Federal State Autonomous Educational Institution of Higher Education «Peoples' Friendship University of Russia»

Engineering Academy

Recommended by the MSSN

WORKING PROGRAM OF THE DISCIPLINE

Name of the discipline PRIORITY DIRECTIONS OF DEVELOPMENT OF COMPUTER SCIENCE AND COMPUTER TECHNOLOGY

It is recommended for the direction of training/specialty
09.06.01 "Computer Science and Computer Engineering" (postgraduate course)

(the code and the name of the training direction/specialty are indicated)

Orientation of the program (profile)
Mathematical modeling, numerical methods and software packages

(name of the educational program in accordance with the orientation (profile)

1. Goals and objectives of the discipline:

Course objective: formation of the profile of Mathematical modeling, numerical methods and software packages (technical sciences) of universal and professional competencies for graduate students, based on an understanding of the fundamental problems of the development of computer science and computer technology.
The objectives of the course are to study: a graduate student should know about modern methods of computer science and computer technology, about methods of research in these areas of knowledge, apply appropriate algorithms in the development of information and computing systems designed to solve research and applied problems.
The main tasks of studying the discipline include: mastering theoretical knowledge in the field of the main categories of scientific research, the content and types of priority areas for the development of computer science and computer technology, as well as the features of the methodology of scientific research in the field of mathematics and mechanics; formation of basic skills in choosing a topic, determining the content of a scientific problem, as well as the goals and objectives of determining priority areas for the development of computer science and computer technology, acquisition of skills in organizing scientific research and evaluating their effectiveness, registration of research papers, dissertations for the degree of candidate of technical sciences.

2. The place of discipline in the structure of the OOP.
Block 1. «Educational disciplines (modules)» Variable part. The discipline is taught in the 2nd year of study.
3. Requirements for the results of mastering the discipline:
As a result of mastering the discipline, the graduate student must:
Know the basic methods of mathematical calculations implemented on a computer, the theoretical foundations of numerical methods, calculation errors, stability and complexity of the algorithm (by memory, by counting time); numerical methods of linear algebra; solution of nonlinear equations and systems; numerical integration and differentiation; methods of function approximation; methods of solving differential equations; methods of solving integral equations.
Be able to use knowledge in computer science and computer engineering, build algorithms for implementing numerical methods for solving applied programs; develop programs that implement numerical methods.
Possess the scientific tools of modern computer science and computer technology, the skills of using the basic tools of numerical methods for solving applied problems; the methodology of constructing, analyzing and applying numerical models in professional activities.

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

- ability to critically analyze and evaluate modern scientific achievements, generate new ideas when solving research and practical problems, including in interdisciplinary fields (UK-1);
- the ability to objectively evaluate the results of research and development carried out by other specialists and in other scientific institutions (OPK-5);
- the ability to develop new research methods and their application in independent research activities in the field of computer science and computer technology, taking into account the rules of copyright compliance (PK-2);
- the ability to independent (including managerial) research activities that require extensive fundamental training in modern areas of branch science, deep specialized training in the chosen direction, possession of skills of modern research methods (PK-3).

5. The volume of the discipline and types of academic work

The volume of the discipline	4 3E 144 hours
The volume of training sessions	40 hours
Lectures	20 hours
Practices	20 hours
Seminars	-
Laboratory work	-
Self-education	104 hours

6. Content of the discipline

6.1. The content of the discipline sections

Summary of the discipline

The main sections of the discipline: Analysis of the priority directions of the development of computational methods. Analysis of priority directions of development of methods for solving ordinary differential equations. Analysis of priority directions of development of methods for solving partial differential equations.

№ p/p	Name of the discipline section	Section content
1	Analysis of the priority directions of the development of computational methods.	Direct methods for solving systems of linear algebraic equations. Conditionality of systems of linear algebraic equations. Iterative methods for solving systems of linear algebraic equations. Uniform approximation of functions by polynomials. Numerical differentiation. Numerical integration. Numerical methods for solving nonlinear equations.
2	Analysis of priority directions of development of methods for solving ordinary differential equations.	Numerical methods for solving ordinary differential equations (ODES) of the first order. Methods of approximate solution of boundary value problems for second-order odes. Methods for minimizing functions of a single variable. Numerical methods for solving integral equations. Basic concepts and definitions of the theory of difference schemes. The finite difference method in the Dirichlet problem for the one-dimensional Poisson equation. Finite-difference computational scheme of the thermal conductivity equation. Finite-difference computational scheme for the oscillation equation. The Ritz method. The choice of basic functions in the Ritz method. The

