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DIE VERBESSERUNG DER LABORARBEITEN IN DER AUSBILDUNG DAS THEMA GRUNDLAGEN DER STROMVERSORGUNG MIT HILFE VON VIRTUELLEN SIMULATOREN

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Abstrakt. In diesem Artikel wurde die Problematik innovativer Methoden im Bildungsbereich betrachtet, sowie die Problematik der Verbesserung der Berufskompetenz von Studierenden durch die Vermittlung des Faches „Grundlagen der Energieversorgung“ in der dualen Ausbildung mittels Ausbildungssimulatoren.
Schlüsselwörter: Elektrizitätswirtschaft, Stromversorgung, virtuell, Simulation, elektronisches Lehrbuch, Simulation, Websystem, Lastplan.

THE IMPROVEMENT OF LABORATORY WORKS IN TRAINING THE SUBJECT OF THE BASICS OF THE ELECTRICITY SUPPLY WITH THE HELP OF VIRTUAL SIMULATORS

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Abstract. In this article, the problems of innovative methods in the field of education were considered, as well as the issues of improving the professional skills of students by teaching the subject "Fundamentals of Power Supply" in dual training using training simulators.
Keywords: electric power industry, power supply, virtual, simulation, electronic textbook, simulation, web system, load schedule.

Today, in the development of the countries of the world, the need for electricity, the modernization and reconstruction of existing power plants, the construction of new facilities of highly efficient energy production technologies, the development of electricity storage systems, and the diversification of energy resources through the use of renewable energy sources are the main goal of the electricity sector. Based on this, by 2030 it is planned to implement more than 52 investment projects related to all aspects of energy development [1].

The electric power industry of the republic rightfully belongs to the main sectors of its economy. This industry, with its production and scientific and technical capabilities, makes a significant contribution to the development of the economy and national security.

The country pays great attention to strengthening the material and technical base of higher educational institutions, filling the educational process with electronic teaching aids, improving didactic support, and preparing students for research activities in their specialization. Therefore, the improvement of the methodological base of the educational process, using all the possibilities and changes, is the duty of all teachers today.

This article discusses the conduct of laboratory work on the subject "Fundamentals of Power Supply" using a virtual simulation electronic textbook, as well as its types and results of simulations in the assimilation by students.

A learning simulator is a model of real events and a strategy evaluation system to understand the behavior of real events. There are many benefits to using simulators, here are a few of the main ones:

1. Anticipation of any process or system performance.
2. Comparison of designs of alternative systems.
3. Identification of alternative sources that affect the operation of the system.

Simulation and other types of modeling have inherent advantages, such as: adaptation of modeling to any situation, completeness of situations, speed of creating any technological processes, visualization, communication and other advantages [2].

As part of the scientific work under study, a virtual simulation laboratory was created, it was also part of a web system, and testing was carried out within the following framework:

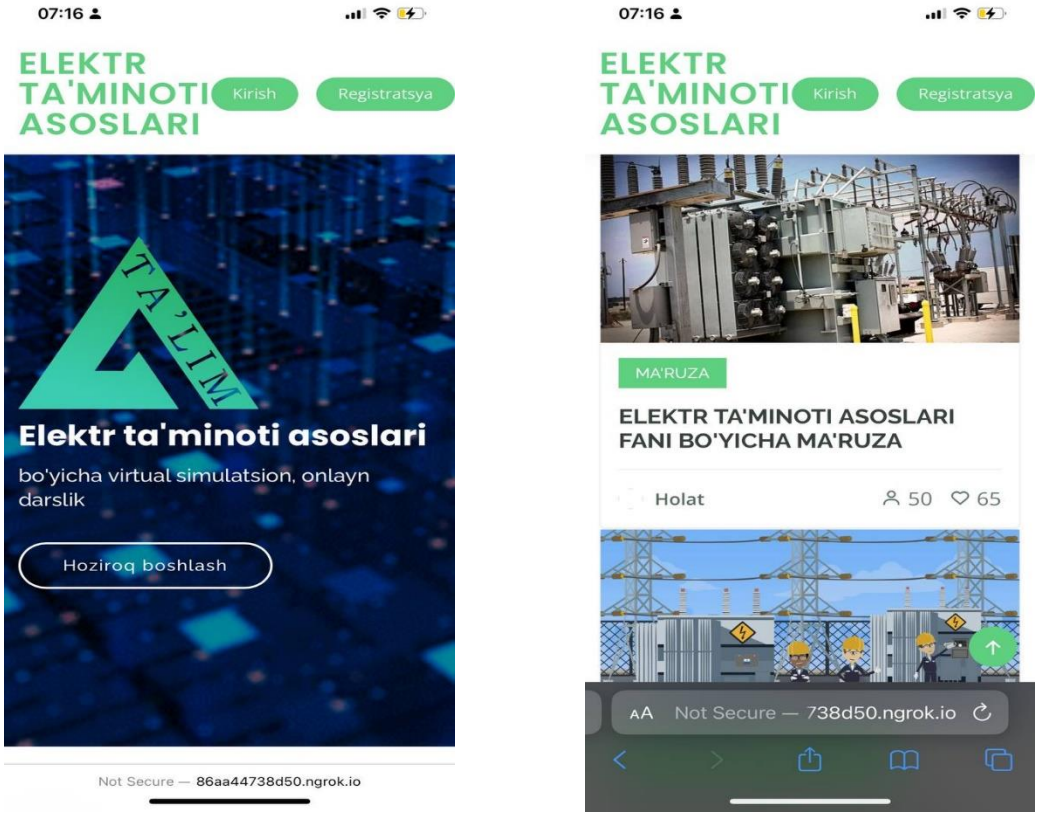

Figure 1. View of the virtual simulation software on the screen of mobile devices.

Currently, the laboratories for the subject "Fundamentals of Power Supply" are used in the form of a stand and have the following disadvantages compared to the upcoming virtual laboratory:

- insufficient level of security;
- high cost of laboratory equipment;

- laboratory work is carried out only in a specially designated auditorium;
- as a result of an error, the equipment fails.

Taking into account all the above disadvantages and inconveniences, virtual simulation laboratory work on this subject can be carried out remotely. Students perform virtual simulation laboratory work on computers and mobile phones running the Android system, while they will be able to consolidate their knowledge [3].

The created virtual simulation laboratory was prepared on the following topics (Figure 1):

1. Cartogram of electrical equipment of industrial enterprises.
2. AVR in the transformer.
3. Studying the scheme of substations.

A number of complex programs and animations were used in the virtual simulation labs, i.e. the main outline and all animations of the lab were created in "Canvas" and the frontend section was formed using HTML, CSS, JS, jQ. The logic section, which is the basis of the simulation, was prepared in python 3.10, and the logic results were connected to the frontend through the Jinja2 language.

If we look at the lab, which is one of the above labs, called industrial plant electrical equipment cartogram, then this virtual lab has three parts:

