Federal State Autonomous Educational Institution of Higher Education
«RUDN University»

Engineering Academy

WORKING PROGRAM OF THE DISCIPLINE

Name of the discipline

Priority areas for the development of mathematics and mechanics

Recommended for the educational program

01.06.01 Mathematics and Mechanics

Focus of the program (profile)
«Dynamics and strength of machines, devices and equipment» (technical sciences)

1. Aims and objectives of the discipline:

Course objective: to develop postgraduate students of the profile Dynamics and strength of machines, devices and equipment (technical sciences) universal and professional competences, based on the understanding of fundamental problems of computer science and computer technology development.
Course objectives are to learn: the postgraduate student should know about the modern methods of computer science and computer engineering, methods of research in these fields of knowledge, to apply appropriate algorithms in the process of development of information-computer systems designed to solve research and applied problems.
The main objectives of the discipline include: mastering theoretical knowledge of the main categories of scientific research, content and types of priority areas of informatics and computer engineering, as well as features of the methodology of scientific research in mathematics and mechanics; formation of basic skills of choosing the topic, defining the content of scientific problems, as well as the purpose and objectives of determining the priority areas of informatics and computer engineering, acquisition of skills to organise scientific research

2. The place of the discipline in the structure

The discipline " Priority areas for the development of mathematics and mechanics " refers to the variable part of block 1 of the curriculum.

Table 1 shows the previous and subsequent disciplines aimed at the formation of discipline competencies in accordance with the competence matrix of EP HE.

Table № 1

Prior and subsequent disciplines aimed at the formation of competencies

№	Code and name of competence	Preceding disciplines	Subsequent disciplines (groups of disciplines)
Universal competences			
1	the ability to design and carry out complex research, including interdisciplinary, based on a holistic systemic scientific worldview using knowledge in the field of history and philosophy of science (UK-2)	History and philosophy of science Research methodology	
2	willingness to participate in the work of Russian and international research teams to solve scientific and scientific and educational problems (UK-3)	Foreign language Research methodology	Foreign language in the field of professional communication Russian in the field of professional communication
3	the ability to plan and solve problems of one's own professional and personal development (UK-5)	History and philosophy of science Research methodology Fundamentals of teaching methods for the development of engineering applications based on mathematical modeling using informatics and computer technology in higher education	Dynamics, strength of machines, devices and equipment

General professional competencies			
4	ability to independently carry out research activities in the relevant professional field using modern research methods and information and communication technologies (GPC-1)	Research methodology	Dynamics, strength of machines, devices and equipment Technology and engineering of nanodevices and systems System analysis, management and information processing Modern problems of control theory
5	willingness to teach in basic educational programs of higher education (GPC-2)		
Professional competence			
6	willingness to apply promising research methods and solve professional problems, taking into account global trends in the development of technical objects for various purposes (PC-1)	Research methodology	Dynamics, strength of machines, devices and equipment Technology and engineering of nanodevices and systems System analysis, management and information processing Modern problems of control theory
7	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-mechanical, mathematical and computational models that have a high degree of adequacy to real processes, machines and structures (PC-3)	Research methodology	Dynamics, strength of machines, devices and equipment Technology and engineering of nanodevices and systems System analysis, management and information processing Modern problems of control theory
8	ability to study patterns and relationships, dynamic processes, stress states and strength of machines, devices and equipment (PC-6).	Fundamentals of teaching methods for the development of engineering applications based on mathematical modeling using informatics and computer technology in higher education	Dynamics, strength of machines, devices and equipment Technology and engineering of nanodevices and systems System analysis, management and information processing Modern problems of control theory

3. requirements for the results of the discipline:

As a result of the discipline, the postgraduate student should:

To know the basic methods of mathematical calculations implemented on a computer, theoretical foundations of numerical methods, calculation errors, stability and complexity of the algorithm (in memory, in counting time); numerical methods of linear algebra; solution of non-linear equations and systems; numerical integration and differentiation; methods of approximation of a function; methods of solution of differential equations; methods of solution of integral equations.

