

MINISTRY OF SCIENCE AND HIGHER EDUCATION OF THE RUSSIAN FEDERATION
Federal State Autonomous Educational Institution
higher education
NORTH CAUCASIAN FEDERAL UNIVERSITY

I APPROVE

Dean of the Faculty of Mathematics
and Computer Science named after
Professor N. I. Chervyakov , Candidate
of Physical and Mathematical Sciences,
Associate Professor

_____T. A. Grobova

ASSESSMENT TOOLS FUND
FOR CONDUCTING THE STATE FINAL CERTIFICATION

Direction	02.04.01 Mathematics and Computer Science
Direction (profile)	Training Program for Electronic Information
Year of commencement of studies	2026
Form of study	full-time
Implemented in a semester	4th semester

Agreed

Head of the Department of the branch of
the Federal State Unitary Enterprise
"Main Radio Frequency Center" in the
Southern and North Caucasian Federal
Districts
Kornienko S. A.

Developed by

Head of the Department of
Computational Mathematics and
Cybernetics
Babenko M.G.

Introduction

1. Purpose: The assessment tool fund is intended for conducting the state final certification of master's degree students in the field of study 02.04.01 Mathematics and computer science, profile Training Program for Electronic Information .

2. The fund of assessment tools for final certification is an appendix to the State Final Certification program .

3. Developer(s): Babenko M.G. , Head of the Department of Computational Mathematics and Cybernetics.

4. An examination of the FOS was conducted. Members of the expert group:
Chairman Lapina M.A. , Associate Professor of the Department of Computational Mathematics and Cybernetics.

Members of the commission:

Peleshenko T. A., Associate Professor of the Department of Computational Mathematics and Cybernetics

Peleshenko V.S., Associate Professor of the Department of Computational Mathematics and Cybernetics

Representative of the employer organization: Representative of the employer organization
Kornienko S.A., Head of the Department of the branch of the Federal State Unitary Enterprise "Main Radio Frequency Center" in Southern and North Caucasian Federal Districts

Expert opinion: The presented FOS complies with the requirements of the Federal State Educational Standard of Higher Education. The forms and means of ongoing assessment proposed by the instructor are adequate to the goals and objectives of the higher education program in the major 02.04.01 Mathematics and Computer Science, as well as the goals and objectives of the state final assessment curriculum. The assessment tools for ongoing performance monitoring and midterm assessment are fully provided.

Validity period of the FOS: for the entire period of implementation of the OP VO

1. List of competencies, the level of mastery of which must be tested during the State Final Attestation

Competency code	Formulation
UK – (No.)	Universal competencies
UK-1	Able to carry out a critical analysis of problematic situations based on a systems approach and develop an action strategy
UK-2	Capable of managing a project at all stages of its life cycle
UK-3	Able to organize and manage the work of a team, developing a team strategy to achieve the set goal
UK-4	Able to apply modern communication technologies, including in foreign language(s), for academic and professional interaction
UK-5	Able to analyze and take into account cultural diversity in the process of intercultural interaction
UK-6	Able to identify and implement priorities for one's own activities and ways to improve them based on self-assessment
OPK-(No.)	<u>General professional competencies</u>
OPK-1	Able to find, formulate and solve current and significant problems in applied and computer mathematics
OPK-2	Able to create and explore new mathematical models in the natural sciences, improve and develop concepts, theories and methods
OPK-3	Capable of independently creating application software based on modern information technologies and network resources, including domestically produced ones
PC-(No.)	<u>Professional competencies</u>
PC-1	Able to demonstrate fundamental knowledge of mathematics and natural sciences, programming and information technology
PC-2	Able to conduct scientific research based on existing methods in a specific area of professional activity
PC-3	Capable of conducting methodological and expert work in the field of mathematics and computer science
PC-4	Capable of conducting patent research, determining forms and methods of legal protection and defense of rights to the results of intellectual activity, and managing rights to them to solve problems in the field of development of science, engineering and technology
PC-5	Able to present and adapt mathematical knowledge, programming methods and information technology in various ways, taking into account the level of the audience
PC- 7	Able to create and explore new mathematical models in the natural sciences, industry and business, taking into account the capabilities of modern information technology, programming and computer equipment
PC- 6	Able to use modern methods of development and implementation of specific algorithms of mathematical models based on programming languages and application packages for modeling
PC- 8	Capable of participating in the management of projects for the creation of information systems and software systems at various stages of the life cycle
PC- 9	Able to take into account knowledge of the problems and trends in the development of the software market in professional activities

2. Description of indicators and criteria for assessing competencies, as well as assessment scales

2.1 Description of indicators

Levels of development competencies (ies), indicator(s) Indicators	Descriptors			
	The minimum level has not been reached (Unsatisfactory) 2 points	Minimum level (satisfactory) 3 points	Intermediate level (good) 4 points	High level (excellent) 5 points
UK-1. Capable of critically analyzing problematic situations based on a systems approach and developing an action strategy.				
Learning outcomes for the course (module): ID-1UK-1 Selects information resources to search for information in accordance with the assigned educational task.	The sources do not correspond to the set educational task. Only one type of source is used, for example, random websites from the Internet. There is a complete lack of assessment of the reliability and relevance of the information. The search is carried out chaotically, without the use of basic search methods.	Some sources are not up to the task or are of questionable reliability. Only basic resources are used, without analysis of other sources. The assessment of reliability is superficial or absent. A limited number of search methods are used, no filters are applied.	The sources are generally consistent with the task, but there are some minor deviations. Several types of sources are used, but without in-depth analysis. The reliability of the information is assessed, but without in-depth comparative analysis. Standard search methods are used, but without the use of complex operators and filters.	The most relevant and reliable sources of information are used, fully aligned with the task at hand. Various types of sources are employed, and advanced search methods are employed. The reliability and relevance of the information found are reasonably assessed.
Learning outcomes for the course (module): ID-2UK-1 Systematizes information obtained from various sources in accordance with the requirements for completing the educational assignment.	The information is presented chaotically, and there is no logic in combining data. There is no analysis of information; systematization is reduced to simple copying of data. The data is not presented in a convenient form, the task does not meet the requirements.	The information is collected, but poorly structured or important aspects are missing. There is an attempt at analysis, but without deep generalization and identification of key ideas. The information is presented, but without clear logic or poorly formatted.	The information is structured, but there are minor gaps in the disclosure of the topic. The information has been analyzed, but may contain minor inconsistencies or insufficient depth of processing. The information is presented in a logical and	Information obtained from various sources covers the topic completely and is presented in a logical structure. An in-depth analysis of the data was conducted, key ideas were identified, and contradictions between

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	The educational task was completed with significant errors or was not completed.	The assignment was partially completed; there were logical errors or shortcomings.	structured form, but there may be minor design errors.	sources were resolved. The information is formatted in accordance with the requirements of the assignment and presented in a visual form. The educational task was completed in full, without logical errors or omissions.
Learning outcomes for the course (module): ID-3UK-1. Formulates and substantiates conclusions and judgments, including through the use of philosophical conceptual frameworks.	The conclusions are formulated unclearly; there is no logical connection between the judgments. The argumentation is weak or absent, the conclusions are declarative. Philosophical categories and concepts are not used or are applied incorrectly. There is no consideration of alternative points of view. The work does not meet the requirements of the academic assignment and contains significant logical and methodological errors.	The wording of conclusions and judgments is sometimes unclear and may contain logical inconsistencies. The argumentation is superficial, the judgments are not sufficiently substantiated. The use of philosophical terms is limited and sometimes incorrect. The analysis of alternative positions was carried out partially or was absent. The work was completed with deviations from the requirements; there are	The conclusions are generally logical, but may contain minor inaccuracies or redundancies in wording. are presented, but individual assertions could be supported by more convincing evidence. Philosophical terms are used, but not always appropriately or without sufficient depth. Various points of view are considered, but their analysis could have been	The conclusions and judgments are formulated clearly, logically and consistently. The argumentation is detailed, using compelling evidence, examples, and references to authoritative sources. Philosophical categories, terms and concepts that correspond to the topic of discussion are applied correctly.