		finite element method. Variational-difference computational scheme of the boundary value problem for the ODU. A variational-difference scheme for a one-dimensional diffusion equation. Construction of basic functions for solving multidimensional problems. A variational-difference scheme for an elliptic equation. The simplest iterative method. Chebyshev iterative method. Conjugate gradient method.
3	Analysis of priority directions of development of methods for solving partial differential equations.	Methods for solving hyperbolic equations. The transfer equation. The splitting method. Basic concepts of optimization theory. Gradient method of unconditional minimization of a function of many variables. The method of conditional gradient minimization of a function of many variables. Methods of multi-criteria optimization. Features of mathematical calculations implemented on a computer. The study of models for stability in a computational experiment. Computer methods for constructing and analyzing phase trajectories of systems. Computer modeling of the behavior of systems based on algebraic methods and geometric representations. Architecture of parallel computing systems. Operating systems: aspects of concurrency. Parallel programming for multicore architectures. Parallel programming for cluster systems.

6.2 Sections of the discipline and interdisciplinary connections with the provided (subsequent) disciplines.

№ p/p	The name of the provided (subsequent) disciplines	№ of sections of this discipline required for the study of the provided (subsequent) disciplines		
		1	2	3
1.	Research practice	1	2	
2.	Teaching practice		2	3
3.	Scientific research	1	2	3

6.3. Sections of disciplines and types of classes

№ p/p	Name of the discipline section	Lect.	Practical class	Lab. class.	Sem.	SRS	Total hours
1	Analysis of the priority directions of the development of computational methods.	5	5			14	24
2	Analysis of priority directions of development of methods for solving ordinary differential equations.	7	8			45	60
3	Analysis of priority directions of development of methods for solving partial differential equations.	8	7			45	60
	IN TOTAL	20	20			104	144

7. Laboratory and practical classes

7.1. Practical exercises

№ p/p	№ of the discipline section	Topics of practical classes	Labor intensity (hrs.)
1.	1	Implementation of uniform approximation of functions by polynomials.	2
2	1	Implementation of numerical differentiation. Implementation of numerical integration.	2
3	1	Implementation of numerical methods for solving nonlinear equations.	2
4	2	Construction of basic functions for solving multidimensional problems.	2
5	2	Implementation of a variational-difference scheme for an elliptic equation.	2
6	2	Implementation of the conjugate gradient method.	2
7	3	Implementation of the splitting method.	2
8	3	Implementation of the gradient method of unconditional minimization of a function of many variables.	2
9	3	Implementation of the conditional gradient method for minimizing a function of many variables.	2
10	3	Implementation of the multi-criteria optimization method.	2

7.2. Laboratory practice

Not provided.

8. Types of independent work

№ p/p	№ of the discipline section	Topics of self-education	Labor intensity (hrs.)
1.	1	Reviewing the materials of scientific conferences in Russian and English to identify the most urgent problems of research activities in the physical and mathematical sciences	27
2	1	Preparation of articles on the subject of dissertation research	27
3	2	Preparation of scientific reports at regional, national and international conferences	27
4	2	Development of scientific projects and participation in regional, national and international competitions in technical sciences	27
5	3	Preparation of materials for participation in grants provided to graduate students and young scientists in Russia and abroad in technical sciences	26
6	3	Preparation and holding of a scientific seminar, a methodological seminar or a master class.	26

9. Educational, methodological and informational support of the discipline:

a) main literature

1. Babenko A. I., Suris Y. B. Discrete differential geometry. Integrable structure-M.; Izhevsk: SIC "Regular and chaotic dynamics": Izhevsk Institute of Computer Research, 2010. - 448 p.
2. Samarsky A. A., Vabishevich P. N. Numerical methods for solving inverse problems of mathematical physics : A textbook. - M.: LKI publishing house, 2014. - 480 p.
3. Naats V. I., Naats I. E. Mathematical models and numerical methods in problems of environmental monitoring of the atmosphere: Monograph-Moscow: FIZMATLIT, 2010. - 328 p.

b) additional literature

1. A.V. Rumyantsev. The finite element method in thermal conductivity problems: Textbook-Kaliningrad: KSU Publishing House, 1995. - 170 p.:
2. Sveshnikov A. G. et al. Linear and nonlinear equations of the Sobolev type-M.: Fizmatlit, 2007. - 736 p.

c) software: only licensed equipment installed in the RUDN is used. The Microsoft Office software package and specialized software Dev-C++, Scilab.

d) databases, information and reference and search engines

RSE Electronic Library http://www.rsl.ru/

Website of the RUDN Library http://lib.rudn.ru/

Science Direct http://www.sciencedirect.com Description: The resource contains a collection of scientific, technical full-text and bibliographic information. The database of a multidisciplinary nature includes scientific journals on exact and technical sciences.