To **be able to** use knowledge of computer science and computer engineering, to build algorithms for implementing numerical methods for solving applications; to develop programmes implementing numerical methods.

To master scientific tools of modern computer science and computer engineering, skills of application of basic tools of numerical methods for solution of applied problems; methodology of construction, analysis and application of numerical models in professional activity.

4. The process of studying the discipline aims to form the following competences:

- the ability to design and carry out complex research, including interdisciplinary, based on a holistic systemic scientific worldview using knowledge in the field of history and philosophy of science (UK-2)
- willingness to participate in the work of Russian and international research teams to solve scientific and scientific and educational problems (UK-3)
- the ability to plan and solve problems of one's own professional and personal development (UK-5)
- ability to independently carry out research activities in the relevant professional field using modern research methods and information and communication technologies (GPC-1)
- willingness to teach in basic educational programs of higher education (GPC-2)
- willingness to apply promising research methods and solve professional problems, taking into account global trends in the development of technical objects for various purposes (PC-1)
- 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-mechanical, mathematical and computational models that have a high degree of adequacy to real processes, machines and structures (PC-3)
- ability to study patterns and relationships, dynamic processes, stress states and strength of machines, devices and equipment (PC-6).

5. Scope of the discipline and types of study

Scope of the discipline	5 TUs 180 hours
The volume of training sessions	20 hours
Lectures	
Practitioners	20 hours
Seminars	-
Laboratory work	-
Independent work	160 hours

6. Content of the discipline

6.1 Content of the sections of the discipline

Summary of discipline content

Main sections of the discipline: Analysis of the priority direction of development of computational methods. Analysis of the priority direction of development of methods for solving ordinary differential equations. Analysis of the priority direction of development of methods for the solution of partial differential equations.

No. n/a	**Name section disciplines**	**Contents of the section**
1	An analysis of the priority direction of computational method development.	Direct methods for solving systems of linear algebraic equations. Conditional 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	An analysis of the priority direction in the development of methods for solving ordinary differential equations.	Numerical methods for solving first-order ordinary differential equations (ODEs). Methods for approximate solution of boundary value problems for ODE of the second order. Methods for minimizing functions of one variable. Numerical methods for solving integral equations. Basic concepts and definitions in the theory of difference schemes. Finite difference method for the Dirichlet problem of the one-dimensional Poisson equation. Finite difference computational scheme for thermal conductivity equation. Finite difference computational scheme for the equation of oscillations. The Ritz method. Selection of basis functions in the Ritz method. Finite element method. Variation difference computational scheme for boundary value problem for ODE. Variation-difference scheme for one-dimensional diffusion equation. Construction of basis functions for solution of multidimensional problems. Variation-difference scheme for elliptic equation. The simplest iteration method. Chebyshevian iterative method. Method of conjugate gradients.
3	An analysis of the priority direction for the development of methods for solving partial differential equations.	Methods for solving hyperbolic type equations. The transfer equation. Splitting method. Basic concepts of optimum theory. Gradient method for unconditional minimisation of a function of many variables. Conditional Gradient Method for Minimisation of a Function of Many Variables. Methods for multi-criteria optimisation. Features of mathematical computations implemented on computers. The investigation of models for stability in a computational experiment. Computer methods for constructing and analyzing phase trajectories of systems. Computer modeling of systems behavior on the basis of algebraic methods and geometrical representations. Architecture of parallel computing systems. Operating systems: aspects of parallelism. Parallel programming for multicore architectures. Parallel programming for cluster systems.

