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Methodical foundations of the use of project-based technologies in teaching physics to students of technical specialties of higher education institutions

The presented work is devoted to the issues of using project technologies of training in higher education institution based on information technology. The training of highly qualified competitive specialists is the main task for all higher educational institutions. In other words, a graduate of a higher educational institution should design highly efficient, technically advanced engineering systems, analyze the effectiveness of a project in comparison with other projects. The question arises of how to prepare such a specialist in the conditions when the current educational system often lags behind the processes taking place in the global space. In this regard, the authors attach special importance to mini-projects that can be carried out in a short time, while these projects build students' skills such as group work, teamwork management, project reporting, design and research skills. The paper also proposes a general structure of the educational project for one semester. This describes the experience of using the computer program Electronics Workbench version 512 in teaching physics to students of technical specialties. The questions of the effectiveness of innovative creativity of students in the performance of tasks of the mini-project in the course of physics are considered on the example of the simulation of the operation of oscillatory circuits – serial and parallel.

Keywords: project-based training technology, educational project, serial oscillation circuit, parallel oscillation circuit, resonance.

Introduction

The bachelor in the technical field needs to not only possess professional knowledge and skills in its field, but also to have professional competence in design and management activities, that is, be able to apply knowledge and design methods and project management elements when solving professional problems. The attitude to the future specialty is largely determined by the nature of the educational work in which future professional activity must be modeled in a certain way.

Therefore, for the successful formation of bachelors' professional competence, project-based training is the most suitable technology. The basis of this technology is the development of cognitive, creative skills, the ability to independently construct their knowledge, the ability to navigate in the information space, the development of critical thinking.

Main part

Currently, training in higher education involves the wide use of innovative educational technologies: credit, modular, design, problem, etc., which act as methodological foundations of the educational process in a modern university. The idea of project-based training is becoming increasingly popular in the univer-

sity environment. Many authors are developing project models of teaching at the university, which involve the technology of project-based training and building individual trajectories [1, 2].

The project technology is based on the theoretical concepts of «pragmatic pedagogy», which was founded by the eminent American philosopher and educator John Dewey (1859–1952). According to his theory, true and valuable is only that which is useful to people, which gives practical results and is directed to the benefit of the whole society. The main provisions of J. Dewey's theory look as follows:

- in ontogenesis, the child follows the mankind path in cognition development;
- the assimilation of knowledge is a spontaneous uncontrollable process;
- for the assimilation of knowledge, students should be exposed to problem-solving tasks that are real life and meaningful for him;
- training should be conducted through the students' appropriate cognitive and project-based activities, consistent with their personal interests;
- the child learns the material, not just while listening or perceiving the senses, but also due to his need for knowledge.

In natural science undergraduate programs, laboratory work in the general course and special sections of physics plays a very important role. The main idea of laboratory work is the unity of theoretical and practical knowledge, the development of research skills, and the ability to demonstrate acquired knowledge while doing laboratory work. Nevertheless, researchers consider that the traditional method of laboratory work set up has a number of didactic imperfections. They are as follows: when performing and defending laboratory works, the students do not work independently; the exchange of research results is only between two students, that is, the participants in the laboratory class are isolated [3]; the requirements for the preparation of various categories of graduates are not fulfilled [4]. In this regard, the authors propose the following solutions to this didactic problem – the use of elements of design training technology in the organization of frontal works; conducting a multi-level laboratory workshop using the project-based method.

The concepts and laws of physics studied in the logic of other training courses are not foreign to their conceptual system and cannot be perceived as secondary. It can also be argued that teaching physics is a basic component of the content of the preparation of a future engineer, economist, physics teacher, etc. This means that the following didactic formula applies to it: every basic component of education, for example, as a composite physical practicum, is included in the content of education as a special didactic tool, and not as «additives» in separate chapters and sections. And in this regard, the question arises about how to improve the concept. That is, the improvement on the basis of computer technologies of teaching methods in traditional disciplines of subject preparation of the future engineer based on the internal and external level of coordination of the fundamental and general disciplines of technical specialties of a higher educational institution (physics, chemistry, computer science, mathematics, foreign language, economics, etc.). The internal level is understood as the coordination of separate sections, symbolic designations, the contents of work programs. The external level of coordination contains the psychological and didactic aspects of choosing one or another approach to learning (problem-oriented, project-oriented, context-sensitive, etc.) [5]. The use of computer applications, technologies not only contributes to a more complete implementation of the fundamental goals of these disciplines, but also leads to a more complete and in-depth analysis of physical phenomena and understanding of physics and, in essence, changes the content of training.

