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MINISTRY OF SCIENCE AND HIGHER EDUCATION OF THE RUSSIAN FEDERATION

Federal State Autonomous Educational Institution of Higher Education

NORTH CAUCASIAN FEDERAL UNIVERSITY

I APPROVED BY

Acting director of the institute

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Ph.D. tech. Sciences , Associate Professor

A.A. Porokhnya

WORKING PROGRAM OF THE DISCIPLINE

Mathematical Logic and Theory of Algorithms for AI

Direction of training	11.03.02 Infocommunication technologies and communication systems
Profile	Intelligent Data Processing in Infocommunication Systems and Networks
Year of commencement of studies	2026
Form of study	full-time
Implemented in a semester	3

Developed by

Professor of the Department of Digital,
robotic systems and electronics

Institute of Advanced Engineering

Doctor of Technical Sciences, professor

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Stavropol 2026 G.

1. Target And tasks development discipline (module)

The goal development disciplines Mathematical Logic and Theory of Algorithms for AI is:

- formation mathematical And logical cultures student;
- grafting understanding universal character laws logic mathematical
- reasoning, understanding roles And places mathematical logic V system sciences;
- development of abstract thinking, general mathematical and information culture.

The main ones tasks development disciplines Mathematical Logic and Theory of Algorithms for AI are:

- stimulation formations general cultural competencies bachelor's degree through the development of a culture of thinking in terms of the practical application of modern methods of mathematical logic;
- expansion of systematized knowledge in the field of mathematics and computer science to ensure the ability to use knowledge of modern problems of science and education in solving educational and professional problems;
- providing conditions for activating students' cognitive activity and developing their experience in using methods of mathematical logic in solving practical problems and stimulating students' research activities in the process of mastering the discipline.

2. Place disciplines (module) V structure educational programs

Discipline Mathematical Logic and Theory of Algorithms for AI refers to To disciplines mandatory parts.

3. A list of planned learning outcomes for a discipline (module), correlated with the planned learning outcomes for the educational program

Code, formulation of competence	Code, formulation indicator	Planned results training in the discipline (module), characterizing the stages of formation competencies, indicators
OPK-1Able to apply fundamental knowledge obtained in the field of mathematical and (or) natural sciences and use it in professional activities	ID-1 _{OPK-1} Possesses basic knowledge obtained in the field mathematical And (or) natural sciences	Knows: - basic concepts of mathematical logic and theory of algorithms; - language and tools of modern mathematical logic; - representations of Boolean functions and methods of their minimization; - typical properties and methods of defining functions of multi-valued logic; - various approaches to defining an algorithm, to assessing the complexity of algorithms; - methods for constructing efficient algorithms; - the possibility of applying general logical principles in mathematics and professional activities.
	ID-2 _{OPK-1} Uses when solving professional problems, knowledge obtained in the field of mathematical and (or) natural sciences	Be able to: - find and explore the properties of representations of Boolean and multi-valued functions by formulas in various bases; - evaluate the complexity of algorithms and calculations; - classify algorithms by complexity classes;

		- apply methods of mathematical logic and the theory of algorithms to solving problems of mathematical cybernetics.
	ID-3 _{OPK-1} Owns selection skills models And methods to solve professional problems activities	Own: - skills in using the language of modern symbolic logic; - skills in applying methods and facts of the theory of algorithms related to solving enumeration problems; - skills in simplifying formulas of propositional algebra and predicate algebra; - skills in modeling applied problems using methods of mathematical logic and the theory of algorithms.
OPK-5. Capable of solving standard tasks of professional activity on information based and bibliographic culture With the use of information and communication technologies, V volume number of domestic producers, and taking into account the main requirements of information taking into account the basic requirements of information security, skills in programming, debugging and testing data processing tasks in high- level languages; the ability to understand the essence and significance of information in the development of modern society, the ability to use the basic methods, ways and means of obtaining, storing, processing information and the skills of working with a computer as a means of information management, observe the basic information security requirements	ID-1 _{OPK-5} Solves professional problems activities using modern information and communication technologies technologies, including those of domestic developers ID-2 _{OPK-5} Solves professional problems activities based on bibliographic culture	Possesses the methodology and skills for solving scientific and practical problems; possesses algorithmic thinking and computer skills, as well as various programming environments and shells; recognizes the dangers and threats arising in this process, taking into account the basic requirements of information security; possesses programming skills, debugging, and testing of data processing tasks in high-level languages; understands the essence and significance of information in the development of modern society; utilizes the basic methods, means, and tools for obtaining, storing, and processing information; and possesses computer skills as a means of information management; and complies with the basic requirements of information security.