6.2 Sections of the discipline and interdisciplinary links with the (further) disciplines provided.

No. n/a	Name of disciplines to be provided (follow-up)	No. of sections of the discipline which are necessary for the study of the (further) disciplines to be covered		
		1	2	3
1.	Research practice	1	2	
2.	Pedagogical practice		2	3
3.	Scientific research	1	2	3

6.3 Sections of the disciplines and types of classes

No. n/a	Name of discipline section	Lectz.	Prakt. zan.	Lab.	Semin	SRS	All-hour.
1	An analysis of the priority direction of computational method development.		6			54	60
2	An analysis of the priority direction in the development of methods for solving ordinary differential equations.		6			54	60
3	An analysis of the priority direction for the development of methods for solving partial differential equations.		8			52	60
	TOTAL		20			160	180

7. 7. Laboratory and practical exercises

7.1 Practical exercises

No. n/a	Discipline section no.	Topics of practical exercises	Labour input (hours)
1.	1	Implementation of uniform approximation of functions by polynomials.	2
2	1	Implement numerical differentiation. Implementation of numerical integration.	2
3	1	Implementation of numerical methods for solving non-linear equations.	2
4	2	The construction of basis functions for solving multidimensional problems.	2
5	2	Implementation of a variation-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 a gradient method for unconditional minimisation of a function of many variables.	2
9	3	Implementation of the conditional gradient method of minimising a function of many variables.	2
10	3	Implementation of a multi-criteria optimisation	2

		method.	

7.2 Laboratory workshop
Not provided.

8. Types of independent work

No. n/a	Discipline section no.	Topics for independent work	Labour input (hours)
1.	1	Reviewing scientific conference proceedings in Russian and English to identify the most topical research issues in the physical and mathematical sciences	27
2	1	Preparation of articles on the subject of the thesis research	27
3	2	Preparing scientific papers at regional, national and international conferences	27
4	2	Development of research projects and participation in regional, national and international competitions in the technical sciences	27
5	3	Preparation of materials for participation in grants awarded to postgraduate students and young scientists in Russia and abroad in the technical sciences	26
6	3	Preparing and running a research seminar, a methodological seminar or a master class.	26

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

(a) Basic literature

1. Bobenko A. I., Suris YU. B. Diskretnaya differentsial'naya geometriya. Integriruyemaya struktura - M.; Izhevsk: NITS "Regulyarnaya i khaoticheskaya dinamika»: Izhevskiy institut komp'yuternykh issledovaniy, 2010. - 448 s.
2. Samarskiy A. A., Vabishchevich P. N. Chislennyye metody resheniya obratnykh zadach matematicheskoy fiziki: Uchebnoye posobiye. - M.: Izd-vo LKI, 2014. - 480 s.
3. Naats V. I., Naats I. E. Matematicheskiye modeli i chislennyye metody v zadachakh ekologicheskogo monitoringa atmosfery: Monografiya - M.: FIZMATLIT, 2010. - 328 s.

b) further literature

1. Rumyantsev A. V. Metod konechnykh elementov v zadachakh teploprovodnosti: Uchebnoye posobiye - Kaliningrad: Izd-vo KGU, 1995. - 170 s.:
2. Sveshnikov A. G. i dr. Lineynyye i nelineynyye uravneniya sobolevskogo tipa - M.: Fizmatlit, 2007. - 736 s.

c) Software: only licensed software installed at PFUR is used. Microsoft Office software package and specialised software Dev-C++, Scilab.

d) databases, reference and retrieval systems

Russian State Library Digital Library http://www.rsl.ru/
PFUR Library website http://lib.rudn.ru/
Science Direct http://www.sciencedirect. Description: This resource contains a collection of scientific, technical full-text and bibliographic information. A multidisciplinary database of scientific journals in the exact and technical sciences.
EBSCO http://search.ebscohost.com, Academic Search Premier (a comprehensive database

containing information on the humanities and the natural sciences).
Oxford University Press http://www3.oup.co.uk/jnls. Oxford University Press Science and Engineering journals in the HSS collection
Sage Publications http://online.sagepub.com . The Sage Publications database includes journals from a variety of disciplines: Sage_STM - over 100 journals in science, engineering and technology.
Springer/Kluwer http://www.springerlink.com. The journals and books from Springer/Kluwer cover different fields of knowledge and are divided into subject categories.
Tailor & Francis http://www.informaworld.com . The magazine collection has over 1,000 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/ European Mathematical Society Resource.
Portal to Mathematics Publications http://www.emis.de/projects/EULER/
Catalogue of mathematical Internet resources http://www.mathtree.ru/.
Zentralblatt MATH (zbMATH) https://zbmath.org
All-Russian mathematics portal mathnet.
Web of Science http://www.isiknowledge.com
Resources of the Institute of Scientific Information on Social Sciences of the Russian Academy of Sciences (ISIS RAS) http://elibrary.ru.
University Information System RUSSIA. http://www.cir.ru/index.jsp.
Gosts system of standards for information, librarianship and publishing http://www.ifap.ru/library/gost/sibid.htm
PFUR Digital Library http://www.rsl.ru/

