«RUDN University»

Engineering Academy

STATE FINAL CERTIFICATION PROGRAM

Direction: 01.06.01 Mathematics and Mechanics

Scientific specialty: Dynamics, strength of machines, devices and equipment (Technical Science)

Moscow,
2021

1. The purpose and objectives of the State Final Certification

The State Final Certification (hereinafter – SFC) is carried out by the State Examination Commissions (hereinafter – SEC) **in order to** determine the compliance of the results of the development of the main educational program « Dynamics, strength of machines, devices and equipment (Technical Science)» by students with the requirements of the educational standard of the RUDN University, approved by the Rector's Order *№ 831 of 10.11.2016.*

The main **tasks** of the SFC are:
- completion of the formation and determination of the student's level of formation of competencies provided for by the educational standard of the RUDN University in the direction 01.06.01 Mathematics and Mechanics (universal, general professional and professional).
- determination of the level of theoretical and practical readiness of the graduate to solve scientific and professional problems, in the areas of professional activity, defined by the educational standard of the RUDN University.
- making a decision by the SEC to assign the qualification *«Researcher. Teacher-researcher»* to a student who has fully mastered the educational program.

2. Forms and place of SFC in the structure of the educational program

The State Final Certification refers to the basic part of Block 4 of the curriculum.

State Final Certification for the educational program Dynamics, strength of machines, devices, and equipment in the direction 01.06.01 Mathematics and Mechanics is carried out in the form of preparation for passing and passing the State Exam, as well as the presentation of a scientific report on the main results of the prepared scientific qualification work (dissertation).

3. List of planned results of mastering the educational program

As a result of mastering the educational program Dynamics, strength of machines, devices, and equipment in the direction 01.06.01 Mathematics and Mechanics, the graduate must have the following universal, general professional and professional competencies:
− the ability to critically analyze and evaluate modern scientific achievements, generate new ideas when solving research and practical problems, including in interdisciplinary areas (UC-1).
− the ability to design and implement complex research, including interdisciplinary research, based on a holistic, systematic scientific worldview, using knowledge in the field of history and philosophy of science (UC-2).
− the willingness to participate in the work of Russian and international research teams to solve scientific and scientific-educational tasks (UC-3).
− the willingness to use modern methods and technologies of scientific communication in the state and foreign languages, including the readiness for communication in oral and written forms in Russian and foreign languages to solve the problems of professional activity, possession of foreign language communicative competence in official business, educational and professional, scientific, socio-cultural, everyday life spheres of foreign language communication (UC-4).

- the ability to plan and solve problems of their own professional and personal development (UC-5).
- the ability to independently carry out research activities in the relevant professional field using modern research methods and information and communication technologies (GPC-1).
- the willingness to teach in the main educational programs of higher education (GPC-2).
- the willingness to apply promising methods of research and solving professional problems, considering global trends in the development of technical facilities for various purposes (PC-1).
- the ability to identify the essence of scientific and technical problems that arise during professional activity, and to apply to their solution the physical and mathematical apparatus, theoretical, computational, and experimental research methods, methods of mathematical and computer modeling (PC-2).
- the willingness to carry out research work and solve scientific and technical problems in the field of applied mechanics based on the achievements of engineering and technology, classical and technical theories, and methods, physical and mechanical, mathematical and computer models that have a high degree of adequacy to real processes, machines, and structures (PC-3).
- the ability to create new generations of machines, devices, equipment, technologies, and materials that have qualitatively new functional properties, as well as to improve existing machines, devices, equipment, and technologies that have increased operational characteristics, lower material, and energy consumption (PC-4).
- the ability to develop methods of mechanics and computational mathematics, computer technologies and decision support systems in scientific research, design, and engineering activities (PC-5).
- the ability to study patterns and connections, dynamic processes, stress states and strength of machines, devices, and equipment (PC-6).
- the willingness to teach courses, disciplines (modules), conduct certain types of training sessions in Russian and foreign languages in higher education programs (PC-7).
- the ability to organize educational, research and project activities of students in higher education programs (PC-8).

4. Scope of the SFC and types of academic work

The State Final Certification is carried out in the form of contact work and in the form of independent work of students (Table 1).

