Federal State Autonomous Institution of Higher education

Peoples' Friendship University of Russia

Academy of Engineering

WORKING PROGRAM OF PRACTICE

Practice: Practical Training and Research in Dynamics and Control of Space Systems (online from RUDN Mission Control Center) / Научно-исследовательская работа

Type of practice: Research work

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

Practical Training and Research in Dynamics and Control of Space Systems (online from RUDN Mission Control Center) is a research practical training and is aimed at deepening, systematizing and consolidating theoretical knowledge, as well as at obtaining professional skills in the field of applied mathematics and computer science, mastering the skills of working on software used in information technology and relevant research methods, obtaining practical skills in the development and analysis of information systems

Research Practice Objectives:

- The main objectives of the practice are to develop skills in the use of modern scientific methods for solving scientific and practical problems.

- Formation of professional skills in conducting scientific research.

- The formation of general and professional competencies in accordance with the educational standart of the RUDN University.

- gathering, systematization and generalization of practical material for use in the graduate qualification work.

- gathering and processing of factual material on the sections of the internship program and compiling a report on the completed task; - gathering materials, systematization and processing of data on the direction to conduct research work.

The tasks are:

- consolidation of the obtained theoretical knowledge in the process of scientific research in solving practical problems;
- gaining experience in performing scientific research;
- gaining experience in the use of modern information technologies in scientific research;
- the formation of the competencies of students in the process of performing scientific research related to future professional activities.
- to study the organization and principles of spacecraft control;
- to learn how to simulate the movement of spacecraft when performing various flight operations;
- to master the primary skills of computer computing technology.

2. Place of practice in the structure of OBOP VO

Practical Training and Research in Dynamics and Control of Space Systems 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".

The student needs:

● to know technologies and programming languages;

●be able to make calculations and make numerical assessments of the performance indicators of complex systems based on data analysis using intelligent machine methods;

● be able to develop and debug auxiliary software systems;

● possess the skills of mathematical modeling, application of numerical methods in the development of programs, performing calculations and obtaining numerical estimates.

Table 1 - List of previous and subsequent disciplines / practices

Competence	Preceding disciplines / practices	Subsequent disciplines
Universal competences		
UC-1	Programming (Python, C++) / Программирование (Python, C++) Databases / Базы данных Structures & Materials Modelling / Моделирование конструкций и материалов Remote Sensing and Geoinformation Systems / Дистанционное зондирование и геоинформационные системы Machine Learning and Big Data Mining / Машинное обучение и анализ больших данных From Data Acquisition to Data Treatment / Сбор и обработка данных System Design / Системное проектирование Dynamics and Control of Space Systems / Динамика и управление космическими системами	Pre-Graduation Internship in Industry / Технологическая практика Master's Thesis Preparation / Преддипломная практика
UC-6	Cross-Cultural Training (Professional and Cultural Visits) / Межкультурная подготовка Practical Training in Receiving Remote Sensing Data from Satellites and its Interpretation (online from RUDN Mission Control Center) / Научно-исследовательская работа	Pre-Graduation Internship in Industry / Технологическая практика Master's Thesis Preparation / Преддипломная практика
UC -7	Programming (Python, C++) / Программирование (Python, C++) Databases / Базы данных Remote Sensing and Geoinformation Systems / Дистанционное зондирование и геоинформационные системы Machine Learning and Big Data Mining / Машинное обучение и анализ больших данных From Data Acquisition to Data Treatment / Сбор и обработка данных Virtual Reality and Computer Vision / Виртуальная реальность и компьютерное зрение Modelling and Validation / Моделирование и валидация	Pre-Graduation Internship in Industry / Технологическая практика Master's Thesis Preparation / Преддипломная практика
General professional competences		
GPC-4	Programming (Python, C++) / Программирование (Python, C++) Databases / Базы данных Remote Sensing and Geoinformation Systems / Дистанционное зондирование и геоинформационные системы	Pre-Graduation Internship in Industry / Технологическая практика Master's Thesis Preparation / Преддипломная практика
Professional competences		

РС-1	Programming (Python, C++) / Программирование (Python, C++) Databases / Базы данных Structures & Materials Modelling / Моделирование конструкций и материалов Remote Sensing and Geoinformation Systems / Дистанционное зондирование и геоинформационные системы Machine Learning and Big Data Mining / Машинное обучение и анализ больших данных From Data Acquisition to Data Treatment / Сбор и обработка данных Applied Mechanics and Engineering / Прикладная механика и проектирование инженерных систем From Data Acquisition to Data Treatment / Сбор и обработка данных Systems Engineering / Проектирование инженерных систем Virtual Reality and Computer Vision / Виртуальная реальность и компьютерное зрение Modelling and Validation / Моделирование и валидация System Design / Системное проектирование Practical Training in Receiving Remote Sensing Data from Satellites and its Interpretation (online from RUDN Mission Control Center) / Научно-исследовательская работа	Pre-Graduation Internship in Industry / Технологическая практика Master's Thesis Preparation / Преддипломная практика
РС-2	Programming (Python, C++) / Программирование (Python, C++) Databases / Базы данных Remote Sensing and Geoinformation Systems / Дистанционное зондирование и геоинформационные системы Machine Learning and Big Data Mining / Машинное обучение и анализ больших данных From Data Acquisition to Data Treatment / Сбор и обработка данных Systems Engineering / Проектирование инженерных систем Virtual Reality and Computer Vision / Виртуальная реальность и компьютерное зрение Modelling and Validation / Моделирование и валидация Practical Training in Receiving Remote Sensing Data from Satellites and its Interpretation (online from RUDN Mission Control Center) / Научно-исследовательская работа	Pre-Graduation Internship in Industry / Технологическая практика Master's Thesis Preparation / Преддипломная практика
РС-3	English Language / Английский язык Aerospace Systems / Аэрокосмические системы Structures & Materials Modelling / Моделирование конструкций и материалов	Pre-Graduation Internship in Industry / Технологическая практика Master's Thesis Preparation / Преддипломная практика

