Федеральное государственное автономное образовательное учреждение высшего образования
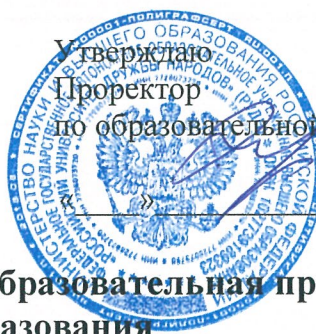## Российский университет дружбы народов

Инженерная академия

Принято
Ученым советом
инженерной академии
Протокол № 2022-08/08
«25» мая 2021 г.

Утверждаю
Проректор
по образовательной деятельности
Ю.Н. Эбзеева
«___»_____ 2021 г.

Основная профессиональная образовательная программа высшего образования

Направление подготовки

01.04.02 Прикладная математика и информатика

Программа разработана в соответствии с требованиями:

ОС ВО РУДН, утвержденным приказом ректора от «21» мая 2021 г. № 371 «Об утверждении актуализированных образовательных стандартов высшего образования, самостоятельно устанавливаемых Российским университетом дружбы народов, по уровням подготовки бакалавриата, специалитета и магистратуры».

Квалификация выпускника: Магистр

Направленность программы: **Space Mission and System Design / Баллистическое проектирование космических комплексов и систем**

Срок освоения программы: в очной форме – 2 года

Форма обучения: очная

Сведения об особенностях реализации основной профессиональной образовательной программы: реализуется на английском языке, совместно с EPF Graduate School of Engineering

Руководитель программы:

Ю.Н. Разумный

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Согласовано:
Председатель МССН
А.Л. Скубачевский

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Согласовано:
Директор академии
Ю.Н. Разумный

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2021 г.

General characteristics of the educational program
Space Mission and System Design

1.1. Purpose (mission) of the educational program of high education.

The program aims to train professionals capable of solving a wide range of mathematical and technical problems in various fields of knowledge and industries where mathematical modelling of complex technical systems and optimization of control processes are needed. The professional fields of application of the acquired knowledge are the design processes of near and far space missions and the thematic processing of remote sensing data in various industries, agriculture and environmental management. The courses in the program on ballistic design for space missions provide advanced knowledge necessary for carrying out professional activities in this field, including the establishment and development of national space programs in emerging economies. Much attention is given to the study of the thematic interpretation of remotely sensed data as a tool to study and monitor our planet and to help effectively use and manage its resources at the national and global levels.

The program trains highly qualified specialists in the field of mathematical and computer modeling of complex technical systems, application of modern IT-technologies, development of special software and mathematical software for control of complex technical systems in the interests of general engineering, aerospace and other knowledge-intensive industries

1.2. Basic information.

The main professional educational program in the direction 01.04.02 "Applied Mathematics and Informatics" (master's level) focus (profile) Space Mission and System Design is implemented in full-time educati on in accordance with a license for the right to carry out educational activities.
The term of education under the program is 2 years.
The volume of the program is 120 credit units (hereinafter referred to as credits). The volume of the Master's program implemented in one academic year is 60 CU.

1.3. Features of the implementation of higher education program.

The educational program is implemented with the use of a network form, using elements of distance learning technologies, through the Telecommunication Educational and Information System of the Peoples' Friendship University of Russia (TUIS), Microsoft Teams.
Educational activities under the master's program are carried out in the state language of the Russian Federation and in English.

1.4. The need of the labor market for graduates of higher education program.

Graduates who have mastered this program are focused on working in Russian and international companies, academic institutions, rocket and space industry enterprises and commercial enterprises in the field of space technology development and application by gaining relevant professional competences through mastering the disciplines in the field of space flight mechanics, ballistic design of space missions, thematic processing of Earth remote sensing data and development of geoinformation systems for various industries, agriculture and environmental management.
Obtaining the RUDN Master diploma and the European Engineer diploma gives additional competitive advantages to the graduates in the labour markets in Russia and abroad. Such specialists are in demand in the labour market of any country, both developed and developing economies. Due to the high level of competences, graduates easily adapt to working life in any company.

1.5. Requirements for the applicant.

For admission to the program, the Admission Rules are valid, approved by the relevant local regulatory act and posted in the public domain on the official website of RUDN University.

A mandatory requirement for applicants is a bachelor's or specialist's degree. The applicant should have a basic understanding of spaceflight theory, a sufficient background in applied mathematics and computer science, and preferably the ability to program in a high-level language. At the same time, an individualized approach to learning in this program will enable students with different levels of entry-level backgrounds to successfully master the program.

1.6. Characteristics of the professional activity of higher education program graduate:
1.6.1 Area of professional activity.

