INNOVATIVE APPROACHES TO CARRYING OUT LABORATORY WORKS ON THE TOPIC "MODELING OF THE MAGNETIC FIELD IN THE INTERPOLE GAP"IN CONDITIONS OF THE MODERNIZED MODEL

Feruza Mardonova Bobokulovna
Teacher of the Department of Physics and Astronomy
Navoi State Pedagogical Institute, Navoi city, Uzbekistan

Annotation

In the article, the authors propose a new modernized model for conducting laboratory work on the course "Fundamentals of Accelerator Physics", which fully covers modern technology and technological progress in physics.

Key words: laboratory work, modernized model, magnetic field, interpole gap, experimental studies, formal equivalence, magnetic circuit.

DOI Number: 10.14704/nq.2022.20.11.NQ66148 **NeuroQuantology 2022; 20(11): 1565-1570**

Introduction. The essence of our proposed model for improving the structure of classes is dictated by the current level of development of science, technology, as well as medicine, equipping educational institutions with the latest installations, equipment, devices, and the widespread use of modern educational, information and communication technologies in the practice of educational institutions of all types. At the same time, the task of developing in students the skills of individual research activity, synthesis and analysis of the results of experimental research in the conditions of an educational and scientific laboratory was also taken into account.

In the sequence of performing traditional laboratory work, which included the following components: the purpose and task of the work, instruments and accessories, a brief theoretical part, the procedure for performing the work, control questions for this work. This approach, in principle, limits the individual, potential capabilities of the student. Does not give him an idea about the comparison, application, development and improvement of innovative abilities.

Main part. The modernized model of the structure of laboratory studies takes into account a set of factors that contribute to a comprehensive solution of the problem of professional preparedness of students, the development of their research abilities. Setting up such a procedure for performing laboratory work fully meets modern requirements and will give a new impetus to the development of a student's research activities.

A comparative analysis of the results of traditional and modernized models of the structure of laboratory work has shown that the old models of laboratory work do not fully cover the current trends in the development of pedagogical and psychological science, or the intellectual level, worldview and thinking of today's students differ sharply.

It should be noted that the amount of information stored in the memory of students every day, according to psychologists, does not reveal about 2000 words, which indicates the need to save the mental, mental and even physical abilities of students when receiving information. In the course of conducting laboratory classes with a new modernized structure, the student simultaneously sees, calculates, reflects, creates working models or layouts with his own hands.

When conducting laboratory classes (if there are more than 12 students in a group), the group is divided into 2 subgroups. The number and name of the laboratory work to be performed are announced. It should also be taken into account that the implementation of the first, frontal laboratory work for all students should be mandatory, since in the course of its implementation the student will get acquainted with the principle of operation of measuring instruments and independently study the calculation of absolute and relative errors.

Structure of the upgraded model

1. Purpose of the work;
2. Instruments and accessories;
3. Brief theoretical part;
4. Description and technical characteristics of the installation;
5. Order of performance of work;
6. Mathematical processing of the results and determination of the error;
7. Information about the recommended, related laboratory work;
8. Independent performance of related laboratory work, obtaining results and mathematical approximation of the data obtained;
9. Theoretical questions;
10. Report on the performance of laboratory work and conclusion.

.

Results and discussions. The order of execution of the modernized structure of laboratory work on the topic: **"Modeling the magnetic field in the interpolar gap."**

1. The purpose of the work:

• Familiarization with the method of modeling the profile of the poles of an electromagnet using a flat model.

• Measurements of the magnetic field distribution in the simulated gap.

