Federal State Autonomous Educational Institution of Higher Education

PEOPLES ' FRIENDSHIP UNIVERSITY OF RUSSIA
Academy of Engineering

WORKING PROGRAM OF THE DISCIPLINE «SYSTEM ANALYSIS, MANAGEMENT AND INFORMATION PROCESSING»

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 systems»

Qualification (degree) of the graduate:

The researcher. Teacher-researcher

Forms of study-full-time

1. Goals and objectives of the discipline:

The purpose of the course is the formation of professional competencies in the field of scientific research on modern methods of system analysis, management and information processing among graduate students of the profile "Mathematical modeling, numerical methods and program complexes".

The objectives of the course are to teach the skills of finding and understanding new, as well as rethinking modern methods of system analysis, management and information processing.

2. The place of discipline in the structure of the OOP.

Block 1 «Educational disciplines (modules)» Disciplines of the postgraduate student's choice. The discipline is taught in the 2nd year.

3. The list of planned learning outcomes in the course, correlated with the planned results of mastering the educational program

As a result of mastering the discipline, the graduate student must:

Know the main modern methods of implementing software packages, modern scientific literature and journal articles in the periodical press devoted to such problems.

Be able to identify current modern theoretical problems of system analysis, management and information processing and explain on this basis the existing facts and processes of development of approximate methods in modern mathematics.

Possess the skills of finding and understanding new, as well as rethinking previously known facts, processes and trends that characterize the formation, evolution and transformation of system analysis, management and information processing in historical retrospect.

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

Professional competencies	
PK-3	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

4. Volume of the course and types of educational work

The volume of the discipline	3 3E 108 hours
The volume of training sessions	40 hours
Lectures	20 hours
Practices	20 hours
Seminars	-
Laboratoru works	-
Self-education	68 hours

5. Content of the discipline

5.1. The content of the discipline sections

The main sections of the discipline: Topical issues of system analysis. Current management issues. Current issues of information processing

№ p/p	**Name of the discipline section**	**Section content**
1	Current issues of system analysis.	Mathematical models of mechanical systems, multi-link robots. The laws of mechanics for the construction of mathematical models. The Lagrange method. The Dalembert principle. Examples of

		constructing mathematical models of mechanical objects. Uncertainties in mathematical models. Probabilistic methods for describing uncertainties. Fuzzy forms of describing uncertainties. Methods for solving parametric identification problems. Structural uncertainty. Problems of solving the problem of structural identification and structural-parametric identification. Mathematical models of flying machines, flying robots. Nonparametric identification of nonlinear systems. The Pontryagin maximum principle. Problems of solving the optimal control problem. Computational methods for solving optimal control problems. The Bellman equation. Analytical design of optimal regulators (ACOR). The method of Lyapunov functions for the synthesis of stabilization systems. The method of analytical design of aggregated regulators. The problem of uncertainty in the problem of control synthesis.
2	Current management issues.	Formulation of the problem of numerical synthesis of control systems. Optimal robust control. H2 and H∞ are the theory of optimal regulation. Representation of a random process by methods of the theory of polynomial chaos. Probabilistic uncertainty in stochastic dynamic control systems. Artificial neural networks. The Widrow-Hoff delta rule and the error back propagation algorithm. Adaptive control systems based on neural networks. Neural networks for solving identification problems. The method of neural networks for solving control synthesis problems. A genetic algorithm. The algorithm of differential evolution. The algorithm of the ant colony. The algorithm of a swarm of bees. The particle swarm algorithm. The principle of small variations of the basic solution for solving numerical and non-numerical optimization problems.
3	Current issues of information processing	A variational genetic algorithm for training a neural network. A variational genetic algorithm for solving the optimal control problem. The method of genetic programming. The method of variational genetic programming. The method of grammatical evolution. The method of variational grammatical evolution. The method of analytical programming. The method of variational analytical programming. The method of the network operator. The method of a multi-layer network operator. Solving problems of identification and control synthesis by symbolic regression methods. Solving the optimal control problem by the symbolic regression method. Systems with shared memory. Distributed memory systems. Graphics accelerators are software tools of parallel technologies. OpenMP, MPI, OpenCL, and CUDA libraries. Evaluation of the parallelization efficiency.

5.2 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		3
2.	Teaching practice	1	2	3
3.	Scientific research	1	2	3

5.3. Sections of disciplines and types of classes

№ p/p	Name of the discipline section	Lect.	Practical class.	Lab. class.	Sem.	CPC	Total hrs.
1.	Current issues of system analysis.	6	6			24	36
2.	Current management issues.	6	6			24	36
3.	Current issues of information processing	8	8			20	36
	IN TOTAL	20	20			68	108

6. Laboratory and practical classes

Not provided.

7. Practical exercises

№ p/p	№ of the discipline section	Topics of practical classes	Labor intensity (hrs.)
1.	1	Computational methods for solving optimal control problems. The Bellman equation.	2
2	1	Analytical design of optimal regulators (ADOR). The method of Lyapunov functions for the synthesis of stabilization systems.	2
3	1	The method of analytical design of aggregated regulators. The problem of uncertainty in the problem of control synthesis.	2
4	2	The algorithm of differential evolution. The algorithm of the ant colony.	2
5	2	The algorithm of a swarm of bees. The particle swarm algorithm.	2
6	2	The principle of small variations of the basic solution for solving numerical and non-numerical optimization problems.	2
7	3	Solving the optimal control problem by the symbolic regression method.	2
8	3	Software tools of parallel technologies.	2
9	3	OpenMP, MPI, OpenCL, and CUDA libraries.	2
10	3	Evaluation of the parallelization efficiency.	2

8. Educational-methodical and informational 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.

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 a list of software and information reference systems (if necessary))

a) software Standard personal computer software
b) ProjectLibre software
c) database, directory and search engine Yandex, Google

10. Educational and methodological support of the discipline:

a) main literature

1. Diveev A. I., Sofronova E. A. The network operator method and its application in control problems. Moscow: RUDN Publishing House, 2012. - 182 p.

b) additional literature

1. Bobenko A. I., Suris Yu. 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. - Moscow: 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.
4. A.V. Rumyantsev. The finite element method in thermal conductivity problems: Textbook-Kaliningrad: KSU Publishing House, 1995. - 170 p.:
5. 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 (INION RAN) 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

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.

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 " SYSTEM ANALYSIS, MANAGEMENT AND INFORMATION PROCESSING " (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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