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		logical errors and shortcomings in the argumentation.	more detailed. The work generally corresponds to the assignment, but there may be minor logical gaps or stylistic flaws.	Alternative points of view are considered, and their strengths and weaknesses are substantiated. The work meets the academic requirements, the conclusions are based on logic and facts, and there are no errors in reasoning.
UK-2. Capable of managing a project at all stages of its life cycle.				
Learning outcomes for the course (module): ID-1 UK-2 As part of the project activities, it models the technological processes of creation and processing of materials taking into account economic factors and in accordance with the requirements of environmental and industrial safety	The technological process is modeled with gross errors or is absent. There is no cost-benefit analysis or it is performed incorrectly. Environmental and industrial safety requirements are ignored. The project does not contain new solutions and uses outdated technologies. The work does not correspond to the assignment, contains critical errors, and lacks a structured	A simplified technological process has been developed; inaccuracies or the absence of some stages are possible. The cost-effectiveness analysis is presented superficially or partially. Only basic safety aspects are taken into account, and measures to reduce environmental impact are not presented. Standard technologies are used without any attempts to optimize or introduce new solutions.	The technological process is designed correctly, but may contain minor flaws or insufficient detail. An analysis of economic efficiency is presented, but the calculations are not detailed in all aspects. Basic safety requirements are met, but minor omissions are possible. Modern technologies are used, but without significant innovations or optimizations. The project meets the	The technological process has been developed with a high degree of detail, taking into account all key stages and factors. A detailed analysis of the economic efficiency of the process is presented, and cost and profitability calculations are carried out. The project complies with modern

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	format.	The project is partially completed; there are logical inconsistencies or calculation errors.	basic requirements of the assignment, but may contain minor flaws in the design or calculations.	environmental and industrial safety requirements and takes into account measures to minimize negative impacts on the environment. Modern technologies and approaches to material processing are used, and process optimization elements have been introduced. The project fully complies with the assignment and is designed in accordance with established standards.
Learning outcomes for the course (module): Implements a new project into production and manages it at all stages of its life cycle	The project plan is missing or presented in an unsystematic manner. The project implementation is not carried out or is carried out with serious problems. There is no system for monitoring and analyzing performance indicators. The economic feasibility has	The project implementation plan has been presented, but contains significant gaps. The project is undergoing implementation with difficulties and management problems are being observed. Benchmarks are not monitored sufficiently and data analysis is fragmented.	The project was planned thoroughly, but with some minor omissions in details. The project is being implemented successfully, but management could be optimized to increase efficiency.	A detailed project implementation plan is presented, taking into account all key aspects (goals, objectives, resources, risks, deadlines). The project was successfully implemented at all

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	not been worked out; there may be high risks of loss. There are no provisions for further development and scaling of the project. The project does not comply with regulatory requirements; there are critical errors in calculations, management and design.	A general cost-benefit analysis is presented, but a detailed economic justification is missing. Issues of further development of the project have not been worked out or are proposed in general terms. The project is partially completed; there may be errors in calculations, management or design.	Key indicators are monitored, but there may be shortcomings in the control system. The economic feasibility of the project is presented, but may require more detailed calculations. Development paths for the project are being considered, but without in-depth consideration of scalability. The project complies with the main regulatory requirements, but there may be minor design flaws.	stages of the life cycle using modern management methods. A performance evaluation system has been implemented, ensuring timely monitoring of key performance indicators. Reasonable calculations of costs, profitability and potential profit are presented. Possibilities for further development and improvement of the project were taken into account, and scaling strategies were proposed. The project fully complies with technical, economic and legal norms and is designed in accordance with established standards.

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UK-3. Capable of organizing and managing a team, developing a team strategy to achieve the set goal.				
Learning outcomes for the course (module): ID-1 UK-3 Manages the production activities of employees	There is no clear distribution of responsibilities and there is chaos in the work. Planning is absent or is carried out formally, and control over implementation is minimal. The management is ineffective, there is a lack of motivation and control over employees. Emerging problems are ignored or not resolved in a timely manner. Production processes are not optimized, which can lead to significant losses of time and resources. Production activities are carried out with serious violations of regulatory requirements.	There are gaps in the distribution of responsibilities and coordination of employees. Planning is underway, but there are significant deviations from deadlines and insufficient control. Human resources management is at a basic level and employee motivation is weak. Problems are resolved with delays or not in full. There is no systematic approach to improving efficiency and reducing costs. Production activities are carried out with violations; there are organizational and regulatory shortcomings.	Responsibilities are distributed, but minor shortcomings in work coordination are possible. The work plan has been drawn up and is being implemented, however, minor deviations from the schedule are possible. Management is good, but there may be minor problems with staff motivation. Problems are resolved in a timely manner, but minor delays or shortcomings in the process are possible. Basic efficiency improvement methods are applied, but the optimization potential is not fully realized. Production activities comply with basic standards, but minor omissions may occur.	Employee responsibilities are clearly distributed, and effective coordination of work is ensured. A detailed work plan was developed and implemented, including deadlines, resources, and milestones. Modern methods of personnel management are successfully applied, and employee motivation is ensured. Problems arising in the production process are quickly and effectively resolved. Strategies are applied to improve labor efficiency and minimize costs. Production activities are organized in full compliance with regulatory

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				requirements.
Learning outcomes for the course (module): ID-2 UK-3 Prepares and presents presentations of plans and results of personal and team activities	The presentation does not have a clear structure, and the sequence of information delivery is chaotic. The main aspects of the topic are poorly covered or absent, and the materials are poorly prepared. The slides are overloaded with text, unreadable, or poorly formatted. The speaker reads the text without expression, does not use intonation, and makes many hesitations. There is no interaction with the audience and the material is presented formally. There is a lack of coordination within the team; speakers do not coordinate information with each other. Either he doesn't answer questions, or he does so uncertainly, with mistakes and deviations from the topic.	The presentation has a weak structure, and the logic of presentation is broken in places. Only the main aspects are presented, important details or evidence base are missing. The slide design contains too much text, poor color combinations, or sloppy elements. The report is read monotonously, there may be frequent hesitation and a lack of expressiveness. Interaction with the audience is minimal, the performance is more like a monologue. During a team presentation, there is a lack of coordination among the speakers and an uneven distribution of roles. Answers to questions from the audience are given with difficulty, uncertainty or deviation from the topic are possible.	The presentation is logically structured, but there may be some minor flaws in the logic of presentation. The basic information is presented, but some aspects may be covered superficially. The presentation design is generally high quality, but there may be some text overload or minor visual flaws. The speaker presents the material confidently, but slight hesitation or monotony of speech is possible. There are attempts to interact with the audience, but they are not always effective. There is interaction between speakers, but there may be inconsistency or uneven distribution of roles.	The presentation is clearly structured and contains a logical sequence of presentation of the material. All key aspects of the plan or performance results are presented and reliable data is used. The slides are professionally designed, the graphics are discreet, the fonts are legible, and the color scheme is not overloaded. The speaker presents the material confidently and clearly, uses expressive means of speech, and maintains eye contact. The presentation is accompanied by explanations, examples, and may

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			Generally answers audience questions, but some answers may not be detailed enough.	include questions for the audience or interactive elements . During a team presentation, the speakers were coordinated, roles were distributed logically, and interaction within the team was smooth. Confidently answers questions from the audience, demonstrating an understanding of the topic and the ability to argue their point of view.
UK-4. Able to apply modern communication technologies, including in a foreign language(s), for academic and professional interactions				
Learning outcomes for the course (module): ID-1 UK-4 Forms and defends one's own opinions and scientific positions, including in foreign language(s)	The judgments are unclear and there is no logical sequence. The argumentation is weak or absent, and the conclusions are not supported by evidence. Unable to defend his point of view; arguments are superficial or incorrect.	The wording is unclear in some places, and logical inconsistencies are possible . The argumentation is weak and there is a lack of references or substantiated evidence. Defending a position is difficult, the arguments are superficial or incomplete.	The judgments are logical, but there may be minor inaccuracies or stylistic excesses. The arguments are compelling, but some points could be supported by stronger evidence. Able to defend his position, but may allow	Own positions and conclusions are formulated clearly, logically, and reasonably. is presented , references to authoritative sources are made, and scientific theories and concepts

