Federal State Autonomous Institution of Higher education

Peoples' Friendship University of Russia

Academy of Engineering

WORKING PROGRAM OF PRACTICE

Practice: Pre-Graduation Internship in Industry / Технологическая практика

Type of practice: Industrial internship

Direction of preparation:

01.04.02 Applied Mathematics and Computer Science

Profile / specialization:

Space Mission and System Design

Moscow,

2021

1. The purpose and objectives of the practice

Pre-Graduation Internship in Industry is an industrial internship and is aimed at deepening, systematizing and consolidating theoretical knowledge, as well as at obtaining professional skills in the field of scientific research in solving practical problems related to the field of applied mathematics and informatics, computer technology and modern programming technologies, as well as in the field of application of this toolkit with a professional focus on the study of mathematical methods and information technologies for ballistic design and application of Earth Remote Sensing space systems and Geoinformation systems. The objectives of the externship are: collection, processing and analysis of raw data (including specialized remote sensing data - remote sensing data) necessary for the development of the master's thesis; formation and development of practical skills and competencies of the master in thematic processing of remote sensing data and use of GIS-technologies, gaining experience in independent scientific and practical professional activities; consolidation and enhancement of theoretical knowledge on the studied disciplines; formation of the master's skills in the development of the master's thesis; development of the master's work on the thematic processing of remote sensing data.

The main tasks of the practice are to develop skills in the use of modern scientific methods for solving scientific and practical problems in the field of ballistic design and Earth remote sensing (ERS) data-based space products and services development.

2**. Place of practice in the structure of OBOP VO**

Pre-Graduation Internship in Industry belongs to the variable component of Block 2 of the curriculum. Requirements for input knowledge and skills: universal, general professional and professional competencies obtained by students as a result of mastering the EP of the master's program "Space Mission and System Design" in the direction 01.04.02 "Applied Mathematics and Computer Science". For Pre-Graduation Internship in Industry practice, graduate students must fully master the disciplines of the basic and variable parts of the curriculum. Of particular importance is the implementation of term papers and research work under the supervision of the student's supervisor. The program of Pre-Graduation Internship in Industry for each student is formed individually and is determined by the student's supervisor

Table 1 - List of previous and subsequent disciplines / practices

Code	Preceding disciplines / practices	Subsequent disciplines
All competences	All disciplines of Block 1 of the curriculum and all trainings	Master's Thesis Preparation / Преддипломная практика
		Master's Thesis Preparation / Преддипломная практика

3**. Ways of conducting the practice**

The ways of doing practical training are:

- stationary;

- field practice.

4. Scope of practice and types of educational work

Table 2 - Scope of practice and types of educational work

Type of educational work	Total, ac. hours	3 module

Contact work of the student with the teacher, including control		64	64
Other forms of educational work, including keeping a diary of practice and preparing a report for students		260	260
Type of certification test			Graded credit
Total labor intensity	academic hours	324	324
	credit units	9	9
Duration of practice	weeks	6	6

5. Place of practice

The place of internship is provided to the student by the head of the internship on the basis of the relevant agreements concluded with the basic organizations.

Students undergo practical training at the Keldysh Institute of Applied Mathematics. Students undergo practical training at the Keldysh Institute of Applied Mathematics and the Institute of Space Research of the Russian Academy of Sciences (RAS); at the enterprises of the State Corporation "Roscosmos" - in the Mission Control Center of JSC "Central Research Institute of Mechanical Engineering", JSC "Scientific and Production Corporation "Precision Instrumentation Systems", JSC "Scientific and Production Corporation "Space Monitoring Systems, Information and Control and Electromechanical Complexes" named after A.G. Iosifian"; at the Research Institute of Aerospace Monitoring "AEROCOSMOS" of the Ministry of Defense of Russia. A.G. Iosifjan; in the Research Institute of Aerospace Monitoring "AEROCOSMOS" of the Ministry of Education and Science of Russia and the Russian Academy of Sciences; in the M.F. Stelmakh Pole Research Institute) of Rostec State Corporation, in the UNIDO Center for International Industrial Cooperation in the Russian Federation.

