Federal State Autonomous Educational Institution
higher education
Peoples' Friendship University of Russia

Engineering Academy

Recommended by ISSC

THE WORKING PROGRAM OF THE DISCIPLINE

Discipline name Priority areas of development of mathematics and mechanics

Direction of training: 01 .06.01 " Mathematics and Mechanics "

Directivity (profile): " Dynamics, ballistics, movement control of aircraft "

Moscow,
20 21

1. The purpose and objectives of the discipline

The aim of the development of the discipline " Priorities for Mathematics and Mechanics " I S THE formation of Aspira ntov system of scientific knowledge about the perspective 's method ah investigating and solving professional problems based on the global trends in the development of aviation and space technology .

The main **objectives of the** discipline are:

- –Ability to design and carry out complex research, including interdisciplinary, based on a holistic systemic scientific worldview using knowledge in the field of history and philosophy of science);
- –Willingness to participate in the work of Russian and international research teams to solve scientific and scientific and educational problems;
- –Ability to independently carry out research activities in the relevant professional field using modern research methods and information and communication technologies .

2. Place of discipline in the structure of the educational program

The discipline " Priority areas of development of mathematics and mechanics " refers to the variable part of Block 1 of the curriculum. Table 1 shows the previous and subsequent disciplines aimed at the formation of discipline competencies in accordance with the competence matrix of EP HE.

Table 1 - List of previous and subsequent disciplines

Prior and subsequent disciplines aimed at the formation of competencies

№ p/p	The cipher and the name of the competence	Previous disciplines	Subsequent disciplines (groups of disciplines)
Universal competencies			
	The ability to design and carry out complex research, including interdisciplinary, based on a holistic systematic scientific worldview using knowledge in the field of history and philosophy of science (CC-2)	History and philosophy of science ,	
	Willingness to participate in the work of Russian and international research teams to solve scientific and scientific-educational problems (CC-3)	Methodology of scientific research	Foreign language in the field of professional communication, Russian language in the field of professional communication, Scientific research (research activity), Scientific research (preparation of a scientific qualification work (dissertation) for the degree of candidate of sciences)
	Ability to plan and solve problems of their own	Methodology of scientific research	Dynamics, ballistics and motion control of aircraft

	professional and personal development (CC-5)		
General professional competencies			
	independently carry out research activities in the relevant professional field using modern research methods and information and communication technologies (OPK-1)	Methodology of scientific research	Practice on obtaining professional skills and experience of professional activity (research practice)
Professional competencies (type of professional activity_____)			
	Willingness to apply promising methods of research and solving professional problems, taking into account global trends in the development of aviation and rocket and space technology (PC-1)	Methodology of scientific research,	Dynamics, ballistics and motion control of aircraft Additional sections of theoretical mechanics and mechanics of space flight Mathematical foundations of ballistic support for the flight of spacecraft Mathematical modeling and motion control of aircraft
	Readiness to develop and research methods for analyzing, synthesizing, optimizing and predicting the quality of the processes of functioning of aviation and rocket technology (PC-3)	Methodology of scientific research	Dynamics, ballistics and motion control of aircraft Additional sections of theoretical mechanics and mechanics of space flight Mathematical foundations of ballistic support for the flight of spacecraft Mathematical modeling and motion control of aircraft
	Ability to develop new mathematical models of objects of aviation and rocket and space technology, to develop analytical and approximate research methods (PC-6)	Fundamentals of teaching methods for developing engineering applications based on mathematical modeling using computer science and computer technology in higher education	Dynamics, ballistics and motion control of aircraft Additional sections of theoretical mechanics and mechanics of space flight Mathematical foundations of ballistic support for the flight of spacecraft Mathematical modeling and motion control of aircraft
Professional and specialized competencies of specialization_____			

3. Requirements for the results of mastering the discipline:

The process of studying the discipline is aimed at the formation of the following competencies:

UK-2, UK-3, UK-5, OPK-1, PC - 1 , PC-3, PC-6

(indicated in accordance with the OS VO RUDN University)

As a result of studying the discipline, the student must:

Know: Know the methods of research and solving professional problems, taking into account the world trends in the development of aviation and rocket and space technology.

Know new methods of development and research of methods of analysis, synthesis, optimization and forecasting of the quality of the processes of functioning of aviation and rocket technology

Know new methods of developing mathematical models of objects of aviation and rocket-space technology

Be able to: Be able to apply research methods and solving professional problems, taking into account world trends in the development of aviation and rocket and space technology.

