Federal State Autonomous Educational Institution of Higher Education
PEOPLES' FRIENDSHIP UNIVERSITY OF RUSSIA
RUDN University

Faculty of Physics, Mathematics and Natural Sciences

educational division (faculty/institute/academy) as higher education programme developer

FINAL STATE EXAMINATION SYLLABUS

Recommended by the Didactic Council for the Education Field of:

01.04.01 Mathematics

field of studies / speciality code and title

The final state examination is implemented within the professional education program of higher education:

Functional methods in differential equations and interdisciplinary research

higher education programme profile/specialisation title

Электронная версия документа

1. FINAL STATE EXAMINATION GOAL AND TASKS

The goal of the final state examination within the framework of the higher education programme implementation is to check the conformity of the students' training outcomes as the programme results with the relevant requirements of the Federal State Educational Standard of the Higher Education or the RUDN University Educational Standards.

The tasks of the final state examination include the following:

- checking the quality of teaching a person basic humanitarian knowledge, natural science laws and phenomena necessary for professional activities of a graduate;

- identifying the level of theoretical and practical readiness of a graduate to perform professional tasks in compliance

 with the qualification obtained;

- establishing the degree of a person's desire for self-development, improving his or her qualifications and skills;

- exploring the formation of a graduate's sustainable motivation for professional activities in compliance with the types of tasks of professional activities provided for by the Federal State Educational Standard of the Higher Education or the RUDN University Educational Standards;

- assessing the level of graduates' ability to find organizational and managerial solutions in non-standard situations and evaluating graduates' readiness to bear responsibility for them;

- ensuring the integration of education and scientific and technical activities, increasing the efficiency of scientific and technological achievements use, reforming the scientific sphere and stimulating innovation;

- ensuring the quality of specialists' training in compliance with the requirements of the Federal State Educational Standards of the Higher Education or the RUDN University Educational Standards.

2. REQUIREMENTS FOR HIGHER EDUCATION PROGRAMME COMPLETION AND LEARNING OUTCOMES

A student who does not have failed tests or exams and who has fully completed the curriculum or the individual curriculum of the higher education programme is allowed to the final state examination.

On the higher education programme completion the graduate is expected to master the following **generic competences** (GC):

Code and descriptor of the generic competences
GC-1. Able to search, critical analysis of problem situations based on a systematic approach, develop an action strategy
GC-2. Able to manage a project at all stages of its life cycle
GC-3. Able to organize and manage the work of the team, developing a team strategy to achieve the goal
GC-4. Able to apply modern communication technologies in the state language of the Russian Federation and foreign language(s) for academic and professional interaction
GC-5. Able to analyze and take into account the diversity of cultures in the process of intercultural interaction

Code and descriptor of the generic competences
GC-6. Able to identify and implement the priorities of their own activities and ways to improve it based on self-assessment
GC-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 received 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

- **general professional competences** (GPC):

Code and descriptor of the general professional competences
GPC-1. The ability to formulate and solve relevant and significant problems in mathematics
GPC-2. The ability to build and analyze mathematical models in modern natural science, technology, economics and management
GPS-3. The ability to use knowledge in the field of mathematics in teaching activities

- professional competences (PC):

Code and descriptor of the professional competences
PC.1. Able to conduct scientific research and obtain new scientific and applied results independently and as part of a scientific team
PC.2. Able to develop and analyze conceptual and theoretical models of scientific problems and tasks to be solved
PC.3. Able to develop and apply mathematical methods, system and application software for solving problems of scientific and design and technological
PC.4. Able to develop and analyze conceptual and theoretical models of the tasks to be solved in design and production and technological activities
PC.5. Able to manage projects, plan research activities, analyze risks, manage a project team
PC.6. Able to organize corporate training processes based on information technology and the development of corporate knowledge bases
PC.7. Able to develop and optimize business plans for scientific and applied projects
PC.8. Able to develop corporate standards and profiles of functional standardization of applications, systems, information infrastructure
PC.9. Able to teach mathematical disciplines and informatics in general educational organizations, professional educational organizations and educational institutions of higher education
PC.10. Able to manage the educational and research activities of students
PK.40.011. Able to carry out work on the processing and analysis of scientific and technical information and research results

3. FINAL STATE EXAMINATION PROCEDURE

The final state examination can be conducted both in in-person format (students and the state examination committee are at RUDN University during the examination), and through the use of distance learning technologies (DLT) available in the RUDN Electronic Information and Educational Environment.

The procedure for in-person or DLT-facilitated final state examination is regulated by the relevant local normative act of the RUDN University.

The final state examination within the framework of the higher education programme includes:

- state exam
- defence of the graduation qualifying paper (degree thesis).

4. STATE EXAM PROCEDURE

The total workload of the State Exam is <u>3</u> credits.