The student can come up with an initiative about the place of an internship. The direction of the professional activity of the organization offered to students for internship must correspond to the profile of the educational program and the types of professional activity for which the graduate of the program is preparing. The place of the internship must be agreed with the head of the department with the subsequent (with a positive decision) conclusion of an appropriate contract with the organization proposed by the student.

Students with disabilities and / or those belonging to the category of "disabled" do practical training, in a form accessible to them in the laboratories of the university, as well as in specialized organizations with which the relevant agreements was concluded and which have the opportunity (equipment, special means and infrastructure) to work with these categories of citizens.

6. The list of the planned results of the internship, correlated with the planned results of the development of the educational program

Pre-Graduation Internship in Industry is aimed at developing the following competencies among students:

Universal competences:

Competence	Indicators of competence achievement
UC-1. Able to carry out a critical analysis of problem situations based on a systematic approach, to develop an action strategy.	UC-1.1 Knows how to collect, select and summarise information. UC-1.2 Can relate heterogeneous phenomena and systematise them within selected professional activities. UC-1.3 Has practical experience in working with information sources, experience in scientific research, scientific text production.
UC-2. Able to manage a project at all stages of its life cycle.	UC-2.1 Is aware of the legal regulations necessary for the implementation of professional activities. UC-2.2 Can identify the type of tasks within selected professional activities, plan own activities on the basis of available resources; correlate the main and the secondary, solve the tasks within selected professional activities. UC-2.3 Has practical experience in the application of the regulatory framework and problem solving in the area of selected professional activities.
UC-2. Able to organize and manage the work of the team, developing a team strategy to achieve the goal.	UC-3.1 Knows the different techniques and methods of personal socialisation and social interaction. UC-3.2 Can build relationships with others and with colleagues. UC-3.3 Has practical experience of participation in teamwork, social projects, patronage or volunteering activities, experience of role allocation in a team environment.
UC-4. Able to apply modern communication technologies in the state language of the Russian Federation and foreign language(s) for academic and professional interaction.	UC-4.1 Knows the literary form of the state language, the basics of oral and written communication in a foreign language, the functional styles of the native language. UC-4.2 Can express his/her thoughts in the state language, mother tongue and foreign language in a business communication situation. UC-4.3 Has practical experience in composing texts of different functional affiliation and different genres in the state language and native language, experience in translating texts from foreign language to native language, experience in speaking in state language and foreign language.
UC-5. Able to analyze and take into account the diversity of cultures in the process of intercultural interaction.	UC-5.1 Knowledge of basic categories of philosophy, laws of historical development, fundamentals of intercultural communication. UC-5.2 Can communicate with representatives of other nationalities and confessions while respecting aesthetic and historical facts, experience in aesthetic evaluation of cultural phenomena.

	UC-5.3 Has practical experience in analysis of philosophical and historical facts, experience in aesthetic evaluation of cultural phenomena.
UC-6. Able to identify and implement the priorities of their own activities and ways to improve it based on self-assessment.	C-6.1 Knows the basic principles of self-education and self-education, professional and personal development, based on career stages and labour market requirements. UC-6.2 Can plan his/her working time and time for self-development. Formulate personal and professional development goals and the conditions for achieving them based on professional development trends and individual and personal characteristics. UC-6.3 Has practical experience in obtaining additional education, studying additional educational programmes.
UC-7. Able to search for the necessary sources of information and data, perceive, analyze, memorize and transmit information using digital means, as well as using algorithms when working with data obtained from various sources in order to effectively use the information received to solve problems; evaluate information, its reliability, build logical conclusions based on incoming information and data.	UC-7.1 Knows how to use digital technology to gather, select and summarise information. UC-7.2 Can apply digital technologies to search, process, analyse, store and present information in applied mathematics and computer science. UC-7.3 Has the skills to apply digital technologies and methods for searching, processing, analyzing, storing and presenting information in applied mathematics and computer science.

