

**Federal State Autonomous Educational Institution of Higher Education "Moscow  
Institute of Physics and Technology  
(National Research University)"**

**APPROVED**  
**Head of the Phystech School of  
Applied Mathematics and  
Informatics**  
**A.M. Raygorodskiy**

**Practice program**

**course:** Personal Research Project/Научно-исследовательская работа  
**major:** Applied Mathematics and Informatics  
**specialization:** Contemporary Combinatorics/Современная комбинаторика  
центр дополнительного, дополнительного профессионального и онлайн-образован  
Phystech School of Applied Mathematics and Informatics  
**term:** 1  
**qualification:** Master  
**type of practice:** industrial  
**practice method:** mipt-based

Semesters, forms of interim assessment:

2 (spring) - Grading test  
3 (fall) - Exam  
4 (spring) - Grading test

Author of the program: A.M. Raygorodskiy, doctor of physics and mathematical sciences, associate professor, senior researcher

The program was discussed at the Phystech School of Applied Mathematics and Informatics 04.03.2024

## Annotation

Industrial practice - research work - is an integral part of the educational process, designed to ensure a close connection between scientific and theoretical and practical training, to give students practical experience in accordance with the profile of the program.

The purpose of the practice is to obtain professional skills and professional experience. The practice provides practical training for students and is aimed at the formation, consolidation, development of practical skills and competencies in the profile of the educational program.

The practice is carried out in the scientific laboratories of the basic and faculty departments of the Physics and Technology School of Applied Mathematics and Informatics.

### 1. General characteristics of practice

#### Purpose of the course

The purpose of the practice is to acquire professional skills and professional experience in the field of mathematics, physics and information technology. The practice provides practical training for students and is aimed at the formation, consolidation, development of practical skills and competencies in the profile of the educational program.

#### Purpose of practice

The objectives of the practice are:

- Development of professional research thinking of students, the formation of a clear idea of the main professional tasks and ways to solve them;
- formation of the ability to independently perform laboratory, computational research in solving professional problems using modern research methods, modern equipment and computing facilities;
- formation of the ability to competently use modern technologies for collecting information, processing and interpreting the obtained experimental data.

During the period of practice, the student must study:

- Information sources on the topic being developed for the purpose of their use in the performance of the final qualifying work;
  - Methods of analysis and processing of statistical data;
  - Information technologies used in scientific research, software products related to the professional sphere;
  - Requirements for the design of scientific and technical documentation;
- execute:
- Analysis, systematization and generalization of information on the topic of research, including bibliographic work on a given topic using modern information technologies;
  - Comparison of the research results of the object of development with domestic and foreign analogues;
  - Analysis of the scientific and practical significance of the research;
  - a report on the work done.

**Forms of practice:** dispersed

### 2. List of the planned results of the practice

Mastering the discipline is aimed at the formation of the following competencies:

Code and the name of the competence	Competency indicators
UC-1 Use a systematic approach to critically analyze a problem, and develop an action plan	UC-1.3 Develop a step-by-step strategy for achieving a goal, foresee the result of each step, evaluate the overall impact on the planned activity and its participants
UC-2 Able to manage a project through all stages of its life cycle	UC-2.2 Forecast the project outcomes, plan necessary steps to achieve the outcomes, chart the project schedule and monitoring plan
UC-3 Able to organise and lead a team, developing a team strategy to achieve a goal	UC-3.1 Organize and coordinate the work of the project stakeholders and help resolve disputes and conflicts
	UC-3.2 Consider the interests, specific behavior, and diversity of opinions of team members/colleagues/counterparties