Table 1 – Scope of the SFC and types of academic work

Type of academic work	Total, academic hours	Semester 8
Preparation for passing and passing the State Exam		
Student's contact work with a teacher	4	4
Student's independent work, including passing the exam	104	104
Type of certification test	exam	

The total labor intensity of the certification test	academic hours	*108*	*108*
	credit units	*3*	*3*
Preparation and presentation of a scientific report on the main results of the prepared Scientific Qualification Work			
Student's contact work with a teacher		8	8
Student's independent work, including the defense of the Final Qualification Work		208	208
Type of certification test		public presentation	
The total labor intensity of the certification test	academic hours	*216*	*216*
	credit units	*6*	*6*
The total labor intensity of the SFC	academic hours	**324**	**324**
	credit units	**9**	**9**

5. State Exam Program

The program of the State Exam in the educational program Dynamics, strength of machines, devices, and equipment in the direction <u>06.01.01 Mathematics and mechanics</u> corresponds to the program of the candidate minimum for a scientific specialty 02/01/06 Dynamics, strength of machines, devices and equipment approved by the order of the Ministry of Education and Science of Russia №. 274 of 08.10.2007.

The State Exam is conducted in writing using examination cards. Each examination card contains three questions.

The questions included in the examination card are interdisciplinary in nature and are aimed at determining the level of theoretical and practical preparedness of the graduate to solve scientific and professional problems in the areas of professional activity defined by the educational standard of RUDN University.

The total number of examination cards is determined by the number of graduate students admitted to the State Exam. The student is given 120 minutes to prepare and defend a written answer to the ticket.

At the State Exam, members of the SEC may ask the graduate additional questions in the field of his/her future professional activity, provided for by the educational standard.

The list of questions for preparing for the State Exam, as well as the criteria for evaluating the results of this stage of the State Final Certification are given in the fund of evaluation means of the SFC.

6. Requirements for a scientific report and the order of its presentation

The scientific report on the main results of the prepared scientific qualification work (dissertation) is a work performed by the student, demonstrating the level of his/her readiness for independent scientific and professional activities.

The volume, structure and procedure of registration of the final qualification work for postgraduate programs (scientific report) is regulated by the National Standard GOST R 7.0.11-2011 «Dissertation and abstract of the dissertation. Structure and rules of registration», as well as the Regulations for the preparation and registration of scientific qualification work (Dissertation) on the programs of training of highly Qualified personnel at the Peoples' Friendship University of Russia, approved by the Rector's Order № 40 of 20.01.2017.

7. Normative and educational and methodological support of the SFC

1. Federal Law «On Education in the Russian Federation» № 273-ФЗ of 29.12.2012.

2. The order of the organization and implementation of educational activities on educational programs of higher education - programs for the training of scientific and pedagogical personnel in graduate school (postgraduate studies), approved by Order of the Ministry of Education and Science of Russia № 1259 of 19.11.2013.

3. The procedure for conducting State Final Certification for educational programs of higher education - programs for the training of scientific and pedagogical personnel in postgraduate studies (adjuncture), residency programs, programs of assistantship-internship, approved by the Order of the Ministry of Education and Science of the Russian Federation № 227 of 18.03.2016.

4. Regulations on the State Final Certification of students in higher education programs - programs for the training of scientific and pedagogical personnel in graduate school, approved by the Rector's Order № 41 of 20.01.2017.

5. Regulations for the use of the "Antiplagiat" system for checking written educational works at RUDN University, approved by the Rector's Order №228 of 30.03.2018.

6. National standard GOST R 7.0.11-2011 «Dissertation and thesis abstract. The structure and registration rules».

7. The program of the candidate minimum of scientific specialty 01.02.06 Dynamics, strength of machines, devices, and equipment, approved by the order of the Ministry of Education and Science of Russia № 274 of 08.10.2007.

8. The main literature specified in the work programs of the disciplines/modules of the educational program (in preparation for the State Exam).

