



ADVANTAGES OF CONDUCTING PHYSICS EXPERIMENTS THROUGH DIGITAL LEARNING TOOLS

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ABSTRACT

This article presents the advantages of digital learning tools in organizing independent study in physics and provides algorithms for virtually organizing and conducting selected experiments from the electromagnetism section of physics using electronic resources.

KEYWORDS: Independent study, experiment, technology, electromagnetic oscillations, alternating current, oscillatory circuit, resonance frequency, voltage, accuracy.

INTRODUCTION

Increasing learners' interest in acquiring knowledge within the education system, enabling them to apply theoretical knowledge in practice, and developing their creative abilities are among today's urgent tasks. In guaranteeing the effectiveness of applying scientific and technological achievements to production, it is important that learners can properly organize and carry out physics experiments and analyze the results. In independent study, there are a number of advantages and factors to using electronic programs for organizing physics experiments; some of them are listed below.

Advantages: high levels of safety and cost-effectiveness when conducting experiments. That is, when using radioactive materials or alternating electric current, it is possible to conduct experiments that might be dangerous in real conditions in a safe way. In addition, the costs of expensive experimental devices and their technical maintenance are significantly reduced;

- the experimenter can repeat experiments an unlimited number of times, which makes it possible to understand physical laws and regularities more thoroughly and helps reduce measurement errors;
- physical phenomena and processes can be displayed at a highly visual level—even when they are otherwise invisible. This deepens the study of theoretical concepts;
- the learner can easily change experimental quantities across a wide range, which makes it possible to analyze what happens under different conditions;
- in distance learning, students can independently carry out experiments anytime and anywhere (with an internet connection). This is ideal for distance and hybrid learning;
- when performing and analyzing experimental work, students have opportunities to collaborate, share data, and conduct joint analysis.
- Disadvantages: students' lack of skills in using computer technology;
- lack of an experimental method or an improperly designed one;
- illogical or unclear sequencing of experimental steps;
- the student spending more time at the computer than prescribed;

- incomplete understanding of measurement techniques and of the computational apparatus.

Factors:

- the accuracy of the simulation, the convenience of the interface, and the compliance of the software with physical laws and regularities;
- integration of the virtual experiment into the curriculum. Active participation and analysis should be required;
- the program's ability to provide the learner with immediate and precise feedback on results, errors, and analyses;
- the development of observation and analysis of experimental results, as well as work on errors in measuring physical quantities.

These advantages help significantly improve the quality of education when virtual laboratories are used alongside traditional laboratories.

Based on the analyses mentioned above, the following can be acknowledged. The difference between non-traditional sessions and traditional ones is that non-traditional sessions create an atmosphere of freedom for learners and allow them to express their opinions openly. Organizing and conducting physics experiments in an independent-study format is certainly effective when the instruments and devices used in the experiments are of sufficient quality. Moreover, teaching physics experiments with the help of non-traditional instructional technologies is one of the advanced pedagogical approaches for further improving learning outcomes. Taking the above into account, below we present an algorithm for virtually performing several experimental tasks on electromagnetic oscillations in physics using computer-based teaching technology.

Experiment. Methodology for determining the resonance voltage in a circuit

Purpose:

1. To study the resonance phenomenon in an alternating-current circuit composed of series-connected R, L, and C elements.
2. To learn to determine the resonant angular frequency of the oscillatory circuit ($\omega_{(res)}$), the resonance voltage in the circuit ($U_{m,(res)}$), the quality factor, and the active resistance.

Required apparatus: An electronic software tool designed for virtual execution of the laboratory work, with the necessary auxiliary functions.

Familiarize yourself with the theoretical information on determining the resonance voltage in the circuit. Obtain the instructor's permission to carry out the measurements. The algorithm and methodology for performing the measurements are as follows:

Step 1. In the dialog window, activate the model titled "Determining the resonance voltage in a circuit" (Fig. 1).

Step 2. From the instruments/equipment box, use a voltmeter, rheostat, capacitor, and coil to assemble the electrical circuit.

1. Assemble the electrical circuit for the task.
2. Set the signal generator's output voltage to 8 V or a similar value.
3. Do not connect the resistor R into the circuit.
4. Enter into the appropriate table the readings for the capacitor capacitance C, the coil voltage U_L , the circuit current I, and the circuit's natural angular frequency ω .



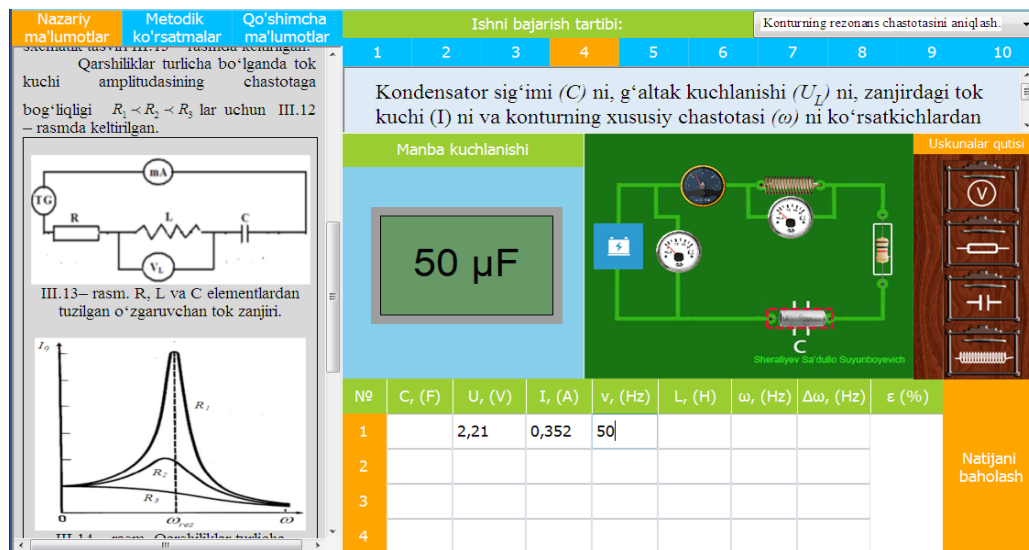


Figure 1. Determining the resonant frequency and voltage of the circuit.

- From determine the coil's inductance L and enter it in the table.
- Based on the measurement results, compute the voltage at resonance using the formula evaluate and record the conclusion.
- After the automatic calculations, analyze and conclude on the absolute and relative errors of the experiment.

Computer-based teaching technology is implemented mainly through electronic learning resources, and its features are as follows:

- it is oriented toward developing students' independent thinking and creative abilities;
- the instructor participates in the learning process as a consultant;
- active integration of information tools and resources in the teaching process is ensured;
- learning motivation is increased;
- the intensity and effectiveness of instruction are enhanced;
- students' skills in independent work and research are formed.

In any teaching process, assessing learners' knowledge is an important task. Since this technology is primarily aimed at independent learning, it is advisable that in the process of evaluating students' knowledge, not only the results of the experiments but also the students' creative activity and ability to work independently be taken into account.

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