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

APPROVED
Head of Landau Phystech-School of Physics & Research
A.V. Rogachev

Practice program

course:	Personal Research Project/Научно-исследовательская работа
major:	Photonics and Optical Informatics
specialization:	Photonics, Quantum Technologies & 2D Materials/Фотоника, квантовые технологии и двумерные материалы
	Физтех-школа физики и исследований им. Ландау
	Chair of the Russian Quantum Centre
term:	1
qualification:	Master
type of practice:	industrial
practice method:	mipt-based

Semesters, forms of interim assessment:

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

Author of the program: G.V. Shlyapnikov, doctor of physics and mathematical sciences

The program was discussed at the Chair of the Russian Quantum Centre 04.04.2022

Annotation

At the Russian Quantum Center students can choose a promising topic of research work, solve relevant theoretical and experimental problems under the guidance of experienced mentors, work on advanced equipment, which has no analogues in Russia and sometimes in the world, participate in conferences and interact with the international scientific community.

Graduate research is often a continuation of the work begun at the undergraduate level and serves as a preparatory stage for the PhD dissertation at the graduate level. Practice begins with the choice of supervisor and research topics, detailed study of the literature, and then begins independent research, the results of which are presentations at conferences, publications in scientific journals and writing a master's degree at the end of the 12th semester.

Research work is carried out in scientific laboratories of the basic department at the Russian Quantum Center. At the end of each semester students submit a report and a written report signed by their supervisor.

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 development of supersensitive sensors, solid-state photomultipliers, femtosecond lasers, supersensitive magnetic cardiograph and others, intended for financial, telecommunications, medical and other industries. The main development is a quantum communication system for absolutely secure transmission of information in banking, military, government and other spheres.

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-1.1 Systematically analyze the problem situation, identify its components and the relations between them
	UC-1.2 Search for solutions by using available sources
	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 Manage all stages of a research project	UC-2.1 Set an objective within a defined scientific problem; formulate the agenda, relevance, significance (scientific, practical, methodological, or other depending on the project type), forecast the expected results and possible areas of their application
	UC-2.2 Forecast the project outcomes, plan necessary steps to achieve the outcomes, chart the project schedule and monitoring plan
	UC-2.3 Organize and coordinate the work of project stakeholders, provide the team with necessary resources
	UC-2.4 Publicly present the project results (or results of its stages) via reports, articles, presentations at scientific conferences, seminars, and similar events
UC-3 Organize and manage a team and develop the team strategy to achieve the objectives	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 fields, including those in a foreign language	UC-4.3 Present the results of academic and professional activities in various academic events, including international conferences
	UC-4.4 Use modern ICT tools for academic and professional collaboration
	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.)
UC-6 Determine priorities and ways to improve performance through self-assessment	UC-6.1 Achieve personal growth and professional development, determine priorities and ways to improve performance
	UC-6.2 Evaluate performance results in correlation with the set objectives and applied methods
Gen.Pro.C-1 Gain fundamental scientific knowledge in the field of physical and mathematical sciences	Gen.Pro.C-1.1 Apply fundamental scientific knowledge in the field of physical and mathematical sciences
	Gen.Pro.C-1.2 Able to summarise and critically evaluate experiences and research results in the field of photonics and opto-informatics
	Gen.Pro.C-1.3 Understands the interdisciplinary links in mathematics and physics and is able to apply them to problems in photonics and opto-informatics
Gen.Pro.C-2 Acquire an understanding of current scientific and technological challenges in professional settings, and scientifically formulate professional objectives	Gen.Pro.C-2.1 Has an understanding of the current state of research in photonics and opto-informatics
	Gen.Pro.C-2.2 Assess the relevance and practical importance of research in professional settings
	Gen.Pro.C-2.3 Understand professional terminology used in modern scientific and technical literature and present scientific results in oral and written form within professional communication
Gen.Pro.C-3 Select and/or develop approaches to professional problem-solving with consideration to the limitations and specifics of different solution	Gen.Pro.C-3.1 Analyze problems, plan research strategy to achieve solution(s), propose, and combine solution approaches
	Gen.Pro.C-3.2 Employ research methods to solve new problems, and apply knowledge from various fields of science (technology)