To be able to use new methods of development and research of methods of analysis, synthesis, optimization and forecasting of the quality of the processes of functioning of aviation and rocket technology

Be able to use new methods for the development of mathematical models of objects of aviation and rocket and space technology

Possess : Possess promising methods of research and solving professional problems, taking into account world trends in the development of aviation and rocket and space technology.

Possess new methods of development and research of methods of analysis, synthesis, optimization and forecasting of the quality of the processes of functioning of aviation and rocket technology

Own new methods for the development of mathematical models of objects of aviation and rocket-space technology

4. Scope of discipline and types of educational work

Table 3 - Scope of discipline and types of educational work
for full-time education

Type of educational work		Total, ac. Hrs.	Semester
			3
Auditory lessons		20	20
including:		-	-
Lectures (L)		-	-
Practical / Seminar Lessons (PL)		20	20
Laboratory work (LW)		-	-
Course project / course work		-	-
Independent work (IWS), including control		160	160
Type of certification test			Exam
Total labor intensity	academic hours	180	180
	credit units	5	5

5. Content of the discipline

5 . 1 . Contents of discipline sections

№ P / p	The name of the discipline section	Section content (topics)
1	1. General information	1.1. Areas of use of aviation and rocket-space technology, tasks at the present stage.
2	2. The current state of aviation and rocket-space science, engineering, technology	2.1. Implementation of information technology in the design, production and operation of aviation and rocket technology . 2.2. Problems and search for solutions
3	3. The main problems and tasks currently facing aviation and	3.1. Prospects and problems of using 3D printing technology, nanotechnology and modeling in the

	rocketry. Finding solutions	production of aviation and rocket technology
4	4. Trends in the development of aviation and rocket-space science, engineering, technology, prospects	4.1. Alternative fuels in aviation and rocketry, aerospace systems . 4.2. Reusable space transport systems, unmanned aerial systems
5	5. Cosmic systems for various purposes: observations, communications, navigation, scientific	5.1. The role and place of space systems in the country's economy. Tasks solved by space observation systems , communications, navigation, scientific systems
6	6. Composition and structure of space systems for various purposes	6.1. The goals of space systems . Orbital and ground segments of space systems . Control and target components of space systems . User segment of space systems .
7	7. Options for building space systems for various purposes	7.1. Target equipment for space systems for various purposes. Orbital construction of space systems for various purposes. MCC and NIK. The composition of the user segment of space systems
8	8. Mathematical models and modeling of space systems	8.1. General structure of the mathematical model. Scenario of the functioning of space systems for building a model. Problems of modeling space systems for various purposes . 8.2. Efficiency criteria for orbital construction of space systems . Efficiency criteria for solving the target problem of space systems . Optimization Problems of Performance Criteria for Space Systems

№ p/p	The name of the discipline section / topic of the lesson	Practice. / workshop.	SRS	Total hrs.
1	**Section #1. General information**	**1**	**8**	**9**
	Topic 1.1. Areas of use of aviation and rocket and space technology, tasks at the present stage	1	8	9
2	**Section #2. The current state of aviation and rocket and space science, technology, technologies**	**3**	**24**	**27**
	Topic 2.1. Introduction of information technologies in the design, production and operation of aviation and rocket technology.	1	8	8
	Topic 2.2. Problems and the search for solutions to them	2	16	2,5
3	**Section #3. The main problems and tasks currently facing the aviation and rocket industry. Finding solutions**	**2**	**16**	**18**
	Topic 3.1. Prospects and problems of using 3D printing technology, nanotechnologies and modeling in the production of aviation and rocket technology	2	16	18
4	**Section No.4. Trends in the development of aviation and rocket and space science, technology, technologies, prospects**	**4**	**32**	**36**
	Topic 4.1. Alternative fuels in aviation and rocket technology, aerospace systems	2	16	18
	Topic 4.2. Reusable space transport systems,	2	16	18