General professional competencies:

Competence	Indicators of competence achievement
GPC-1. Able to solve actual problems of fundamental and applied mathematics.	GPC-1.1 Analyse problems in basic and applied mathematics. GPC-1.2 Formulates research problems. GPC-1.3 Solves relevant problems in basic and applied mathematics.
GPC-2. Able to improve and implement new mathematical methods for solving applied problems.	GPC-2.1 Uses results of applied mathematics to learn, adapt new methods for solving problems in the area of professional interest. GPC-2.2 Implements and improves new methods for solving applied problems in the area of professional interest. GPC-2.3 Performs qualitative and quantitative analysis of the obtained solution in order to construct an optimal variant.
GPC-3. Able to develop mathematical models and analyze them when solving problems in the field of professional activity.	GPC-3.1 Develops mathematical models in applied mathematics and computer science. GPC-3.2 Analyse mathematical models to solve applied professional problems. GPC-3.3 Develops and analyses new mathematical models to solve applied problems in applied mathematics and computer science.

GPC-4. Able to combine and adapt existing ones; information and communication technologies for solving problems in the field of professional activity, taking into account the requirements of information security.	GPC-4.1 Analyse applied mathematics and computer science problems using information technology. GPC-4.2 Consider basic information security requirements. GPC-4.3 Uses modern information and communication technologies to solve problems in Applied Mathematics and Computer Science, taking into account information security requirements.

Professional competences:

Competence	Indicators of competence achievement
PC-1. Able to formulate goals, tasks of scientific research in applied mathematics and computer science, computer engineering and modern programming technologies, to choose methods and means of problem solving.	PC-1.1. Has a fundamental knowledge of mathematics and/or science, programming and information technology. PC-1.2. Can identify, formulate and solve standard problems in his/her own research activities in the area of applied mathematics and computer science, computer science and modern programming technologies. PC-1.3 Has practical experience of research activities in applied mathematics and computer science, computer science and modern programming technologies.
PC-2. Able to apply modern theoretical and experimental methods to develop mathematical models of investigated objects and processes related to professional activity in the field of training and to participate in their implementation in the form of software products.	PC- 2.1 Knows modern theoretical and experimental methods for developing mathematical models, innovative design tools and elements of information systems architecture PC- 2.2 Can design and implement mathematical model algorithms based on simulation languages and application packages PC- 2.3 Has practical experience in developing implementation options for information systems using innovative tools.
PC-3. Able to analyse, including in English, the technical solutions worked out and applied, as well as to upgrade the technical solutions for the development of a ground-based automated spacecraft control system.	PC- 3.1 Knows the established and applied technical solutions, including those from English language sources, for developing a ground based automated spacecraft control system. PC- 3.2 Can develop and upgrade technical solutions for the development of ground-based automated spacecraft control system. PC- 3.3 Skills in the development of ground based automated spacecraft control system.
PC-4. Able to carry out work and research on the application of mathematical methods and information technology to the ballistic design of space complexes and systems.	PC- 4.1 Knows the basic concepts in the application of mathematical methods and information technology. PC- 4.2. Will be able to apply mathematical methods and information technologies in the area of ballistic design of space systems and systems. PC- 4.3 Has practical experience in ballistic design of space complexes and systems.
PC-5. Able to participate in the development of a unified software environment, organisation and control of the software development process of	PC- 5.1 Knows modern design tools and elements of information systems architecture. PC- 5.2 Has basic knowledge of standards, norms and rules for the development of technical documentation of software products and software systems, knows the

Competence	Indicators of competence achievement
information systems, automated spacecraft control system and preparation of software documentation.	requirements for the development of the terms of reference for the conceptual design of a unified software environment and the logic of ground-based automated spacecraft control system. PC- 5.3 Will be able to analyze normative and technical documentation for the development of software documentation for components of ground-based automated spacecraft control system. PC- 5.4 Manage the development and approval of software documentation
PC-6. Able to carry out work and research on the processing and analysis of scientific and technical information in the application of mathematical methods and information technology for the creation of space products and the provision of space services based on the use of remote sensing data and geographic information systems.	PC- 6.1 Knows the fundamental principles of remote sensing, basic concepts in the application of mathematical methods and information technology of remote sensing systems, knows the theory and methodology for creating thematic information products and providing services based on the use of remote sensing data. PC- 6.2 Can solve analytical problems, can use geographic information system software packages, understands the big data approach and basic processing workflows, can use remote sensing materials and geographic information technology in modelling and interpretation of interpretation results. PC- 6.3 Has the skills to create space products and provide space based data from remote sensing and geographic information systems.