4. Volume educational disciplines (module) And forms of control

Amount of classes: total: 4 credits, 144 academic hours.	OFO, In academic hours
Contact work:	32.00/0
Lectures/including practical training	0
Laboratory work /including practical training	0
Practical classes /including practical training	32.00/0
Independent work	58.00
Forms of control	

Exam	54.00
Credit	-
Credit with grade	-
Coursework	No

5. Content disciplines, structured By topics (sections) With indication quantities hours And species classes

No.	Chapter (topic) disciplines and theirs brief content	Developed competencies, indicators	Contact work students with a teacher, hours			Independent work, hours	Forms of ongoing monitoring of academic performance
			Lectures	Practical classes	Laboratory work		
1	Introduction V mathematical logic 1. Goals And tasks disciplines. 2. Structure And subsequence studies disciplines. 3. Security disciplines And recommendations By her study. 4. Story mathematical logic, How scientific directions.	OPK-1 ID-1 _{OPK-1}				2	Attendance control, notes, testing
2	Algebra statements 1. Algebraic operations over statements And their properties. 2. Formulas And functions algebra logic. Law duality. 3. Perfect disjunctive And conjunctive normal forms Boolean functions. 4. Completeness And isolation systems Boolean functions. Performance O classes Post. Practical lesson #1 LOGICAL TRANSFORMATIONS	OPK-1 ID-2 _{OPK-1}		2		2	Attendance control, notes, testing
3	Logics predicates 1. Concept predicate. 2. Logical operations over predicates. 3. Quantifiers And quantifiers operations.	OPK-1 ID-3 _{OPK-1}				2	Attendance control, notes, testing
4	Calculus statements 1. Alphabet, formulas And subformulas calculus statements 2. Axioms calculus statements 3. Main rules conclusion 4. Definition provable (output) formulas 5. Derivatives rules conclusion. Theorem deductions 6. Connection algebra statements With calculus statements Practical lesson #2 MINIMIZATION OF BOOLEAN FUNCTIONS	OPK-1 ID-1 _{OPK-1}		2		2	Attendance control, notes, testing

5	Calculus predicates 1. Definition formulas calculus predicates 2. Axioms calculus predicates And main rules conclusion 3. General significance And feasibility formulas calculus predicates 4. Pre-prepared, Skulemov's And clausal forms performances formulas calculus predicates	OPK-1 ID-2 _{OPK-1}				2	Attendance control, abstract, testing
6	Theories first order 1. Formal axiomatic theories 2. Logical And special axioms 3. Rules conclusion And concept proof V theories first order 4. Concepts interpretations And models theories. Isomorphism interpretations 5. Examples axiomatic theories first order with special axioms Practical lesson #3 SYNTHESIS OF LOGIC CIRCUITS	OPK-1 ID-3 _{OPK-1}		2		2	Attendance control, notes, testing
7	Problems axiomatic constructions theories first order 1. Problem consistency 2. Problem independence systems axioms 3. Formalizability And solvability theories 4. Categoricity theories 5. Problem completeness theories	OPK-1 ID-1 _{OPK-1}				2	Attendance control, notes, testing
8	Main principles constructions systems automation evidence 1. Production tasks automatic proof theorems 2. Unification 3. Method resolutions 4. Algorithm search refutations method resolutions 5. Proof truth logical Clause method resolutions Practical lesson #4 APPLICATIONS OF PROPOSAL CALCULUS TO PROOF THEORY	OPK-1 ID-2 _{OPK-1}		2		2	Attendance control, notes, testing
9	Logical transformations 1. Execution logical transformations. 2. Solution tasks With using laws logic statements.	OPK-1 ID-2 _{OPK-1}				2	Interview
10	Minimization Boolean functions 1. Minimization Boolean functions method Quina 2. Minimization Boolean functions method kart Carnot 3. Minimization incompletely certain logical functions Practical lesson #5 THE METHOD OF RESOLUTIONS IN PROPOSITIONAL CALCULATION	OPK-1 ID-2 _{OPK-1}		2		2	Interview
11	Synthesis logical schemes 1. Sequential And parallel connections valves. 2. Main stages constructions combinational schemes V selected functionally full set.	OPK-1 ID-2 _{OPK-1}				2	Interview
12	Applications calculus statements To theories evidence 1. Provability formulas 2. Construction conclusions from aggregates formulas Practical lesson #6	OPK-1 ID-2 _{OPK-1}		2		4	Interview