№ p/p	The name of the discipline section / topic of the lesson	Practice. / workshop.	SRS	Total hrs.
	unmanned aircraft systems			
5	**Section #5. Space systems for various purposes: observations, communications, navigation, scientific**	**2**	**16**	**18**
	Topic 5.1. The role and place of space systems in the country's economy. Tasks solved by space surveillance systems, communications, navigation, scientific systems	2	16	18
6	**Section No. 6. Composition and structure of space systems for various purposes**	**2**	**16**	**18**
	Topic 6.1. Goals of space systems. The orbital and ground segments of space systems. Control and target components of space systems. User segment of space systems	2	16	18
7	**Section No. 7. Options for building space systems for various purposes**	**2**	**16**	**18**
	Topic 7.1. Target equipment of space systems for various purposes. Orbital construction of space systems for various purposes. MCC and NICKNAME. Composition of the user segment of space systems	2	16	18
8	**Section No. 8. Mathematical models and modeling of space systems**	**4**	**32**	**36**
	Topic 8.1. The general structure of the mathematical model. The scenario of the functioning of space systems for building a model. Problems of modeling space systems for various purposes.	2	16	18
	Topic 8.2. Criteria for the effectiveness of the orbital construction of space systems. Criteria for the effectiveness of solving the target task of space systems. Tasks of optimization of criteria for the effectiveness of space systems	2	16	18
	Exam	**20**	**160**	**180**

№ p/p	The name of the discipline section / topic of the lesson	Practice. / workshop.	SRS	Total hrs.
1	**Section #1. General information**	**1**	**8**	**9**
	Topic 1.1. Areas of use of aviation and rocket and space technology, tasks at the present stage	1	8	9
2	**Section #2. The current state of aviation and rocket and space science, technology, technologies**	**3**	**24**	**27**
	Topic 2.1. Introduction of information technologies in the design, production and operation of aviation and rocket technology.	1	8	8
	Topic 2.2. Problems and the search for solutions to them	2	16	2,5
3	**Section #3. The main problems and tasks currently facing the aviation and rocket industry. Finding solutions**	**2**	**16**	**18**
	Topic 3.1. Prospects and problems of using 3D	2	16	18

№ p/p	The name of the discipline section / topic of the lesson	Practice. / workshop.	SRS	Total hrs.
	printing technology, nanotechnologies and modeling in the production of aviation and rocket technology			
4	**Section No.4. Trends in the development of aviation and rocket and space science, technology, technologies, prospects**	**4**	**32**	**36**
	Topic 4.1. Alternative fuels in aviation and rocket technology, aerospace systems	2	16	18
	Topic 4.2. Reusable space transport systems, unmanned aircraft systems	2	16	18
5	**Section #5. Space systems for various purposes: observations, communications, navigation, scientific**	**2**	**16**	**18**
	Topic 5.1. The role and place of space systems in the country's economy. Tasks solved by space surveillance systems, communications, navigation, scientific systems	2	16	18
6	**Section No. 6. Composition and structure of space systems for various purposes**	**2**	**16**	**18**
	Topic 6.1. Goals of space systems. The orbital and ground segments of space systems. Control and target components of space systems. User segment of space systems	2	16	18
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	Topic 8.1. The general structure of the mathematical model. The scenario of the functioning of space systems for building a model. Problems of modeling space systems for various purposes.	2	16	18
	Topic 8.2. Criteria for the effectiveness of the orbital construction of space systems. Criteria for the effectiveness of solving the target task of space systems. Tasks of optimization of criteria for the effectiveness of space systems	2	16	18
	Exam	**20**	**160**	**180**

6 . Laboratory workshop *(if available) - not provided*

7. Practical lessons (seminars) *(if any)*

P/p №.	Discipline section number	Practical lessons (seminars)	Labor capacity (hour.)
1.	1	Topic 1.1. Areas of use of aviation and rocket and space	1

		technology, tasks at the present stage	
2.	2	Topic 2.1. Implementation of information technology in the design, production and operation of aviation and rocket technology .	1
3	2	Topic 2.2. Problems and search for solutions	2
4	3	Topic 3.1. Prospects and problems of using 3D printing technology, nanotechnology and modeling in the production of aviation and rocket technology	2
5	4	Topic 4.1. Alternative fuels in aviation and rocketry, aerospace systems	2
6	4	Topic 4.2. Reusable space transport systems, unmanned aerial systems	2
7	5	Topic 5.1. The role and place of space systems in the country's economy. Tasks solved by space observation, communication, navigation systems, scientific systems	2
8	6	Topic 6.1. The goals of space systems. Orbital and ground segments of space systems. Control and target components of space systems. User segment of space systems	2
9	7	Topic 7.1. Target equipment for space systems for various purposes. Orbital construction of space systems for various purposes. MCC and NIK. The composition of the user segment of space systems	2
10	8	Topic 8.1. General structure of the mathematical model. Scenario of the functioning of space systems for building a model. Problems of modeling space systems for various purposes .	2
11	8	Topic 8.2. Efficiency criteria for orbital construction of space systems. Efficiency criteria for solving the target problem of space systems. Optimization Problems of Performance Criteria for Space Systems	2

