclusions can you draw about phase measurements in RC, RL, and RLC circuits? How does the phase change as a function of the capacitance and inductance, and why? What is the best technique for experimentally measuring the phase difference between two sinusoids when using an oscilloscope?

Group Report

1.) Plot on one graph the data obtained in Parts 1 and 2 of the Procedure. Use phase as the abscissa (y-axis) and the element value as the ordinate (x-axis). Comment on the curves obtained. In particular, what can be said about the values of phase that will result if the element values are made very small or very large? Why?

2.) Plot on one graph the data obtained in Parts 3 and 4 of the Procedure. Use phase as the abscissa (y-axis) and the element value and frequency as the ordinate (x-axis). Comment on the curves obtained. What value would the phase difference approach if the frequency of the wave was made very small? What value would the phase difference approach if the frequency was made vary large? Why?