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	Significant errors in presentation, does not know the relevant terminology. Does not actively participate in discussions or is unable to respond to objections with reason. The work does not meet academic standards and contains serious logical and stylistic errors.	Foreign language is used with errors, and there may be difficulties in expressing complex scientific ideas. Participates in discussions, but does not always take counterarguments into account or respond to them correctly. The work was completed with deviations from scientific standards; there may be errors in the formatting.	minor flaws in the logic of reasoning. Presents a scientific position in a foreign language with minor errors and uses specialized vocabulary. Takes part in discussions, but does not always fully analyze the opponents' arguments. The works meet academic standards, but minor stylistic flaws are possible.	are used correctly. Confidently defends his point of view, relying on logic, facts and scientific arguments. Freely expresses and defends his scientific positions in a foreign language, using specialized vocabulary. Effectively conducts scientific debates, knows how to take into account alternative points of view and oppose them with arguments. Presentations and written works are prepared in accordance with academic standards.
Learning outcomes for the course (module): ID-2 UK-4 Uses Russian and foreign languages as a means of business communication, clearly and distinctly presents problems	The presentation is incoherent, the logic of the text is broken, and the material is difficult to perceive. A significant number of	The presentation is not structured enough; there may be logical gaps or redundancy of information. Grammatical, spelling and punctuation errors that affect	The presentation is coherent and clear, but there may be minor logical or stylistic flaws. Generally fluent in Russian and foreign	The material is presented clearly, consistently and logically, and there are no semantic or stylistic errors.

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and solutions, and justifies conclusions	errors makes the text difficult to understand. Lack of argumentation or use of unsupported, weak arguments. Business communication norms are violated; stylistic and communication errors are possible. Unable to adapt communication style to business situations and experiences significant communication difficulties. Unable to use a foreign language in business communication, makes serious mistakes that interfere with understanding.	the perception of the text are allowed. The arguments presented are poorly supported by facts, and the conclusions are not convincing enough. Template phrases are used, mistakes in business communication style are made. Has difficulty adapting speech to different formats of business communication. Limited use of foreign language, errors in vocabulary and grammar leading to misunderstandings.	languages, with occasional mistakes that do not affect understanding. Quite a compelling argument, but in some places there may be weak justification or a lack of evidence. In general, business communication standards are observed, but there may be minor violations of etiquette or style. Can adapt communication style, but sometimes has difficulty choosing the appropriate form of interaction. Uses a foreign language in business communication, but may have minor errors or lack confidence.	High level of proficiency in Russian and foreign languages, correct use of business vocabulary, absence of spelling, punctuation and grammatical errors. The conclusions are reasoned, supported by evidence, and use critical analysis of information. Business communication standards are observed, and professional terminology is used correctly and appropriately. Able to adapt communication style depending on the situation (official negotiations, business correspondence, presentations, discussions). Freely uses a foreign

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				language in business communication and argues his position without difficulty.
UK-5. Able to analyze and consider cultural diversity in intercultural interactions.				
Learning outcomes for the course (module): ID-1 UK-5 Analyzes and draws conclusions on social, ethical, scientific and technical issues arising in professional activities.	The analysis is absent or fragmentary. The conclusions are made without justification and contain logical errors. Scientific methods of analysis are not used and there is no systematic approach. Social and ethical aspects are ignored, and the proposed solutions do not comply with professional ethics. The conclusions are impractical and have no value for professional activity. The text is poorly structured, contains many errors, and is unclear.	The problem is considered superficially; a comprehensive approach is lacking. The conclusions are not sufficiently substantiated, contain logical gaps or weak argumentation. The application of analysis methods is formal in nature or limited to one approach. Social and ethical aspects are only partially touched upon or considered superficially. The conclusions and recommendations are difficult to implement in practice and require significant revision. The text contains stylistic and logical errors, and the presentation is unclear in places.	The analysis covers the main aspects of the problem, but may not be detailed enough. : The conclusions are generally logical and well-founded, but the argumentation may be incomplete or not always convincing. Basic methods of analysis are used, but without in-depth study. In general, social and ethical aspects are taken into account, but the analysis of these factors may not be comprehensive enough. The solutions are applicable, but require refinement or adaptation to specific conditions. The text is logical and	A comprehensive analysis of the problem was carried out, taking into account all significant aspects (social, ethical, scientific, technical). The conclusions follow logically from the analysis, are reasoned, and supported by reliable sources and facts. Scientific approaches, methods of analysis, comparative, critical or systemic analysis are used. Social and ethical aspects are taken into account, and the proposed solutions comply with professional ethics.

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			literate, but there may be minor stylistic or structural flaws.	The conclusions and proposed solutions are applicable in practice and take into account the real conditions of professional activity. The text is presented clearly, logically, without stylistic and grammatical errors.
Learning outcomes for the course (module): ID-2 UK-5 Objectively evaluates the diversity of cultures and identifies their individual characteristics	Culture is treated superficially or with errors, and there is a lack of deep understanding of the topic. There are biased judgments, stereotypes, and no critical analysis of information. Does not differentiate between cultures or makes significant errors in description. Comparative analysis is absent or made without argumentation. Incorrect statements are allowed, intercultural specifics are not taken into account. The text is unstructured and	Considers cultural diversity superficially, without deeply exploring its aspects. Stereotypes and lack of critical analysis are possible. Provides general facts but does not emphasize the unique features of cultures. Comparison of cultures is formal in nature or limited to simple statements. Respectful, but may use inappropriate terms or simplistic generalizations. The text contains logical and stylistic errors, and the presentation is not clear enough.	Covers the topic well, but may not take into account some aspects (such as economic or historical influence). Generally objective, but some stereotypical or superficial judgments are possible. Describes key characteristics of crops, but does not always emphasize unique features. There are attempts to compare cultures, but not always with clear arguments. Demonstrates respect for	Demonstrates a comprehensive understanding of cultural diversity, taking into account historical, social and economic contexts. Analyzes cultures without stereotypes and bias, using scientific sources and reliable data. Clearly articulates the unique characteristics of different cultures and highlights their distinctive features. Competently compares cultures, revealing their

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	contains numerous grammatical and stylistic errors.		cultural differences, but may not take into account all the nuances of intercultural communication. The text is logical and literate, but minor stylistic or structural errors are possible.	similarities and differences based on logical arguments. Shows respect for cultural traditions, uses terminology correctly, and demonstrates a high level of intercultural competence. The information is presented logically, consistently, competently and without stylistic errors.
UK-6. Able to identify and implement priorities for one's own activities and ways to improve them based on self-assessment.				
Learning outcomes for the course (module): ID-1 UK-6 Ready for self-development, self-realization, and use of creative potential	Does not show initiative in learning and professional development. Lack of clear goals and desire to achieve them. Does not show creativity, is not interested in finding new solutions. Does not analyze his actions, does not draw conclusions from mistakes. Does not plan his development, does not use	Shows interest in development, but does so irregularly or formally. Has a general vector of development, but experiences difficulties in achieving set goals. Sometimes he suggests unconventional ideas, but rarely puts them into practice. Poor analysis of one's achievements and mistakes,	Strives for development, but may show insufficient regularity or depth in studying new areas. Sets goals for himself, but does not always clearly define the ways to achieve them. Shows creativity, but does not always apply it in practice. Analyzes his actions, but does not always draw	Constantly works on his professional and personal growth, strives to acquire new knowledge and skills. Clearly formulates personal and professional goals, successfully achieves them, demonstrating initiative. Demonstrates a high level of creativity,