methods	Gen.Pro.C-3.3 Gain knowledge of analytical and computational methods of problem-solving, understand the limitations for applying the obtained solutions in practice
Gen.Pro.C-4 Successfully perform a task, analyze the results and present conclusions, apply knowledge and skills in the field of physical and mathematical sciences and ICTs	Gen.Pro.C-4.1 Apply ICT knowledge and skills to find and study scientific literature and use software products
	Gen.Pro.C-4.2 Apply knowledge in the field of physical and mathematical sciences to solve problems, make conclusions, and evaluate the obtained results
	Gen.Pro.C-4.3 Justify the chosen method of scientific research
Gen.Pro.C-5 Undertake professional training, achieve professional growth, and become a team leader in a professional sphere, tolerant of social, ethnic, religious and cultural differences	Gen.Pro.C-5.1 Tolerate social, ethnic, religious, and cultural differences in teamwork
	Gen.Pro.C-5.2 Manage a small professional team
	Gen.Pro.C-5.3 Apply new knowledge and achieve personal and professional growth
Pro.C-1 Assign, formalize, and solve tasks, develop and research mathematical models of the studied phenomena and processes, systematically analyze scientific problems and obtain new scientific results	Pro.C-1.1 Locate, analyze, and summarize information on current research findings within a selected subject field
	Pro.C-1.2 Make hypotheses, build mathematical models of the studied phenomena and processes, evaluate the quality of the developed model
	Pro.C-1.3 Able to apply theoretical and/or experimental research methods in photonics and opto-informatics to a specific scientific problem and interpret the results obtained
Pro.C-2 Organize and conduct scientific research and testing independently or as a member (leader) of a small research team	Pro.C-2.1 Able to plan and carry out research in photonics and opto-informatics independently or as part of a research team
	Pro.C-2.2 Conduct tests of research results through scientific publications and participation in conferences
Pro.C-3 Professionally use research and testing equipment (devices and installations, specialized software) in a selected subject field	Pro.C-3.1 Understand the operating principles of the equipment and specialized software
	Pro.C-3.2 Conduct an experiment (simulation), using research equipment (software)
	Pro.C-3.3 Evaluate the accuracy of the experimental (numerical) results

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
1 semester		
1	Formulation of the problem	35
2	Collection, processing, analysis and systematization of scientific and technical information on the research topic	335
3	Preparation and conduct of scientific research	425
4	Preparation of interim report	15
Total AH in 1 semester		810
2 semester		
5	Scientific research and analysis of the result	795
6	Preparation of interim report	15
Total AH in 2 semester		810
3 semester		
7	Scientific research and analysis of the result	1 215
8	Preparation of interim report	15
Total AH in 3 semester		1 230
4 semester		
9	Scientific research and analysis of the result	1 155
10	Preparation of the final report	15
Total AH in 4 semester		1 170
AH in total		4 020

4.2. Work content

Semester: 1 (Fall)

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.

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: 2 (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 interim report

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

Semester: 3 (Fall)

7. 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.

8. 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)

9. 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.

10. 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 of studies as well as list of reports on 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 department at the Russian Quantum Center.

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

Main literature

1. Подготовка и защита бакалаврской работы, магистерской диссертации, дипломного проекта [Электронный ресурс], учеб. пособие / Ю. Н. Новиков. — СПб., Лань, 2019.— URL: https://e.lanbook.com/book/122187 (дата обращения: 29.01.2021). - Полный текст (Режим доступа : из сети МФТИ / Удаленный доступ)

Additional literature

1. Искусство писать научные статьи, научно-практическое руководство / Е. З. Мейлихов. — Долгопрудный, Интеллект, 2020.— URL: http://books.mipt.ru/book/301312 (дата обращения: 18.12.2020). - Полный текст (Режим доступа : из сети МФТИ / Удаленный доступ)

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. Inspec Analytics – аналитический модуль базы данных Inspec https://inspec-analytics-app.theiet.org/. Inspec Analytics позволяет визуализировать результаты поиска, сравнивать полученные результаты на уровне учреждений, авторов, тематик по количеству публикаций.
3. 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
4. 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
5. Сайт кафедры: https://rqc.ru/education

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 cource

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 departmentили 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.

SUPPLEMENT

Assessment funds for practice

major:	Photonics and Optical Informatics
specialization:	Photonics, Quantum Technologies & 2D Materials/Фотоника, квантовые технологии и двумерные материалы Физтех-школа физики и исследований им. Ландау Chair of the Russian Quantum Centre
term:	1
qualification:	Master

Semesters, forms of interim assessment:

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

Author: G.V. Shlyapnikov, doctor of physics and mathematical sciences

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-1.1 Systematically analyze the problem situation, identify its components and the relations between them
	UC-1.2 Search for solutions by using available sources
	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 Manage all stages of a research project	UC-2.1 Set an objective within a defined scientific problem; formulate the agenda, relevance, significance (scientific, practical, methodological, or other depending on the project type), forecast the expected results and possible areas of their application
	UC-2.2 Forecast the project outcomes, plan necessary steps to achieve the outcomes, chart the project schedule and monitoring plan
	UC-2.3 Organize and coordinate the work of project stakeholders, provide the team with necessary resources
	UC-2.4 Publicly present the project results (or results of its stages) via reports, articles, presentations at scientific conferences, seminars, and similar events
UC-3 Organize and manage a team and develop the team strategy to achieve the objectives	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 fields, including those in a foreign language	UC-4.3 Present the results of academic and professional activities in various academic events, including international conferences
	UC-4.4 Use modern ICT tools for academic and professional collaboration
	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.)
UC-6 Determine priorities and ways to improve performance through self-assessment	UC-6.1 Achieve personal growth and professional development, determine priorities and ways to improve performance
	UC-6.2 Evaluate performance results in correlation with the set objectives and applied methods
Gen.Pro.C-1 Gain fundamental scientific knowledge in the field of physical and mathematical sciences	Gen.Pro.C-1.1 Apply fundamental scientific knowledge in the field of physical and mathematical sciences
	Gen.Pro.C-1.2 Able to summarise and critically evaluate experiences and research results in the field of photonics and opto-informatics
	Gen.Pro.C-1.3 Understands the interdisciplinary links in mathematics and physics and is able to apply them to problems in photonics and opto-informatics
Gen.Pro.C-2 Acquire an understanding of current scientific and technological challenges in	Gen.Pro.C-2.1 Has an understanding of the current state of research in photonics and opto-informatics
	Gen.Pro.C-2.2 Assess the relevance and practical importance of research in professional settings

professional settings, and scientifically formulate professional objectives	Gen.Pro.C-2.3 Understand professional terminology used in modern scientific and technical literature and present scientific results in oral and written form within professional communication
Gen.Pro.C-3 Select and/or develop approaches to professional problem-solving with consideration to the limitations and specifics of different solution methods	Gen.Pro.C-3.1 Analyze problems, plan research strategy to achieve solution(s), propose, and combine solution approaches
	Gen.Pro.C-3.2 Employ research methods to solve new problems, and apply knowledge from various fields of science (technology)
	Gen.Pro.C-3.3 Gain knowledge of analytical and computational methods of problem-solving, understand the limitations for applying the obtained solutions in practice
Gen.Pro.C-4 Successfully perform a task, analyze the results and present conclusions, apply knowledge and skills in the field of physical and mathematical sciences and ICTs	Gen.Pro.C-4.1 Apply ICT knowledge and skills to find and study scientific literature and use software products
	Gen.Pro.C-4.2 Apply knowledge in the field of physical and mathematical sciences to solve problems, make conclusions, and evaluate the obtained results
	Gen.Pro.C-4.3 Justify the chosen method of scientific research
Gen.Pro.C-5 Undertake professional training, achieve professional growth, and become a team leader in a professional sphere, tolerant of social, ethnic, religious and cultural differences	Gen.Pro.C-5.1 Tolerate social, ethnic, religious, and cultural differences in teamwork
	Gen.Pro.C-5.2 Manage a small professional team
	Gen.Pro.C-5.3 Apply new knowledge and achieve personal and professional growth
Pro.C-1 Assign, formalize, and solve tasks, develop and research mathematical models of the studied phenomena and processes, systematically analyze scientific problems and obtain new scientific results	Pro.C-1.1 Locate, analyze, and summarize information on current research findings within a selected subject field
	Pro.C-1.2 Make hypotheses, build mathematical models of the studied phenomena and processes, evaluate the quality of the developed model
	Pro.C-1.3 Able to apply theoretical and/or experimental research methods in photonics and opto-informatics to a specific scientific problem and interpret the results obtained
Pro.C-2 Organize and conduct scientific research and testing independently or as a member (leader) of a small research team	Pro.C-2.1 Able to plan and carry out research in photonics and opto-informatics independently or as part of a research team
	Pro.C-2.2 Conduct tests of research results through scientific publications and participation in conferences
Pro.C-3 Professionally use research and testing equipment (devices and installations, specialized software) in a selected subject field	Pro.C-3.1 Understand the operating principles of the equipment and specialized software
	Pro.C-3.2 Conduct an experiment (simulation), using research equipment (software)
	Pro.C-3.3 Evaluate the accuracy of the experimental (numerical) results

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.

ОТЧЕТ
о прохождении производственной практики научно-исследовательская работа
наименование практики

____ семестр, ____/____ учебный год

ФИО обучающегося	
Физтех-школа, группа	
Место прохождения практики	
Задание на практику	
Отчет (проделанная работа и полученные результаты)	
Отзыв руководителя о работе обучающегося	
Оценка за работу обучающегося, рекомендуемая руководителем	

Обучающийся _____ дата составления отчета _____
Контактный телефон: 8-9__-___-__-__

Руководитель практики _____ /_____/
Контактный телефон: 8-9__-___-__-__ e-mail:
Зав. кафедрой _____ /_____/