e) periodicals

- Algebra and analysis
- Discrete mathematics
- Journal of Computational Mathematics and Mathematical Physics
- Proceedings of the Russian Academy of Sciences. Mathematical Series
- Mathematical notes
- A mathematical compendium
- Mathematical modelling
- Theoretical and mathematical physics
- Probability theory and its applications
- Advances in mathematical sciences
- Functional analysis and its applications
- Computer science and its applications
- Problems of information transfer
- Informatics systems and tools
- Proceedings of the V.A. Steklov Mathematical Institute
- Mathematical issues in cryptography
- Current problems in mathematics
- Computational methods and programming
- Proceedings of the I. G. Petrovsky Seminar
- Scientific Notes of 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 street, 3, bld. 1, 5. Multimedia classroom and equipment of Infocommunication Management laboratory. The laboratory consists of three subdivisions - educational (aud. 110), educational-scientific (aud. 116), scientific (aud. 123).) and scientific (aud. 123), and is equipped with modern network equipment and computer technology (a set of liquid-crystal display Sharp PNL702B, monitor 24" Acer V243HAOBD, the system unit (processor Intel Core i7-2600 OEM <3.40GHz, 8Mb, 95W, LGA1155 (Sandy Bridge)>, 16GB OP, HDD 2 TB), projector DMS800 with an interactive whiteboard Board 1077, HP xw7800, Intel Core2 2.4 GHz (8 pcs.). Laboratory facilities enable the implementation of infocommunication environment application development projects, lectures and laboratory classes with multimedia teaching tools. Display classrooms DK3, DK4, DK6, DK7, Intel Core i3-550 3.2 GHz - 60 pcs.

11. methodological guidelines for organising the study of the discipline:

11.1 Guidelines for postgraduate students.

In practical classes of the discipline there are control activities to identify the obtained knowledge, skills and competences. In the framework of independent work postgraduate students study educational-methodical support of the discipline, prepare homework, work on questions and assignments for self-study, search and review scientific publications and electronic sources of information. Independent work must be systematic and controlled by the teacher, taken into account by the teacher for grading.

In order to improve the quality of the discipline, the postgraduate student should prepare for a lecture, as it is the leading form of organisation of student learning and realises the functions that contribute to it:

- to form the basic concepts of the discipline,
- stimulate interest in the discipline and its topics of study,
- The main objective is to systematise and structure the whole body of knowledge in the discipline,
- orientation in the scientific literature revealing the problems of the discipline.

The preparation for the lecture is as follows:

- study of the material from the previous lecture,
- Analysis of the topic of the forthcoming lecture (from the thematic plan, from the lecturer's information),
- familiarise yourself with the teaching material in the textbook and teaching aids,
- analyse the place of the topic under study in their professional training,
- prepare questions to ask the lecturer during the lecture.

Preparing for the practical exercises:

- The training session plan: first the main questions, then the discussion questions, assessing the scope of the assignment;

- Study the lecture notes on the topic of the practical session, selecting the material necessary for the study of the questions posed;
- Familiarisation with the recommended basic and additional literature on the topic, and new publications in periodicals;
- To highlight the main concepts of the topic, which will contribute to an effective mastery of the discipline;
- Prepare an abstract or mini-abstract that can be used for public speaking in class.

You can use the syllabus in terms of objectives, list of knowledge, skills, terms and training issues as a guide for the organisation of your studies.

