Polarization Rotation AC PreLab
Rochester Institute of Technology

PHYS-316 Advanced Lab*

January 11, 2022

Review of RLC resonant circuits

Operating the copper coil apparatus in AC poses a problem, since the magnet must be driven with an AC current to produce an AC field. The solenoid has a considerable inductance, since it is a big coil. Any inductor "opposes change" in current. In the popular electronics world, small inductors are often called "chokes", since they "choke off" changes in current! This is not good if you are trying to put an AC current into a system.

1. The solenoid used in this experiment has a nominal inductance of 6 mH and a nominal resistance of approximately 2.5 Ω. It has a 2-Ω resistor in series with it.
   (a) What is the complex impedance of an inductor?
   (b) If you were to try to run this as simply a 6 mH inductance and a 4.5 Ω total resistance in series, what amplitude voltage (zero-to-peak) would be needed in order to put a current of amplitude 1 A (zero to peak) through the system, if you were to try to run at a frequency of 1 kHz? At 50 kHz?
2. In order to get an appreciable current at a reasonable frequency, it is best to build a series RLC circuit (commonly called a "tank circuit"). For this lab, a 1.0-μF capacitor is used in series with the inductor and the resistance (both the external resistance and the nominal resistance of the solenoid coil).
   (a) Look up the resonant frequency of a series RLC circuit. Compute it for the parameters given above. Compare to the resonance frequency for a zero-resistance perfect oscillator, the LC circuit. How much does the resistance affect the resonance frequency?
   (b) Cite your sources for the above review information.
3. The nominal inductance of the solenoid was given in the manufacturer's manual to be 6 mH.
   (a) Review the other specs for the solenoid in the DC PreLab.
   (b) Use Google to find an inductance calculator for a solenoid. Using the specs provided, what inductance do you calculate for this coil? Note, you may have to approximate an average coil radius or something depending on the calculator you

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find. If it is a calculator that asks for the permeabilitiy of the core, just use 1.0 for the relative permeability of air.

(c) What website did you consult?

(d) Is your calculated number even close to the value reported by the manufacturer; how do they compare? Note that the spec sheet probably measured the actual inductance rather than relying on a calculated approximation, and that inductance calculations are notorious for being off.