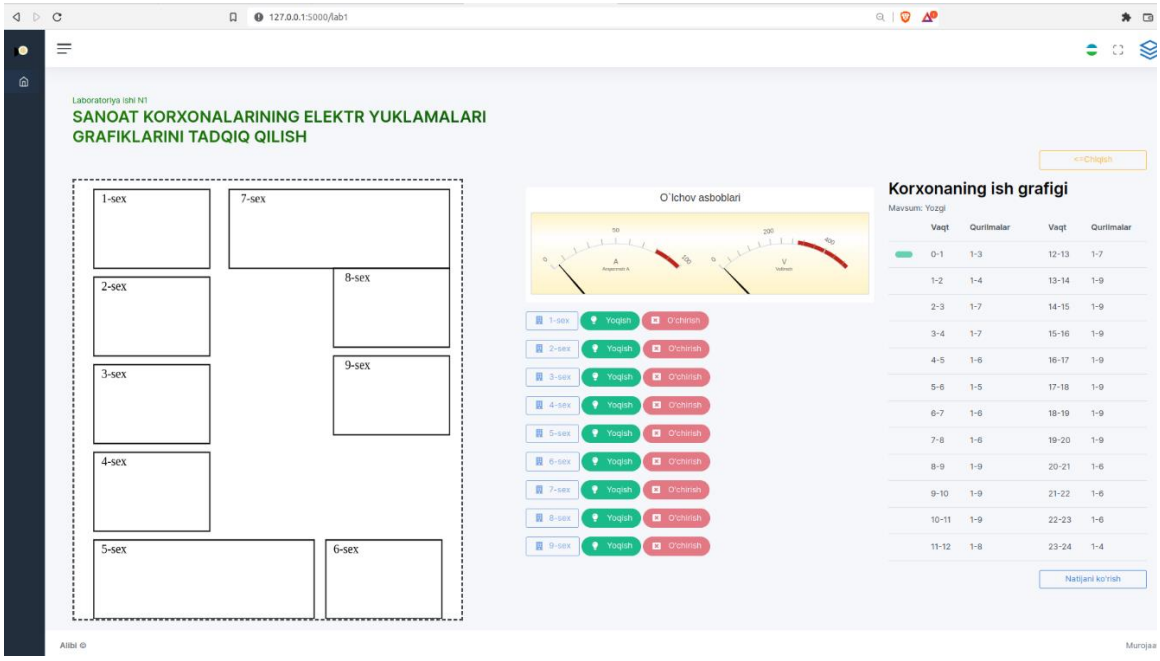

Figure 2. Cartogram of electrical equipment of industrial enterprises.

1. Theoretical part - in this section, students will receive theoretical knowledge about laboratory work.

2. Practical part - in this part, the student creates a virtual representation of the process of connecting consumers based on a schedule according to the given parameters.

3. Testing - in this section, all the knowledge and experience gained will be consolidated (test).

The purpose of performing laboratory work on the cartogram of electrical loads of industrial enterprises includes obtaining graphs of electrical loads by experiment, the coefficient and other quantities when calculating the electrical loads of the city and industrial enterprises corresponding to the schedule. (Figure 2).

When designing the power supply of modern cities and industrial enterprises, the main rational solution to complex technical and economic issues is related to the correct calculation of the load on electricity. Identifying electrical components is the first step in mastering any electrical system. An error in determining the electrical load can lead to a decrease in the technical and economic indicators of industrial enterprises. Knowing about electrical loads helps to determine the following specific parameters:

- choice of transformers and transformations;
- definition of freedom of movement;
- checking the economic current density;
- calculation of voltage dissipation and its fluctuations;
- selection of protective and compensating devices

There are three types of components in the industrial electric power system diagram: active power P, reactive power Q, and current power I. Electric charging is prohibited by electronic devices, and electric charging time can be recorded by automatic devices. Active power, reactive power and lines of current change over time are called active power load versus current curves [4].

