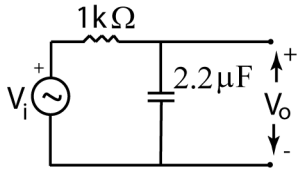
Physics 242 – Electronics

Experiment 2 – Complex Impedance

Introduction

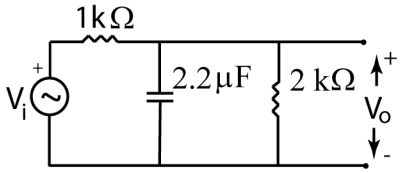
We have seen in class that capacitors and inductors can be handled in steady-state sinusoidal circuit analysis in a manner exactly analogous to ordinary resistance, if the concept of resistance is generalized to allow complex numbers. In this experiment we will test the relations describing the impedance of capacitors and inductors and the applicability of series-parallel methods for combining them.

Procedure and Questions

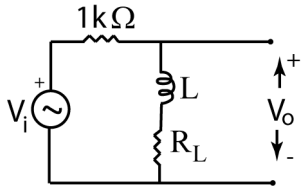


1. Construct the circuit shown above, using a nominally 1 kΩ resistor and 2.2 μF capacitor. Measure your component values first, using the LCR meter to measure the capacitance. Adjust the amplitude of your function generator to 1.0 V peak-to-peak while observing V_i with the oscilloscope. Adjust the frequency to 200 Hz. Measure both V_i and V_o carefully with the 'scope. Calculate the expected value of V_o using circuit theory and the measured values of the components. Remember that $\omega = 2\pi f$, where ω is the angular frequency in rad/s and f is the frequency in Hz.

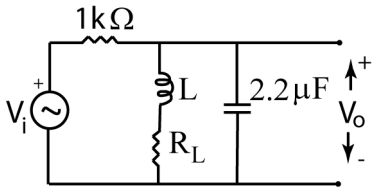
Compare the calculated (show all steps in your calculation) and measured voltage values. Find the percent difference. Is your experimental result consistent with the complex impedance theory?



2. Measure the resistance of a nominally 2 kΩ resistor and connect it across your capacitor as shown above. Then measure both V_i and V_o carefully with the 'scope, and answer the same question as before.



3. Measure the inductance of the nominally 2.6 H inductor with the LCR meter. Note that the meter also displays the series resistance of the inductor at the top of the display—also record this value. Then build the circuit shown above. Note that the resistance R_L represents the inductor's intrinsic series resistance that you measured with the LCR meter (so it is not another component to be added to the circuit; it is automatically included in the inductor.) Then measure both V_i and V_o carefully with the 'scope, and answer the same question as before.



4. Construct the circuit shown above, using the same capacitor you used before. As before, resistance R_L represents the inductor's intrinsic series resistance that you measured with the LCR meter. Then measure both V_i and V_o carefully with the 'scope, and answer the same question as before.