The result of the practice is knowledge, skills, abilities and experience of professional activity, which characterize the stages of the formation of competencies and ensure the achievement of the planned results of mastering the educational program, presented in Table 3.

Table 3 - Learning outcomes in the discipline, correlated with the planned results of mastering OBEP HE

Competence	**Knowledge**	**Practice**	**Skills**
1	2	3	4
UC-1. Able to carry out a critical analysis of problem situations based on a systematic approach, to develop an action strategy.	Know the methods of generalization, analysis and critical understanding of information in order to systematize it, and predict the results of research tasks	Be able to analyze, synthesize and critically summarize information about the research object	Possess the techniques of generalization, analysis and critical understanding of information when setting research tasks and choosing ways to solve them in order to acquire new knowledge and skills
UC-2. Able to manage a project at all stages of its life cycle.	Know the methods of organizing research and design work and managing the team during their implementation	Be able to use in practice the methods of organizing research and design work	Have the skills to develop plans and programs for innovative activities at the enterprise.

UC-2. Able to organize and manage the work of the team, developing a team strategy to achieve the goal.	To know the main forms of activity of the head of the department, the leader of the group of employees for the formation of the goals of the team and the adoption of organizational and managerial decisions	Be able to accumulate, structure existing knowledge and find ways to solve complex professional problems	Possess the methodology for presenting the results of one's own and collective scientific research during their discussions
UC-4. Able to apply modern communication technologies in the state language of the Russian Federation and foreign language(s) for academic and professional interaction.	forms and methods of organizing scientific and bibliographic search (including in electronic catalogs and via the Internet);	navigate scientific, industrial and social and social spheres of activity	Possess the methodology of working with scientific literature
UC-5. Able to analyze and take into account the diversity of cultures in the process of intercultural interaction.	Know the place and role of representatives of different cultures in the process of intercultural interaction	Be able to find a common language with representatives of different cultures in the process of intercultural interaction	Have the skills of independent research activities in a professional field based on taking into account scientific interests with representatives of different cultures
UC-6. Able to identify and implement the priorities of their own activities and ways to improve it based on self-assessment.	Know the place and role of your professional activity, ways of developing your area of professional activity, directions for improving and developing your intellectual and general cultural level	Be able to implement new ideas in theoretical and experimental research	Possess methods of collecting and analyzing scientific and technical information in order to use it to solve professional problems
UC-7. Able to search for the necessary sources of information and data, perceive, analyze, memorize and transmit information using digital means, as well as using algorithms when working with data obtained from	Know modern information technologies and computer tools for conducting scientific research and assessing their results	Be able to apply computer modeling methods in scientific and professional activities	Be proficient in software development techniques. Possess modern software testing techniques. Have the skills to use software when carrying out design, engineering and design work

various sources in order to effectively use the information received to solve problems; evaluate information, its reliability, build logical conclusions based on incoming information and data.			
GPC-1. Able to solve actual problems of fundamental and applied mathematics.	Know the methods of the studied disciplines of the curriculum and new directions of development in the field of fundamental and applied mathematics	Formulate and solve problems arising in the course of writing a scientific article or analytical review; analyze and organize the collected material.	Use the results of mastering the disciplines of the master's program to solve urgent problems of fundamental and applied mathematics
GPC-2. Able to improve and implement new mathematical methods for solving applied problems.	modern theoretical and experimental methods for the development of mathematical models of the objects and processes under study	Application of modern methods for the development of mathematical models of the objects and processes under study.	Development of mathematical models of the studied objects and processes related to professional activities in the direction of training
GPC-3. Able to develop mathematical models and analyze them when solving problems in the field of professional activity.	Develops mathematical models in applied mathematics and computer science	Analyse mathematical models to solve applied professional problems	Develops and analyses new mathematical models to solve applied problems in applied mathematics and computer science
GPC-4. Able to combine and adapt existing ones; information and communication technologies for solving problems in the field of professional activity, taking into account the requirements of information security.	Know the existing information and communication technologies, taking into account the requirements of information security	Be able to use in practice existing information and communication technologies to solve problems in the field of professional activity	Possess the skills of developing mathematical models of the objects and processes under study related to professional activity in the field of training, combine and adapt existing information and communication technologies to solve problems in the field of professional activity, taking into account the requirements of information security

