**Research Paper**　　　　　　　　　　　　　　**Physics**

# Simulation of Series RLC Circuit Using Matlab Computer Program: Study Effect of Variable Component on Frequency Response

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**ABSTRACT**

Simulation developed in computer for physics education provides a broader, more balanced, and more flexible education than a traditional physics major. Author developed RLC series waveform simulation using computer program MATLAB. Simulation developed to understand the effect of variable component in the series RLC circuit on the frequency response. In the simulation students just enter the variable element R(Resistor) or L(Inductor) or C(Capacitor) in the given format, and can find the two different frequency response in the single figure. Effect of L, C and R, can be separately analyzed by students from the generated frequency response.

**KEYWORDS**　　　　MATLAB, Series RLC Circuit, Frequency Response, Phasor Voltage

## INTRODUCTION

Simulations and Multimedia have already been much explored, in some cases achieving visible success for learning (namely some simulations with a game look) but also knowing some in success (Multimedia did not correspond to the hype). Telematics, Virtual Reality and Computers-Based Laboratories seem to be the more promising fields[1]. Computer simulations are applications of special interest in physics teaching because they can support powerful modeling environments involving physics concepts and processes[2]. A prototypical virtual physics laboratory has been constructed that allows students to control the laboratory environment as well as the physical properties of objects in that laboratory[3]. The simulated physics experiments highly realistic with high designability and operability, obtaining impressive virtual effects and greatly improving the experiment teaching[4]. Jong-Heon Kim present a computer-based virtual reality simulation that helps students to learn physics concepts such as wave propagation, ray optics, relative velocity, electric machines, etc. at the level of high school or college physics[5]. Computational physics provides a broader, more balanced, and more flexible education than a traditional physics major. Moreover, presenting physics within a scientific problem-solving paradigm is a more effective and efficient way to teach physics than the traditional approach[6]. Escalada Lawrence, describes and evaluates five activities developed for the physics classroom with the use of computer technology such as space, time, frames of reference, and momentum[7]. Bayrak Celal, during his study revealed that the experimental group which had the instruction through the computer simulation was more successful than the control group who had face-to-face instruction.

## MATLAB

MATLAB provides a range of numerical computation methods for analyzing data, developing algorithms, and creating models. The MATLAB language includes mathematical functions that support common engineering and science operations. Core math functions use processor-optimized libraries to provide fast execution of vector and matrix calculations. MATLAB provides tools to acquire, analyze, and visualize data, enabling you to gain insight into your data in a fraction of the time it would take using spreadsheets or traditional programming languages. You can also document and share your results through plots and reports or as published MATLAB code. MATLAB provides a high-level language and development tools that let you quickly develop and analyze algorithms and applications

MATLAB includes a variety of tools (Table 1) for efficient algorithm development, including:

**Table – 1 MATLAB tools for develop simulation**

| | |
| --- | --- |
| Command Window | Lets you interactively enter data, execute commands and programs, and display results |
| MATLAB Editor | Provides editing and debugging features, such as setting breakpoints and stepping through individual lines of code |
| Code Analyzer | Automatically checks code for problems and recommends modifications to maximize performance and maintainability |
| MATLAB Profiler | Measures performance of MATLAB programs and identifies areas of code to modify for improvement |

With the MATLAB language, you can write programs and develop algorithms faster than with traditional languages because you do not need to perform low-level administrative tasks such as declaring variables, specifying data types, and allocating memory. In many cases, the support for vector and matrix operations eliminates the need for for-loops. As a result, one line of MATLAB code can often replace several lines of C or C++ code.

## SERIES RLC CIRCUIT

In a series RLC circuit containing a resistor, an inductor and a capacitor as shown in figure 1. The source voltage $V_s$ is the phasor sum made up of three components, $V_R$, $V_L$ and $V_C$ with the current common to all three. Since the current is common to all three components it is used as the horizontal reference when constructing a voltage triangle. Voltage triangle for a series RLC circuit is given is as under.
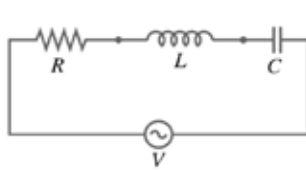
$$V_S{}^2 = V_R{}^2 + (V_L - V_C)^2$$