The field of professional activity of graduates who have mastered the Master's program includes: scientific, research organizations related to solving scientific and technical problems; research and computing centers; research and production organizations; educational organizations of higher education and professional educational organizations, public authorities, organizations of various forms of ownership, industry and business that develop and use information systems, scientific achievements, products and services in the field of applied mathematics and informatics. The program is aimed at obtaining professional competences within the framework of the professional standards 25.030 «Specialist in design and development of ground-based automated spacecraft control systems», 25.017 «Earth remote sensing (ERS) data-based space products and services development».

1.6.2 Object of professional activity.

The objects of professional activity of the graduates of the Master program are: mathematical modelling; mathematical physics; inverse and uncorrected problems; numerical methods; probability theory and mathematical statistics; operations research and systems analysis; optimization and optimal control; discrete mathematics; nonlinear dynamics, computer science and control; mathematical models of complex systems: theory, algorithms, applications; mathematical and computer image processing methods; mathematical and information support of economic activities; mathematical methods and software for information protection; mathematical methods and software for computer networks; information systems and their research using methods of mathematical forecasting and system analysis; high-performance computing and parallel programming technologies; intelligent systems; software engineering; system programming; tools, technologies, resources and services for e-learning and mobile learning, scientific research automation; programming languages, algorithms, libraries and software packages, system and application software products; system and application software; databases; enterprise management systems; network technology.

1.6.3 Types of professional activity.

The types of professional activities for which graduates of the Master's program are prepared:
- research activities.

1.6.4 Tasks of professional activity.

A graduate who has mastered the master's program, in accordance with the types of tasks of professional activity that the educational program is focused on, is ready to solve the following professional tasks:
research activities:

- the construction of mathematical models and their investigation by analytical methods, the development of algorithms, methods, software, tools on the subjects of ongoing research projects.
- systems research using the methods of mathematical forecasting and systems analysis;
- developing and applying modern high-performance computing technologies, using modern supercomputers in the research carried out;
- study of new scientific results, scientific literature or research projects in accordance with the profile of the object of professional activity;
- compilation of scientific reviews, abstracts and bibliographies on the subjects of the research in progress, preparation of scientific and technical publications on the subjects of the research in progress.

1.7. Requirements for the learning outcomes of higher education program.

As a result of mastering the educational program, the graduate develops the following universal, general professional and professional competences:

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	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.

Competence	Indicators of competence achievement
development of 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.

1.8. Competence matrix.

	Name of disciplines (modules) in accordance with the curriculum	Universal competences						
		UC-1 ability to carry out a critical analysis of problem situations based on a systematic approach, to develop an action strategy	UC -2 ability to manage a project at all stages of its life cycle	UC -3 the ability to organize and manage the work of the team, developing a team strategy to achieve the goal	UC-4 ability to apply modern communication technologies in the state language of the Russian Federation and foreign language(s) for academic and	UC-5 ability to analyze and take into account the diversity of cultures in the process of intercultural interaction	UC-6 ability to identify and implement the priorities of their own activities and ways to improve it based on self-assessment	UC-7 ability 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
Block 1	**Base component**							
	French as Foreign Language / Russian as Foreign Language (Французский язык как иностранный / Русский язык как иностранный) / English Language / Английский язык				+			
	Cross-Cultural Training (Professional and Cultural Visits) / Межкультурная подготовка			+	+	+	+	
	Programming (Python, C++) / Программирование (Python, C++)	+						+

Block 1	Variable component							
	Databases / Базы данных	+						+
	Aerospace Systems / Аэрокосмические системы		+					
	Structures & Materials Modelling / Моделирование конструкций и материалов	+						
	Remote Sensing and Geoinformation Systems / *Дистанционное зондирование и геоинформационные системы*	+						+
	System Design / Системное проектирование	+	+					
	On-board Energy / Бортовая энергия							
	Dynamics and Control of Space Systems / Динамика и управление космическими системами	+	+					
	Course works / projects							
	Project "Drone Systems Engineering. Part 1" / Курсовой проект "Разработка систем беспилотных летательных аппаратов. Часть 1"	+	+					
	Project "Drone Systems Engineering. Part 2" / Курсовой проект "Разработка систем беспилотных летательных аппаратов. Часть 2"		+					
	Elective Subjects							

	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		+					
	Systems Engineering / Проектирование инженерных систем		+					
	Virtual Reality and Computer Vision / Виртуальная реальность и компьютерное зрение							+
	Modelling and Validation / Моделирование и валидация							+
Block 2	**Variable component**							
	Practical Training in Receiving Remote Sensing Data from Satellites and its Interpretation (online from RUDN Mission Control Center) / Научно-исследовательская работа, учебная	+	+				+	
	Practical Training and Research in Dynamics and Control of Space Systems (online from RUDN Mission Control Center) / Научно-исследовательская работа, учебная	+					+	+
	Pre-Graduation Internship in Industry / Технологическая практика	+		+			+	+
	Master's Thesis Preparation / Преддипломная практика	+	+	+	+	+	+	+