Laboratory works are an effective environment for implementing the technology of project-based teaching physics in technical specialties of a higher educational institution. Their use contributes to the formation of a sustainable engineer methodologically motivated and oriented interest in teaching physics, the ability to reclaim and use its scientific content as a methodological experimental and technological means of innovative engineering activity. Despite the high significance of the problem, its comprehensive solution does not exist until now. The organization of a methodological orientation of the educational process in physics is required in that part that concerns the support of an experiment that substantially expands the scope of training and educational research of students.

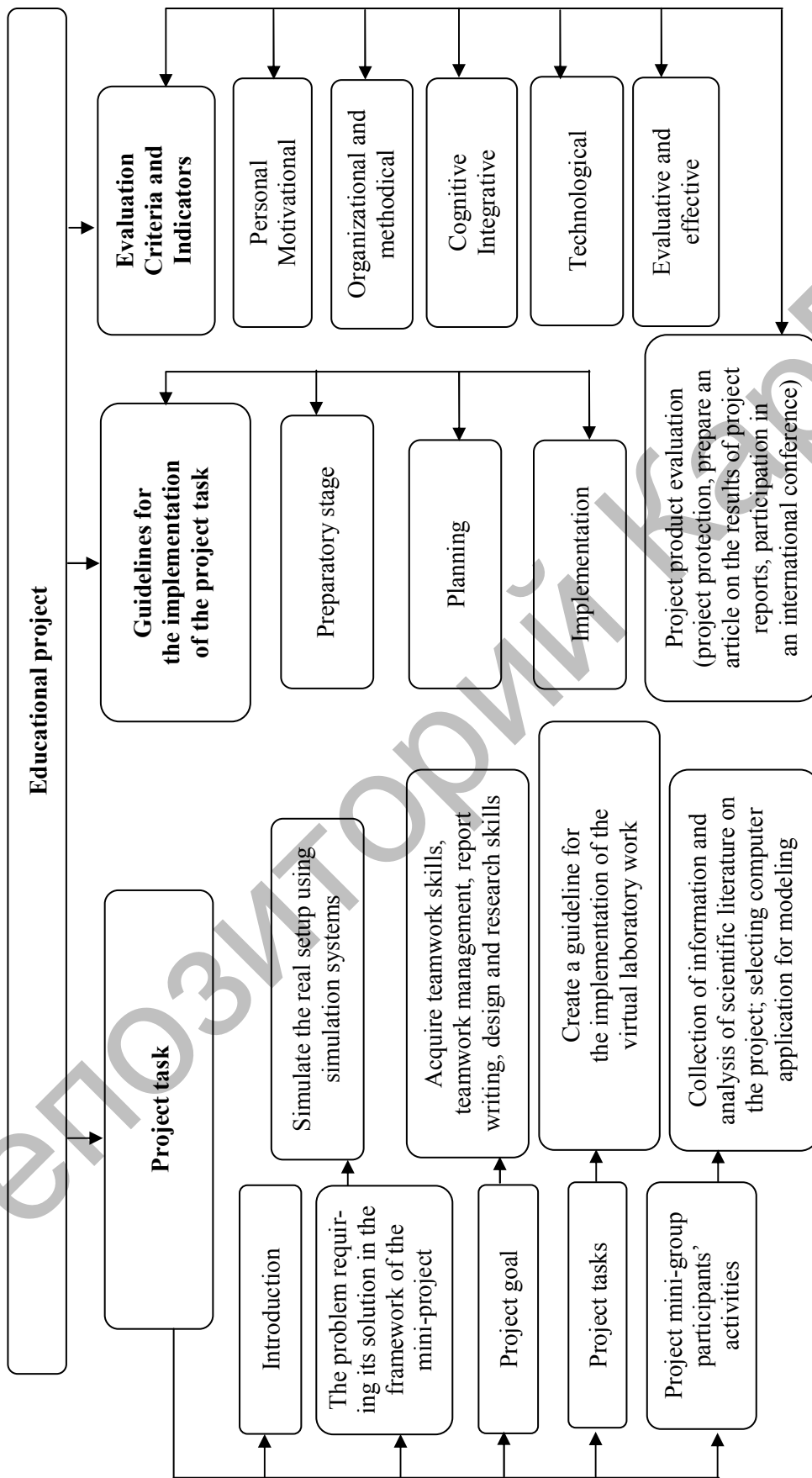


Figure 1. Structure of Educational Project

V. Larionov and A. Leader in their works argue that the combination of virtual and real experiment and simulation in a physical workshop is the main element of the project activity and is necessary in the educational laboratory of the new generation educational laboratory in physics [6]. Taking into account the specifics of a technical specialty when teaching students in physics, which lasts for 2 semesters, educational projects can be compiled on topics that form the professional competencies of the future engineer. The number of participants in mini-projects may consist of 3-5 students. Students themselves can choose the group where they would like to work together and carry out the project. Of course, the teacher, given the abilities of each participant, can make changes in mini-groups. The purpose of the educational project is to create conditions under which students, working in various mini-groups, develop:

