METHODS OF ORGANIZING PRACTICAL CLASSES AND LABORATORY WORKS IN PHYSICS WITH THE HELP OF MULTISIM SOFTWARE

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Annotation: This article discusses the advantages of conducting Practical lessons and Laboratory works virtually in Physics classes, and the ways to perform practical laboratory work using the Multisim software.

Keywords: STEAM education, virtual method, software, laboratory work, an electrical circuit.

Reforms in the Republic, as in all areas, set before us a number of urgent tasks that need to be implemented in the education sector in order to raise the quality of education to world standards.

Such tasks include the introducing the advanced foreign experiences in the education sector, using the modern pedagogical techniques and innovative teaching methods during the classes, creating a new generation of educational and methodological literature, conducting fundamental and applied scientific researches, the development of new state educational standards and curriculum, as well as gradual introduction of STEAM (science, technology, engineering, arts, and mathematics) educational methods.

One of the methods of execution above tasks in the teaching of physics is to effectively organize laboratory works. Laboratory works create an opportunity for learners to comprehend the theoretical knowledge taught during the lessons. This leads to the development of students' skills to apply their knowledge in practice.

However, there are limited opportunities to conduct full-scale laboratory experiments in physics due to the lack of equipment for laboratory work, life-threatening nature of laboratories, long duration of the performance, the complexity of mathematical calculation of results and etc.

Virtual laboratory works are the best solution for the barriers written above. Virtual laboratories are modern teaching aids that are cheaper and completely safer than the experiments with real elements, tools, and equipment.

Virtual laboratories give an opportunity for learners:

– to study complex physical phenomena in an understandable way;

– to conduct an experiment, even if the experiment is almost impossible or difficult (e.g., studying the motions of cosmic bodies, studying the motion of objects at high pressure, studying the microscopic objects, studying how a nuclear reactor works and etc.)

– to pause and to continue the experiment in order to analyze the interim results and possible changes around it;

– to study the phenomena in dynamics (e.g., observation of the motion of objects in space and time);

– to perform an action that is impossible in a full-scale experiment - to change the Spatio-temporal dimensions of the phenomenon;

– to ensure the necessary conditions for the experiment and the parameters of the system of objects under study, regardless of its condition, as well as the safety of the experimental tuning elements;

– to accompany in a model experiment with a visual interpretation of the constant relationships between the system parameters being studied (in the form of dynamic graphs, diagrams, etc.);

– to study the phenomenon in a "pure" form, to accurately reflect the conditions necessary for its occurrence;

– to draw students 'attention to the main point of the event being studied due to the multimedia effect and thus contribute to a deeper understanding of its essence.

When using interactivity as a function of a new learning environment, new advantages are added to the previously mentioned advantages of virtual experimentation:

– to ensure an active approach to education aimed at developing the main components of the educational process of schoolchildren;

– to fulfill the motivational need of schoolchildren (especially reading motivation) and to help them to improve their ability to plan, to execute and to control their own actions;

– to develop the independence of cognitive activity, which determines the success of students in the implementation of educational activities;

– to create conditions for the students' creative activity.

One of the software allows us to conduct virtual laboratory lessons in physics is Multisim software created by National Instruments (NI) company. The presence of modern tools in the software allows you to design and conduct experiments on electronic devices, ranging from simple to very complex. This tool is ideal for teaching because it has the ability to remove any restrictions on elements and tools. In addition, the NI Multisim software can act as a trainer for principles of operation of real electronic and measuring instruments and schemes [3,4].

NI Multisim software is distinguished by its software modeling, efficient results, and convenience. It is possible to create, model, and study analog and digital radio electronic devices of any complexity with the help of the software. However, in order to get accurate results, the user must have mastered the rules and methods of working with the software and have the skills to apply them to study and research the processes in electronic circuits.