Resources of the information and telecommunications network «Internet»:

1. ELS RUDN University and other ELS, to which university students have access based on concluded agreements:
- Electronic Library System of the RUDN University – ELS RUDN http://lib.rudn.ru/MegaPro/Web
- ELS «Университетская библиотека онлайн» http://www.biblioclub.ru
- ELS Юрайт http://www.biblio-online.ru
- ELS «Консультант студента» www.studentlibrary.ru
- ELS «Лань» http://e.lanbook.com/
2. 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/
- abstract database SCOPUS http://www.elsevierscience.ru/products/scopus/

Software:

1. Specialized software for the preparation of scientific reports and independent work of students:
- Windows 7 (Microsoft Subscription Enrollment for Education Solutions № 86626883 от 01.04.2018 г.).
- Microsoft Office 2007 (Microsoft Subscription Enrollment for Education Solutions № 86626883 от 01.04.2018 г.).

- Windows XP (Microsoft Subscription Enrollment for Education Solutions № 86626883 от 01.04.2018 г.).
- Microsoft Office 2003 (Microsoft Subscription Enrollment for Education Solutions № 86626883 от 01.04.2018 г.).
- MATLAB R2008b (361405 2008 г.);
- Mathcad 14 (7A1354555).
- Borland Developer Studio 2006 (License Certificate Number: 33080, 33081, 33082).
- Notepad++ (free application).
- Acrobat Reader DC (free application).

Methodological materials for independent work of students in the process of preparing a scientific report:

1. The regulations for the preparation and execution of scientific qualification work (dissertation) on training programs for highly qualified personnel at the Peoples' Friendship University of Russia, approved by the Rector's Order № 40 of 20.01.2017.
2. Numerical Models for Differential Problems [Electronic resource]: Undergraduate textbook. - Electronic text data. - : Springer Milan, 2009. - (; 2). - System requirements: Windows XP and higher. - ISBN 978-88-470-1071-0. http://lib.rudn.ru/MegaPro/UserEntry?Action= Rudn_FindDoc&id=328049&idb=0.
3. Evolutionary Design of Intelligent Systems in Modeling, Simulation and Control [Electronic resource] : Monograph. - Electronic text data. - : Springer Berlin Heidelberg, 2009. - (Studies in Computational Intelligence; 257). - System requirements: Windows XP and higher. - ISBN 978-3-642-04514-1. http://lib.rudn.ru/MegaPro/UserEntry?Action=Rudn_FindDoc&id=327239&idb=0.
4. Differential equations in applications [Текст] : Transl. from the Russ. / V.V. Amel'kin. - Book in English. - M. : Mir, 1990. - 279 p. : il. - ISBN 5-03-000521-8 : 0.80.22.16 - A498.
5. Mathematical modeling and digital simulation for engineers and scientists / J.M. Smith. - Book in English. - New York : Wiley, 1977. - 332 p.: il. - (A Wiley-Interscience publication). - 30.00. ЗБТ - S652.
6. Analysis, Partial Differential Equations and Applications [Electronic resource]: Proceedings. - Electronic text data. - : Birkhauser Basel, 2009. - (Operator Theory: Advances and Applications ; 193). - System requirements: Windows XP and higher. - ISBN 978-3-7643-9898-9. http://lib.rudn.ru/MegaPro/UserEntry?Action=Rudn_FindDoc&id=327847&idb=0.
7. Elementary differential equations with applications / W.R. Derrick, S.I. Grossman. - Book in English. - Reading : Addison-Wesley, 1976. - 597 p. : il. - (Addison-Wesley series in mathematicos ; 1470). - 13.30.ЗБМ - D438.
8. Optimal Control of Coupled Systems of Partial Differential Equations [Electronic resource] : Proceedings. - Electronic text data. - : Birkhauser Basel, 2009. - (International Series of Numerical Mathematics ; 158). - System requirements: Windows XP and higher. - ISBN 978-3-7643-8923-9. http://lib.rudn.ru/MegaPro/UserEntry?Action=Rudn_FindDoc&id=327783&idb=0.

9. Fuzzy Information and Engineering Volume 2 [Electronic resource] : Proceedings. - Electronic text data. - : Springer Berlin Heidelberg, 2009. - (Advances in Soft Computing ; 62). - System requirements: Windows XP and higher. - ISBN 978-3-642-03664-4. http://lib.rudn.ru/MegaPro/UserEntry?Action=Rudn_Find-Doc&id=326966&idb=0.