PC-1. Able to formulate goals, tasks of scientific research in applied mathematics and computer science, computer engineering and modern programming technologies, to choose methods and means of problem solving.	Has a fundamental knowledge of mathematics and/or science, programming and information technology	Can identify, formulate and solve standard problems in his/her own research activities in the area of applied mathematics and computer science, computer science and modern programming technologies	Has practical experience of research activities in applied mathematics and computer science, computer science and modern programming technologies
PC-2. Able to apply modern theoretical and experimental methods to develop mathematical models of investigated objects and processes related to professional activity in the field of training and to participate in their implementation in the form of software products.	Knows modern theoretical and experimental methods for developing mathematical models, innovative design tools and elements of information systems architecture	Can design and implement mathematical model algorithms based on simulation languages and application packages	Has practical experience in developing implementation options for information systems using innovative tools
PC-3. Able to analyze, including in English, the technical solutions worked out and applied, as well as to upgrade the technical solutions for the development of a ground-based automated spacecraft control system.	Knows the established and applied technical solutions, including those from English language sources, for developing a ground based automated spacecraft control system	Can develop and upgrade technical solutions for the development of ground-based automated spacecraft control system	Skills in the development of ground based automated spacecraft control system
PC-4. Able to carry out work and research on the application of mathematical methods and information technology to the ballistic design of space complexes and systems.	Knows the basic concepts in the application of mathematical methods and information technology	Will be able to apply mathematical methods and information technologies in the area of ballistic design of space systems and systems	Has practical experience in ballistic design of space complexes and systems
PC-5. Able to participate in the development of a unified software environment,	Knows modern design tools and elements of information systems architecture.	Will be able to analyze normative and technical documentation for the development of	Manage the development and approval of software documentation

organisation and control of the software development process of information systems, automated spacecraft control system and preparation of software documentation.	Has basic knowledge of standards, norms and rules for the development of technical documentation of software products and software systems, knows the requirements for the development of the terms of reference for the conceptual design of a unified software environment and the logic of ground-based automated spacecraft control system	software documentation for components of ground-based automated spacecraft control system	
PC-6. Able to carry out work and research on the processing and analysis of scientific and technical information in the application of mathematical methods and information technology for the creation of space products and the provision of space services based on the use of remote sensing data and geographic information systems.	Knows the fundamental principles of remote sensing, basic concepts in the application of mathematical methods and information technology of remote sensing systems, knows the theory and methodology for creating thematic information products and providing services based on the use of remote sensing data	Can solve analytical problems, can use geographic information system software packages, understands the big data approach and basic processing workflows, can use remote sensing materials and geographic information technology in modelling and interpretation of interpretation results	Has the skills to create space products and provide space-based data from remote sensing and geographic information systems

7. Structure and content of practice

№ п/п	Practice stages	Types of work carried out by students	Educational work on forms, academic hours		**Total , ac.h.**
			Contact work	Other forms of educational work	