a team strategy to achieve a goal	UC-3.3 Foresee the results (consequences) of both individual and collective actions
	UC-3.4 Plan teamwork, distribute tasks to team members, hold discussions of different ideas and opinions
UC-4 Use modern communication tools in the academic and professional field, including those in a foreign language	UC-4.1 Exchange business information in oral and written forms in Russian and at least one foreign language
	UC-4.2 Use the acquired skills to write, translate, and edit various academic texts (abstracts, essays, reviews, articles, etc.)
Gen.Pro.C-1 Address current challenges in fundamental and applied mathematics	UC-4.3 Present the results of academic and professional activities at various academic events, including international conferences
Gen.Pro.C-3 Develop mathematical models and conduct their analysis in the processes of professional problem-solving	UC-4.4 Use modern ICT tools for academic and professional collaboration
Gen.Pro.C-4 Combine and adapt current information and communications technologies (ICTs) to meet professional challenges	Gen.Pro.C-1.2 Consolidate and critically assess professional experience and research findings
Pro.C-1 Become part of a professional community and conduct local research under scientific guidance using methods specific to a particular professional setting	Gen.Pro.C-1.3 Understand interdisciplinary relations in applied mathematics and computer science and apply them in professional tasks
Pro.C-2 Understands and is able to apply modern mathematical apparatus and algorithms, the basic laws of natural science, modern programming languages and software; operating systems and networking technologies in research and applied activities	Gen.Pro.C-3.1 Analyze problems, plan research strategy to achieve solution(s), propose, and combine solution approaches
Pro.C-3 Participate in scholarly discussions, make speeches and presentations (oral, written, and online) on scientific topics, present research materials, proofread, edit, reference scientific works	Gen.Pro.C-3.3 Gain knowledge of analytical and computational methods of problem-solving, understand the limitations for applying the obtained solutions
	Gen.Pro.C-3.4 Gather, expand, and apply mathematical knowledge to solve non-standard problems, including problems in a new, unfamiliar environment or interdisciplinary context
	Gen.Pro.C-4.2 Apply ICTs to solve the task in hand, to draw conclusions, and to evaluate the obtained results
	Gen.Pro.C-4.1 Use ICTs to search and analyze professional information, highlight, structure, format, and present it in the form of analytical reviews with sound conclusions and recommendations
Pro.C-1.1 Apply principles of scientific work, methods of data collection and analysis, ways of argumentation; prepare scientific reviews, publications, abstracts, and bibliographies on research topics in Russian and English	Pro.C-1.1 Apply principles of scientific work, methods of data collection and analysis, ways of argumentation; prepare scientific reviews, publications, abstracts, and bibliographies on research topics in Russian and English
Pro.C-1.3 Use practical knowledge of scientific argumentation when analyzing a research subject area	Pro.C-1.3 Use practical knowledge of scientific argumentation when analyzing a research subject area
Pro.C-2.1 Demonstrate expert knowledge of research basics in the field of ICTs, philosophy and methodology of science, scientific research methods, and apply skills to use them	Pro.C-2.1 Demonstrate expert knowledge of research basics in the field of ICTs, philosophy and methodology of science, scientific research methods, and apply skills to use them
Pro.C-2.2 Demonstrate practical experience of applying methods and digital signal processing algorithms, using the Internet, abstracting, referencing, searching for bibliographic sources, and working with scientific sources	Pro.C-2.2 Demonstrate practical experience of applying methods and digital signal processing algorithms, using the Internet, abstracting, referencing, searching for bibliographic sources, and working with scientific sources
Pro.C-2.3 Use fundamental knowledge in the field of information theory to carry out research tasks	Pro.C-2.3 Use fundamental knowledge in the field of information theory to carry out research tasks
Pro.C-3.1 Learn the basics of scholarly discussion and the forms of verbal scientific communication	Pro.C-3.1 Learn the basics of scholarly discussion and the forms of verbal scientific communication
Pro.C-3.2 Hold an appropriate discussion of ICTs and information systems, ask and answer questions related to a particular scientific subject	Pro.C-3.2 Hold an appropriate discussion of ICTs and information systems, ask and answer questions related to a particular scientific subject
Pro.C-3.3 Participate in student science conferences, hold discussions on IT topics in various formats (face-to-face, online, by correspondence)	Pro.C-3.3 Participate in student science conferences, hold discussions on IT topics in various formats (face-to-face, online, by correspondence)