	Applied Mechanics and Engineering / Прикладная механика и проектирование инженерных систем Systems Engineering / Проектирование инженерных систем System Design / Системное проектирование On-board Energy / Бортовая энергия Practical Training in Receiving Remote Sensing Data from Satellites and its Interpretation (online from RUDN Mission Control Center) / Научно-исследовательская работа	
PC-4	Aerospace Systems / Аэрокосмические системы Structures & Materials Modelling / Моделирование конструкций и материалов Applied Mechanics and Engineering / Прикладная механика и проектирование инженерных систем Systems Engineering / Проектирование инженерных систем System Design / Системное проектирование Practical Training in Receiving Remote Sensing Data from Satellites and its Interpretation (online from RUDN Mission Control Center) / Научно-исследовательская работа	Pre-Graduation Internship in Industry / Технологическая практика Master's Thesis Preparation / Преддипломная практика
PC-5	Aerospace Systems / Аэрокосмические системы Structures & Materials Modelling / Моделирование конструкций и материалов Applied Mechanics and Engineering / Прикладная механика и проектирование инженерных систем Systems Engineering / Проектирование инженерных систем System Design / Системное проектирование On-board Energy / Бортовая энергия Practical Training in Receiving Remote Sensing Data from Satellites and its Interpretation (online from RUDN Mission Control Center) / Научно-исследовательская работа	Pre-Graduation Internship in Industry / Технологическая практика Master's Thesis Preparation / Преддипломная практика
PC-6	Machine Learning and Big Data Mining / Машинное обучение и анализ больших данных From Data Acquisition to Data Treatment / Сбор и обработка данных Practical Training in Receiving Remote Sensing Data from Satellites and its Interpretation (online from RUDN Mission Control Center) / Научно-исследовательская работа	Pre-Graduation Internship in Industry / Технологическая практика Master's Thesis Preparation / Преддипломная практика

3**. Ways of conducting the practice**

The ways of doing practical training are:

- stationary;

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		116	116
Type of certification test			Graded credit
Total labor intensity	180	180	180
	credit units	5	5
Duration of practice	weeks	1.7	1.7

5. Place of practice

The place of internship is provided online from RUDN Mission Control Center.

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

The practice is aimed at developing the following competencies among students: (UC-1; UC -2; UC -6; UC -7; GPC-4; PC-1; PC-2; PC-3; PC-4; PC-5; PC-6):

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-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.
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.
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 information systems, automated spacecraft control system and preparation of software documentation.	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 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 internship 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-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
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	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

form of software products.			
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, organisation and control of the software development process of information systems, automated spacecraft control system and preparation of software documentation.	Knows modern design tools and elements of information systems architecture. 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	Will be able to analyze normative and technical documentation for the development of software documentation for components of ground-based automated spacecraft control system	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	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	Has the skills to create space products and provide space-based data from remote sensing and geographic information systems

data and geographic information systems.		interpretation of interpretation results	

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	2	-	2
3	Main	Study of educational and scientific literature on the topics selected at the previous stage;	18	34	52
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	34	54
5		Selection of initial data for the experiment Conducting the experiment	2	34	36
…		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	-	6	6
….	Reporting	Preparing an internship report	-	8	8

….		Intermediate attestation (preparation for protection and protection of the report)	2	-	2
		TOTAL:	**64**	**116**	**180**

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 the training, the following educational technologies are used:

- consultations with the scientific advisor;
- solving professional problems from an actual subject field;
- completing tasks of sections of independent work; teamwork;
- practical classes and / or laboratory works aimed at the collective implementation of specific tasks on research and development;
- discussion when commenting on the results of the research.

The teaching technologies used in conducting research are aimed at:

- development of teamwork and interpersonal communication skills,
- organization of group discussion and conversation,
- development of optimal methods for conducting scientific research, building mathematical models, conducting a numerical and (or) simulation experiment

During the process of doing practical training the following research and development technologies are used:

- mastering teaching methods of analysis and interpretation of the results of research activities;
- fulfillment of written and calculated assignments within the framework of the practice of using the 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);
- the use of various digital libraries and legal reference systems by students.