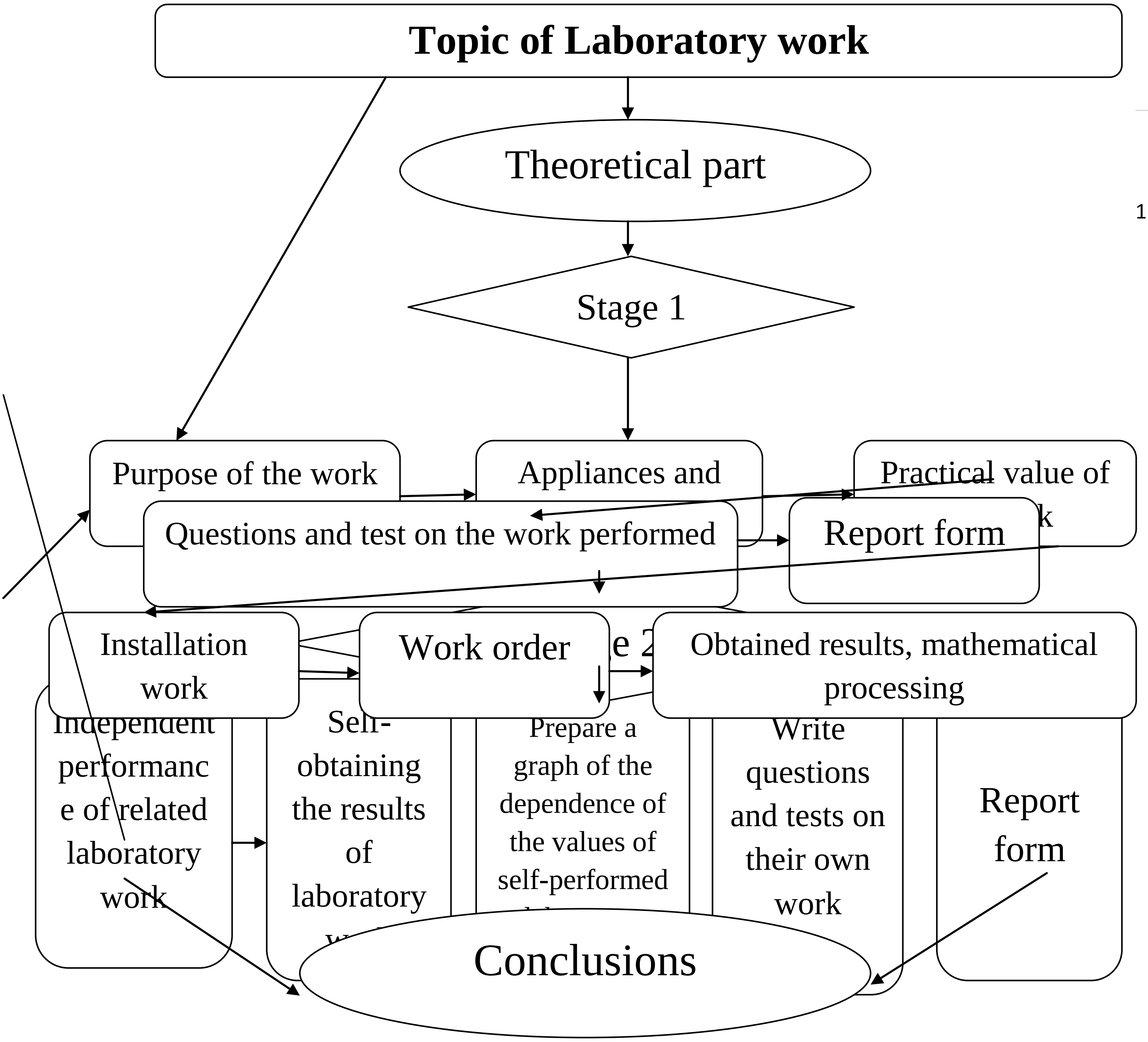
• Pole profile corrections.

2. Instruments and accessories: Solenoid magnetic circuit (flat) model (fasteners not shown) 1-magnetizing coil, 2-pole gap stencil.

3. Brief theoretical part:

Magnetic field - a field that acts on moving electric charges and on bodies with a magnetic moment, regardless of the state of their motion. The magnetic field can be created by the current of charged particles and / or the magnetic moments of electrons in atoms (and the magnetic moments of other particles, which usually manifest themselves to a much lesser extent) (permanent magnets). In addition, it arises as a result of a change in the electric field over time. The main quantitative characteristic of the magnetic field is the magnetic induction vector

Figure 1. Scheme and stages of the simulation laboratory work.



From a mathematical point of view, a magnetic field is described by a vector field given at each point in space.

Often in the literature, as the main characteristic of the magnetic field in vacuum (that is, in the absence of matter), they choose not the magnetic induction vector, but the magnetic field strength vector, which formally can be done, since these two vectors coincide in vacuum, but in a magnetic medium the vector does not carry already of the same physical meaning, being an important, but still auxiliary quantity.

