Reactance of a Coil

A magnetic coil in an ac circuit acts like a frequency-dependent resistance. Additionally, it produces a phase shift between the voltage and the current.

Goal: You make yourself familiar with the oscilloscope and the frequency generator, two devices which are widely used in labs.

Devices:

- Frequency generator
- LCD oscilloscope
- Coils and resistors

Measurements:

A Make a note of the values printed on the coil (number of turns, inductance) and the dimensions of the coil (length, diameter).

B Measure the resistance of a 1 kΩ resistor with a multimeter.

C Connect the resistor and the coil in series to the frequency generator. Attach channel 1 of the oscilloscope to the voltage across the coil and channel 2 to the voltage across the resistor. Make sure that the common potential is connected to the oscilloscope's ground connector (black).

Set the frequency generator to a sine wave with a frequency of some 10 kHz. Adjust the settings such that there are at least two periods of the voltage signal with reasonable amplitude on the screen.

D Use the oscilloscope to measure the two voltage signals' frequencies and peak to peak values and record them in a data table.

Repeat the measurement for a total of ten frequencies between 10 kHz and 50 kHz.

E Connect channel 1 directly to the output voltage of the frequency generator (channel 2 as before). Adjust the frequency such that there is a visible time shift between the two signals on the screen. Read off the signals' frequency and amplitudes and measure the magnitude of the time shift between them.

Interpretation:

1. Graph the ratio of the peak to peak voltages (channel 1 to channel 2) vs. the corresponding frequency.
2. Fit a linear regression to your data and, using its slope, find the coil's inductance. Compare the result to the value printed on the coil.
3. Calculate the inductance from the dimensions of the coil and compare this result to the one of step 2.
4. Calculate the impedance and the phase shift for the values of measurement E using the formula for a series circuit and compare the results to the measured values.

Requirements: For a short report, work at least on steps 1 and 2 of the interpretation. The complete interpretation is required for a full report.

Hand in your report and the lab notes by Tuesday, 10 May 2011.