1	Organizational and preparatory	Receiving an individual assignment for practice from a supervisor	2	-	2
2		Workplace safety briefing (laboratory and / or production)	2	-	2
3	Main	Study of educational and scientific literature on the topics selected at the previous stage;	18	82	100
4		Development of a mathematical model to solve the problem; Conducting scientific research within the framework of the constructed mathematical model Development of a software package (PC) that implements the solution of the problem	20	80	100
5		Selection of initial data for the experiment Conducting the experiment	2	80	82
…		Processing of results	2	-	2
		Analysis of experimental results	16		16
		Preparation, if necessary, of materials for public presentation of research results at a conference, scientific seminar, in a peer-reviewed periodical			
….		Keeping an internship diary	-	8	8
….	Reporting	Preparing an internship report	-	10	10
….		Intermediate attestation (preparation for protection and protection of the report)	2	-	2
		TOTAL:	**64**	**260**	**324**

For students from among persons with disabilities and / or belonging to the category of "disabled", if necessary, the head of the practice develops individual tasks, a plan and procedure for passing the practice, taking into account the peculiarities of their psychophysical development, individual capabilities and health status, an educational program adapted for these students (if any) and in accordance with individual rehabilitation programs for the disabled.

8. Educational, research and scientific-production technologies used in practice

In the process of doing undergraduate practice, the following educational technologies are used:
- contact work of a student with a teacher, which consists in receiving an individual assignment, undergoing safety instructions, receiving advice on internship issues, filling out current and reporting documentation, as well as protecting a report on internship;
- other forms of educational work (educational activities), which include the main activity of the student on the implementation of sections of practice in accordance with the individual task, recommended methods and literature sources, aimed at the formation of certain professional skills or experience of professional activity provided for by the practice program, as well as filling out the current and reporting documentation, and preparing for the defense of the report on the passage of internship.

During the internship, the following research and development technologies are used:
- mastering the methods of analysis of information and interpretation of the results of research activities by students;
- execution of written analytical and calculation tasks within the framework of practice using recommended information sources;
- the use of various computer software products for graphic, analytical and / or industrial purposes (depending on the place of internship and the specifics of the task);
- use by students of various electronic libraries and reference legal systems, etc.

9. Methodical and informational support of educational practice

Main literature:

It is selected by the student individually, depending on the topic of the final qualifying work, in agreement with the head of the practice.

Additional literature:

1. Okhotsimsky D.E., Sikharulidze Y.G. Fundamentals of Space Flight Mechanics. Textbook. - Moscow: Nauka, 1990. - 448 p.
2. Curtis H. Orbital mechanics for engineering students. – Elsevier, 2013 – 912 p.
3. Classical and Modern Methods of Automatic Control Theory. Textbook in 5 vols. 2nd edition, revised and supplemented / Edited by K.A. Pupkov, N.D. Egupov. - Moscow: Bauman Moscow State Technical University Publisher, 2004.
4. Martin Wegmann, Jakob Schwalb-Willmann, Stefan Dech An Introduction to Spatial Data Analysis: Remote Sensing and GIS with Open Source Software (Data in the Wild) 1st Edition, Kindle Pelagic Publishing, 2020
5. E.O. Wilson, Dawn J. Wright, Christian Harder GIS for Science, Volume 3: Maps for Saving the Planet. Esri Press, 2021, 228p
6. Tom Koch Cartographies of Disease: Maps, Mapping, and Medicine, new expanded edition Esri Press, 2017, 412p
7. Jindong Li Satellite Remote Sensing Technologies Springer, Singapore, Space Science and Technologies, 2021, 421p
8. Remote Sensing and Image Interpretation, 7th Edition, Thomas Lillesand, Ralph W. Kiefer, Jonathan Chipman, 736 p
9. List of available Indices Index DataBase A database for remote sensing indices. URL: https://www.indexdatabase.de/db/i.php