### 3. List of the planned results of the practice

As a result of studying the course the student should:

know:

- Approaches to the organization of independent and collective research work;
- Principles of organizing experiments and tests;
- Principles of formalizing the results of research work;
- To have an idea of the economic component of scientific research.

be able to:

- to carry out search, processing, analysis and systematization of scientific and technical information, to select methods and means of solving problems set by the research program;
- Perform processing and analysis of the results of experiments and tests;
- Analyze the difficulties arising in research activities and contribute to their resolution;
- to design a solution to a research problem, based on current legal regulations and available resources and restrictions;
- To formalize and present the results of research work.

master:

- The skills of preparing plans and programs for conducting scientific research, technical developments, assignments for performers.

### 4. Practice content

#### 4.1. Main stages of practice

№	Practice stage content	Labor intensity (hours), including independent work
2 semester		
1	Formulation of the problem	500
2	Collection, processing, analysis and systematization of scientific and technical information on the research topic	175
Total AH in 2 semester		675
3 semester		
3	Preparation and conduct of scientific research	500
4	Preparation of interim report	190
Total AH in 3 semester		690
4 semester		
5	Scientific research and analysis of the result	900
6	Preparation of the final report	225
Total AH in 4 semester		1 125
AH in total		2 490

#### 4.2. Work content

Semester: 2 (Spring)

##### 1. Formulation of the problem

Conducting a safety briefing, familiarizing students with the internal regulations. Setting a research task, drawing up a plan of practice, developing a research program.

##### 2. Collection, processing, analysis and systematization of scientific and technical information on the research topic

Study of scientific, periodical (including foreign) literature on the research topic. Selection and justification of the accepted direction of research. Preparation of an analytical review. Formulation of the goals and objectives of the study. Planning experimental research.

Semester: 3 (Fall)

### 3. Preparation and conduct of scientific research

Preparation and implementation of experimental and / or theoretical scientific research within the framework of the task.

### 4. Preparation of interim report

Preparation of an interim report on practice for a semester based on the results of mastering the practice.

Semester: 4 (Spring)

### 5. Scientific research and analysis of the result

Preparation and implementation of scientific research (continuation of the work begun in the previous semester), data processing and analysis of the results.

### 6. Preparation of the final report

Preparation of a report on practice based on the results obtained, presentation at a scientific seminar / meeting of the department.

## 4.3. Practice supervision

The practice is managed by the student's appointed scientific advisor, whose duties include:

- Scientific and educational-methodical management of research work;
- Development of individual tasks for students, performed during the practice period;
- Provision of assistance to students in the development of a plan for conducting research;
- Conducting consultations (research seminar, lectures) on conducting research;
- control over the implementation of the research plan;
- verification of the reporting documentation on the implementation of research work.

Discussion of the plan and intermediate results of research is carried out at the department that prepares students, as well as within the framework of the scientific seminar of the department and organizations with which cooperation is conducted and on the basis of which research can be carried out.

The results of research work should be drawn up in the form of a report and submitted for consideration and approval to the supervisor. Attached to the report (if any) is a list of articles and abstracts of the student's reports published on the topic исследования, а также список докладов и выступлений studying at scientific conferences and seminars. Lists of published works and speeches are accompanied by supporting documents (reprints of articles, photocopies of abstracts, as well as certificates of participation in conferences or the conference program).

Based on the results of the research work, the supervisor gives the student an assessment.

## 5. Description of the material and technical facilities that are necessary for the implementation of the educational process of the course (training module)

To carry out the practice, you need: a workplace in an educational or scientific unit that is a place of practice, a workplace for independent work, containing a personal computer with access to the Internet and the electronic educational environment of the MIPT.

Place of practice: scientific laboratories of the basic and faculty departments of the Physics and Technology School of the Physics and Technology School of Applied Mathematics and Informatics.