Therefore, despite the formal equivalence of both approaches for vacuum, from a systematic point of view, it should be considered the main characteristic of the magnetic field, namely the magnetic field can be called a special type of matter, through which the interaction between moving charged particles or bodies with a magnetic moment is carried out. In the special theory of relativity, magnetic fields are a necessary consequence of the existence of electric fields.

4. Description and technical characteristics of the installation.

The final refinement of the required profile of the accelerator poles is carried out by fitting the profile on models that make it possible to correct the profile based on the results of magnetic measurements.
The easiest way to do this is with the help of the so-called "flat" model of the interpole gap, shown in Figure 2. The magnetic circuit of the installation is assembled from electrical steel sheets with a thickness of 0.35 mm. The magnetic field is excited by the magnetizing coil 1, powered from an industrial network with a frequency of 50 Hz. Blocks of the magnetic circuit A and B form two flat poles. The desired shape of the interpole gap is set according to stencil 2.
To measure the magnetic field, a measuring coil with a large number of turns is used. The voltage induced in the coil is measured with a voltmeter. Since the induced voltage is proportional to the amplitude of the magnetic induction at the location of the coil, the equality is true:

$$n = -\frac{\partial B}{\partial R} \cdot \frac{R}{B} = -\frac{\partial U}{\partial R} \cdot \frac{R}{U} \qquad (1)$$

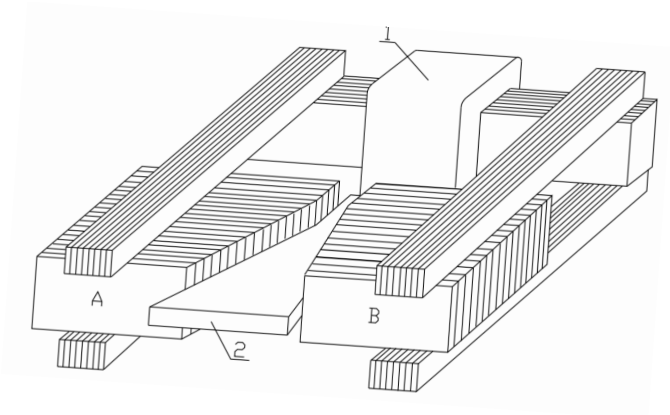


Figure 2. Magnet circuit of an electromagnet (flat) model (fasteners not shown)
1-magnetizing coil, 2-pole gap stencil.

If the dependence *U(R)* is taken point by point, then the decline indicator can be calculated using the formula:

$$n(R_{cp}) = -\frac{\Delta U}{\Delta R} \cdot \frac{R_{cp}}{U_{cp}},$$

$$\text{где } \Delta U = U_{i+1} - U_i;\ \Delta R = R_{i+1} - R_i;\ R_{cp} = \frac{R_i + R_{i+1}}{2};\ U_{cp} = \frac{U_i + U_{i+1}}{2} \qquad (2)$$

5. The order of the work.

1. Loosen the fastening bolts of blocks A and B, forming the poles of the electromagnet (Fig. 2).
2. Using a stencil, set the required profile of the interpole gap. In this case, it is necessary to ensure that the axial line of the set gap coincides with the line along which the measuring coil moves along the guides.
3. Remove the stencil and fix blocks A and B, tighten the loose bolts.
4. Measure the voltage on the coil *U(R)* depending on the radial coordinate. To do this, it is necessary to bind the scale of the ruler with the measuring coil to the coordinates of the interpolar gap. Stencil № 1 reproduces the interpole gap of the betatron at an energy of 16 MeV at R_0/R_c =1.4, stencil

№ 2 reproduces the betatron at 11 MeV at R_0/R_c =1.6. Both betatrons have a rectilinear pole profile, the slope of which is calculated by the formula:

$$\frac{\alpha_0}{2} = arctg\frac{\delta_0 n_0}{2R_0}. \quad (3)$$

at n_0=2/3.

6. Mathematical processing of the results and determination of the error;

Table 1.

Geometric dimensions of interpole gaps in centimeters

Stencil	R_H	R_0	R_c	δ_H	δ_0	δ_B	δ_c
№1	19,56	15,21	10,86	7,27	6,146	4,91	2,14
№2	18,37	13,37	8,35	8,6	7,0	5,10	2

Record the measurement results in table 2 and calculate the dependence $n = f(R_{Cp})$ using formula (2). Build a graph.