10. Intelligent Distributed Computing 3 [Electronic resource] : Monograph. - Electronic text data. - : Springer Berlin Heidelberg, 2009. - (Studies in Computational Intelligence ; 237). - System requirements: Windows XP and higher. - ISBN 978-3-642-03214-1. http://lib.rudn.ru/MegaPro/UserEntry?Action=Rudn_Find-Doc&id=327251&idb=0.

11. Amosov A.A., Dubinskij Ju.A., Kopchenova N.V. Vychislitel'nye metody dlja inzhenerov. – M.: Vyssh. shk., 1994. – 544 p.

12. Bahvalov N.S., Zhidkov N.P. Chislennye metody: Uchebnoe posobie dlja studentov fiziko-matematicheskih special'nostej vysshih uchebnyh zavedenij. - M.: BINOM. Laboratorija znanij, 2015. - 636 p.

13. Ventcel' E.S. Teorija verojatnostej. M.: Vysshaja shkola, 2002. – 575 p.

14. Knut D.Je. Iskusstvo programmirovanija v 3-h tomah – M.: Izd. dom Vil'jams, 2008. – T.1 – 720p, T.2 – 832 p., T.3 - 824 p.

15. Ortega Dzh., Pul U. Vvedenie v chislennye metody reshenija differencial'-nyh uravnenij. – M.: Nauka, 1986. – 288 p.

16. Samarskij A.A. Chislennye metody: Uchebnoe posobie. - M.: Nauka, 1989. - 430 p.

17. Samarskij A.A., Vabishhevich P.N. Chislennye metody reshenija obratnyh za-dach matematicheskoj fiziki: Uchebnoe posobie. - M.: Izd-vo LKI, 2014. - 480 p.

18. Suharev A.G., Timohov A.V., Fedorov V.V. Kurs metodov optimizacii. - M.: Nauka, 1986. - 326 p.

19. Moiseev N.N. Chislennye metody v teorii optimal'nyh sistem. - M.: Nauka, 1971. - 424 p.

8. Material and technical support of the SFC

To prepare for the State Exam and submit a scientific report, students use the premises for independent work.

To conduct a State Exam and/or present a scientific report, a room with a capacity of 12 or more people is used, which is equipped with working places for all members of the SEC, with the opportunity to listen to reports, view public presentations of speakers, keep records and minutes, there are places for listeners who want to attend the procedure for presenting a scientific report. The necessary equipment of the premises includes:

- equipment for public presentations, including a multimedia screen, projector, audio equipment.

- a board to illustrate the answers to questions.

- tablets/stands of at least A1 format (if necessary), for placing graphic material on them as part of a scientific report.

The student can notify the issuing department of his wishes for additional material and technical equipment (if necessary) of the auditorium designated for conducting the SFC with a written statement no later than a week before the defense procedure.

9. Evaluation Fund

The evaluation fund formed for the State Final Certification of students in the educational program Dynamics, strength of machines, devices, and equipment in the direction 01.06.01 Mathematics and Mechanics, includes:

- a list of competencies that students should master as a result of mastering the educational program.

- description of indicators and criteria for assessing competencies, as well as assessment scales.

- standard control tasks or other materials necessary for evaluating the results of the mastering of the educational program.

- methodological materials that define the procedures for evaluating the results of the mastering of the educational program.

9.1 The list of competencies that students should master as a result of mastering the educational program

As a result of mastering the educational program Dynamics, strength of machines, devices, and equipment in the direction 01.06.01 Mathematics and Mechanics, the graduate must have all the universal, general professional and professional competencies listed in paragraph 3 of this Program.

9.2 Indicators, criteria, and scales of competence assessment in the process of conducting the SFC

According to the results of the State Exam, the assessment is made in accordance with the point-rating system adopted in the RUDN (point / ECTS / assessment of the Russian Federation, maximum 100 points).

The assessment based on the results of the State Exam is determined by the results of the verification by the SEC members of the student's written answer to the examination card and (if necessary) the quality of the student's answers to the additional questions of the SEC members.

The scale and evaluation criteria of the State Exam are presented in Table 2.