- communication skills;
- problem-solving skills;
- the skill of finding information from various sources [7];
- research skills, which include such issues as identifying problems, collecting information, observing, conducting experiments, analyzing, building hypotheses, generalizing);
- systems thinking skills.

In this regard, we propose a general structure of the educational project (Fig. 1).

The use of design technologies with the use of information technologies in teaching physics is given in the works of N. Shiyani, I. Kiseleva, O. Alykova, and others [8–10].

Using this structure of the mini-project, various works were performed by students of the specialty Instrument Making and Information Systems. Let us show one example on the topic «Oscillatory circuit. Free and forced electromagnetic oscillations. Resonance». Electronics Workbench system was used as an application program. With the help of the Electronics Workbench system, students developed a virtual model of the operation of oscillatory circuits – serial and parallel type [11].

The scheme for determining the amplitude-frequency characteristic of a parallel circuit is shown in Figure 2.

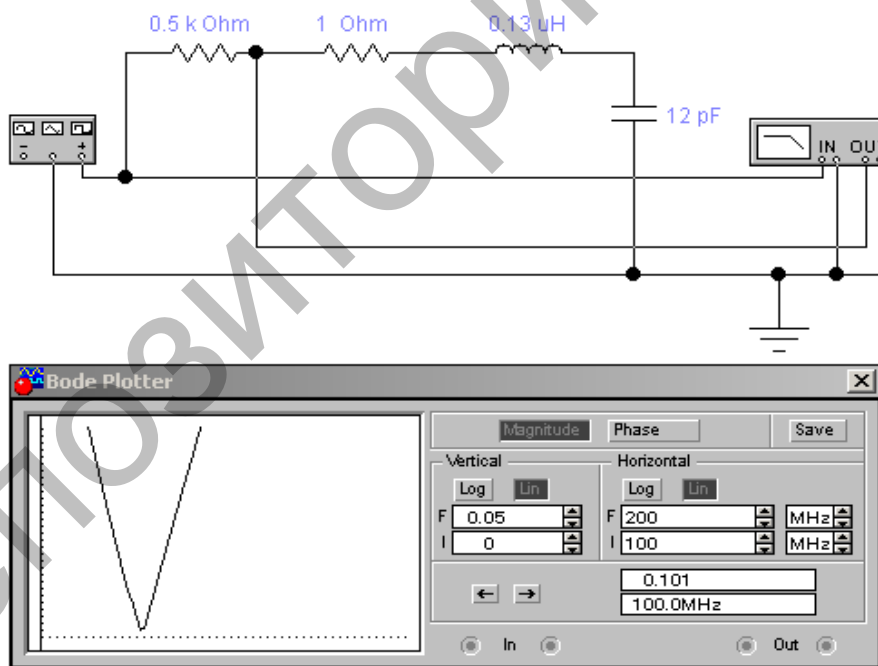


Figure 2. The scheme of obtaining the amplitude-frequency response of the serial circuit and the amplitude-frequency response of the serial oscillating circuit