The state exam is held in one or more disciplines and (modules) of the higher education programme, whose mastery bears a decisive importance for graduates' occupational performance.

The state exam is held in two stages:

The first stage is an assessment of the level of preparation of a graduate in the form of computer testing using the tools available in the RUDN Electronic Information and Educational Environment;

The second stage is the assessment of the graduate's preparation for future professional activity in the form of an oral exam using examination bills.

In order to prepare students for taking the state exam, the head of the educational programme (no later than one calendar month before the start of the final state examination) shall familiarise the graduate students with the final state examination syllabus, the comprehensive list of theoretical issues included in the state exam, examples of work-related (occupational) situational tasks (cases) that the students will have to solve in the process of taking the state exam, as well as with the procedure for each stage of the state exam and the grading system for evaluating its results (with assessment materials).

Before the state exam, students are offered consultations on issues and tasks included in the state exam (mandatory pre-exam consultation).

The procedure for conducting the computer testing within the final state examination is as follows:

1) in the tests of the parts of the state interdisciplinary exam, a minimum number of questions of the main sections of the main educational program is required to comply with the requirements of the general safety of the student's competence in the framework of the free ES of HE RUDN University and the proven educational program of this area of study;

2) the number of questions in the test - 20; The total time allotted to complete the test is 120 minutes.

The procedure for conducting the second stage of the state exam is as follows:

1) in the tests of the parts of the state interdisciplinary exam, a minimum number of questions of the main sections of the main educational program is required to comply with the requirements of the general safety of the student's competence in the framework of the free OS of HE RUDN University and the proven educational program of this area of study;

2) the number of questions in the test - 10; The total time allotted to complete the test is 90 minutes.

Program of the second stage of the state exam

1) Completeness of metric spaces. Contraction mapping theorem. Application: proof of the existence and uniqueness theorem for the Cauchy problem for ordinary differential equations.
2) Hahn-Banach theorem. Extension of linear functionals in locally convex spaces. Application: separability of convex sets (without proof).
3) Measurable functions and their main properties. Theorem on passage to the limit for a sequence of measurable functions. Egorov's theorem (without proof).
4) Definition of the Lebesgue integral and its main properties. Its connection with the Riemann integral.
5) Absolute continuity of the Lebesgue integral. Lebesgue's theorem on passage to the limit.
6) The implicit function theorem. The formula for the derivative of an implicitly defined function.
7) Linear operators in normed spaces. Boundedness and non-discontinuity. Compact operators and their properties.
8) Linear operators in finite-dimensional spaces. Scheme for reducing the matrix of a linear operator to Jordan form (without proof). Reducing the matrix of a Hermitian operator to a diagonal form.
9) Hilbert spaces. Linear operators in Hilbert spaces. Symmetric (Hermitian) operators. Hilbert's theorem for compact symmetric operators.
10) Linear programming problem and duality theorem.
11) Matrix games and mixed strategies. Neumann's theorem.
12) Stability and asymptotic stability in the sense of Lyapunov. Lyapunov's lemma on stability. Lyapunov's theorem on asymptotic stability with respect to linear approximation (without proof).
13) Construction of a solution to a homogeneous ordinary differential equation with constant coefficients. Vronsky's determinant for a system of equations and equations of the nth order, its main properties, the method of variation of constants. Liouville's formula (no proof).
14) Harmonic functions. Maximum principle for harmonic functions.
15) Differentiability of functions of a complex variable. Cauchy-Riemann conditions.
16) Holomorphic functions and their expansion into power series (Taylor series).
17) The classical problem of the calculus of variations. Derivation of the Euler-Lagrange equation.
18) Linear problem of optimal control. Pontryagin's maximum principle (without proof).
19) Compact sets in topological spaces. Compactness criterion in topological and metric spaces. Properties of functions continuous on a compact set.
20) Necessary conditions and sufficient conditions for the extremum of a function of several variables.

21) Definition of the Riemann integral and basic properties. Lebesgue criterion for Riemann integrability of functions (without proof).
22) Fundamental theorem of algebra. Application: existence of eigenvalues of matrices of linear operators acting on complex spaces

The state exam results evaluation is carried out in accordance with the methodology set forth in the assessment toolkit that is specified in the Appendix to this syllabus.

5. REQUIREMENTS FOR GRADUATION QUALIFYING PAPER (DEGREE THESIS) AND PROCEDURE FOR ITS DEFENCE

The degree thesis is a graduation qualifying paper that the student (several students in a team) prepare to demonstrate his/her/their level of competence and work readiness.

The list of degree theses themes offered to students for further work is approved by the order of the head of the educational division (faculty/institute/academy) that runs the higher education programme, the respective information is delivered to the students by the programme head no later than six months before the date of the final state examination start.

The students are allowed to suggest their own themes for the theses, under the set procedure.