The software can be used to demonstrate the experiments in laboratory classes on topics related to the "Electronics" chapter of physics [5]. As an example, let's give a demonstration of the process of using the NI

Multisim software to cover the topic of "Electrical Circuits and Connections in the Home" included in the 8th-grade physics curriculum. It is considered to be a life-threatening experiment. Thus, it is not possible to conduct a demonstration on this topic directly in the classroom.

The fact that the tools in the software panel are in English also allows students to learn how to name physics terms in English.

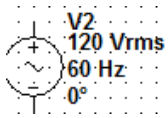
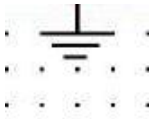
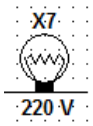
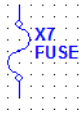
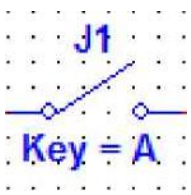
Purpose of the work: to study the electrical circuit in the home.

Virtual elements: alternating current (AC) power supply, switches, lightbulbs, electrical fuses.

Work procedure:

1. Run the NI Multisim software.

2. Choose the AC power supply, switches, light bulbs, and fuse holders in the toolbar and place them in the software workspace.

The electrical circuit in the home (Demonstrative experiment)				
Name of the element	**How it looks**	**Elements bar icon**	**Family**	**Designations**
AC power supply			POWER_ SOURCES	AC_POWER
Ground connection			POWER_ SOURCES	GROUND
Virtual lamps 4 pcs			VIRTUAL_ LAMP	LAMP_ VIRTUAL
Fuse holders 2 pcs			SCH_CAP_ SYMS	FUSE
Switches 4 pcs			SWITCH	SPST

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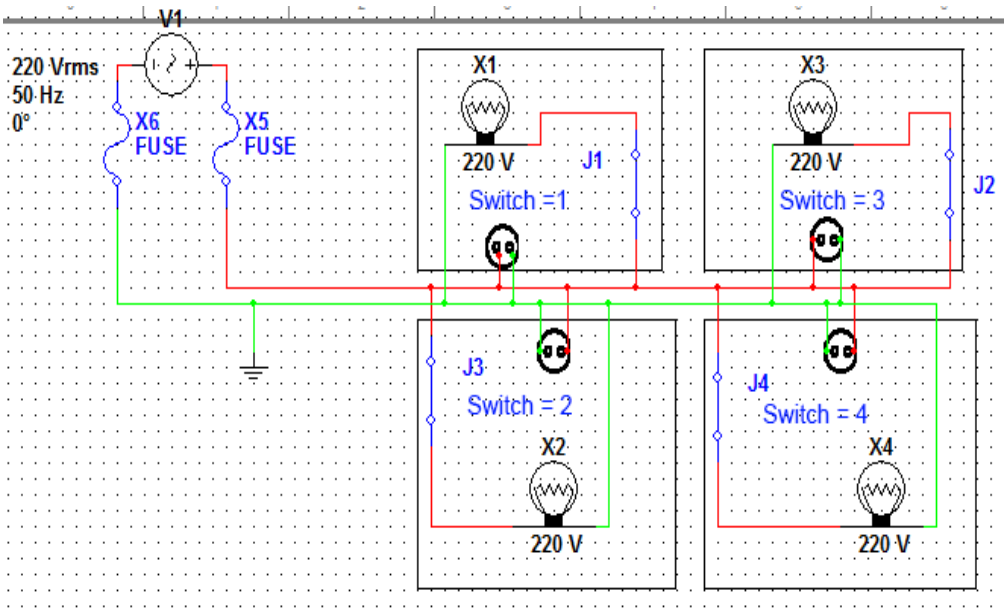
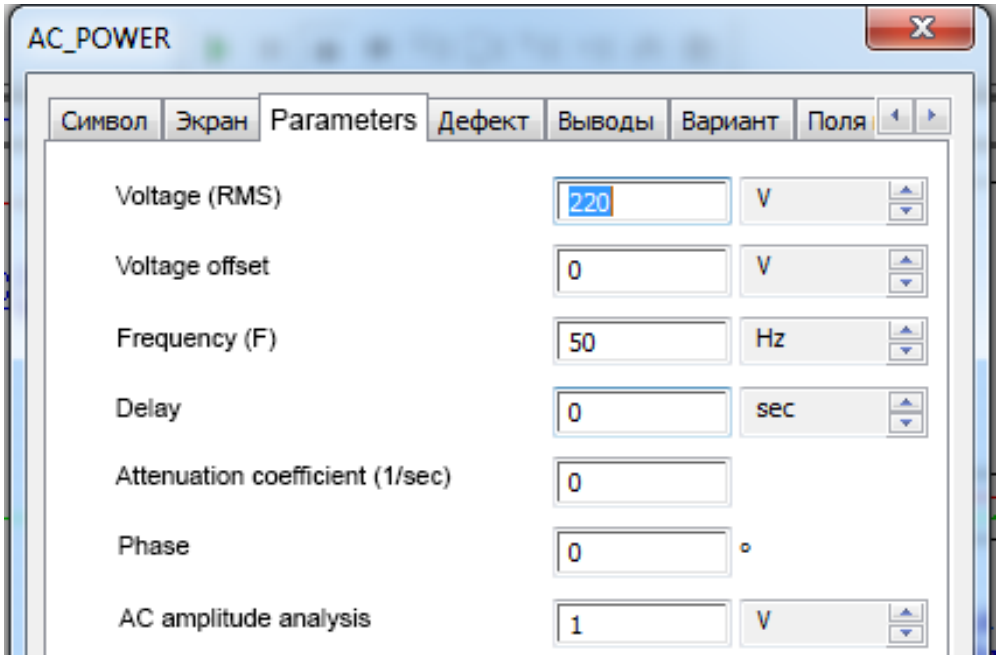
3. Connect the components with the mouse as shown below.