Table 2.

The measured distribution of the decay index along the radius

R, sm	R_1	R_2	R_3			
U	U_1	U_2	U_3			
R_{cp}	$\frac{R_1+R_2}{2}$	$\frac{R_2+R_3}{2}$				
ΔR	R_2-R_1	R_3-R_2				
U_{cp}	$\frac{U_1+U_2}{2}$	$\frac{U_2+U_3}{2}$				
$-\Delta U_{Cp}$	U_1-U_2	U_2-U_3				
$n(R_{Cp})$						

For the studied profile according to the formulas:

$$tg\frac{\alpha_0}{2} = \frac{\delta_н - \delta_в}{2(R_н - R_c)} \quad (4)$$

$$\delta(R) = \delta_в + (R - R_c)tg\frac{\alpha_0}{2} \quad (5)$$

calculate $tg\frac{\alpha_0}{2}$ and dependence *δ (R).* Enter the data in table 3 and according to the formula

$$n(R) = \frac{2R}{\delta(R)}tg\frac{\alpha_0}{2} \quad (6)$$

find the expected distribution *n = f (R)* based on the shape of the pole profile.

The measured $n = f(R_{Cp})$ and calculated distributions should be built on the same graph, analyze and explain the course of the dependencies.

Make a plan for correcting the profile of the poles and repeating step 4, measure the corrected distribution along the radius of the magnetic field decay indicator.

Table 3

R			
R-Rc			
$\delta(R)$			
$2R \cdot tg\frac{\alpha_0}{2}$			
n(R)			

Control questions

1. Can the real pole profile be replaced by a straight line?
2. How can I correct the value of the decay index at the calculated radius on an already manufactured electromagnet?
3. Why is the center core made in disc sets?
4. How does the height of blocks A and B, which form the poles of a flat model, affect the accuracy of measuring the distribution $n = f(R)$.

Conclusion. To achieve the intended goal, the student needs to know how the application of this work in practice is carried out, whether he will be able to independently perform related laboratory work, experimental setup schemes in virtual states.

Such algorithmization in carrying out laboratory work is of practical importance. During the experimental performance of laboratory work, the student prepares for independent conduct of similar work: he actively participates in the process itself, makes decisions independently, determines errors, and on the basis of this, independently derives physical patterns.

References:

1. A.A. Detlaf., V.M., Yavorsky. Physics course. Moscow, Higher School. -2002. –S.719.

2. A.K. Mynbaeva, Z. M. Sadvakasova. Innovative Teaching Methods, or How Interesting to Teach: A Study Guide. - 7th ed., Add. - Almaty, 2012. –p. 277-278.

3. V.G. Nechaeva, E.V. Shevchenko, L.K. Voronova, A.V. Korzhuev. Teaching physics at a medical University: history and modernity. Siberian medical journal. No.7, 2010. -p. 36-39.

4. T.A. Tereshko. Innovative education in higher education // Training of highly qualified scientific personnel in the context of innovative development of society: Proceedings of the Intern. scientific-practical. conf. - Minsk: GU "BelISA", 2009. -p. 242-244.

5. E.Kh. Bozorov, L.Kh. Zoirova, Zh.Z. Khusanov, M.Yu. Rakhimova, O.Sh. Togaev. Training of top-level specialists in radiation medicine and its relevance. // XXX International Scientific and Practical Conference: "Modern Science: Topical Issues, Achievements and Innovations". Russia, Anapa. October 24, 2020 -p. 6-9.

6. V.S. Rublev, M.P. Verevkina, M.N. Shabarova. Pedagogical technologies: guidelines. –Omsk, 2008. –p. 96.

7. I.F. Kharlamov. Pedagogy. Mn. University. –2000. -p. 283.

8. R.S. Nemov. Psychology: /Textbook. for students of higher. ped. study. Establishments. - M .: Tumanit, VLADOS-2005. -p. 651.

9. L.N. Muzaffarova, D.I. Kamalova, G.M. Turlibayev. Interactive learning technologies. Study guide. - Navoi: NavSPI, -2021. -p. 89.

10. A.O. Abdurakhmanova, M.A. Kalieva, A.A. Syzdykova and others. Effective teaching methods in a medical university - Methodological recommendations. Ed. 1 / - Astana, 2015. –p. 55.