$$V_S = \sqrt{V_R{}^2 + (V_L - V_C)^2}$$

$$V_R = i \ R$$

$$V_L = i \ jwL$$

$$V_R = i \ \frac{1}{jwC}$$

**Figure – 1 Series RLC circuit**

### SERIES RLC ANALYSIS IN MATLAB

The purpose of this MATLAB example is to explore the effects of varying the resistance, Inductance and Capacitance value in the series RLC circuit as explained in figure 2.
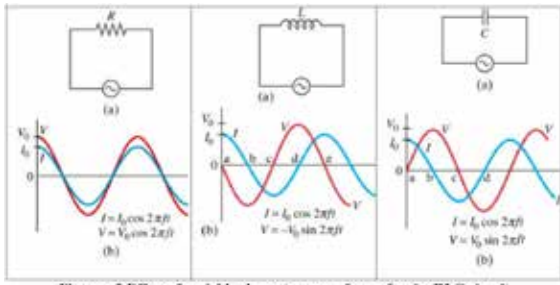


**Figure – 2 Effect of variable element on waveform of series RLC circuit**

The program designed in MATLAB help students to understand effect of variable element (R or L or C) in the circuit. The program window is indicated in figure 3.



**Figure – 3 MATLAB program Editor Window**



**Figure – 4 Analyzed frequency response obtained from MATLAB program**

After debugging program, following statement found in the command window and students just enter the variable components in form of 'R or L or C'

**Statement:**
Enter the variable component in Series RLC circuit TYPE R or L or C; Variable =

Students can analyze effect of variable components in a single debug, entering Variable = R, Variable = L and Variable = C in the same program and found concern frequency response as illustrated in figure 4.
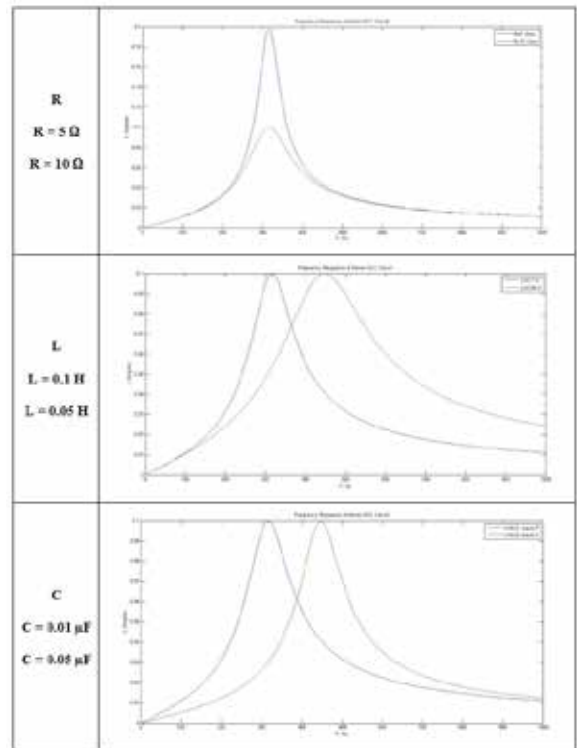
## REFERENCES

1. Carlos, F., & Jorge, A. (1998). Trindade, Use of Computers in Physics Education, Proceedings of the "Euroconference'98 - New Technologies for Higher Education", Aveiro, Setembro. 2. Athanassios, J., & Vassilis, K. (2001). Computer simulations in physics teaching and learning: a case study on students' understanding of trajectory motion, Computers & Education, 36(2), 183–204. 3. Bowen, L. R., Engleberg, M., & Benedetti, R. (1993). Applying virtual reality in education: A prototypical virtual physics laboratory, Virtual Reality, Proceedings., IEEE Symposium on Research Frontiers, San Jose, CA, USA, 67 – 74. 4. TAN, S., HUO, J., & WANG, X. (2005). Application of Computer Virtual Technology to the College Physics Experiment Simulation System, Journal of University of Science and Technology of China, 3. 5. Jong-Heon, K., Sang-Tae, P., Heebok, L., Keun-Cheol, Y., & Heeman, L. (2001). Virtual Reality Simulations in Physics Education, IMEJ of Computer-Enhanced Learning, 3. 6. Rubin, L. (2006). Computational Physics: A Better Model for Physics Education?, Comput. Sci. Eng. 8, 22. 7. Escalada, L. T. (1996). Applications of Interactive Digital Video in a Physics Classroom, Journal of Educational Multimedia and Hypermedia, 5(1), 73-97. 8. Bayrak, C. (2008). Effects of Computer Simulations Programs on University Students' Achievements in Physics, Turkish Online Journal of Distance Education, 9(4), 53-62.