

Programa de Doctorado en Diseño, Fabricación y Gestión de Proyectos Industriales

Study of the RC, RL and RLC Series Circuits by using a Smartphone as a Signal Generator

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The smartphone sensors offer good opportunities for physics teaching laboratories within introductory and first-year university courses [1-8]. The published work covers a wide range of topics such as linear and circular motions, oscillations, hydrostatics, waves, acoustics, optics, and magnetism. However, not much has been published in relation to the use of smartphones sensors to study the basic electric circuits commonly included in general physics courses for engineering [9-12].

In this work, we will use the smartphone as a variable voltage generator to the study RC, RL and RLC series circuits (see RC circuit in figure 1) in first-year physics courses for engineering. For this purpose, the tone generator function within the free Android "Physics Toolbox Suite" app. has been used. Simultaneously, the sound oscilloscope included in the same app. has been used to visualise the voltage signals at the different components.

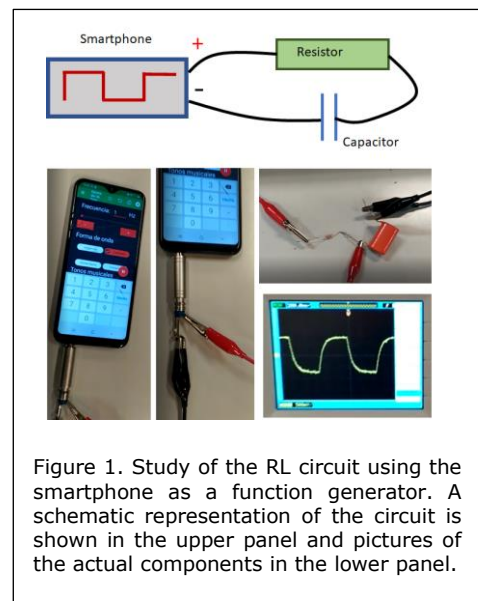


Figure 1. Study of the RL circuit using the smartphone as a function generator. A schematic representation of the circuit is shown in the upper panel and pictures of the actual components in the lower panel.

- [1] P. Vogt and J. Kuhn, "Experiments using cell phones in physics classroom education: The computer-aided g determination," *Phys. Teach.* 49, 383–384 (Sept. 2011).
- [2] P. Vogt and J. Kuhn, "Analyzing simple pendulum phenomena with a smartphone acceleration sensor," *Phys. Teach.* 50, 439–440 (Oct. 2012).
- [3] J. C. Castro-Palacio, L. Velázquez-Abad, M. H. Gimenez, and J. A. Monsoriu, "Using a mobile phone acceleration sensor in physics experiments on free and damped harmonic oscillations," *Am J Phys* 81, 472–475 (2013).
- [4] J. C. Castro-Palacio, L. Velázquez-Abad, F. Gimenez, and J. A. Monsoriu, "A quantitative analysis of coupled oscillations using mobile accelerometer sensors," *Eur J Phys* 10, 737–744 (2013).
- [5] J.C. Castro-Palacio, L. Velázquez-Abad, J.A. Gómez-Tejedor, F.J. Manjón y J.A. Monsoriu, "Using a smartphone acceleration sensor to study uniform and uniformly accelerated circular motions," *Revista Brasileira de Ensino de Física* 36 (2), 2315 (2014).
- [6] M. H. Giménez, J. C. Castro-Palacio, and J. A. Monsoriu, "Direct visualization of mechanical beats by means of an oscillating smartphone," *The Physics Teacher* 55 (2017) 424.
- [7] S. O. Parolin and G. Pezzi, "Smartphone-aided measurements of the speed of sound in different gaseous mixtures," *Phys. Teach.* 51, 508–509 (Nov. 2013).
- [8] I. Salinas, M. H. Giménez, J. A. Monsoriu, and J. C. Castro-Palacio, "Characterization of linear light sources with the smartphone's ambient light sensor," *Phys. Teach.* 56, 562 (2018).
- [9] K. Forinash, "Smartphones as portable oscilloscopes for physics labs," *The Physics Teacher* 50, 242 (2012).
- [10] J. R. Groff, "Estimating RC Time Constants Using Sound," *Phys. Teach.* 57, 393 (2019).
- [11] S. R. Pathare, M. K. Raghavendra, and S. Huli, "Low-Cost Alternative for Signal Generators in the Physics Laboratory," *Phys. Teach.* 55, 301 (2017).
- [12] K. Forinash, "Smartphones—Experiments with an External Thermistor Circuit," *Phys. Teach.* 50, 566 (2012).