## 6. List of the main and additional literature, that is necessary for the course (training module) mastering

Main literature

1. Random Graphs /B. Bollobas ; University of Memphis, Trinity College. Cambridge, Cambridge University Press, 2001

2. Foundations of cryptography%hVolume II%iBasic applications /O. Goldreich ; Weizmann Institute of science. New York, Cambridge University Press, 2009

3. Foundations of cryptography%hVolume I%iBasic tools /O. Goldreich ; Weizmann Institute of science. New York, Cambridge University Press, 2006

Книги выдаются на кафедрах

5. Discrete Mathematics and Application, Springer, 2020, Andrei M. Raigorodskii, Michael Rassias.

6. Trigonometric Sums and Their Applications, Springer, 2020, Andrei M. Raigorodskii, Michael Rassias.

#### Additional literature

1. WOG. Workshop on graphs, networks and their applications [Text], Abstracts (Moscow, Russia, May 14-16, 2018)/The ministry of education and science of the Russian Federation, federal state autonomous institution of higher education "Moscow institute of physics and technology (state university)" (MIPT), -Moscow, MIPT, 2018

2. Python machine learning, Machine learning and deep learning with Python, scikit-learn, and TensorFlow/S. Raschka, V. Mirjalili, -Birmingham ; Mumbai, Packt, 2017

### 7. List of curricular resources for independent work on practice

1. Questel Orbit <https://www.orbit.com/> – объединяет около 100 баз данных, предназначенных специалистам в области патентоведения и широкому кругу исследователей. Основная патентная база FamPat содержит данные 95 патентных ведомств всех регионов мира; патенты объединены в семьи по тематическому признаку.

2. Sage journals – более 100 журналов доступно в полнотекстовом режиме в области естественных наук, техники и медицины.

<https://journals.sagepub.com/action/doSearch?filterOption=allJournal&AllField=research&content=journalTitle&target=titleSearch&pageSize=100&startPage=0>

3. Taylor&Francis journals – более 2000 журналов по всем областям знаний. Журналы разделены по коллекциям в области STM наук (Science, Technology & Medicine) и HSS (Humanities & Social Sciences), а также по более узким, конкретным областям знаний,

<https://www.tandfonline.com/action/doSearch?AllField=research&startPage=&target=titleSearch&content=title>

<http://www.consultant.ru/>

<https://www.fips.ru/>

<https://patents.google.com/>

<https://www.wipo.int/portal/ru/>

### 8. List of web resources that are necessary for the practice mastering

Database:

–Referential-bibliographic and scientometric (bibliometric) database Web of Science Core Collection;

–Abstract and scientometric database (citation index) Scopus.

Electronic libraries:

–RFBR electronic library - <https://www.rfbr.ru/rffi/ru/library>;

–Scientific electronic library - <https://elibrary.ru>.

### 9. Guidelines for students to master the course

The assignment for practice is determined by the supervisor, taking into account the specifics of the research work of the department or the base enterprise. The basis of the content of the student's independent work during the implementation of the practice program is the development of methods, приемов, technologies for analyzing and systematizing scientific and technical information, developing plans and programs for conducting scientific research and acquiring practical skills in carrying out research activities, taking into account the interests and capabilities of the department или базового предприятия, где it is being carried out. When completing an individual assignment, the student must combine practical work on the subject of the assignment with a theoretical study of the issue using the recommended information resources. When working with literary sources, it is recommended to draw up a short synopsis with the obligatory fixation of the bibliographic data of the source. Research work ends with writing a report.