8. Logistics of the discipline

Table 5 - Material and technical support of the discipline

Auditorium with a list of logistics	**Location**
Educational laboratory "Laboratory of computing systems and methods of processing big data": № 409 Equipment and furniture: - Personal graphic workstations based on the AVK -1 system unit + monitor (13 pcs.); –Interactive whiteboard Polyvision TSL 610; –Projector Epson EB - X 02; –Switch Cisco Catalyst 2960 24; –Line filter. There is Internet access. –List of licensed software. Details of the supporting document: 1. Windows 7 (Microsoft Subscription) Enrollment for Education Solutions № 86626883 of 04.01.2018 g).; 2. Microsoft Office 2007 (Microsoft Subscription) Enrollment for Education Solutions № 86626883 from 01.04.2018 g).; 3. Borland Developer Studio 2006 (License Certificate Number: 33080, 33081, 33082);	Moscow, st. Ordzhonikidze, 3

4.	MATLAB R 2008 b (361405 2008);	
5.	**Notepad ++ (free application).**	
6.	**Acrobat Reader DC (free application)**	

9. Information support of the discipline

(the list of information technologies used in the implementation of the educational process in the discipline (module) is indicated , including the list of software and information reference systems (if necessary))

a) software Standard software for personal computers

b) ProjectLibre software

c) databases, information and reference and search engines Yandex, Google.

Resources of the information and telecommunications network "Internet":

1. EBS of RUDN University and third-party EBS to which university students have access on the basis of concluded agreements:

- Electronic library system RUDN - EBS RUDN http://lib.rudn.ru/MegaPro/Web
- EBS "University Library Online" http://www.biblioclub.ru
- EBS Yurayt http://www.biblio-online.ru
- EBS "Student Consultant" www.studentlibrary.ru
- EBS "Doe" http://e.lanbook.com/

2. Websites of ministries, departments, services, manufacturing enterprises and companies whose activities are core to this discipline:

3. Databases and search engines:

- electronic fund of legal and normative-technical documentation http://docs.cntd.ru/
- Yandex search engine https: // www .yandex.ru /
- Google search engine https://www.google.ru/
- SCOPUS abstract database http: // www .elsevierscience.ru / products / scopus /

Methodological materials for independent work of students and studying the discipline (also posted in the TUIS RUDN University in the corresponding section of the discipline):

1. A course of lectures on the discipline " Priority areas of development of mathematics and mechanics " (*Appendix 2*).
2. Methodical instructions for independent work of students in the discipline " Priority areas of development of mathematics and mechanics " (*Appendix 3*).

10 . Educational and methodological support of the discipline

Main literature:

1. Malyshev V.V. Optimization methods in problems of system analysis and control: Textbook. - M .: Publishing house MAI-PRINT, 2010.

2. Modern problems of computational mathematics and mathematical modeling: in 2 volumes / [otv. ed. NS Bakhvalov, VV Voevodin] Inst. Vychisl. mathematics. - M .: Nauka, 2005.

3. Samarskiy A.A., Mikhailov A.P. Mathematical modeling: Ideas, methods, examples. - M .: Fizmatlit, 2008.
4. Councils B. Ya., Yakovlev SA Modeling of systems: Textbook. for universities - 3rd ed., rev. and add. - M .: Higher. shk., 2001.
5. Averchenkov V.I., Fedorov V.P., Kheifets M.L. Fundamentals of mathematical modeling of technical systems / Tutorial. Bryansk: BSTU Publishing House, 2004 .-- 271 p.
6. Tikhonov N.A., Tokmachev M.G. Fundamentals of Mathematical Modeling / Tutorial. Moscow: Faculty of Physics, Moscow State University, 2013
7. Samarskiy AA, Vabishchevich PN Numerical methods for solving inverse problems of mathematical physics: Textbook. - M.: Publishing house of LCI, 2014 .-- 480 p.