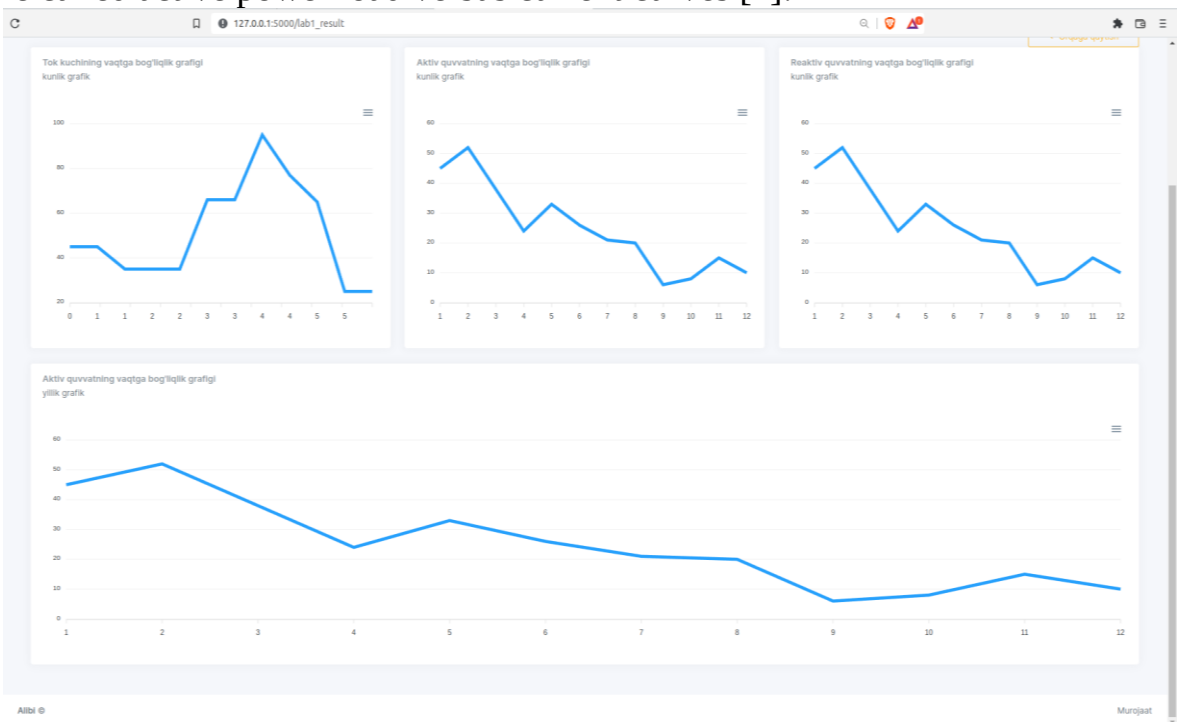

Figure 3. Graphs of loads of industrial enterprises.

Load schedules can be produced for individual and group electricity consumers. Individual graphs are needed to refine high power consumption graphs. In the design of the power supply system in cities and industrial enterprises, group load

schedules are used. Load curves of industrial enterprises are divided into daily and annual (Fig. 3).

From the daily and annual load schedules, the following are revealed: average, root-mean-square maximum load power; the amount of electricity used daily and annually; active, reactive and full power; Changes in the mode of power supply. From the daily load schedules, you can build an annual schedule and determine the number of hours of operation at maximum load during the year.

Instead of laboratory work, students are invited to complete the following tasks:

1. Get acquainted with the features of laboratory work.
2. Get a daily graph of active and reactive power using meters.
3. Draw up an annual schedule of active and reactive productivity by duration.
4. Determine the coefficients of the daily and annual load schedules.

The student does not have any particular difficulties in managing the proposed virtual laboratory work and conducting experiments. Assignments are given in the form of a "random" function on all laboratory workstations. At the appointed time, the student turns on or off the consumers. After completing the tasks, to get the results, click on the finish button and get monthly, quarterly and annual charts, as well as a table in the form of numbers.

In recent years, the number of students in higher educational institutions in our country has been expanding and starting from the next academic year, a new type of education "distance learning" is being introduced. There are some difficulties in increasing the growth of students in higher education, such as the lack of classrooms. The place of higher education has independent dance classes, and the availability of training halls in the regions is guaranteed. Such changes and ways to solve problems are the main task that is on the agenda of higher education institutions.

In modern education, the institution or performance is not entirely satisfactory, as there is not enough system connecting them. Therefore, after the training lessons, the student spends some time in the training simulator virtually performing experimental work, after performing sequential actions, he will have enough skills to participate in any enterprise processes.

Therefore, the introduction of simulators into the learning process in educational institutions in technical areas creates modern conditions in education and ensures its high level. In addition, every student who receives knowledge from a professionally competent teacher will try to have the best academic performance. It is proved that with the help of a virtual simulation educational project, it is possible to provide a quality education for students.

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