Table 2 – *The scale and evaluation criteria of the State Exam*

Grading scale	86-100 points	69-85 points	51-68 points	0-50 points

| Criteria | - the content of the examination card material is fully disclosed.
- the material is presented correctly, in a certain logical sequence.
- terminology is used accurately.
- the ability to illustrate theoretical positions with concrete examples and apply them in a new situation is shown.
- the answer was made independently, without leading questions.
- demonstrated the ability to creatively apply knowledge of theory to solving professional problems.
- demonstrated a high level of competence formation. | - questions of the examination material are presented in a systematic and consistent manner.
- demonstrated the ability to analyze the material, but not all conclusions are reasoned and evidence-based.
- the assimilation of the main literature is demonstrated.
- the answer contains one of the following disadvantages:
- there are small gaps in the presentation that do not distort the content of the answer.
- a mistake or more than two shortcomings were made in the coverage of secondary questions, which are easily corrected at the comment of the examiner. | - the content of the material is incomplete or inconsistently disclosed, but a general understanding of the issue is shown and skills that are sufficient for further assimilation of the material are demonstrated.
- the main categories on the considered issue and on the additional issues are mastered.
- there were difficulties or mistakes in the definition of concepts, the use of terminology, corrected after several leading questions.
- with incomplete knowledge of the theoretical material, insufficient formation of competencies, skills and abilities is revealed, the student cannot apply the theory in a new situation.
- the assimilation of the main literature is demonstrated. | - the main content of the educational material has not been disclosed.
- found ignorance or misunderstanding of the most part or the most important part of the educational material.
- mistakes were made in the definition of concepts, when using terminology, which were not corrected after several leading questions.
- competencies, skills, and abilities are not formed. |

The scientific report is assessed in accordance with the point-rating system adopted by the RUDN University (score / ECTS / assessment of the Russian Federation, maximum 100 points) according to the following indicators, which allow assessing the level of competence formation provided by the educational program:

Scientific report evaluation indicators	Maximum score
- compliance of the content of the scientific report to the approved Scientific Qualification Work (SQW) topic and the assigned task, clarity of the formulation of the goals and objectives of the research	20
- reliability, originality, and novelty of the results obtained in the SQW	10
- practical value of the performed SQW	10
- style of presentation of the scientific report	5
- compliance with the approved registration requirements SQW	10
- quality of presentation and report	10
- quality of answers to the questions of the SEC members	10
- evaluation of the scientific work of a graduate student by the supervisor (review)	10
- assessment of the SQW by the reviewer (review)	10
- availability of publications on the topic of work, certificates, awards, etc.	5

The scale and criteria for evaluating a scientific report based on the results of SQW are presented in Table 3.

Table 3 – Scale and criteria for evaluating a scientific report

Compliance of the content of the scientific report to the approved SQW topic and the assigned task, clarity of the formulation of goals and objectives of the research

Scale	15-20 points	5-14 points	1-4 points	0 points
Criteria	The SQW is carried out on an actual topic, the goals and objectives of the research are clearly formulated.	The SQW is carried out on an actual topic, there are minor comments on the formulation of the goals and objectives of the study.	The relevance of the SQW topic raises doubts. The goals and objectives of the SQW are formulated with significant remarks, not clearly enough. There is no link between the essence of the topic and the most significant directions for solving the problem under consideration.	The goals and objectives of the SQW do not correspond to the approved topic of work and do not disclose the essence of the research being conducted

Reliability, originality, and novelty of the results obtained in the SQW

Scale	7-10 points	4-6 points	1-3 points	0 points
Criteria	An in-depth analysis of the research object was performed. The reliability, originality, and novelty of the conclusions on the research topic are noted.	The analysis of the research object has not been carried out deeply enough the reliability, originality and novelty of the conclusions have a number of minor remarks.	The reliability, originality and novelty of the conclusions based on the results obtained give rise to serious remarks.	The reliability of the results is questioned, the originality and novelty of the results are absent

Practical value of the performed SQW

Scale	7-10 points	4-6 points	1-3 points	0 points
Criteria	The paper provides a new solution to a theoretical or practical problem that is of significant importance for the professional field.	The paper provides a partial solution to a theoretical or practical problem that is important for the professional field.	The paper considers only the directions of solving the problem, the results obtained are general or insufficiently reasoned.	The results are not of practical value

Style of presentation of the scientific report

Scale	4-5 points	2-3 points	1 points	0 points
Criteria	The scientific style of presentation of the work results with correct references to literary sources is noted.	There are minor remarks on the scientific style of the presentation of the results and/or on the correctness of references to sources	There are serious remarks about the scientific style of presentation of the work results and/or about the correctness of references to sources.	The style of the presentation does not correspond to the scientific one, the references to the sources are incorrect

Compliance with the approved registration requirements SQW

Scale	7-10 points	4-6 points	1-3 points	0 points
Criteria	SQW fully complies with the requirements for registration.	SQW with minor remarks complies with the requirements for registration.	SQW has important notes on compliance with the requirements for registration	The SQW does not meet the requirements for registration.