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	available educational and professional resources. Does not share experience, does not show interest in teaching others.	lack of behavioral adjustments based on experience. Self-development planning is chaotic and available resources are not always used. Shares knowledge sporadically, without a systematic approach.	conclusions for further growth. Generally effective in planning his/her learning and development, but sometimes has difficulty with time management. Ready to share knowledge, but does not always do so actively.	offers unconventional solutions, and implements innovative ideas. Analyzes his achievements and mistakes, adjusts self-development strategies. Manages time effectively and uses a variety of methods and resources for learning and development. Shares experience, inspires and motivates others to develop.
Learning outcomes for the course (module): ID-2 UK-6 Defines and implements priorities of own activities	Doesn't know how to prioritize, chooses unimportant or non-urgent tasks. Either completely absent or has no logical structure. Does not achieve set goals, work is not completed on time or is of poor quality. Unable to adapt to changing conditions, has difficulty adjusting his plans. There is no analysis of one's	Prioritization is not always effective; errors in assessing the importance of tasks are possible. Plans his work, but often deviates from the plan or does not complete it completely. Achieves goals with delays or requires additional support. Difficulty adapting to changes, requires significant	Sets priorities correctly, but can sometimes underestimate important tasks. Makes a work plan, but does not always adhere to it strictly. In most cases, it successfully completes the assigned tasks, but minor delays are possible. Can change plans when circumstances change,	Able to correctly prioritize activities, taking into account importance, urgency, and long-term goals. Develops detailed work plans and successfully allocates resources and time. Achieves assigned tasks on time, demonstrates organization and

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	own activities; the same mistakes are repeated. Avoids responsibility, requires constant external control.	time for restructuring. Poorly analyzes the results of activities and does not use the experience gained for further improvement. Can perform tasks, but without the proper level of initiative and responsibility.	but sometimes this requires additional time. Evaluates the results of work, but does not always apply the findings in practice. Takes a responsible approach to completing tasks, but may require outside supervision.	independence. Quickly adapts to changes, adjusting priorities as necessary without loss of efficiency. Evaluates the results of his activities, identifies strengths and weaknesses, and uses this for further development. Takes responsibility for decisions made and their implementation.
OPK-1. Capable of identifying, formulating, and solving current and significant problems in applied and computer mathematics.				
Learning outcomes for the course (module): ID-1 OPK-1 Finds and formulates significant problems of applied and computer mathematics.	Identifies unimportant or irrelevant issues. The analysis is superficial or non-existent, and there is no attempt to put the problem into context. The argumentation is weak or completely absent. Either does not use scientific sources or refers to unreliable data. Completely absent, the topic is addressed without any new	Identifies the problem, but it may be minor or not urgent enough. The problem statement is not clear enough or contains inaccuracies. The analysis is superficial, without sufficient consideration of the context and existing research. Explains the problem, but the arguments are poorly supported by facts or	Identifies important issues, but there may be minor flaws in the choice of topics. Formulates the problem correctly, but may use redundant or insufficiently precise formulations. Analyzes the problem, but does not always cover all its aspects. Explains the significance	Identifies problems of important theoretical and practical significance in applied and computer mathematics. Formulates the problem clearly and correctly, using mathematical terminology and argumentation. Explores the problem

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	perspective.	examples. Relies on a limited amount of material and sometimes uses unconfirmed or outdated data. There is no original approach; the problem is treated in a formulaic manner.	of the problem, but the argumentation may not be deep enough. Uses scientific papers and articles, but may not have enough sources or may not have the most up-to-date data. Demonstrates unconventional thinking, but ideas are not always original or deeply developed.	in a broad context, taking into account modern research and practical aspects. Explains the significance of the problem in a well-reasoned manner and provides examples of its impact on other areas. Based on scientific publications, modern research, and data from reliable sources. Offers an original or non-standard view of the problem, reveals new aspects.
Learning outcomes for the course (module): ID-2 _{OPK-1} knows and uses methods for solving significant problems of applied and computer mathematics.	Poorly versed in mathematical methods, uses them inappropriately or with gross errors. Selects inappropriate or outdated methods to solve problems. Unable to solve a problem or makes critical errors. Cannot explain his choices,	Familiar with the methods, but uses them without full understanding. Sometimes it chooses a less efficient solution method, which leads to additional calculations or errors. Solves problems, but there may be errors in calculations or algorithms.	Has a command of the basic methods for solving problems in applied and computer mathematics, but may make minor errors. Generally selects an appropriate method, but sometimes does not consider more effective	Demonstrates a strong command of modern mathematical methods, including analytical, numerical, and algorithmic approaches. Able to analyze a problem and select the optimal solution taking

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	The minimum level has not been reached (Unsatisfactory) 2 points	Minimum level (satisfactory) 3 points	Intermediate level (good) 4 points	High level (excellent) 5 points
	applies methods without understanding their essence. Does not own modern software or refuses to use it. Works mechanically, without analyzing or adapting methods to the task.	Explains the choice of method superficially, without comparison with alternatives. Uses mathematical software but does not use its advanced features. Uses standard methods without trying to optimize solutions.	alternatives. Solves problems correctly, but may have difficulty working with non-standard cases. Can explain his choice, but the reasoning is not always complete or deep. Can work with mathematical programs, but does not use them to their full potential. Can offer unconventional solutions, but without deep research.	into account the specifics of the task. Successfully applies methods in practice, achieving correct and justified results. Clearly explains why the chosen method is appropriate for solving the problem, compares alternative approaches. Proficient in specialized software (MATLAB, Python , Maple , etc.) and applies it in calculations. Offers original ideas for modifying or adapting methods to solve complex problems.
OPK-2. Capable of creating and exploring new mathematical models in the natural sciences, improving and developing concepts, theories, and methods.				
Learning outcomes for the course (module): ID-1 _{OPK-2} Conducts research into new mathematical models in the natural sciences	Poorly oriented in the theoretical base and existing models. Unable to develop or adapt a mathematical model. Does not evaluate models or	Familiar with basic mathematical models, but does not delve into their principles and rationale. Able to adapt existing models, but has difficulty	Has a good understanding of key models but may struggle with new concepts. Develops mathematical models, but without	Demonstrates a confident command of modern mathematical models applicable to the natural sciences. Develops and

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	does so with gross errors. Applies methods incorrectly or does not use them at all. Doesn't see how mathematical models can be applied in the natural sciences. Either he doesn't know the math programs or he uses them incorrectly. Cannot provide convincing evidence to prove the correctness of his conclusions. Does not participate in scientific research and conferences.	developing new ones. Understands models but does not critically analyze them. Uses a limited set of methods and allows for inaccuracies in calculations. Applies models formally, without taking into account the real context. Knows basic software functions, but does not use advanced tools. Explains models superficially and does not always provide correct arguments. Works on scientific papers, but without significant contribution to research activities.	significant innovation or deep analysis. Evaluates models but does not always suggest effective improvements. Has a command of analytical methods, but applies them with minor errors or without sufficient depth. Can apply models to real-world problems, but does not always take into account all the nuances. Has knowledge of mathematical software, but does not use it to its full potential. Generally substantiates his work, but does not always use the most relevant or substantiated sources. Prepares scientific materials, but does not always actively participate in scientific events.	substantiates original mathematical models for describing natural phenomena and processes. Able to critically evaluate existing models, identify their limitations and suggest improvements. Uses modern mathematical methods, including numerical, analytical and statistical approaches. Demonstrates how a mathematical model can be used to solve real scientific problems. Uses specialized software (MATLAB, Python , Wolfram Mathematica , etc.) for modeling and analysis. Provides compelling evidence to support the model's validity, drawing on relevant

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				research and data. Presents research results at conferences, seminars or in scientific articles.
Learning outcomes for the course (module): ID-2 OPK-2 Develops new and improves existing concepts, theories and methods	Not familiar with modern concepts, theories and methods. Incapable of formulating new scientific ideas. Does not introduce any changes to existing theories and methods. The ideas lack argumentation or contradict scientific principles. The developments have no practical value. Does not have the necessary software. Does not participate in scientific discussions, conferences, or publications. Completely absent, only a template approach is used.	Familiar with the basic concepts, but does not have a deep enough understanding of their relationship to contemporary scientific problems. Makes minor modifications to existing methods, but does not formulate fundamentally new concepts. Improvements are minor or superficial, without serious analysis. There are errors or gaps in the logic of reasoning, the argumentation is weak. The proposed methods are difficult to adapt to real-world problems. Limited knowledge of specialized software, use of only basic functions. Rarely participates in conferences or publications,	Understands basic theories and methods, but does not always embrace the latest trends. Formulates new approaches, but they may require further refinement or clarification. Provides improvements to existing methods but does not make a significant scientific contribution. The ideas are clearly presented, but the argumentation may not be deep enough. New methods are applicable in practice, but there may be difficulties in adapting them. Has knowledge of the necessary software, but does not use it to its full	Demonstrates excellent knowledge of current concepts, theories and methods, their history and modern development trends. Independently formulates and justifies new concepts, theories, or methods using a creative and scientifically sound approach. Able to critically analyze current scientific approaches and make meaningful improvements. The ideas developed are distinguished by their clarity, internal logic and well-reasoned scientific validity.