	From the methodological development, solve problems with even numbers						
13	Method resolutions V propositional calculus 1. Proof truth logical Clause method resolutions. 2. Main principles logical programming.	OPK-1 ID-2 _{OPK-1}				4	Interview
14	Logics predicates 1. Finding regions truth predicates. 2. Proof equivalence formulas logic predicates. 3. Application logic predicates For records mathematical definitions And proposals. Practical lesson #7 PREDICATE LOGIC	OPK -1 ID-2 _{OPK-1}		2		4	Interview
15	Construction conclusions V calculus predicates 1. Feasibility And general significance formulas logic predicates. 2. Pre-prepared, Skolemovskaya And clausal forms performances formulas V calculus predicates .	OPK-1 ID-2 _{OPK-1}				4	Interview
16	Models first-order logic 1. Theories With equality And partial ordering 2. Theory groups, rings And fields 3. Theory natural numbers 4. Theory vector spaces Practical lesson #8 Models of first-order logic	OPK-1 ID-2 _{OPK-1}		2		4	Interview
17	Basics structural programming 1. Compound language programming And his alphabet 2. Identifiers, variables, constants and keywords 3. Program on language high level 4. Concept type data. 5. Main types data 6. Order announcements And initialization of variables 7. Operations language programming 8. Expressions V language programming Practical Job No. 9 Programming algorithms linear structure	ID-1o _{PC-5} ID- 2o _{PC-5} ID-3o _{PC-5}		4		4	Interview
18	Basics structural programming 1. Theorem structures And structured programming 2. Simple And composite operators 3. Simple And composite conditions 4. Operators branching 5. Operators transmissions management Practical Job No. 10	ID-1o _{PC-5} ID- 2o _{PC-5} ID-3o _{PC-5}		4		4	Interview

	Programming branching structure algorithms						
19	Modular And structured programming 1. Concept modularity 2. Local And global variables 3. Announcement And definition recursive functions 4. Transmitted And returnable parameters of recursive functions Practical Job No. 11 Programming recursive algorithms	ID-1o PC-5 ID-2o PC-5 ID-3o PC-5		4		4	Interview
20	1. Algorithms solutions tasks internal sorting and information retrieval algorithms 2. Complexity algorithms 3. Production tasks search Production tasks sorting data Straight And fast methods internal sorting Practical Job No. 12 Tasks sorting And search	ID-1o PC-5 ID-2o PC-5 ID-3o PC-5		4		4	Interview
TOTAL				32.00		58.00	

6. Fund evaluation funds For conducting current control academic performance And midterm assessment of students in a discipline (module)

Assessment Tools Fund (ATF) for ongoing monitoring of academic performance The assessment and midterm evaluation of students in the course (module) "Mathematical Logic and Theory of Algorithms for AI" is based on a list of acquired competencies, indicating the stages of their development during the course (module) mastery. The assessment provides objective monitoring of the achievement of planned learning outcomes. The assessment includes:

- description of indicators and criteria for assessing competencies at various stages of their formation, description of assessment scales;
- methodological materials defining the procedures for assessing knowledge, skills, abilities and (or) work experience, characterizing the stages of competence development;
- standard test assignments and other materials necessary for assessing knowledge, skills and the level of mastery of the competencies being developed in the process of mastering the discipline (module).

FOS is application To this program discipline (module).

7.Methodological instructions For students By development disciplines

When starting work, each student should take into account the following provisions.

The discipline (module) is structured on a thematic principle, each topic is a logically complete section.