Additional literature:

1. Gill F, Murray W., Wright M. Practical optimization. - M.: Mir, 1985 -512 p.
2. Lebedev AA, Bobronnikov VT, Krasil'shchikov MN, Malyshev VV. Statistical dynamics and optimization of aircraft control. - M .: Mechanical engineering, 1985. - 280 p.
3. Malyshev V.V. Optimization methods for complex systems. Tutorial. - M .: MAI, 1981.- 76 p.
4. Malyshev V.V. Programming optimal control of aircraft. - M .: MAI, 1982.
5. Polak E. Numerical optimization methods. One approach. - M .: Mir, 1974- 376 p.
6. Samarskiy A.A., Mikhailov A.P. Math modeling. Moscow: Nauka, 1997.320 p.
7. Bakhvalov NS Numerical methods / NS Bakhvalov, NP Zhidkov, GM Kobelkov. - M .: Laboratory of basic knowledge, 2001 .-- 632 p.
8. Gultyaev A.K. MatLab 5.2 Simulation modeling in the Windows environment. SP .: Crown-print, 1999.
9. Computer networks. Comprehensive manual for construction, operation and planning. User encyclopedia. Per. from English Kiev: Diasoft, 1998.
10. Samarskiy A.A., Mikhailov A.P. Math modeling. Moscow: Nauka, 1997.320c.
11. Korobeynikov V.P. Principles of mathematical modeling. Vladivostok: Dalnauka, 1997, 240 p.
12. Samarsky A.A., Vablitsevich P.N., Samarskaya E.A. Problems and exercises on numerical methods. Moscow: Editorial URSS, 2000.208 p.

11. Methodical instructions for students on mastering the discipline (module)

The organization of classes in the discipline " Priority areas of development of mathematics and mechanics " is carried out in the following types of educational work: interactive practical classes (seminars), preparation of independent work and their subsequent defense.

The implementation of the competence-based approach in the framework of the training area 0 1 .06.01 " Mathematics and Mechanics " provides for a combination in the educational process of contact work with a teacher and extracurricular independent work of students for a more complete formation and development of his professional skills, independent study of some topics of the course and confirmation of their knowledge in the course of control activities.

Graduate student is obliged to master all the topics provided for by the curriculum of the discipline. Certain topics and issues of training are submitted for independent study. Graduate student studies the recommended literature and briefly outlines the material, and clarifies the most difficult issues requiring clarification

during consultations. The same should be done with sections of the course that were skipped due to various circumstances.

The aim of practical training and seminars is to provide graduate student knowledge and develop practical skills in the field of ballistics and navigation rockets. To achieve this purpose both traditional forms of work - the tasks, work with the process equipment / specialized software under execution and laboratory work and the like, and interactive methods - group work, case studies, etc.

Using the method of analyzing a specific situation, students develop such qualifications as the ability to clearly formulate and express their position, the ability to communicate, discuss, perceive and evaluate information received in verbal form. Practical classes and seminars are held in special classrooms equipped with the necessary visual aids.

Independent work covers the study of individual questions of the theoretical course by students.

Independent work is carried out on an individual basis based on teaching and learning materials discipline (*application 2 -4*). The level of mastering the material on independently studied issues of the course is checked during current control and certification tests (exam and / or test) in the discipline.

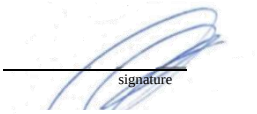
12. Fund of assessment tools for intermediate certification of students in the discipline (module)

The fund of assessment tools, formed for the current monitoring of progress and intermediate certification of students in the discipline " Priority areas of development of mathematics and mechanics " is presented in *Appendix 1* to the work program of the discipline and includes:

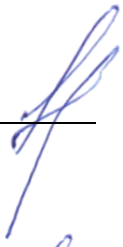
- a list of competencies with an indication of the stages of their formation in the process of mastering the educational program;
- description of indicators and criteria for assessing competencies at various stages of their formation, description of assessment scales;
- typical control tasks or other materials necessary to assess knowledge, skills, skills and (or) experience of activity, characterizing the stages of the formation of competencies in the process of mastering the educational program;
- methodological materials that determine the procedures for assessing knowledge, skills, skills and (or) experience of activities, characterizing the stages of the formation of competencies.

The program has been drawn up in accordance with the requirements of the OS of VO RUDN

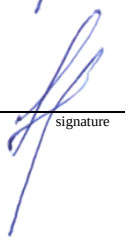
Developers:

Associate Professor at the Department of Mechanics and Mechatronics		O.E. Samusenko
position	signature	initials, surname
senior teacher Department of Mechanics and Mechatronics		T.A. Morozova
position	signature	initials, surname

Program manager

Professor at the Department of Mechanics and Mechatronics		Yu.N. Razumovskiy
position, department name signature initials, surname		

Department Director mechanics and mechatronics

		Yu.N. Razumovskiy
signature		initials, surname