**Assessment funds for practice**

<b>major:</b>	Applied Mathematics and Informatics
<b>specialization:</b>	Contemporary Combinatorics/Современная комбинаторика центр дополнительного, дополнительного профессионального и онлайн-образования "Пуск" Phystech School of Applied Mathematics and Informatics
<b>term:</b>	1
<b>qualification:</b>	Master
Semesters, forms of interim assessment:	
	2 (spring) - Grading test
	3 (fall) - Exam
	4 (spring) - Grading test
<b>Author:</b>	A.M. Raygorodskiy, doctor of physics and mathematical sciences, associate professor, senior researcher

## 1. Competencies formed during the process of studying the practice

Code and the name of the competence	Competency indicators
UC-1 Use a systematic approach to critically analyze a problem, and develop an action plan	UC-1.3 Develop a step-by-step strategy for achieving a goal, foresee the result of each step, evaluate the overall impact on the planned activity and its participants
UC-2 Able to manage a project through all stages of its life cycle	UC-2.2 Forecast the project outcomes, plan necessary steps to achieve the outcomes, chart the project schedule and monitoring plan
UC-3 Able to organise and lead a team, developing a team strategy to achieve a goal	UC-3.1 Organize and coordinate the work of the project stakeholders and help resolve disputes and conflicts
	UC-3.2 Consider the interests, specific behavior, and diversity of opinions of team members/colleagues/counterparties
	UC-3.3 Foresee the results (consequences) of both individual and collective actions
	UC-3.4 Plan teamwork, distribute tasks to team members, hold discussions of different ideas and opinions
UC-4 Use modern communication tools in the academic and professional field, including those in a foreign language	UC-4.1 Exchange business information in oral and written forms in Russian and at least one foreign language
	UC-4.2 Use the acquired skills to write, translate, and edit various academic texts (abstracts, essays, reviews, articles, etc.)
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	UC-4.4 Use modern ICT tools for academic and professional collaboration
Gen.Pro.C-1 Address current challenges in fundamental and applied mathematics	Gen.Pro.C-1.2 Consolidate and critically assess professional experience and research findings
	Gen.Pro.C-1.3 Understand interdisciplinary relations in applied mathematics and computer science and apply them in professional tasks
Gen.Pro.C-3 Develop mathematical models and conduct their analysis in the processes of professional problem-solving	Gen.Pro.C-3.1 Analyze problems, plan research strategy to achieve solution(s), propose, and combine solution approaches
	Gen.Pro.C-3.3 Gain knowledge of analytical and computational methods of problem-solving, understand the limitations for applying the obtained solutions
	Gen.Pro.C-3.4 Gather, expand, and apply mathematical knowledge to solve non-standard problems, including problems in a new, unfamiliar environment or interdisciplinary context
Gen.Pro.C-4 Combine and adapt current information and communications technologies (ICTs) to meet professional challenges	Gen.Pro.C-4.2 Apply ICTs to solve the task in hand, to draw conclusions, and to evaluate the obtained results
	Gen.Pro.C-4.1 Use ICTs to search and analyze professional information, highlight, structure, format, and present it in the form of analytical reviews with sound conclusions and recommendations
Pro.C-1 Become part of a professional community and conduct local research under scientific guidance using methods specific to a particular professional setting	Pro.C-1.1 Apply principles of scientific work, methods of data collection and analysis, ways of argumentation; prepare scientific reviews, publications, abstracts, and bibliographies on research topics in Russian and English
	Pro.C-1.3 Use practical knowledge of scientific argumentation when analyzing a research subject area
Pro.C-2 Understands and is able to apply modern mathematical apparatus and algorithms, the basic	Pro.C-2.1 Demonstrate expert knowledge of research basics in the field of ICTs, philosophy and methodology of science, scientific research methods, and apply skills to use them

laws of natural science, modern programming languages and software; operating systems and networking technologies in research and applied activities	Pro.C-2.2 Demonstrate practical experience of applying methods and digital signal processing algorithms, using the Internet, abstracting, referencing, searching for bibliographic sources, and working with scientific sources
	Pro.C-2.3 Use fundamental knowledge in the field of information theory to carry out research tasks
Pro.C-3 Participate in scholarly discussions, make speeches and presentations (oral, written, and online) on scientific topics, present research materials, proofread, edit, reference scientific works	Pro.C-3.1 Learn the basics of scholarly discussion and the forms of verbal scientific communication
	Pro.C-3.2 Hold an appropriate discussion of ICTs and information systems, ask and answer questions related to a particular scientific subject
	Pro.C-3.3 Participate in student science conferences, hold discussions on IT topics in various formats (face-to-face, online, by correspondence)