9. Methodical and informational support of educational practice

Educational and methodological materials posted in the Telecommunication educational and information system (TUIS, http://esystem.pfur.ru/) and the university educational portal (http://web-local.rudn.ru).

Literature required to complete research assignments • resources of the RUDN Information and Library Center http://lib.rudn.ru;

Scientific digital library http://elibrary.ru.

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

Directory of Orep 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 Orep - http://www.springeropen.com/journals

At the end of the academic semester during midterm week, 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).

a) main literature

1) Bolotin S.V., Karapetyan A.V., Kugushev E.I., Treschev D.V. Theoretical Mechanics. Textbook. - Moscow: Academia Publishing Center, 2010. - 432 c. ISBN 978-5-7695-5946-4

2) Demin V.G. The motion of an artificial satellite in a non-central gravitational field. Moscow-Izhevsk. 2010. - 420 c. ISBN 978-5-93972-851-5

3) Arnold V.I., Kozlov V.V., Neishtadt A.I. Mathematical aspects of classical and celestial mechanics. "Modern problems of mathematics. Fundamental Directions. VOL.3" MOSCOW, 1985. - 304 p.

4) Baranov A.A., Razumny V.Yu. Formation and Maintenance of Spacecraft Orbits with Low thrust engines. - Preprint of the Keldysh Institute of Applied Mathematics. Preprint of the Keldysh Institute of Applied Mathematics of the Russian Academy of Sciences, 2010. - № 52. - 32 p.

5) Okhotsimsky D.E., Sikharulidze Y.G. Fundamentals of Space Flight Mechanics. Textbook. - Moscow: Nauka, 1990. - 448 p.

6) Lawden D.F. Optimal trajectories for space navigation. - Moscow: Mir, 1966. - 152 p.

7) Chernov A.A., Chernyavsky G.M. Orbits of Remote Sensing Satellites: Lectures and Exercises. - Moscow: Radio and Communications, 2004. - 200 p.

8) Alexeev K.B., Bebenin G.G., Yaroshevsky V.A. Spacecraft Maneuvering. - Moscow: Mashinostroenie, 1970. - 232 p.

9) Eliasberg P.E. Introduction to the Theory of Flight of Artificial Earth Satellites. - Moscow: Nauka, 1965. - 540 p.

10) Sikharulidze Y.G. Ballistics of Flying Vehicles. - Moscow: Nauka, Main Editorial Office for Physical and Mathematical Literature, 1982. - 352 p.

11) Reshetnev M.F., Lebedev A.A., Bartenev V.A., Krasilshchikov M.N., Malyshev V.A. Control and Navigation of Artificial Earth Satellites in Circular Orbits. - Moscow: Mashinostroenie Publisher, 1988. 336 p.

12) Solovyov Ts.V., Tarasov E.V. Forecasting interplanetary flights. - Moscow: Mashinostroenie, 1973. - 400 p.

13) Sehgal, J. (1996). Pedology : Concepts and Applications , Kalyani Publishers, New Delhi.

14) List of available Indices Index DataBase A database for remote sensing indices. URL: https://www.indexdatabase.de/db/i.php

15) Dreshchinsky, V. A. Methodology of scientific research: a textbook for undergraduate and graduate programs / V. A. Dreshchinsky. - 2nd ed., Rev. and add. Moscow: Yurayt Publishing House, 2017.324 p. - (Bachelor and Master. Academic course). - ISBN 978-5-534 - () 2965-9. - Text: electronic EBS Yurayt [site]. - URL:

16) Modern computer technologies: textbook / R.G. Khismatov, R.G. Safin, D.V. Tuntsev, N.F. Timerbaev; Ministry of Education and Science of Russia, Federal State Budgetary Educational Institution of Higher Professional Education "Kazan National Research Technological University". - Kazan: Publishing House of KNRTU, 2014 .-- 83 p .: schemes. - Bibliography. in the book. - ISBN 978-5-7882-1559-4; Access mode: http://biblioclub.ru/index.php?page=book&id=428016

17) Fundamentals of scientific research and patenting: teaching aid / comp. V.A. Valkov, V.A. Golovatyuk, V.I. Kochergin, S.G. Shchukin. - Novosibirsk: Novosibirsk State Agrarian University, 2013. 228 p. Access mode: http://biblioclub.ru/index.php?page=book&id=230540

b) additional literature and Internet sources

Ushakov, E.V. Philosophy and methodology of science: textbook and workshop for undergraduate and graduate programs E.V. Ushakov. Moscow: Yurayt Publishing House, 2017 .-- 392 p. - (Bachelor and Master. Academic course). ISBN 978-5-534-02637-5. - Text: electronic / EBS Yurayt [site]. Url:

Kanke, V.A. History, philosophy and methodology of technology and informatics. textbook for masters / V. A. Kanke. - Moscow: Yurayt Publishing House, 2017.409 p. - (Master). - ISBN 978-5-9916-3100-6, - Text: electronic EBS Yurayt [site]. - URL:

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

During the practice, 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:

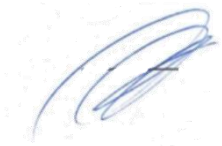
- a list of competencies formed in the course of internship;

- 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