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	The minimum level has not been reached (Unsatisfactory) 2 points	Minimum level (satisfactory) 3 points	Intermediate level (good) 4 points	High level (excellent) 5 points
		limiting himself to coursework or diploma theses. Uses standard approaches and does not show significant originality.	potential. Presents his work, but publications or reports are limited to small studies. Demonstrates innovative thinking, but ideas require refinement or additional argumentation.	New or improved methods find application in real-world problems, as confirmed by examples and experiments. Proficient in mathematics, statistics, and software for developing and testing new theories. Presents the results of the work in the form of publications, conference reports, and scientific discussions. Offers original solutions, goes beyond standard methods, and formulates new scientific hypotheses.
OPK-3. Capable of independently creating application software based on modern information technologies and network resources, including domestically produced ones.				
Learning outcomes for the course (module): ID-1 OPK-3 Independently creates application software products	Does not know programming languages or uses them incorrectly. The program does not start or does not perform its stated functions.	Understands basic concepts but uses a limited set of tools. The program performs basic functions, but has shortcomings, errors, or insufficient functionality.	Proficient in basic programming languages and technologies, but sometimes makes minor mistakes. Creates functioning	Proficient in modern programming languages (Python , C++, Java , etc.), libraries and development tools.

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	The minimum level has not been reached (Unsatisfactory) 2 points	Minimum level (satisfactory) 3 points	Intermediate level (good) 4 points	High level (excellent) 5 points
	The code is chaotic, unreadable and cannot be improved. Missing or implemented incorrectly. Ignores data protection and testing. There is a complete lack of documentation It is impossible to improve the program without rewriting it from scratch. Uses outdated or inappropriate tools. Cannot explain how the program works and what problems it solves.	The code is unstructured, does not scale well, or is complicated by redundant solutions. Uses a database, but makes mistakes in organizing data storage. Tests the program manually but does not use automated testing. The program description is superficial or absent. Fixing bugs requires significant changes to the code. Works only with basic tools, avoids new technologies. The description of the program's operation is incomplete or not clear enough.	software, but it may need some improvement or optimization. The code structure is logical, but may not be the most efficient or flexible. Uses a database, but does not always optimize queries or data structure. Knows the basics of testing and security, but applies them selectively. Describes the main aspects of the program's operation, but the documentation may be incomplete. Makes corrections and changes, but this requires significant effort. Uses modern tools, but does not always master new technologies. Can explain functionality, but does not always justify technical solutions.	Independently develops and brings to operational status application software, including user interface, data processing and logic. Designs a competent software architecture, taking into account the principles of modularity, scalability, and performance. Confidently uses relational and non-relational databases (MySQL , PostgreSQL , MongoDB , etc.). Implements vulnerability protection, writes tests (unit testing, integration testing), and creates clear and structured documentation for users and developers.

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				Can upgrade the product, implement new features and fix bugs.
Learning outcomes for the course (module): ID-2 ОПК-3 Knows and can find modern information technologies, including domestically produced ones, necessary for the creation of applied software products	Not familiar with modern information technologies. Cannot find or analyze technologies, uses only already known tools. Incapable of selecting and implementing the required technology in software product development. Uses limited, outdated, or inappropriate tools. Does not evaluate technologies, uses them without understanding their features.	Familiar with some modern tools, but poorly aware of their relevance. Can find information, but is not always able to evaluate its reliability and applicability. Uses technology, but is often limited to basic capabilities. Works with a limited set of tools and avoids learning new ones. Selects technologies intuitively, without deep analysis.	He understands modern information technologies, but does not always know the latest updates. Finds the necessary technologies, but does not analyze them in depth. Uses found tools, but does not always fully exploit their capabilities. Works with multiple languages and frameworks, but may avoid complex or new tools. Keeps up with new technologies, but is not always actively involved in professional communities.	Well-versed in modern information technologies, including domestic and foreign developments. Confidently and quickly finds the necessary technologies, analyzes their advantages and disadvantages. Able to select and effectively use tools for creating application software products. Proficient in various programming languages, libraries, frameworks, cloud services and DevOps tools. Knowledge of domestic IT products (OS, databases, development

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				platforms) and the ability to adapt them to specific tasks.
PC-1. Able to demonstrate fundamental knowledge of mathematical and natural sciences, programming, and information technology.				
Learning outcomes for the course (module): ID-1 PC-1 In his professional activities, he demonstrates fundamental knowledge of mathematics and natural sciences.	Has limited knowledge in mathematics and natural sciences, which is insufficient for professional activity Incapable of applying knowledge in professional practice or does so extremely rarely and with a large number of errors. Difficulties in solving problems that require even basic knowledge often require help and correction. Shows no interest in updating knowledge and scientific development. Does not understand basic concepts and principles, or understands them only partially.	Has basic knowledge in mathematics and science. Can apply basic concepts but has difficulty solving more complex problems. Sometimes makes mistakes in applying knowledge in professional activities. Requires additional assistance to solve problems that require deeper understanding. Understands the basic principles, but does not actively improve his knowledge.	Has fairly deep knowledge in the field of mathematics and natural sciences. Applies knowledge to professional activities with little or no assistance. Can solve most problems, although sometimes additional explanation is required. Understands basic concepts and principles, but may make minor errors in complex situations. Regularly updates his knowledge, but may not be as active in mastering innovations.	Demonstrates deep and comprehensive knowledge of mathematics and science. Freely and confidently applies acquired knowledge in professional practice. Explains theoretical concepts logically and reasonably and solves complex problems. Identifies and effectively solves problems requiring an interdisciplinary approach. Constantly improves his knowledge and actively follows new achievements in the field of science.
Learning outcomes for the course (module):	Has limited knowledge and skills in programming and	Can use basic programming tools and information	Uses programming tools and information	Confidently and effectively uses various

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ID-2 PC-1 Solves problems of professional activity using programming and information technology tools	information technology and is unable to effectively solve problems using them. Does not solve problems independently or solves them with significant errors that require significant intervention. Does not use modern programming tools or information technologies, despite the availability of such capabilities. He practically does not update his knowledge in this area and does not apply new approaches.	technology, but has difficulty solving more complex problems. Requires assistance in solving non-standard problems or uses ineffective methods. Applies standard approaches to problem solving, but sometimes makes mistakes or misses important details. Knowledge in programming and IT is limited and requires additional practice to improve.	technology to solve problems, effectively handling most situations. Can develop standard solutions, but in some cases additional assistance or time is required to resolve complexities. Understands basic tools and technologies, but sometimes does not use them fully or with maximum effectiveness. Constantly improves his knowledge, but is sometimes slow to master new approaches or technologies.	programming tools and information technologies to solve professional problems. Develops complex and custom software solutions, taking into account all necessary requirements and details. Initiates and applies new tools and technologies to improve work efficiency. Solves problems logically, consistently and with high accuracy, demonstrating a creative approach to problem solving. Actively improves his skills and knowledge in the field of programming and information technology, follows the latest trends and implements