The quality factor and the resonant frequency of the serial circuit with the parameters shown in the diagram:

$$\nu = \frac{1}{2\pi\sqrt{L \cdot C}} = \frac{1}{2 \cdot 3,14 \sqrt{0,13 \cdot 10^{-6} \cdot 12 \cdot 10^{-12}}} = 128 \text{ Mhz,}$$

$$Q = \frac{2\pi \cdot \nu \cdot L}{r} = \frac{2 \cdot 3,14 \cdot 128 \cdot 10^6 \cdot 0,13 \cdot 10^{-6}}{1} = 104 .$$

The diagram for determining the amplitude-frequency characteristic of a parallel circuit is shown in Figure 3. Quality factor and resonant frequency of the serial circuit with the parameters indicated on the diagram:

$$\nu = \frac{1}{2\pi\sqrt{L \cdot C}} = \frac{1}{2 \cdot 3,14 \sqrt{0,13 \cdot 10^{-6} \cdot 15 \cdot 10^{-12}}} = 110 \text{ Mhz}$$

$$Q = \frac{R}{2\pi \cdot \nu \cdot L} = \frac{10600}{2 \cdot 3,14 \cdot 150 \cdot 10^6 \cdot 0,13 \cdot 10^{-6}} = 100,2$$

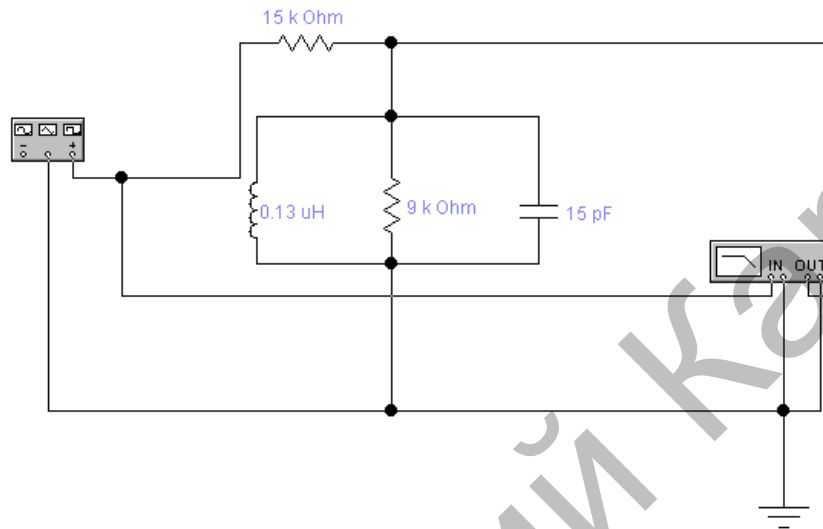


Figure 3. The scheme of obtaining the amplitude-frequency characteristics of the parallel oscillatory circuit

Amplitude-frequency characteristic of a parallel circuit on the screen of a virtual oscilloscope is obtained (Fig. 4).

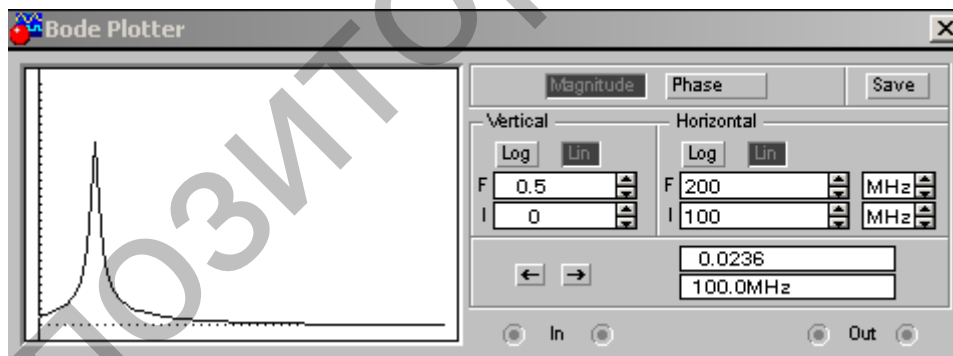


Figure 4. Amplitude-frequency characteristic of the parallel circuit

Conclusion

Thus, the student, working in the information system of modeling Electronics Workbench and showing innovative creativity in the design and modeling of the principle of operation of various electrical circuits, shows sufficient performance of the mini-project.