The lecture material is devoted to the examination of key, basic provisions of the courses and the explanation of educational assignments assigned to students for independent work.

Practical work is carried out with the aim of consolidating the acquired information and acquiring skills for its application in solving practical problems in the relevant subject area.

Students' independent work is aimed at independent study of additional material, preparation for practical classes, and completion of all types of independent work.

To successfully master the discipline, it is necessary to complete all types of independent work using the recommended sources of information.

8. Educational and methodological And informational security disciplines

8.1. List of basic and additional literature required for mastering the discipline (module)

8.1.1. Scroll basic literature:

1. Goryushkin, A.P. Mathematical logic and theory of algorithms: textbook / A. P. Goryushkin. - Saratov: Vuzovskoe obrazovanie, 2022. - 499 p. - Text: electronic // Digital educational resource IPR SMART: [site]. - URL: <https://www.iprbookshop.ru/117296.html>, unlimited copies.
2. Afanasyev, S.G. Mathematical logic: a tutorial / S. G. Afanasyev. - Moscow: IP R Media, 2021. - 82 p. - Text: electronic // Digital educational IPR SMART resource : [website]. - URL: <https://www.iprbookshop.ru/103656.html>, unlimited copies.
3. Gamova, A. N. Mathematical logic and theory of algorithms: a textbook for students of the Faculty of Mechanics and Mathematics and the Faculty of Computer Science and information technology / A. N. Gamova. - Saratov: Publishing House Saratov university, 2020. - 91 c. - Text: electronic // Digital

IPR SMART educational resource : [website]. - URL:
<https://www.iprbookshop.ru/106266.html>, unlimited copies.

8.2. List of educational and methodological support for independent work of students in a discipline (module)

4. Khomenko, T. V. Discrete Mathematics. Selected Methods of Set Theory and Mathematical Logic. Laboratory Workshop / T. V. Khomenko. - Astrakhan: Astrakhan state architectural and construction university, EBS ASV, 2020. - 111 c.- Text: electronic // Digital educational resource IPR SMART: [website]. - URL: <https://www.iprbookshop.ru/100830.html>, unlimited copies
5. Machikina, E. P. Mathematical logic and theory of algorithms: a teaching aid / E. P. Machikina. - Novosibirsk: Siberian State University of Telecommunications and Informatics, 2020. - 86 p. - Text: electronic // Digital educational IPR SMART resource : [website]. - URL: <https://www.iprbookshop.ru/102154.html>, unlimited copies

8.3. Scroll resources information and telecommunications networks Internet required for mastering the course (module)

1. www.biblioclub.ru - Electronic library system University Library Online
2. www.eLibrary.ru - Scientific electronic library
3. www.iprbookshop.ru - Electronic library system IPRbooks
4. www.catalog.ncfu.ru - Electronic library system SKFU

9. List of information technologies used in the implementation of the educational process in the discipline (module), including a list of software and information reference systems

Lectures are delivered using computers and multimedia presentations. During seminars and practical classes, students present presentations they prepared during their independent work hours.

Informational reference systems:

Information and reference and information and legal systems used in the study of the discipline:

1.	Mathematical Logic. Boris Boyarshinov's access mode] Course [
	[http://www.intuit.ru/studies/courses/2308/608] .

Software security:

1	Alto Working station 10
2	Alto Working station K
3	Alt "Server"
4	Office packages programs - R7 - Office

10. Description logistical bases, necessary For implementation of the educational process in the discipline (module)

The material and technical base ensures the implementation of all types of disciplinary and interdisciplinary training, laboratory, and research work of students (portable laptop, portable projector, computers with the necessary software and Internet access).

Lecture classes	1	The classroom for conducting lecture-type classes is equipped with specialized furniture and technical teaching aids used for presenting educational information to a large audience: a laptop, a projector. Educational and visual aids benefits V view thematic presentations,
		corresponding workers programs disciplines.

Practical exercises	1	The classroom for seminar-type classes is equipped with specialized furniture and technical teaching aids for presenting educational information, including a projector and interactive whiteboard. Internet access is available, as is access to the university's educational network.
Independent work	1	A room for independent student work, equipped with computers and internet access, providing access to an electronic information and educational environment.