EBSCO http://search.ebscohost.com, Academic Search Premier (a database of complex topics, contains information on the humanities and natural fields of knowledge).

Oxford University Press http://www3.oup.co.uk/jnls. Journals in the exact and technical sciences Oxford University Press presented in the HSS collection

Sage Publications http://online.sagepub.com The Sage publication database includes journals in various branches of knowledge: Sage_STM – more than 100 journals in the field of natural sciences, technology.

Springer/Kluwer http://www.springerlink.com. Journals and books published by Springer / Kluwer cover various fields of knowledge and are divided into subject categories.

Tailor & Francis http://www.informaworld.com . The collection of journals includes more than 1000 titles in all fields of knowledge.

American Mathematical Society http://www.ams.org/ Resource of the American Mathematical Society.

European Mathematical Society http://www.euro-math-soc.eu/ Resource of the European Mathematical Society.

Portal to Mathematics Publications http://www.emis.de/projects/EULER/

Catalog of mathematical Internet resources http://www.mathtree.ru/

Zentralblatt MATH (zbMATH) https://zbmath.org

All-Russian Mathematical portal mathnet.ru

Web of Science http://www.isiknowledge. com

Resources of the Institute of Scientific Information on Social Sciences of the Russian Academy of Sciences (ISISS RAS) http://elibrary.ru.

University Information System RUSSIA. http://www.cir.ru/index.jsp.

GOST standards system of standards for information, library and publishing http://www.ifap.ru/library/gost/sibid.htm.

Electronic Library of the RUDN http://www.rsl.ru/

e) periodicals

- Algebra and Analysis
- Discrete mathematics
- Journal of Computational Mathematics and Mathematical Physics
- News of the Russian Academy of Sciences. Mathematical series
- Mathematical notes

- Mathematical Collection
- Mathematical modeling
- Theoretical and mathematical physics
- Probability theory and its applications
- Achievements of mathematical sciences
- Functional analysis and its applications
- Computer Science and its applications
- Problems of information transmission
- Computer science systems and tools
- Proceedings of the V. A. Steklov Mathematical Institute
- Mathematical questions of cryptography
- Modern problems of mathematics
- Computational methods and programming
- Proceedings of the seminar named after I. G. Petrovsky
- Scientific notes of the Moscow State University
- Fundamental and applied mathematics
- Review of Modern Physics
- Annual Review of Astronomy and Astrophysics
- Annual Review of Biochemistry
- Chemical Reviews
- Nature Physics
- Annual Review of Condensed Matter Physics
- Annals of Mathematics
- Journal of the American Mathematical Society
- Acta Mathematica
- Communications on Pure and Applied Mathematics
- Swarm and Evolutionary Computation
- Geometric and Functional Analysis
- Formal Aspects of Computing
- Discrete Mathematics
- Theory of Computing Systems
- Reports on Progress in Physics
- New Journal of Physics

10. Material and technical support of the discipline:

Moscow, Ordzhonikidze str., 3, building 1, 5. Multimedia auditorium and equipment of the laboratory "Information Communication Management". The laboratory consists of three divisions - educational (room 110), educational and scientific (room 116) and scientific (room 123), and is equipped with modern network equipment and computer equipment (a set of Sharp PNL702B liquid crystal display, a 24" Acer V243HAOBD monitor, a system unit (Intel Core i7-2600 OEM processor <3.40 GHz, 8Mb, 95W, LGA1155(Sandy Bridge)>, 16GB OP, HDD 2 TB), a DMS800 projector with an interactive whiteboard Board 1077, HP XW7800, Intel Core2 2.4 GHz (8 pcs.)). The laboratory base allows you to carry out projects on the development of applied means of the infocommunication environment, conduct lectures and laboratory classes with multimedia teaching tools. Display classes DK3, DK4, DK6, DK7, Intel Core i3-550 3.2 GHz-60 pcs.