Block 3	State Final Attestation							
	Final Exams / Государственный экзамен	+	+	+	+	+	+	+
	Master's Thesis Defending / Защита магистерской диссертации	+	+	+	+	+	+	+

		General professional competences			
	Name of disciplines (modules) in accordance with the curriculum	GPC-1 ability to solve actual problems of fundamental and applied mathematics	GPC-2 ability to improve and implement new mathematical methods for solving applied problems;	GPC-3 ability to develop mathematical models and analyze them when solving problems in the field of professional activity	GPC-4 ability 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
Block 1	**Base component**				
	French as Foreign Language / Russian as Foreign Language (Французский язык как иностранный / Русский язык как иностранный) / English Language / Английский язык				
	Cross-Cultural Training (Professional and Cultural Visits) / Межкультурная подготовка				
	Programming (Python, C++) / Программирование (Python, C++)	+	+	+	+
Block 1	**Variable component**				
	Databases / Базы данных				+

	Aerospace Systems / Аэрокосмические системы		+	+	
	Structures & Materials Modelling / Моделирование конструкций и материалов		+	+	
	Remote Sensing and Geoinformation Systems / Дистанционное зондирование и геоинформационные системы			+	+
	System Design / Системное проектирование		+	+	
	On-board Energy / Бортовая энергия		+	+	
	Dynamics and Control of Space Systems / Динамика и управление космическими системами		+	+	
	Course works / projects				
	Project "Drone Systems Engineering. Part 1" / Курсовой проект "Разработка систем беспилотных летательных аппаратов. Часть 1"			+	+
	Project "Drone Systems Engineering. Part 2" / Курсовой проект "Разработка систем беспилотных летательных аппаратов. Часть 2"			+	+
Block 2	**Variable component**				
	Practical Training in Receiving Remote Sensing Data from Satellites and its Interpretation (online from RUDN Mission Control Center) / Научно-исследовательская работа, учебная				+
	Practical Training and Research in Dynamics and Control of Space Systems (online from				+

	RUDN Mission Control Center) / Научно-исследовательская работа, учебная				
	Pre-Graduation Internship in Industry / Технологическая практика		+	+	+
	Master's Thesis Preparation / Преддипломная практика	+	+	+	+
Block 3	**State Final Attestation**				
	Final Exams / Государственный экзамен	+	+	+	+
	Master's Thesis Defending / Защита магистерской диссертации	+	+	+	+

		Professional competences					
	Name of disciplines (modules) in accordance with the curriculum	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-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-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-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-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-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.
Block 1	**Базовая компонента**						
	French as Foreign Language / Russian as Foreign Language (Французский язык как иностранный / Русский язык как иностранный) / English Language / Английский язык			+			
	Cross-Cultural Training (Professional and Cultural Visits) / Межкультурная подготовка						
	Programming (Python, C++) / Программирование (Python, C++)	+	+				
Block 1	**Variable component**						

	Databases / Базы данных	+	+				
	Aerospace Systems / Аэрокосмические системы			+	+	+	
	Structures & Materials Modelling / Моделирование конструкций и материалов	+		+	+	+	
	Remote Sensing and Geoinformation Systems / Дистанционное зондирование и геоинформационные системы	+	+				+
	System Design / Системное проектирование	+		+	+	+	
	On-board Energy / Бортовая энергия			+		+	
	Dynamics and Control of Space Systems / Динамика и управление космическими системами	+		+	+	+	
	Course works / projects						
	Project "Drone Systems Engineering. Part 1" / Курсовой проект "Разработка систем беспилотных летательных аппаратов. Часть 1"		+		+	+	
	Project "Drone Systems Engineering. Part 2" / Курсовой проект "Разработка систем беспилотных летательных аппаратов. Часть 2"		+		+	+	
	Elective Subjects						

	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	+		+	+	+	
	Systems Engineering / Проектирование инженерных систем	+		+	+	+	
	Virtual Reality and Computer Vision / Виртуальная реальность и компьютерное зрение	+	+				
	Modelling and Validation / Моделирование и валидация	+	+				
Block 2	**Variable component**						
	Practical Training in Receiving Remote Sensing Data from Satellites and its Interpretation (online from RUDN Mission Control Center) / Научно-исследовательская работа, учебная	+	+	+	+	+	+
	Practical Training and Research in Dynamics and Control of Space Systems (online from RUDN Mission Control Center) / Научно-исследовательская работа, учебная	+	+	+	+	+	+

	Pre-Graduation Internship in Industry / Технологическая практика	+	+	+	+	+	+
	Master's Thesis Preparation / Преддипломная практика	+	+	+	+	+	+
Block 3	**State Final Attestation**						
	Final Exams / Государственный экзамен	+	+	+	+	+	+
	Master's Thesis Defending / Защита магистерской диссертации	+	+	+	+	+	+