Quality of presentation and report

Scale	7-10 points	4-6 points	1-3 points	0 points
Criteria	The presentation and report fully reflect the content of the SQW, demonstrated a good command of the material of the work, a confident, consistent and logical presentation of the results of the study.	There are minor comments on the presentation and/or report on the topic of the SQW. Minor inaccuracies were made in the presentation of the results of the SQW, which do not distort the main content of the work.	There are significant comments on the quality of the presentation and/or report on the topic of the SQW. Significant inaccuracies were made in the presentation of the material, affecting the essence of understanding the main content of the SQW, and the logic of the presentation was violated.	The presentation and/or report does not reflect the essence of the SQW. Possession of the work material is not demonstrated.

Quality of answers to the questions of the SEC members			
Scale	**7-10 points**	**4-6 points**	**1-3 points**	**0 points**
Crite-ria	The answers to the questions are given in full	Answers are given incompletely and/or with minor errors	The answers to the questions are incomplete, with serious errors	The answers to the questions are not given

Evaluation of the scientific work of a graduate student by the supervisor			
Scale	**7-10 points**	**4-6 points**	**1-3 points**	**0 points**
Criteria	Excellent	Good	Acceptable	Unacceptable

Assessment of the SQW by the reviewer			
Scale	**7-10 points**	**4-6 points**	**1-3 points**	**0 points**
Criteria	Excellent	Good	Acceptable	Unacceptable

Availability of publications on the topic of work, certificates, awards, etc.			
Scale	**4-5 points**	**2-3 points**	**1 points**	**0 points**
Criteria	The results of the study have been tested in speeches at conferences, seminars, there are publications in the press, the results are confirmed by a certificate of implementation, etc.	The results of the study are declared for presentation at conferences, seminars, or accepted for publication in the press, for implementation.	The results of the research are prepared for discussion at conferences, seminars, or are prepared for publication in the press, for implementation.	The research results are not planned for publication, for a report at conferences, seminars, or for implementation.

9.3 Standard control tasks or other materials necessary for evaluating the results of the mastering of the educational program.

List of questions to prepare for the State Exam:

Mathematical Foundations

1.   Elements of the theory of functions and functional analysis. The concept of the measure and the Lebesgue integral. Metric and normalized spaces. Spaces of integrable functions. Sobolev spaces. Linear continuous functionals. The Hahn-Banach theorem. Linear operators. Elements of spectral theory. Differential and integral operators.

2.   Extreme tasks. Convex analysis. Extremal tasks in Euclidean spaces. Convex tasks on the minimum. Mathematical programming, linear programming, convex programming. Minimax tasks. Fundamentals of the calculus of variations. Optimal control tasks. The maximum principle. The principle of dynamic programming.

3.   Probability theory. Mathematical statistics. Axiomatics of probability theory. Probability, conditional probability. Independence. Random variables and vectors. Elements of the correlation theory of random vectors. Elements of the theory of random processes. Point and interval estimation of distribution parameters. Elements of the theory of statistical hypothesis testing. Elements of multidimensional statistical analysis. Basic concepts of the theory of statistical solutions. Fundamentals of information theory.

Information Technologies

4. Decision-making. The general problem of the solution. The loss function. Bayesian and minimax approaches. The method of sequential decision-making.

5. Research of operations and tasks of artificial intelligence. Expertise and informal procedures. Design automation. Artificial intelligence. Image recognition.

Computer Technologies

6. Numerical methods. Interpolation and approximation of functional dependencies. Numerical differentiation and integration. Numerical methods for finding the extremum. Computational methods of linear algebra. Numerical methods for solving systems of differential equations. Spline approximation, interpolation, finite element method. Fourier transform, Laplace transform, Haar transform, etc. Numerical methods of wavelet analysis.