11. Methodological recommendations for the organization of the study of the discipline:

11.1. Methodological recommendations for graduate students.

During practical classes in the discipline, control measures are carried out in order to identify the acquired knowledge, skills, skills and competencies. As part of their independent

work, graduate students study the educational and methodological support of the discipline, prepare homework, work on questions and tasks for self-preparation, search and review scientific publications and electronic sources of information. Independent work should be systematic and controlled by the teacher, taken into account by the teacher for issuing certification.

To improve the quality level of mastering the discipline, a graduate student should prepare for a lecture, since it is the leading form of organizing student learning and implements functions that contribute to:

- formation of the basic concepts of the discipline,
- stimulating interest in the discipline, the topics of its study,
- systematization and structuring of the entire body of knowledge in the discipline,
- orientations in the scientific literature that reveals the problems of the discipline.

Preparation for the lecture is as follows:

- study of the material of the previous lecture,
- analysis of the topic of the upcoming lecture (according to the thematic plan, according to the information of the lecturer),ознакомление с учебным материалом по учебнику и учебным пособиям,
- analysis of the place of the studied topic in your professional training,
- preparation of questions that can be asked to the lecturer at the lecture.

Preparation for practical classes:

- introduction to the practical lesson plan: first with the main questions, then with questions for discussion, assessment of the scope of the task;
- study of the lecture summary on the topic of the practical lesson, selection of the material necessary for studying the questions posed;
- familiarization with the recommended main and additional literature on the topic, new publications in periodicals;
- identification of the main concepts of the topic under study, the possession of which contributes to the effective development of the discipline;
- preparation of abstracts or mini-notes that can be used for public speaking in the classroom.

The working program of the discipline in terms of goals, a list of knowledge, skills, terms and educational questions can be used by you as a guide in the organization of training.

Preparation for the test. It is necessary to prepare for the test purposefully, regularly, systematically and from the first days of training in this discipline. At the very beginning of studying the discipline, the graduate student gets acquainted with the program for the discipline, the list of knowledge and skills that the graduate student should possess, control measures, a textbook, textbooks on the discipline being studied, electronic resources, a list of questions for the test.

Systematic performance of educational work at lectures, practical classes and classes will allow you to successfully master the discipline and create a good basis for passing the test.

Graduate students are required to attend classes, perform tasks of the head of the discipline, get acquainted with the recommended literature and prepare an essay for a round table (the choice of the topic of the essay is carried out in agreement with the head of the discipline and the scientific supervisor). Graduate students carry out projects, creative tasks for independent work, taking into account the profile of the disciplines that they will implement in the course of industrial practice. The results of completing tasks for independent work are evaluated on the basis of a point-rating assessment and are reflected in the educational route of the graduate student. When certifying a graduate student, the quality of work in the classroom is evaluated (the ability to conduct a scientific discussion, the ability to clearly and succinctly formulate their thoughts), the level of preparation for independent research activities of a specialist in the field of higher school pedagogy, the history of pedagogy and education, the quality of tasks (presentations, reports, analytical notes, etc.).

11.2. Methodological recommendations for teachers.

In the course of training in the discipline "Priority directions of development of computer science and computer technology", the teacher should pay special attention to the organization of practical classes and monitor the independent work of graduate students. In the process of mastering the discipline, graduate students should be focused not only on actively mastering the totality of pedagogical knowledge, but also on the ability to creatively apply them in practice, extrapolating to the modern educational process in higher education.

When studying section 1 "Analysis of priority directions for the development of computational methods", the teacher should pay the attention of graduate students to the content of the categorical apparatus of the discipline, its relationship with other concepts. It is important to consider in practical classes the applied possibilities of applying various methods of scientific research.

When conducting lectures, it is necessary to involve graduate students in discussions concerning current scientific problems in the field of computer science and computer engineering.

Mastering the content of section 2 "Analysis of priority directions for the development of methods for solving ordinary differential equations" takes place at lectures and practical classes. The work in practical classes should be aimed at actively mastering the totality of theoretical knowledge that emphasizes the features of the content of the stages of scientific research. The teacher should focus graduate students on the ability to organize and conduct various types of scientific research in computer science and computer engineering.

Mastering the content of section 3 "Analysis of priority directions for the development of methods for solving partial differential equations" the teacher uses a variety of technologies and forms of classes and creates conditions for graduate students to demonstrate communicative skills, readiness to conduct a discussion on scientific problems.

During the interim certification, the quality of mastering the main research categories by graduate students, their ability to use knowledge to solve scientific problems and their readiness to actualize scientific competence in the real research process of the university, scientific organization, etc. is evaluated.