10. Martin Wegmann, Jakob Schwalb-Willmann, Stefan Dech An Introduction to Spatial Data Analysis: Remote Sensing and GIS with Open Source Software (Data in the Wild) 1st Edition, Kindle Pelagic Publishing, 2020
11. E.O. Wilson, Dawn J. Wright, Christian Harder GIS for Science, Volume 3: Maps for Saving the Planet. Esri Press, 2021, 228p
12. Tom Koch Cartographies of Disease: Maps, Mapping, and Medicine, new expanded edition Esri Press, 2017, 412p
13. Jindong Li Satellite Remote Sensing Technologies Springer, Singapore, Space Science and Technologies, 2021, 421p
14. Remote Sensing and Image Interpretation, 7th Edition, Thomas Lillesand, Ralph W. Kiefer, Jonathan Chipman, 736 p
15. List of available Indices Index DataBase A database for remote sensing indices. URL: https://www.indexdatabase.de/db/i.php
16. Vasiliev F.P. Optimization methods. - M .: Factorial Press, 2002 .-- 824s.
17. Himmelblau D. Applied nonlinear programming. - M .: Mir, 1975 .-- 534 p.
18. Shary S.P. Computational Methods Course. - Novosibirsk, SO RAN, 2016 - 531 p.
19. Kosarev V.I. 12 lectures on computational mathematics (introductory course). - M .: Fizmatkniga, 2013 - 240 p.
20. Bakhvalov N.S., Zhidkov N.P., Kobelkov G.M. Numerical methods. - M .: Nauka, 1987.
21. Python 3. The essentials. Prokhorenok N., Dronov V., BHV-Petersburg, 2019 - 610 p .;
22. Python. Express course. Seder N., St. Petersburg: Peter, 2019 - 480 p .;
23. Algorithms. Reference with examples in C, C ++, Java and Python. Heineman J., Pollis G., Selkov S., St. Petersburg: Alpha Kniga LLC, 2017 - 432 p .;
24. Automating Injured Tasks with Python: A Practical Guide for Beginners. Svejrart El., M .: "ID Williams", 2017 - 592 p .;
25. Numerical methods: Computational workshop. Vabishchevich PN, Moscow: "LIBROKOM", 2010 - 320 p .;
26. High-level language programming. C / C ++. Khabibullin I.Sh., St. Petersburg: BHV-Petersburg, 2006 - 512 p .;
27. C ++ Programming in Visual Studio 2010 Express. Prokhorenok N.A., 2010 - 71 p .;
28. The programming language C. Brian W. Kernighan, D.M. Ritchie, Williams, 2015 - 288 p .;
29. C ++ programming language. Stroustrup B., Martynov N.N., Moscow: Binom, 2011. - 1135 p .;
30. Programming language C. Lectures and exercises. S. Prata, Moscow: Williams Publishing House, 2013 - 960 p .;
31. Algorithms construction, analysis and implementation in the C programming language. Vorozhtsov A.V., Vinokurov N.A., Moscow: MIPT, 2007 - 452 p .;
32. Programming and computer science. Antonyuk V.A., Ivanov A.P., Moscow: Physical Faculty. Moscow State University M.V. Lomonosov, 2015 - 64 p.
33. Artificial intelligence with examples in Python Joshi P., M., St. Petersburg: Dialectics, 2019 - 450 p.
34. Algorithms. Construction and analysis. Cormen T. et al., Williams Publishing House, 2009 - 1296 p.
35. Algorithms. An introduction to design and analysis. A.V. Levitin, Williams, 2006 .-- 574 p.
36. Algorithms. Dasgupta S., Papadimitriu H., Vazirani U., MCNMO, 2014 - 320 p.
37. Construction and analysis of computational algorithms. Aho A., Hopcroft J., Ullman J., M.: Mir, 1979 - 535 p.,
38. Golitsyna, O. Fundamentals of Algorithmization and Programming / I. Popov –SPb, 2003.

39. Knut, D.E. The Art of Programming, Volume 1. Basic Algorithms, 3rd ed .: Per. from English : Uch. Pos. - M.: Publishing House "Williams", 2000. - 720 p. silt

At the end of the Intership each student submits a written report on research work to the supervisor.

The research report is compiled by each student independently. When preparing reports on research and development, it is necessary to adhere to the following structure:

- List of contents, in which the student sets out information about all sections of his work;
- An assignment in which the student sets out the task assigned to him;
- Literary review of the sources studied during the research;
- Sections that contain practical solutions and analysis of the results obtained;
- Presentation of calculation results in the most user-friendly form and their analysis;
- Conclusions, in which the student briefly summarizes what was done;
- Bibliography;
- Applications (if any).