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				innovations.
PC-2. Capable of conducting scientific research based on existing methods in a specific area of professional activity.				
Learning outcomes for the course (module): ID-1 PC-2 Conducts scientific research in the field of parallel computer technologies.	Incapable of conducting independent scientific research in the field of parallel computer technologies. Uses parallel computing with a large number of errors or does not use modern approaches in research at all. The works have no scientific value or do not lead to significant results. Incapable of solving problems that require advanced knowledge in the field of parallel computing. Does not follow advances in the field, does not update his knowledge and does not apply modern methods.	Conducts scientific research using parallel computing, but the research is often limited to basic or outdated approaches. Uses parallel technologies, but mainly to solve simple or well-known problems. Demonstrates basic knowledge of parallel computing technologies, but work often lacks originality or scientific merit. Not always able to offer optimal solutions or methods, often requires consultations and assistance. Does not show active interest in innovations in the field, sometimes uses outdated methods and approaches.	Conducts scientific research in the field of parallel computer technologies, solving problems using existing methods and algorithms. Uses parallel computing in his research, but may encounter difficulties when solving more complex and non-standard problems. Develops and applies parallel algorithms, but the work may require modifications to improve their efficiency or accuracy. The work has scientific significance, but may be presented on less prestigious scientific platforms. Keeps up to date with advances in parallel computing, but does not update his knowledge and	Initiates and successfully conducts scientific research in the field of parallel computer technologies, proposing new approaches or solutions. Demonstrated deep knowledge of the theory and practice of parallel computing, applying it to solve complex scientific and engineering problems. Creates and optimizes parallel algorithms and systems, demonstrating a high degree of originality and scientific value of the work. The works are of high scientific significance, published in leading scientific journals or presented at

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			skills as actively as the field requires.	international conferences. He constantly improves his knowledge in the field of parallel computer technologies and actively follows new achievements and research in this area.
Learning outcomes for the course (module): ID-2 PC-2 Conducts reviews of scientific articles, abstracts and dissertations in the fields of mathematics and information technology	Incapable of objectively and fully reviewing scientific articles, abstracts and dissertations in the fields of mathematics and information technology. Reviews are not well-founded, are often superficial or incomplete, and do not provide valuable recommendations for improving the work. Peer-reviewed materials are assessed superficially, without a deep understanding of the subject of the study, which can lead to incomplete or erroneous conclusions. Does not update his	Reviews papers in mathematical and information science fields, but the analysis is not always deep or detailed. Knowledge in this area is sufficient for a general understanding of the work, but may be insufficient for a critical and comprehensive analysis. It identifies key weaknesses, but the recommendations are often general and do not always lead to significant improvements. Occasionally makes oversimplified or inaccurate judgments, especially in complex scientific matters.	Reviews scientific papers in the fields of mathematics and information science, providing comprehensive and well-reasoned reviews, although the detail could sometimes be improved. Possesses good knowledge in relevant areas, which allows him to identify the main strengths and weaknesses of the work. Recommendations and comments provide useful directions for revising articles and dissertations, but may not always be	Reviews research articles, abstracts, and dissertations in the fields of mathematics and information science at a high level, providing detailed, informed, and constructive comments. Demonstrates a deep knowledge of mathematics and information technology, which allows for informed conclusions about the scientific significance and novelty of the materials presented.

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	knowledge of scientific research, which may result in missing important aspects during peer review. Demonstrates a lack of commitment and professionalism in reviewing.	Further development and updating of knowledge in the field of mathematical and information technologies is required for higher quality peer review.	sufficient for a thorough revision of the work. He is objective in his assessments and clearly formulates his conclusions, but sometimes he may not take into account certain nuances or details. Regularly updates their knowledge, but may not be as actively involved in new scientific trends.	Skillfully identifies the strengths and weaknesses of work, analyzes the methodology and results of research, and offers well-founded recommendations for improvement or revision. The peer-reviewed works are of high quality, and the comments are constructive and aimed at developing the topic under study. Constantly improves his knowledge, monitors new achievements in the field of science and actively participates in the scientific community.
PC-3. Capable of conducting methodological and expert work in the field of mathematics and computer science.				
Learning outcomes for the course (module): ID-1 PC-3	Incapable of conducting expert work in mathematics at the required level and does	Conducts expert work in mathematics, but often reveals shortcomings in the	Conducts expert assessments of mathematics effectively,	Conducts expert work in mathematics at a high level, providing

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Conducts expert work in mathematics.	not provide substantiated conclusions or recommendations. Knowledge in the field of mathematics is limited and insufficient to perform expert functions. Expert opinions are either incomplete or erroneous and do not help in solving the assigned tasks. Requires constant assistance and intervention to complete work, and does not demonstrate a desire to develop in his or her field. Does not update his knowledge or follow new developments in mathematics, which affects the quality of his work.	depth of analysis or justification of conclusions. Knowledge in the field of mathematics is limited and sufficient only for solving basic problems. Expert opinions are often general in nature and do not always provide a high degree of accuracy and validity. Recommended solutions may not be detailed enough or may not address all aspects of the problem. Additional practice and updating of knowledge is required to improve the quality of expert work.	providing sound conclusions and recommendations, although details may occasionally require clarification or improvement. Possesses good knowledge and understanding of basic mathematical theories and methods, which allows solving problems of medium complexity with satisfactory quality. Expert opinions are clear, but may not always be as detailed or in-depth as possible. The works are valuable for practice, but may require additional clarification or adjustments. Regularly updates his knowledge and finds new approaches, although the implementation of innovations occurs with	comprehensive and insightful analysis based on advanced mathematical theories and methods. He has deep knowledge and experience in various fields of mathematics, which allows him to solve complex and multifaceted problems and provide recommendations with a high degree of accuracy. Expert opinions and recommendations are high-quality, detailed and substantiated, and have scientific value. He constantly improves his knowledge and practical skills, follows new achievements in mathematics and actively participates in the scientific community.

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	The minimum level has not been reached (Unsatisfactory) 2 points	Minimum level (satisfactory) 3 points	Intermediate level (good) 4 points	High level (excellent) 5 points
			some delay.	The results of the work influence the development of a project, research or the solution of professional problems.
Learning outcomes for the course (module): ID-2 PC-3 Conducts expert work in the field of computer science	Unable to carry out expert work in the field of computer science at the required level. Demonstrates superficial knowledge, which leads to erroneous conclusions in expert opinions. Does not take into account modern methods and technologies and cannot objectively evaluate software and information systems. Expert opinions are inaccurate, incomplete or lack practical value. Shows no interest in development and does not follow advances in computer science.	Has basic knowledge in computer science, but may experience difficulties in analyzing complex systems when conducting expert work. Expert opinions are superficial and may contain shortcomings or insufficiently convincing arguments. Evaluates software and technical solutions, but cannot always suggest optimal ways to improve them. Requires additional verification or consultation from more experienced specialists. Knowledge is being updated slowly, and work is being carried out primarily using	He has a strong knowledge of computer science and applies it when conducting expert work, but may sometimes make minor mistakes. Able to analyze and evaluate information systems, software solutions and databases, but sometimes requires clarification or additional study of the issue. Makes logical and reasonable conclusions, but may not analyze the details of complex problems in sufficient depth. Expert opinions are useful and applicable in practice, but sometimes require minor revisions or	Deep understanding of computer science, including algorithms, data structures, programming, databases, computer networks and other key areas. Confidently conducts expert work using modern methodologies and tools, applying analytical and systemic approaches. Provides detailed, well-reasoned expert opinions based on objective data analysis and modern scientific approaches. Able to identify potential risks, point out vulnerabilities and

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		outdated methods and without taking into account modern trends.	more detailed justification. Keeps abreast of technological developments, but may not always be able to quickly implement new approaches.	propose effective solutions to optimize systems and processes. He actively improves his knowledge, follows current trends in computer science, and uses advanced technologies in his expert work. Expert opinions are recognized by colleagues, used in scientific and applied projects, and have a high level of reliability.
Learning outcomes for the course (module): ID-3 _{PC-3} Prepares teaching materials in the fields of mathematics and computer science	ID-3 _{PC-3} Prepares teaching materials in the fields of mathematics and computer science The material presented does not meet modern requirements or educational standards. There are no examples, practical applications, or clarity, which makes it difficult to understand the information.	Prepares teaching materials, but they may not be complete or structured enough. The information is presented clearly, but may contain inaccuracies or outdated information. Uses traditional methods of presenting information without taking into account modern educational trends. The teaching materials require significant revision	Develops teaching materials that comply with educational standards and requirements. The materials are structured and logical, but in some places additional explanations or examples may be required. Uses modern approaches to teaching, but may not be active enough in	Develops high-quality teaching materials that are clearly structured, accessible, and meet modern requirements. Demonstrates a deep knowledge of mathematics and computer science, which is reflected in the accuracy and relevance of the material presented.