11.3. Fund of evaluation tools for assessing the development of competence.

Compliance of assessment systems (previously used assessments of final academic performance, ECTS assessments and the point-rating system (BRS) of current academic performance assessments) (In accordance with the Rector's Order No. 996 of 27.12.2006):

BRS points	Traditional assessments in	Points for translating grades	Scores	ECTS Scores
86 - 100	5	95 - 100	5+	A
		86 - 94	5	B
69 - 85	4	69 - 85	4	C
51 - 68	3	61 - 68	3+	D
		51 - 60	3	E
0 - 50	2	31 - 50	2+	FX
		0 - 30	2	F

A	***"Excellent"*** - the theoretical content of the course has been fully mastered, without gaps, the necessary practical skills of working with the mastered material have been formed, all the training tasks provided for in the training program have been completed, the quality of their performance is estimated by the number of points close to the maximum**.**

B	***"Very well"*** - the theoretical content of the course is fully mastered, without gaps, the necessary practical skills of working with the mastered material are mainly formed, all the training tasks provided for in the training program are completed, the quality of most of them is estimated by the number of points close to the maximum.
C	***"Well"*** - the theoretical content of the course is fully mastered, without gaps, some practical skills of working with the mastered material are not sufficiently formed, all the training tasks provided for in the training program are completed, the quality of performance of none of them is estimated by the minimum number of points, some types of tasks are completed with errors.
D	***"Acceptable"*** - the theoretical content of the course has been partially mastered, but the gaps are not significant, the necessary practical skills for working with the mastered material have been mainly formed, most of the training tasks provided for in the training program have been completed, some of the completed tasks may contain errors.
E	***"Mediocre"*** - the theoretical content of the course has been partially mastered, some practical work skills have not been formed, many of the training tasks provided for in the training program have not been completed, or the quality of some of them is estimated by the number of points close to the minimum.
FX	***"Conditionally unsatisfactory"*** - the theoretical content of the course has been partially mastered, the necessary practical work skills have not been formed, most of the training tasks provided for in the training program have not been completed, or the quality of their performance is estimated by the number of points close to the minimum; with additional independent work on the course material, it is possible to improve the quality of performing training tasks.
F	***"Certainly unsatisfactory"*** - the theoretical content of the course has not been mastered, the necessary practical work skills have not been formed, all completed training tasks contain gross errors, additional independent work on the course material will not lead to any significant improvement in the quality of performing training tasks.

11.4. Evaluation criteria

Evaluation method	**Maximum number of points**	**Evaluation criteria**
1. Protection of the review results	**5**	5-The work was done without errors, during the defense the graduate student confidently explains the work and answers additional questions; 4-The work was done without errors, during the defense, the graduate student confidently explains the purpose and objectives of the work, when answering additional questions, he admits inaccuracies, finds it difficult to answer; 3- The work was done without errors, when defending the answers to additional questions, the graduate student admits inaccuracies, finds it difficult to answer; 2- There are minor non-critical errors in the work 1-The work contains significant errors
2. Discussion of the draft article	**5**	
3. Presentation at the conference	**5**	
4. Justification of the methods planned for use in the dissertation	**5**	
5. Protection of the main research results in the form of a presentation	**5**	
6. Presentation on the topic of the dissertation	**5**	
7. Attendance of classes	**25**	Proportional to the classes attended

8. Colloquium on 1 topic (1 question)	**15**	The answer to the question is evaluated: 11-15 points – a confident answer to the main question, an answer to additional questions 6-10 points – a confident answer to the main question, when answering additional questions, the graduate student experiences some difficulties 1-5 points – an uncertain answer to the main question
9. Oral survey on the test (2 questions on topics 2 and 3)	**30**	
In total	**100 points**	

12. Performance assessment documentation package for the intermediate certification of students in the discipline (module)

Materials for assessing the level of mastering the educational material of the discipline " PRIORITY DIRECTIONS OF DEVELOPMENT OF COMPUTER SCIENCE AND COMPUTER TECHNOLOGY " (evaluation materials), which include a list of competencies indicating the stages of their formation, a description of indicators and criteria for evaluating competencies at various stages of their formation, a description of assessment scales, standard control tasks or other materials necessary for evaluating knowledge, skills, skills and (or) experience of activity that characterize the stages of competence formation in the process of mastering an educational program, methodological materials that determine the procedures for evaluating knowledge, skills, skills and (or) experience of activity that characterize the stages of competence formation are fully developed and are available to students on the discipline page in the TUIS RUDN.

The program is compiled in accordance with the requirements of OS VO RUDN

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