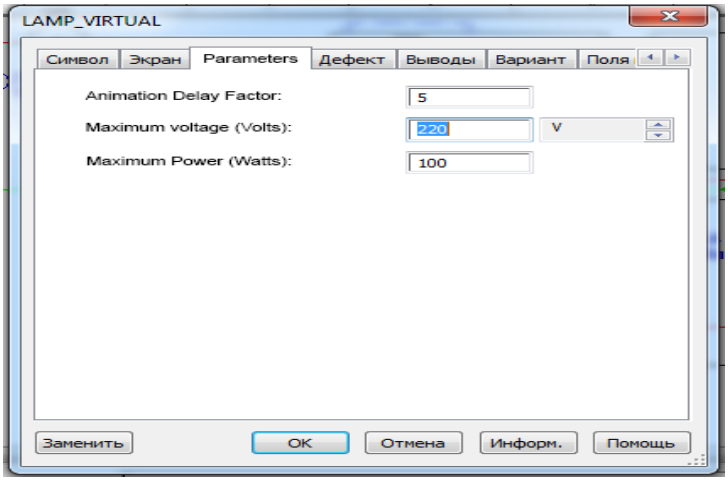


4. Set the AC power supply to 220V and 50Hz. To do this, hover the mouse pointer over the source icon and press the left mouse button twice.



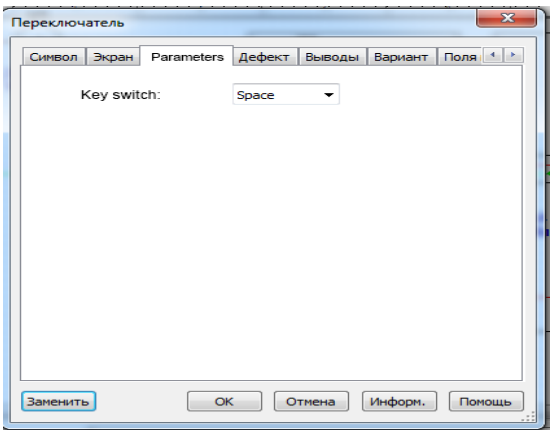
After the voltage is changed to 220V, the frequency is changed to 50Hz, press the OK button.