7. Computational experiment. Principles of conducting a computational experiment. Model, algorithm, program.

8. Algorithmic languages. Introduction to high-level programming languages. Application packages.

Methods of mathematical modeling

9. Basic principles of mathematical modeling. Elementary mathematical models in mechanics, hydrodynamics, and electrodynamics. Universality of mathematical models. Methods for constructing mathematical models based on the fundamental laws of nature. Variational principles of constructing mathematical models.

10. Methods of research of mathematical models. Stability. Checking the adequacy of mathematical models.

11. Mathematical models in scientific research. Mathematical models in statistical mechanics, economics, and biology. Methods of mathematical modeling of measurement and computing systems. Tasks of reduction to the ideal device. Synthesis of the output signal of an ideal device. Checking the adequacy of the measurement model and the adequacy of the reduction results. Models of dynamic systems. Special points. Bifurcations. Dynamic chaos. Ergodicity and mixing. The concept of self-organization. Dissipative structures. Modes with aggravation.

Approximate topics of scientific research carried out in the department:
1. Ensuring the reliability of thermoelectric semiconductor devices during ultra-long operation using methods of physical and technological diagnostics.
2. Theoretical and numerical study of increasing the system throughput using a multi-electrode semiconductor optical amplifier ME-SOA in optical access networks.

9.4 Methodological materials that define the procedures for evaluating the results of the mastering of the educational program

Methodology for evaluating the results of the State Exam

According to the results of the State Exam, an assessment is made in accordance with the point-rating system adopted by the RUDN University (score / ECTS / assessment of the Russian Federation).

According to the results of the State Exam, a graduate student can receive a maximum of 100 points. The assessment is determined by the results of verification by the SEC members of the student's written answer to the examination card and (if necessary) the quality of the graduate student's answers to additional questions from the SEC members. The assessment received by the graduate according to the results of the State Exam is put in the statement of the State Exam (by the chairman of the SEC), in the minutes of the meeting of the SEC (by the secretary of the commission) and is brought to the student.

Methodology for evaluating the results of the presentation of a scientific report

For the efficiency and convenience of the work of the members of the GEC, it is recommended to provide them with an auxiliary document "*The Worksheet for the assessment of the formation of competencies during the SFC*", the form of which is given in Annex 1.

In the process of hearing the scientific report, the members of the SEC assign points for each of the above indicators. At the end of the presentation of the report, each of the members of the SEC sums up all the assigned points.

The final assessment of the formation of competencies is an assessment given after hearing a scientific review by all members of the SEC who attended the hearing. To determine the final grade, it is necessary to calculate and round off the arithmetic average of the grades given by all members of the State Commission. In the event of any controversial issues, the chairman of the SEC has a casting vote.

The total score received by the graduate student based on the results of the presentation of the scientific report is affixed to the examination sheet (by the chairman of the SEC) and in the minutes of the SEC meeting (by the secretary of the commission).

Developer
Assistant Professor of the Basic Department
of Nanotechnology and
Microsystem Technology   M.O. Makeev

Acting head
of the Basic Department
of Nanotechnology and
Microsystem Technology   S.V. Agasieva

WORKSHEET assessment of the formation of competencies during the SFC		
Direction:	**01.06.01 Mathematics and Mechanics**	
Educational program (academic specialty):	**01.02.06**	
Dynamics, strength of machines, devices, and equipment (Researcher. Teacher-researcher.)		
Full name of the SEC member:		
Date:		
Certification test:	*Presentation of the scientific report*	
Full name of graduate:		
Indicators for evaluating the protection of the Final Qualification Work	**Maximum score**	**Actual score**
- compliance of the content of the scientific report to the approved Scientific Qualification Work (SQW) topic and the assigned task, clarity of the formulation of the goals and objectives of the research	20	
- reliability, originality, and novelty of the results obtained in the SQW	10	
- practical value of the performed SQW	10	
- style of presentation of the scientific report	5	
- compliance with the approved registration requirements SQW	10	
- quality of presentation and report	10	
- quality of answers to the questions of the SEC members	10	
- evaluation of the scientific work of a graduate student by the supervisor (review)	10	
- assessment of the SQW by the reviewer (review)	10	
- availability of publications on the topic of work, certificates, awards, etc.	5	
Total score:	100	
Signature of the SEC member		