Use of information technologies in the laboratory practice in the course "measuring instruments and devices in radio engineering"

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Abstract. The article discusses an example of the use of e-learning in a laboratory workshop in the discipline "Measuring instruments and radio engineering devices." The structure of the organization of e-learning is considered. Some work of the workshop are described.

1. Introduction

The rapid development of technologies currently determines the need for society to train highly qualified technical specialists. The integration of various fields of science requires engineers to possess relevant knowledge and skills, both in their profile and in mating specialties.

Important tasks in the preparation of competent personnel in technical specialties are their interdisciplinary education and the availability of relevant theoretical knowledge and practical skills for working with modern equipment when graduating [1].

One of the solutions to these problems can be considered the use of electronic educational resources and distance learning technologies in the educational process. This approach allows students to realize remote access to essential information from anywhere in the world, to facilitate monitoring of the learning through testing and enables the remote communication of students with teachers and students among themselves. The introduction of e-courses in the educational process helps to change the presentation of information, the form of practical training, as well as the methods of knowledge control and reporting. All these measures allow students to develop the ability to adapt to modern realities, the ability to use specific knowledge and skills to solve tasks using specific examples (simplifying the scheme, increasing labor productivity, reducing time costs), as well as the ability to form the main idea from a large amount of information provided.

The authors created an electronic educational resource for the methodological and software of the laboratory workshop on the course "Measuring Instruments and Devices of Radio Engineering". This course is available in the Moodle distance learning system.

For several years, the Moodle system has been widely used to organize e-learning at the Radiophysical Department of Tomsk State University [2]. At the faculty, a series of electronic resources are presented in the Moodle system for information and methodological support of lectures, seminars, laboratory and practical classes, as well as for organizing students' independent work [3-5].

In the framework of this workshop, students will have to work with real measuring instruments, most of which are part of the NI ELVIS II + software and hardware complex [6], and PXI standard modular devices from the equipment park of the Tomsk Regional Common Use Center: Center of radio-physics
measurements, diagnostic and researching of parameters of natural and artificial materials. For the control of measuring equipment and its programming, most laboratory work uses the LabVIEW laboratory virtual instrument development environment [7].

2. Laboratory Workshop Description

The laboratory course has a modular structure. Each of the works is divided into thematic sections. Students begin the course with an introduction to the measuring instruments from the NI ELVISmx kit. This platform has been actively used at the Radiophysical Department for the past few years to organize laboratory and practical classes [8].

All measurements are carried out using the prototype board of the NI ELVISmx platform, instrument control is carried out both in manual mode and using software. To better consolidate the knowledge gained, students are invited to work with individual measuring instruments from the faculty’s measuring equipment fleet (multimeters, power supplies, etc.).

Over the course of three laboratory work, students gain skills in working with such measuring instruments as: an oscilloscope, a spectrum analyzer, signal generators and learn to read data from devices.

Since many measuring instruments use signal generators, in the next block of laboratory work, students are invited to familiarize themselves with one of the promising directions of generating arbitrary waveforms based on DDS (Direct Digital Synthesizers) [9] for a better understanding of the operation and the possibility of analyzing incorrect readings of measuring equipment when they occur.

In order for students to understand the implementation of direct digital synthesis, the LabVIEW program is used, and the hardware is NI ELVIS internal generator, AD9833 synthesizer, computer sound card and mobile phones. The virtual devices used in this work are presented in Figure 1.

The next group of laboratory works is devoted to the problem of measurement automation [10]. In one of the works of this cycle, students are invited to measure the dielectric constant of a substance in a wide frequency range. For clarity, the recalculation of primary values is first carried out in manual mode, and then using the measurement automation program written in the LabVIEW program. Graphs are constructed based on the obtained values and a comparison of the permittivity spectra of substances obtained in manual and automatic mode.

Currently, interest in a comprehensive study of the parameters of substances forces us to carry out a large number of measurements for the rational use of both human and technical resources. In this regard, there is a tendency to use remote access technology in the measurement process [11].

The final block of laboratory work is aimed at the formation of practical skills of remote work with measuring instruments. In these works, students are invited to independently organize remote control of measuring instruments using the LabVIEW and TeamViewer programs. A fragment of the web page for remote access to measuring equipment is presented in Figure 2.
Figure 2. A fragment of a remote access page for devices created by students through a program Labview

3. Course structure

All laboratory works of this workshop have the same structure, shown in Figure 3. Their methodological support includes: theoretical material, testing, input and output questionnaires, guidelines for work and a tool for submitting a report in electronic form.

Figure 3. Fragment of an electronic resource page

The methodological support of the laboratory work contains the theoretical material needed to understand the instrument user manual for the equipment and a quiz based on the material presented. The admission to the work is a successfully passed test. Otherwise, the student does it again, after a
certain period of time.

After studying the guidelines, students begin to perform the practical part of the laboratory work. Each individual item is confirmed by a screenshot of the operation panel used by the device. At the end of the lesson, students draw up a report file, which they send to the teacher for verification. For these purposes, an electronic component “Submit a report on laboratory work” is provided in the electronic resource.

The introduction of electronic educational resources allows you to remotely evaluate the level of students' knowledge acquisition through surveys and testing in electronic form of reports on the work done. For feedback with students, a section such as questionnaires is provided. With it, the teacher can learn their attitude to a particular approach to the presentation of educational material.

Analysis of the results of the input and output questionnaires of students showed that students have a positive attitude towards such an organization of the educational process. Most of the respondents spoke in favor of combining full-scale experiment and modeling, as well as for the practice of solving urgent technical problems in laboratory work. The majority of students (75%) indicated that they liked the availability of creative assignments and additional points for them.

4. Conclusion

Thus, the above approach for conducting laboratory practical work using electronic educational resources allows us to solve such problems as the rational use of specialized classrooms and educational and methodological resources, which is especially important for a large number of students and limited hardware and software.

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