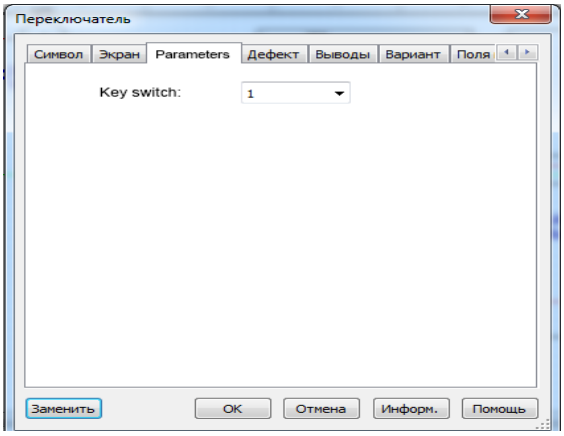
5. Change the voltage of the virtual lamps to 220V and its power to 100W. To do this, hover the mouse pointer over each virtual lamp icon and press the left mouse button twice.



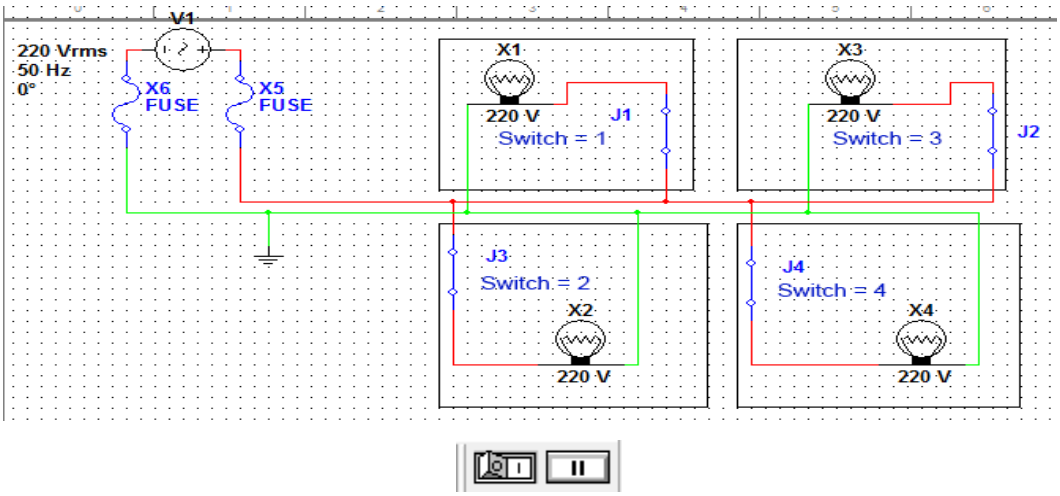
After the voltage is changed to 220V, the power is changed to 100W, press the OK button.

6. Attach the keyboard keys to the switches. To do this, hover the mouse pointer over each key icon and press the left mouse button twice.





In the window that appears, type 1 instead of “Space” and click OK. Keyboard keys 2, 3, 4 are attached in the same way for the remaining switches. (You may not want to install sockets and room drawings because they are a bit complicated to install and because they don't work in the simulation process)



7. Run the simulation process.

8. Use the 1,2,3,4 keys on the keyboard to connect and disconnect the switches and monitor the operation of the electrical circuit from the room.

9. Study the general structure of the chain.

10. Draw conclusions.

In the process of drawing an electrical circuit diagram on this topic, students have the opportunity to learn the elements of the circuits, the English names of the tools, to design an electrical circuit diagram, and to ask for help (by communicating) from each other. As a result, students will learn about the structure of the electrical circuit of the house, the analysis of electrical circuits, their proper use, their shortcomings, and ways to overcome these shortcomings.

To sum up, the use of virtual laboratories during the physics classes strengthens the theoretical knowledge acquired by students and allows them to apply it in practice.

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