Preparing for a test. It is necessary to prepare for the test in a purposeful, regular, systematic manner and from the first days of study in the discipline. At the very beginning of the discipline the postgraduate student gets acquainted with the discipline programme, the list of knowledge and skills that the postgraduate student should possess, control activities, textbook, textbooks on the discipline studied, electronic resources, the list of questions for the test.

Systematically completing the coursework in lectures, practical classes and tutorials will enable you to successfully master the discipline and create a good basis for passing the examination.

Postgraduate students are required to attend classes, complete the assignments of the Head of Discipline, get acquainted with the recommended literature and prepare an essay for the round table (the choice of essay topic is made in consultation with the Head of Discipline and academic supervisor). Postgraduate students carry out projects, creative tasks for independent work, taking into account the profile of the disciplines that will be implemented by them during the industrial practice. The results of independent work assignments are evaluated on the basis of the grade-rating and are reflected in the educational route of the postgraduate student. During the attestation of postgraduate student the quality of work in the classroom (ability to conduct a scientific discussion, the ability to clearly and concisely formulate his thoughts), the level of preparation for independent research activities of a specialist in the field of pedagogy of higher education, history of pedagogy and education, the quality of assignments (presentations, reports, analytical papers, etc.) are evaluated.

11.2 Guidelines for teachers.

In the process of teaching the discipline " Priority areas for the development of mathematics and mechanics " the teacher should pay special attention to the organization of practical classes and monitor the independent work of postgraduate students. In the process of mastering the discipline postgraduate students should be focused not only on active 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.

While studying section 1 "Analysis of priority directions of computational methods development" the teacher should draw postgraduate students' attention to the content of the categorical apparatus of the discipline, its interrelation with other concepts. It is important to consider in the practical sessions the applications of different research methods.

Lectures should involve postgraduate students in discussions that address current scientific issues in the field of computer science and computing.

Mastering the content of section 2 "Analysis of priority direction of development of methods of solution of ordinary differential equations" takes place in lectures and practical classes. Work at practical lessons should be aimed at active mastering of a set of theoretical knowledge, emphasising the peculiarities of the content of the stages of scientific research. The teacher should guide postgraduate students to the ability to organise and conduct various types of scientific research on computer science and computer engineering.

In mastering the content of section 3 "Analysis of priority direction of development of methods of solution of partial differential equations" the teacher uses a variety of technologies and

forms of classes and creates conditions for postgraduate students to demonstrate communication skills, readiness to lead a discussion on scientific problems.

The interim assessment evaluates the quality of postgraduate students' mastery of basic research categories, their ability to use knowledge to solve scientific problems and their readiness to actualise scientific competence in the actual research process of the university, scientific organisation, etc.

11.3 Assessment tools for assessing the mastery of the competence.

Compliance of grading systems (previously used grades of final academic achievement, ECTS grades and grading-rating system (GRS) of assessments of current progress) (In accordance with the Rector's Order No. 996 of 27.12.2006)

BRS scores	Traditional assessments in the RF	Scores for transferring grades	Assessments	ECTS grades
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 any gaps, the necessary practical skills to work with the mastered material have been formed, all the learning tasks in the study programme have been completed, the quality of their performance is assessed with a number of points close to the maximum**.**
B	***"Very good"*** - the theoretical content of the course has been fully mastered without any gaps, the necessary practical skills to work with the mastered material have been mostly formed, all the learning tasks in the curriculum have been completed, the quality of most of them has been assessed as close to the maximum number of points.
C	***"Good"*** - the theoretical content of the course has been fully mastered without any gaps, some practical skills in working with the mastered material have been insufficiently formed, all the learning tasks in the curriculum have been completed, none of them has been assessed with a minimum score, some types of tasks have been completed with mistakes**.**
D	***"Satisfactory"*** - the theoretical content of the course has been partly mastered, but the gaps are not significant, the necessary practical skills to work with the mastered material have been mostly formed, most of the curriculum tasks have been completed, some of the completed tasks may contain mistakes.