As an application to the report, diagrams, tables, graphs, draft documents developed by students, etc. can be introduced.

Part of the research report can be a scientific publication with the participation of a student (thesis in the conference collection, scientific article in the journal).

c) software and Internet resources

OC Windows, MS Office (Microsoft Subscription Enrollment for Education Solutions), 6pay3ep Firefox (MPL-2.0 license) or 6pay3ep Chrome (JIM14eH3H51 Google Chrome Terms of Service); Adobe Reader (Adobe Software License Agreement).

LibreOffice office suite (MPL-2.O license),

The GNU Compiler Collection sys-devel / gcc (GPL-3 + LGPL3 + Il (GPL-3 + libgcc libstdc-i + gcc-runtime-library-exception-3.1) FDL-1.3 +)

Free Pascal Compiler dev-lang / fpc (JIHUeH3V151 GPL-2 LGPL-2.1-withlinking-exception)

High-performance programming language for technical computing devlang / julia-bin (MIT license)

r) databases, reference and search systems:

Telecommunication educational information system (TUIS) http://esystem.pfur.ru scientific electronic library http://elibrary.ru

RFBR library http://www.rfbr.ru/rffl/ru/library

Directory of Open Access Journals (DOAJ) http://doaj.org/

Elsevier http://www.elsevier.com/about/open-access/open-archives

SPIE Digital Library http://spiedigitallibrary.org/spiereviews/resource/l/spivj2

Springer Open - http://www.springeropen.com/journals

10. Material and technical support of scientific research practice

Premises: classrooms, laboratories, computer classes of the Department of Mechanics and Mechatronics, display classrooms for the management of information technology support of the RUDN University, the RUDN University library.

Equipment: computer equipment (Intel Core i3 level or higher) for collecting, processing and organizing literary material, conducting a numerical experiment.

Name of special rooms and rooms for independent work	Equipment of special rooms and rooms for independent work
RUDN Moscow, st. Miklukho-Maklaya, 6 RUDN Flight Control Center	A set of specialized furniture; hardware: PC "Khoper" (4 pcs.), Monitor 23.6 Viewsonic VG2433-LED (4 pcs.), Projection screen Projecta Home Screen 316x416, LCD panel Philips 52 model BDL5231V / 100, LCD panel for creating a video wall Orion OLM-4611 (1 pc.), LCD panel for creating a video wall Orion OLM-4611 (8 pcs.), Bose Companion speaker system (1 pc.), Interactive 3D-Pointer system, MEIJIN computer, P / computer system. Esprimo block NYK3F0012776 mon. YEFQ614055, P / computer system. Esprimo block NYK3F0012794 mon. YEFQ614089, P / computer system. Block Esprimo YK1M001806 mon. YESV030505, P / computer system. Block Esprimo YKQBO48715 mon. YE7J36089, P / computer system. Block Esprimo YL6K005094 mon. YV1PQ13636, P / computer system. Block Esprimo YL6K005288 mon. YV2L010546, Internet access capability

11. Forms of practice assessment

In the process of passing the training, the professor carries out current control of the student's implementation of the assignment for practice. Based on the results of the practice, intermediate certification is provided in the form of a set-off with an assessment (based on the results of the defense of the report on practice).

12. Fund of assessment tools for intermediate certification of trainees

The fund of assessment tools, formed to conduct ongoing monitoring of progress and intermediate certification of students of practice for obtaining primary professional skills and research skills, is presented in *Appendix 1* to the work program of practice and includes:

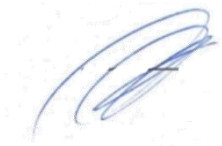
- a list of competencies formed in the course of internship;

- description of indicators and criteria for assessing competencies, description of assessment scales;

- typical control tasks or other materials necessary to assess knowledge, skills, abilities and (or) experience of activities, characterizing the level of competence formation;

- methodological materials defining the procedures for assessing knowledge, skills, skills and (or) experience of activities, characterizing the level of competence formation.

Developers:

Associate professor  O.E. Samusenko

Director of the department  Yu.N. Razoumny