Of course, at the laboratory work it is impossible to develop a full educational project. Therefore, classes are conducted as full-scale laboratory work, the results of which are used in the implementation of the educational project for comparison with the results obtained on virtual instruments. At the laboratory work, the main methodological guidelines are provided for the educational projects. The main part of the mini-project is performed during the tutorial.

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Жобалық технологияларды жоо-ның техникалық мамандықтарында білім алатын студенттерге физиканы оқытуда қолданудың әдістемелік негіздері

Мақала жоғарғы оқу орнында жобалық технологияларды ақпараттық технологиялар негізінде қолдану мәселелеріне арналған. Қазіргі уақытта жоғарыбілікті, бәсекеге қабілетті мамандарды даярлау барлық жоғарғы оқу орындарының ең басты міндеттерінің бірі болып табылады. Басқаша айтқанда, жоғарғы оқу орнының түлегі тиімділігі жоғары техникалық жағынан мінсіз болатын инженерлік жүйелерді жобалай, жобаның басқа жобалармен салыстырғандағы тиімділігіне талдау жасай білу керек. Осындай мамандарды қалай даярлау керектігі жайлы сұрақ туындайды. Сол себепті авторлар қысқа уақыт аралығында жүргізуге болатын, мини-жобалардың негізгі ерекшеліктеріне аса көңіл бөлді. Сонымен қатар авторлар ұсынылып отырған жобалардың студенттердің бойында топта жұмыс жасай білу, ұжымдық топты басқара білу, жобаның есебін дайындай білу, жобалық-зерттеушілік іс-әрекет дағдыларын қалыптастыруға мүмкіндік беретін инновациялық технологиялардың бірі екендігі жайлы айтады. Бұл жобаларды бір семестр аралығында орындаудың жалпы құрылымы келтірілді. Техникалық мамандықтарында білім алатын студенттеріне физиканы оқыту барысында Electronics Workbench 512 қолданбалы компьютерлік бағдарламасын қолданудың тәжірибесі келтірілді.

Кілт сөздер: жобалық оқыту технологиясы, оқу жобасы, тізбекті тербелмелі контур, параллель тербелмелі контур, резонанс.

А.Б. Искакова, А. К. Каирбаева

Методические основы использования проектных технологий при обучении физике студентов технических специальностей вуза

Статья посвящена вопросам использования проектных технологий обучения в высшем учебном заведении на основе информационных технологий. Подготовка высококвалифицированных конкурентоспособных специалистов является основной задачей для всех высших учебных заведений. Другими словами, выпускник высшего учебного заведения должен проектировать высокоэффективные, технически совершенные инженерные системы, анализировать эффективность проекта в сравнении с другими проектами. Возникает вопрос о том, как подготовить такого специалиста в условиях, когда действующая система образования нередко отстает от процессов, происходящих в мировом пространстве.

В связи с этим авторы уделяют особое значение на минипроекты, которые можно проводить за короткое время, при этом эти проекты формируют у студентов такие навыки, как работа в группе, управление коллективной работой, составление отчета проекта, навыки проектно-исследовательской деятельности. Также в работе предложена общая структура проведения учебного проекта на протяжении одного семестра. При этом описывается опыт использования компьютерной программы Electronics Workbench версии 512 в обучении физике студентов технических специальностей. Рассмотрены вопросы эффективности инновационного творчества студентов при выполнении заданий минипроекта по дисциплине «Физика» на примере моделирования работы колебательных контуров – последовательного и параллельного типов.

Ключевые слова: технология проектного обучения, учебный проект, последовательный колебательный контур, параллельный колебательный контур, резонанс.

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