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	The materials do not promote effective learning and require significant revision. Does not show any desire to improve and update teaching materials.	to improve their effectiveness. The materials may be useful, but require additional clarification from the teacher.	introducing innovative technologies. The teaching materials are clear and useful, but may require periodic revision or updating. Overall, the materials are successfully used in the educational process, but they could be improved in terms of clarity and interactivity.	Uses modern teaching methods, interactive technologies and visual examples, which promotes effective assimilation of the material. Prepares materials that can be used both for independent learning and in the educational process. Updates and improves teaching materials taking into account the latest scientific and technological advances. The materials are positively evaluated by colleagues, students or experts in the field of education.
PC-4. Capable of conducting patent research, determining forms and methods of legal protection and defense of rights to the results of intellectual activity, and managing rights to them to solve problems in the field of development of science, engineering, and technology.				
Learning outcomes for the course (module): ID-1 PC-4 Makes rational choices regarding	Does not have sufficient knowledge about intellectual property protection and is unable to make an informed	Knows the basic methods of protecting intellectual property, but may have difficulty choosing the	Possesses strong knowledge in the field of intellectual property protection, but may not	Deeply understands the laws and regulations governing the protection of

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methods of protecting intellectual property rights;	choice of protection method. Makes mistakes when completing documents, which can lead to registration refusal or vulnerability of intellectual property rights. Does not take into account legal risks, which may lead to the loss of exclusive rights to development or scientific work. Shows no interest in studying legislation and modern methods of protecting intellectual property. Unable to advise colleagues or participate in the process of legal protection of intellectual property.	optimal method. Able to prepare basic documentation, but requires specialist assistance for complex legal issues. Does not always take into account all risks when choosing a protection method, which can lead to insufficient legal protection of the object. Has a superficial knowledge of patenting, licensing and copyright. Updates his knowledge irregularly, which may lead to the use of outdated security methods.	always take into account all the nuances of specific cases. Makes the right choice of protection method, but in complex situations may require additional analysis or consultation with specialists. Able to prepare documentation for intellectual property protection, but it may require revision. Generally makes rational decisions, but may not take into account some strategic or economic factors. Keeps abreast of developments in the field of intellectual property, but does not always apply the latest methods in practice.	intellectual property, including patent law, copyright, trademarks and related rights. Confidently analyzes intellectual property and selects the most effective protection methods depending on the specifics of the development or scientific work. Able to competently prepare applications for patents, copyright certificates, register trademarks and draw up licensing agreements. Explains and justifies the choice of protection method, taking into account economic, legal and strategic aspects. Monitors changes in legislation and implements modern approaches to

Levels of development competencies (ies), indicator (s) Indicators	Descriptors			
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				protecting intellectual property. Provides advice to colleagues and helps organize the process of protecting intellectual property in scientific and industrial projects.
Learning outcomes for the course (module): ID-2 PC-4 Conducts patent research in the field of computing and communication systems.	Does not possess patent research methods and is unable to correctly analyze patent information. Makes mistakes in assessing the patentability of developments, which can lead to legal risks or denial of patent registration. Does not know how to work with patent databases, performs searches insufficiently comprehensively or with errors. Patent research reports do not meet requirements, contain incomplete or inaccurate data. Does not follow changes in patent legislation and shows	Has a general understanding of patent research, but has difficulty analyzing complex technical solutions. Performs patent information searches but may not fully assess the novelty and patentability of a development. Analyzes only a limited range of sources, which may lead to incomplete or inaccurate conclusions. Able to prepare a report, but it requires significant revisions and additions. Updates his knowledge in the field of patent analysis irregularly, which reduces the effectiveness of research.	Has strong knowledge in the field of patent research and is able to analyze technical solutions from the point of view of patent law. Performs searches and analysis of patent information, but may not take into account some specific aspects of international patent law. Formulates well-founded conclusions about the patent purity of developments, but in complex cases requires additional consultations with specialists. Able to prepare a patent research report, but may	He has a deep understanding of patent law, regulations, and international agreements governing the protection of intellectual property in the field of computing and communications systems. Confidently conducts patent research, analyzes existing patents, and determines the patent purity of developed solutions. Uses specialized databases (WIPO, EPO, USPTO, Rospatent, etc.) to search and analyze

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	no interest in studying modern methods of patent analysis.		not always consider all potential legal risks. Keeps abreast of new trends in the patent field, but does not always apply the latest search and analysis methods.	patent information. Provides sound assessments of the novelty and patentability of technical solutions and develops strategies for protecting intellectual property. Competently prepares patent research, compiles reports with a detailed analysis of the technological landscape and potential legal risks. Monitors trends in the patent field and new developments in computing and communication systems, and applies current research methods.
PC-5. Able to present and adapt mathematical knowledge, programming methods, and information technology in various ways, taking into account the audience's level.				
Learning outcomes for the course (module): ID-1 PC-5	Does not assess the audience's level of preparation before and	Partially assesses the audience's level of preparation, but does so	Analyzes the audience's level of preparation, but may not always take into	Confidently analyzes the audience's level of preparation before and

Levels of development competencies (ies), indicator (s) Indicators	Descriptors			
	The minimum level has not been reached (Unsatisfactory) 2 points	Minimum level (satisfactory) 3 points	Intermediate level (good) 4 points	High level (excellent) 5 points
Assesses the level of preparation of listeners during their public speeches	during the presentation. The presentation of the material does not take into account the differences in the preparation of the listeners, which leads to difficulties in understanding. Does not use feedback or ignores audience questions. Does not adjust the presentation of material depending on the audience's reaction. The presentations are ineffective, and the audience does not absorb the material because its complexity does not correspond to their level of preparation.	intuitively, without using objective methods. Limited variation in presentation of material depending on the level of the audience, which can lead to misunderstanding or oversimplification of complex topics. Uses feedback, but does not always take it into account when further developing presentations. Able to interact with an audience, but sometimes has difficulty adapting explanations.	account all factors (different levels of knowledge among listeners, specifics of the topic). Uses standard assessment methods (questions, discussions), but less frequently uses interactive or adaptive approaches. Corrects the presentation of the material, but sometimes does not respond quickly enough to the difficulties in understanding of the listeners. Receives feedback from the audience and takes it into account when preparing subsequent speeches. Knows how to interact with the audience, but may not always respond effectively to their needs.	during a presentation, adapting the presentation of material depending on the audience's knowledge and experience. Uses various assessment methods (surveys, testing, discussions, analysis of questions from the audience and feedback). Flexible adjustment of the pace and complexity of the material, ensuring its accessibility for all categories of listeners. Able to effectively interact with audiences, explaining complex topics in understandable language. Draws conclusions from the results of assessing the level of preparation of listeners

Levels of development competencies (ies), indicator (s) Indicators	Descriptors			
	The minimum level has not been reached (Unsatisfactory) 2 points	Minimum level (satisfactory) 3 points	Intermediate level (good) 4 points	High level (excellent) 5 points
				and uses them to improve future presentations Uses interactive methods (cases, dialogues, discussions) to more accurately determine the audience's level of knowledge.
Learning outcomes for the course (module): ID-2 _{PC-5} Adapts the presentation of mathematical knowledge and programming methods to the level of the students	Does not adapt the presentation of the material to the level of the audience, which leads to its misunderstanding. Uses overly complex or, conversely, simplified explanations that do not correspond to the level of the listeners. Does not assess the audience's level of preparation and does not adjust the presentation of the material depending on the audience's reaction. Ignores feedback and does not analyze the effectiveness of the information presented.	Assesses the level of students formally, without a deep analysis of their knowledge and needs. Partially adapts the material, but does not always make it understandable for all listeners. Limited to basic explanation methods, without the use of additional visual and interactive tools. The balance between theory and practice can be disrupted, making it difficult to learn the material. Feedback from listeners is not always analyzed and taken into account in future	Assesses the level of preparation of the audience and adapts the presentation of the material, but may not always take into account differences in the level of knowledge within the group. Uses a variety of teaching methods, but may limit itself to standard examples and exercises. It balances theory and practice fairly well, but may not always take into account the needs of a specific audience. Able to explain complex	Confidently determines the audience's level of preparation and flexibly adapts the presentation of material, making it accessible and understandable. Uses a variety of teaching methods, including visualization, real-world examples, analogies, and interactive elements. Finds the optimal balance between theory and practice, helping students effectively absorb the material.

