SOME IDEAS FOR ORGANIZATION OF LABORATORY PRACTICUM IN PHYSICS

E. KAZAKOVA, M. KRUCHEK, E. MOSHKINA, O. SERGEEVA, E. TIKHOMIROVA

PETROZAVODSK STATE UNIVERSITY (RUSSIAN FEDERATION)
SOME IDEAS FOR ORGANIZATION OF LABORATORY PRACTICUM IN PHYSICS

INTRODUCTION

✓ Laboratory practicum in physics is devoted to introducing students to the reality of the world around us, that is, to real physics. Due to experiential learning, students understand that it is an experiment that is the basis for putting forward hypotheses explaining physical phenomena, and formulating new postulates of the theory.

✓ Students gain experience in experimental activities, acquire skills in the use of basic measuring instruments, get acquainted with modern methods and techniques of physical measurements, develop skills of processing and analysis of measurement results, the ability to apply theoretical knowledge to solve practical problems, and enhance independent learning skills.

✓ Competent planning and continuous improvement of the organization and methods of conducting a laboratory practicum is an important step towards increasing the efficiency of teaching physics in higher education.
SOME IDEAS FOR ORGANIZATION OF LABORATORY PRACTICUM IN PHYSICS

PROBLEMS FACED BY LABORATORY PRACTICUM TEACHERS IN PETROZAVODSK STATE UNIVERSITY

➢ First- and second-year students often do not possess independent learning skills; they are not always able to perform high-quality calculations and analyze the results; students lack graphic information processing skills, etc.
➢ Students differ in the initial level of training in physics and mathematics, which requires the formation of individual learning paths.
➢ In the learning process, it may happen that a student performs a laboratory experiment on a topic that has not been discussed yet in a lecture and a practical class.
➢ It is required to take into account the specific features of various areas of training of future engineers when choosing the tasks of a laboratory practicum.
SOME IDEAS FOR ORGANIZATION OF LABORATORY PRACTICUM IN PHYSICS

METHODICAL APPROACH TO MODERNIZATION OF LABORATORY PRACTICUM

- Providing each student with a separate laboratory setup: physics laboratories should be equipped with a sufficient number of experimental facilities on various topics.

- Improving instructional materials: development of exercises and individual tasks of different levels of complexity for each laboratory work, taking into account different areas of training of future specialists, application of different methods for calculating errors (direct and indirect measurements) and graphical methods for processing experimental data.

- Organizing laboratory classes in the form of "mini-cycles". Within each "mini-cycle" students perform laboratory work on one topic. It provides a way to coordinate such classes with the study of this topic in lectures and practical classes.

- Conducting a laboratory practicum through the use of various interactive educational technologies, such as the round table method, project-based learning, brainstorming, etc.
SOME IDEAS FOR ORGANIZATION OF LABORATORY PRACTICUM IN PHYSICS

METODICAL APPROACH TO MODERNIZATION OF LABORATORY PRACTICUM

Example of organizing laboratory classes in the form of "mini-cycles":

- The total number of experiments in "Electricity and Magnetism" laboratory is 23. The laboratory activities are constituted by the following "mini-cycles": electrostatics and direct current, magnetic field and electromagnetic induction, electrical oscillations and alternating current. Experiential learning within each “mini-cycle” runs parallel with the study of this topic in lectures and practical classes. This allows students to more successfully prepare for the laboratory work and reporting on experimental results.

- Within the framework of a “mini-cycle”, students perform general-purpose laboratory works, regardless of the field of study, as well as field-specific ones, designed to be performed only by students in certain areas. As an example of a general-purpose laboratory experiment, we can name “Measurement of coil inductance by Joubert method”. For students majoring in "Electric Power Engineering and Electrical Engineering" the laboratory experiment "Research of a single-phase transformer" was specially set up, in which students not only study various transformer operating modes but also determine the parameters of the equivalent circuit, calculate electric power losses and the efficiency of a transformer. Similarly, students majoring in “Technical Physics” and “Electronics and Nanoelectronics” are supposed to work on “Rectifier Circuits,” performing which they get acquainted with half-wave and full-wave AC rectification circuits, study the effect of capacitive and inductive smoothing filters. These topics go far beyond the scope of a regular physics course, but studying them provides a way to prepare students for further study of special disciplines based on a physics course.
SOME IDEAS FOR ORGANIZATION OF LABORATORY PRACTICUM IN PHYSICS

TECHNICAL APPROACH TO MODERNIZATION OF LABORATORY PRACTICUM

- Use of the same laboratory setup for various experiments (multitasking of a setup).
- Introduction of modifications to standard equipment and measurement methods to increase the efficiency of its use.
Example of modernization of standard laboratory experiment:
The experiment “Studying the phenomenon of electromagnetic induction” (PHYWE equipment) is aimed to investigate the dependence of the amplitude of the induction EMF pulse on the speed of the magnet which falls vertically through the turns of the coil. Initially, the speed of the magnet at a given position of the coil varied with the height of the magnet fall. Such experimental conditions did not allow us to obtain a sufficient interval of variation in the magnitude of the magnet speed and verify Faraday's law. In a new version of the experiment, after laboratory setup modification, the magnet moves through a long glass tube on which five coils connected in series with the same number of turns are wound. The recorded values decreased dramatically: EMF by a factor of 20 and time intervals by a factor of 10. In this version of the laboratory experiment, we managed to significantly expand the range of magnet speeds and improve the quality of the results.
RESULTS

The training of highly qualified engineers requires continuous improvement of the educational process, which should be based on student’s personal activities. It means that the content of a course should be designed in such a way that, despite different levels of initial training, first- and second-year students could find their own individual learning paths.

The methodical and technical approaches to the modernization of the laboratory practicum in physics demonstrated the following advantages:

• optimization of the educational process;
• implementation of interactive forms of conducting classes;
• ensuring variability through the use of tasks of different levels of complexity;
• strengthening students' motivation to study physics;
• the development of a number of general professional competencies based on the subject matter of physics.
Thank you for your time!