11. Peculiarities development disciplines (module) persons With limited health opportunities

Students with disabilities are provided with special textbooks, teaching aids and didactic materials, special technical teaching aids for collective and individual use, the services of an assistant (helper) who provides students with the necessary technical assistance, as well as the services of sign language interpreters and tactile sign language interpreters.

The acquisition of a discipline (module) by students with disabilities can be organized jointly with other students, as well as in separate groups.

The acquisition of a discipline (module) by students with disabilities is carried out taking into account the characteristics of their psychophysical development, individual capabilities and health status.

In order to ensure accessibility to higher education in the educational The program provides individuals with disabilities with the following benefits when mastering a discipline (module):

1) For persons With limited opportunities health by vision:

- the presence of an assistant who provides the student with the necessary technical assistance, taking into account individual characteristics (helps to take up a work place, move around, read and complete an assignment, including writing down dictation),
- written assignments, as well as instructions on how to complete them, are written in large print,
- special textbooks, educational benefits And didactic materials (having large font or audio files),
- individual uniform lighting Not less 300 luxury,
- If necessary, the student is provided with a magnifying device to complete the assignment;

2) For persons With limited opportunities health by hearsay:

- the presence of an assistant who provides the student with the necessary technical assistance, taking into account individual characteristics (helps to take up a work place, move around, read and complete an assignment, including writing down dictation),
- the availability of sound amplification equipment for collective use is ensured; if necessary, the student is provided with sound amplification equipment for individual use;
- provided with appropriate sound means for reproducing information;

3) for persons with disabilities who have musculoskeletal disorders (including severe impairments of the motor functions of the upper limbs or the absence of upper limbs):

- written assignments are completed on a computer with specialized software or dictated to an assistant;

- By desire student tasks can be carried out V oral form.

12. Peculiarities implementation disciplines With application distance learning technologies and e-learning

According to parts 1 articles 16 Federal law from 29 December 2012 G. No. 273- FZ According to the Law "On Education in the Russian Federation," *e-learning* is defined as the organization of educational activities using information contained in databases and used in the implementation of educational programs, as well as the information technologies, technical means, and information and telecommunications networks that support its processing, enabling the transmission of said information and interaction between students and teachers. *Distance learning technologies* are educational technologies implemented primarily using information and telecommunications networks with indirect (remote) interaction between students and teachers.

The course may be implemented using distance learning technologies and e-learning, in whole or in part. The components of the course curriculum (course syllabus, assessment and methodological materials, and assessment forms) implemented using remote educational technologies And electronic training, contain indication of their use.

When organizing educational activities using distance learning technologies and e-learning, asynchronous and synchronous methods of interaction between educational participants may be provided. relationships by means of information and telecommunications networks "Internet".

When using distance learning technologies and e-learning, the curriculum for the discipline shall indicate: methods for implementing interaction between participants in educational relations via the information and telecommunications network "Internet" (VKS - video conferencing, ET - electronic testing); links on electronic information and educational environment SKFU, to educational platforms and resources of other organizations, to which public access is provided via the Internet; for synchronous learning – online class times and instructors; for asynchronous learning – online course authors.

When organizing midterm assessment using distance learning technologies and e-learning, the Methodological Recommendations for the use of technical means that ensure the objectivity of results during midterm and state final assessment for higher education programs - bachelor's degree programs, specialist programs and master's degree programs using distance learning technologies are used. technologies (Letter Ministry of Education Russia from December 7, 2020 G. No. MN-19/1573-AN "On the direction of methodological recommendations").

The implementation of the discipline using e-learning and distance learning technologies is carried out using electronic information and educational Wednesday SKFU, To which provided for access students through the Internet information and telecommunications network, or using the resources of other organizations, including platforms that provide services for video conferencing, online meetings and distance learning (MTS-Link), as well as using the capabilities of social networks for communication between students and teachers.

The educational and methodological support for a discipline implemented using e-learning and distance learning technologies includes a work program, educational and methodological manuals or a course of lectures, methodological instructions for the implementation of various types of educational activities of students provided for by the discipline, and other educational and methodological materials posted in the information and educational environment of SKFU, presented in electronic form.