E	***"Intermediate"*** **-** the theoretical content of the course has been partly mastered, some practical work skills have not been developed, many of the curricular tasks have not been completed, or the quality of some of them has been assessed as close to the minimum number of points.
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 learning tasks in the curriculum have not been completed or the quality of their completion is assessed as close to the minimum; with additional independent work on the course material, the quality of completion of the learning tasks can be improved.
F	***"Absolutely unsatisfactory"*** - the theoretical content of the course has not been mastered, the necessary practical work skills have not been formed, all completed assignments contain gross errors, additional independent work on the course material will not lead to any meaningful improvement in the quality of the course assignments.

11.4 Evaluation criteria

Assessment method	**Maximum number points**	**Evaluation criteria**
1. Protecting the results of the review	**5**	5-The work is completed without errors, during the defence the postgraduate student confidently explains the work and answers additional questions; 4- The work is completed without errors, during the defence the postgraduate confidently explains the aim and objectives of the work, with answering additional questions Makes inaccuracies, has difficulty with the answer; 3 - The work has been completed without errors, with protection in response to additional questions the postgraduate student admits to inaccuracies, has difficulty answering; 2 - There is some minor work to be done non-critical errors 1- The work contains substantial mistakes
2. discussion of the draft article	**5**	
3. Speaking at the conference	**5**	
4 Rationale for the methods to be used in the thesis	**5**	
5. Presentation of the main results of the study	**5**	
6. Speaking on the topic of the dissertation	**5**	
7.Attendance at classes	**25**	Proportionate to classes attended
8. Colloquium on 1 topic (1 question)	**15**	Grades for the answer to the question: 11-15 points - confident answer to the main question, answer to additional questions 6-10 points - confident answer to the main question, when answering the additional questions the graduate has some difficulties 1-5 points - unsure answer to the main question

9. Oral questioning for credit (2 questions on topics 2 and 3)	**30**	
Total	**100 points**	

12. Assessment toolkit.

12.1 Questions to be put to the colloquium on topic 1 (intermediate assessment).

1. What is the essence of direct methods for solving systems of linear algebraic equations?
2. The concept of conditioning systems of linear algebraic equations.
3. Iterative methods for solving systems of linear algebraic equations.
4. Uniform approximation of functions by polynomials.
5. Numerical differentiation.
6. Numerical integration.
7. Numerical methods for solving non-linear equations.

12.2 Questions to be taken for credit (topics 2 and 3).

1. Numerical methods for solving first-order ordinary differential equations (ODEs).
2. Methods for approximate solution of boundary value problems for second order ODE.
3. Minimisation methods for functions of one variable.
4. Numerical methods for solving integral equations.
5. Basic concepts and definitions of the theory of difference schemes.
6. Finite difference method for the Dirichlet problem of the one-dimensional Poisson equation.
7. Finite-difference computational scheme for the heat conduction equation.
8. A finite-difference computational scheme for the oscillation equation.
9. The Ritz method.
10. Selection of basis functions in the Ritz method.
11. Finite element method.
12. Variation-difference computational scheme for boundary value problem for ODE.
13. Variation-difference scheme for the one-dimensional diffusion equation.
14. The construction of basis functions for solving multidimensional problems.
15. A variational difference scheme for an elliptic equation. The simplest iterative method.
16. Chebyshev iterative method.
17. The method of conjugate gradients.
18. Methods for solving hyperbolic type equations.
19. The transfer equation.
20. Split method.
21. Basic concepts of the theory of optimisation.
22. The gradient method of unconditional minimisation of a function of many variables.
23. The conditional gradient method of minimising a function of many variables.
24. Multi-criteria optimisation methods.
25. Features of mathematical calculations implemented on a computer.
26. Stability testing of models in a computational experiment.
27. Computer-based methods for constructing and analysing the phase trajectories of

systems.

28. Computer modelling of system behaviour based on algebraic methods and geometric representations.
29. The architecture of parallel computing systems.
30. Operating systems: aspects of parallelism.
31. Parallel programming for multicore architectures.
32. Parallel programming for cluster systems.

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