## 2. Competency assessment indicators

As a result of studying the course the student should:

### know:

- Approaches to the organization of independent and collective research work;
- Principles of organizing experiments and tests;
- Principles of formalizing the results of research work;
- To have an idea of the economic component of scientific research.

### be able to:

- to carry out search, processing, analysis and systematization of scientific and technical information, to select methods and means of solving problems set by the research program;
- Perform processing and analysis of the results of experiments and tests;
- Analyze the difficulties arising in research activities and contribute to their resolution;
- to design a solution to a research problem, based on current legal regulations and available resources and restrictions;
- To formalize and present the results of research work.

### master:

- The skills of preparing plans and programs for conducting scientific research, technical developments, assignments for performers.

## 3. Student practice reporting

Interim certification in practice is carried out in the form of a differentiated test and an exam.

During the period of practice, the student is obliged:

- Completely fulfill the research plan;
- follow the instructions of the head of research work;
- be responsible for the work performed and its results.

Assessment for industrial practice - research work - is given to the student by the scientific supervisor based on the results of the defense of his work. The defense of research work is carried out in the form of a scientific seminar of the department. When evaluating research work, the following is taken into account:

- implementation of the research plan;
- presentation of research results;
- R&D report of the established form (Appendix 1).

The mark "excellent" (8-10 points) is given if the individual task is completed in full, the student has shown a high level of independence and a creative approach to its implementation.

The mark "good" (5-7 points) is given if the individual task is completed in full, there are some shortcomings in the design of the presented material.

The mark "satisfactory" (3-4 points) is given if the task as a whole is completed, but there are shortcomings in the implementation of individual sections (parts) of the task during practice, there are comments on the design of the collected material.

The mark "unsatisfactory" (1-2 points) is given if the task is completed only partially, there are numerous comments on the design of the collected material.

<b>ОТЧЕТ</b>	
<b>о научно-исследовательской работе за ___ семестр ___ / ___ учебного года</b>	
<b>ФИО обучающегося</b>	
<b>Физтех-школа/факультет, группа</b>	
<b>Базовая организация, кафедра</b>	
<b>Тема НИР</b>	
<b>Текущее состояние НИР за семестр (проданная работа и полученные результаты)</b>	
<b>Итоги НИР за семестр</b>	Доклады на научных конференциях, семинарах (авторы, название доклада и конференции, место проведения)
	Научные публикации (авторы, название работы и издания)
	Участие в конкурсах на лучшую НИР и выставках (авторы, название работы и конкурса (экспоната и выставки))
	Медали, дипломы, грамоты, премии и т.п. на конкурсах на лучшую НИР и на выставках (авторы, название работы и конкурса (экспоната и выставки), вид награды)
	Проекты, поданные на конкурсы грантов (авторы, название и вид гранта)
	Полученные гранты (авторы, название и вид гранта)
	Другое (заявки и охранные документы на объекты интеллектуальной собственности, проданные лицензии на их использование, стипендии Президента и Правительства РФ и т.п.)
<b>Материальная поддержка НИР обучающегося за семестр (с указанием источника финансирования)</b>	
<b>План работы на следующий семестр</b>	
<b>Отзыв научного руководителя</b>	
<b>Рекомендованная оценка НИР обучающегося за семестр</b>	

Обучающийся \_\_\_\_\_ дата составления отчета \_\_\_\_\_

Научный руководитель \_\_\_\_\_ /ФИО/

Зав. кафедрой \_\_\_\_\_ /ФИО/