UNIVERSIDADE da MADEIRA

Experimental Science
P10: Free RLC circuit oscillations.

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1. Purpose

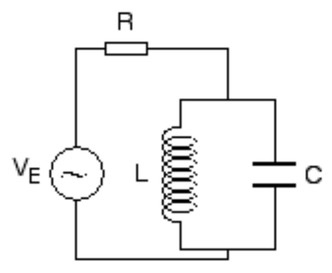
- Experimental verification of a power dependency between two physical quantities.
- Experimental verification of an exponential dependency between two physical quantities.
- Perform numerical evaluations.

2. Introduction

An *RLC* circuit is composed of a resistor *R*, a capacitor *C* and an inductor *L*. The inductor is a component that is able to transform electric potential energy into magnetic potential energy and vice-versa.

The physical characteristics of an inductor are quantified into one parameter, the *inductance L*. The inductance SI unit is the henry (H).

This is the circuit we will be studying:



V_E is the voltage produced by the signal generator and applied to the circuit.

To better understand this activity we will resort to an analogy. A swing is a mechanical system similar to an RLC circuit. On a swing it is easy to observe the periodic conversion of gravitational potential energy into kinetic energy. There is a similar process occurring in an RLC circuit: the periodic conversion of electric potential energy stored in an electric field in a capacitor into energy stored in a magnetic field in an inductor. After the initial oscillation of the swing, the oscillations amplitude decreases until it comes to a complete halt. As in the swing, the RLC circuit oscillation's amplitude decreases as time goes by.

On this lab activity we'll study damped RLC circuit oscillations. The initial circuit kickoff is provided by the application of a square signal. Then damped output oscillations are measured at the *LC* parallel terminals. We will observe that this output signal decreases exponentially over time.

It is possible to demonstrate that the output signal period T depends solely on L and C:

$$T = 2\pi\sqrt{LC}$$

3. Previous questions

This activity involves the use of 11 capacitors. Determine the RLC circuit output signal period obtained for each one (use the capacitors and inductor nominal values).

4. Experimental activity

4.1 Material

1 oscilloscope, 1 signal generator, 1 multimeter, 11 capacitors (10 nF, 22 nF, 47 nF, 68 nF, 100 nF, 150 nF, 330 nF, 470 nF, 680 nF, 1 μF and 1.5 μF), 1 resistor (10 kΩ), 1 inductor (100 mH), connection wires, crocodile connectors, breadboard.

4.2 Additional information

Don't forget that all measurements have an associated experimental error and that a measurement without an experimental error estimate is useless. If you have enough time, please repeat the measurements (repetition improves our error estimate).

4.3 Procedure

4.3.1 Oscillations frequency

1. Assemble the figure's RLC circuit. Before you close the circuit ask the teacher to confirm the connections.
2. This study involves the use of several capacitors. Organize your circuit so it is easy to replace them.
3. Measure the components physical parameters (resistance, capacity) with the multimeter. Add an extra column to the table to write the capacitor codes.
4. If possible measure also the inductor inductance (ask the teacher).
5. Connect the two oscilloscope probes to the circuit so you can measure the input (channel A – signal generator) and output (canal B – capacitor terminals) signals. To ensure a greater signal stability of the measured signal set the oscilloscope trigger source to the input signal.
6. Use to oscilloscope to set the signal generator to a square signal with a peak to peak voltage of 10 V and a 50 Hz frequency.
7. For each capacitor use the oscilloscope to measure the damped oscillation period (measure the time between two consecutive peaks) and record it into a table. Always use the most sensitive scale.

If you have enough time, please repeat the previous measurements.

4.3.2 Oscillations amplitude

Place a 100 nF capacitor into the circuit. Measure the amplitude for each of the damped signal peaks along with the corresponding time (multiple of half the measured period). Record your measurements into a table with the following headline:

A (V)	t (s)

If you have enough time, please repeat the previous measurements.