The student who has passed the state exam is admitted to defend the graduation degree thesis *(if there is a state exam in the final state examination procedure)*.

The student (students) is/are allowed to defend his/ her/their thesis only if this fully completed degree paper is signed by the respective graduate (s), the supervisor, the consultant (if any), the heads of the educational department and educational division; the thesis is also subject to the external review procedure (mandatory for master's and specialist's programmes) and the plagiarism check (in the "Antiplagiarism" system). The review of the graduation qualifying paper supervisor shall be attached as well, with a specific emphasis laid on the graduate's activities in the course of the degree thesis drafting.

No later than 14 days before the date of the thesis defence, a rehearsal of the procedure is held at the presence of the degree thesis supervisor and other academic staff of the educational department, in order to timely identify and eliminate shortcomings in the structure, content and design of the degree thesis.

The degree theses are introduced to the State Examination Board members at the public defence procedure. It includes the students' oral reports with mandatory multimedia (graphic) presentations that introduce the thesis main content.

At the end of the reports, the students reply orally to the State Examination Board members' questions regarding the subject, structure, content of the paper and the profile/ specialisation of the higher education programme. The reports and / or answers to the Board members' questions may be delivered in a foreign language.

The stages of the graduation qualifying paper preparation, the requirements for its structure, volume, contents and design, as well as the list of mandatory and recommended documents submitted for defence are specified in the relevant guidelines.

The evaluation of the degree thesis defense results is carried out in accordance with the methodology set forth in the assessment toolkit that is specified in the Appendix to the syllabus.

6. REQUIREMENTS FOR EQUIPMENT AND TECHNOLOGY SUPPORT FOR FINAL STAE EXAMINATION

1) An auditorium for lecture-type classes, equipped with a set of specialized furniture; board (screen) and technical means of multimedia presentations;
2) Computer class for testing.

7. RESOURCES RECOMMENDED FOR FINAL STATE EXAMINATION

Main readings to prepare for the state exam and/or degree thesis defence:
1. Kudryavtsev L.D. Course of mathematical analysis, vol. 1–3, any edition.
2. Fikhtengolts G.M. Course of differential and integral calculus, v. 1, p. 1–3, any edition.
3. Gelfand I.M. Lectures on linear algebra, any edition.
4. Kostrikin A.I. Introduction to Algebra, any edition.
5. Veselov A.P., Troitsky E.V. Lectures on analytic geometry. St. Petersburg; M.; Krasnodar: Lan, 2003.
6. Pontryagin L.S. Ordinary differential equations, any edition.
7. Shabat B.V. Introduction to complex analysis, ch. 1. M.: Nauka, 1985.
8. Kolmogorov A.N., Fomin S.V. Elements of the theory of functions and functional analysis, any edition.
9. Alekseev V.M., Tikhomirov V.M., Fomin S.V. Optimal Control, any edition.

Additional readings to prepare for the state exam and/or degree thesis defence: -

Internet sources
1. Electronic libraries (EL) of RUDN University and other institutions, to which university students have access on the basis of concluded agreements:
- RUDN Electronic Library System (RUDN ELS) http://lib.rudn.ru/MegaPro/Web
- EL "University Library Online" http://www.biblioclub.ru
- EL "Yurayt" http://www.biblio-online.ru
- EL "Student Consultant" www.studentlibrary.ru
- EL "Lan" http://e.lanbook.com/
- EL "Trinity Bridge"

2.*Databases and search engines:*
- electronic foundation 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/

The training toolkit and guidelines for student's self-studies to prepare for the state exam and /or to draft the degree thesis and defend it*:

1. The guidelines for drafting and formatting the degree thesis within the higher education programme «Functional methods in differential equations and interdisciplinary research»
2. The procedure for the degree thesis check in the "Anti- plagiarism" system.
3. The procedure for conducting the final state examination under the higher education programme «Functional methods in differential equations and interdisciplinary research» through the use of DLT and proctoring system.

Электронная версия документа

*The training toolkit and guidelines for the student's self-studies are placed on the final state examination page in the university telecommunication training and information system under the set procedure.

8. ASSESSMENT TOOLKIT AND GRADING SYSTEM* FOR EVALUATION OF GRADUATES' COMPETENCES LEVEL

The assessment materials and the grading system* to evaluate the graduate's level of competences (competences in part) formation as the results of the higher education programme completion are specified in the Appendix to this syllabus.

* The assessment materials and the grading system are formed on the basis of the requirements of the relevant local normative act of RUDN University (regulations / order).

HEAD OF DUCATIONAL DEPARTMENT:
Director,

Mathematical institute

Muravnik A.B.

educational department	signature	name and surname

HEAD
OF HIGHER EDUCATION PROGRAMME:
Professor,

Mathematical institute

Burenkov V.I.

position, department	signature	name and surname