Levels of development competencies (ies), indicator (s) Indicators	Descriptors			
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	The presentation of the material is formal, with no effort to make it accessible and understandable.	performances.	topics clearly, but in some cases requires additional preparation or clarification. Uses feedback to improve delivery, but does not always make significant adjustments.	Able to explain complex mathematical concepts and programming methods in a variety of ways, tailored to the audience. Demonstrates a high level of proficiency in mathematical knowledge and programming methods, supporting theory with practical problems. Prepares educational materials of varying levels of difficulty, allowing the audience to gradually deepen their knowledge.
PC- 7 . Able to create and explore new mathematical models in the natural sciences, industry, and business, taking into account the capabilities of modern information technology, programming, and computer equipment.				
Learning outcomes for the course (module): ID-1 PC- 7 With the help of modern information technologies, explores newly created mathematical models in the	Ineffective or outdated information technologies are used, resulting in the creation of inaccurate or incomplete mathematical models. These models do not meet modern standards and do not take	Basic or outdated information technology methods are used to study mathematical models. The models are created taking into account basic principles, but lack accuracy or do not	Modern information technologies are used to study mathematical models, but some aspects may not be fully developed. The models comply with basic	Utilizes advanced information technologies to research and create mathematical models in various fields of natural science and

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natural sciences of industry;	into account key parameters necessary for problem solving. Appropriate software and analysis tools are either lacking or inadequately applied. Model analysis is superficial or nonexistent, and the research results are not meaningful or useful.	account for all possible variables. The use of software tools is limited to standard functions, without in-depth data analysis. Simple approaches to problem solving are used, and the research results remain superficial, without providing new proposals or	principles and standards, but could be improved in terms of accuracy and the use of additional analytical methods. Current programs and algorithms are used, but more suitable tools for specific tasks could be used. The analysis results yield good conclusions, but are not always supported by additional hypotheses or proposals for	industry. The models are developed with high accuracy and meet current scientific and technical requirements. The research process includes comprehensive data analysis, model optimization, and the use of specialized software. Based on the results obtained, new hypotheses or improvements to existing models are proposed, demonstrating a deep understanding of the subject matter. A high level of detail and precision of presentation is ensured.
Learning outcomes for the course (module): ID-2 PC- 7 Conducts Parallel Computer and Network Technologies as part of his professional activities	Does not utilize parallel computing and networking technologies or utilizes them with minimal effectiveness. Knowledge and skills are insufficient to solve	Utilizes parallel computing and network technologies but encounters difficulties in their application. Knowledge and skills allow for solving only basic problems or	Successfully utilizes parallel computer and network technologies in their professional work, applying them to solve standard problems. These	Expertise in parallel computing and network technologies to solve problems in their work. Demonstrates deep knowledge and

Levels of development competencies (ies), indicator (s) Indicators	Descriptors			
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	professional problems using these technologies. Technologies are not applied properly, leading to significant errors or inefficiencies. Important aspects such as performance, reliability, or security are not considered when using parallel computing and networking solutions.	applying standard solutions without considering the specifics and peculiarities of work processes. Use of technologies is limited, and additional efforts may be required to achieve the desired results. Errors related to insufficient consideration of parallel computing or network interactions may be encountered during work.	technologies are used effectively, but there are minor shortcomings in the selection of tools or algorithms. The results meet basic requirements but can be optimized. Overall, their understanding of these technologies is sufficient to solve most problems; however, more complex situations may require additional effort.	experience in applying these technologies to improve work efficiency. Applies advanced methodologies and solutions, optimizes processes and operations, and achieves high results. Utilizes complex tools and algorithms for parallel computing and networking, ensuring high reliability and performance. Knowledge and skills enable not only task completion but also the development of new approaches and improvements.
Learning outcomes for the course (module): ID-3 PC -7 Uses modern programming languages and application software packages to implement specific algorithms and	Ineffective use of modern programming languages and application packages leads to significant errors in the implementation of algorithms and mathematical models. The development	The implementation of algorithms and mathematical models relies on basic or outdated programming languages and application packages, which limits the capabilities and effectiveness	Uses modern programming languages and application packages to implement algorithms and mathematical models, but sometimes the choice of tools may be	Utilizes modern programming languages and application packages to implement complex algorithms and mathematical models.

Levels of development competencies (ies), indicator (s) Indicators	Descriptors			
	The minimum level has not been reached (Unsatisfactory) 2 points	Minimum level (satisfactory) 3 points	Intermediate level (good) 4 points	High level (excellent) 5 points
mathematical models	process may be unstructured or rely on outdated and inappropriate tools, reducing productivity and decision accuracy. A lack of understanding of the correct selection of tools for task implementation leads to ineffective results.	of problem solving. The work relies on standard solutions that are not always suitable for more complex or specific tasks. The implementation of algorithms and models may be functional, but requires improvements in terms of optimization, performance, and the use of current tools.	subject to improvement or optimization. The implemented solutions effectively solve the assigned tasks, but in some cases, more modern or specialized tools may be used. The work was completed with a sufficient degree of accuracy and performance, but some elements may require refinement or improvement.	Their work utilizes cutting-edge tools and technologies, enabling them to achieve high productivity, accuracy, and optimization of solutions. They demonstrate deep knowledge and skills in various programming languages and software, as well as in selecting the most appropriate tools for each task. Their work is characterized by a high degree of automation and implementation efficiency, as well as innovative solutions.
PC- 6 . Able to use modern methods of developing and implementing specific algorithms for mathematical models based on programming languages and application packages for modeling.				
Learning outcomes for the course (module): ID-1 PC- 6 Using modern software packages for modeling, it explores newly created mathematical models;	You're using modeling software packages ineffectively, resulting in models that don't meet requirements. Model analysis and diagnostics are performed without taking	You use basic modeling software, but your approach to model analysis and diagnostics is limited. Some model elements require refinement, and a systems approach is not always	You're choosing the right mathematical modeling packages, but in some cases, your choice of tools or approaches could be improved. Your model analysis and diagnostics	Expertly selects and applies modern software packages for mathematical modeling. You successfully identify key aspects of models,

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	into account important factors, making it difficult to identify and resolve problems. Models are not optimized, and approaches to their analysis require significant improvement to achieve accurate results.	applied adequately. Modeling results may require improvement in accuracy and efficiency, and problem identification and resolution are often limited to superficial analysis.	are conducted within standard procedures, but not all possible aspects are always considered. The work is high-quality, but additional efforts are needed to optimize and improve the accuracy of the models.	conduct comprehensive analysis, and diagnose them using a systems approach. Your models are highly accurate and meet current standards. You effectively research and optimize models, identify and resolve problems, allowing you to propose new solutions and improvements.
Learning outcomes for the course (module): ID-2 PC- 6 Uses modern methods for developing algorithms for mathematical models	Experiencing difficulties applying modern algorithm development methods to mathematical models, resulting in low algorithm accuracy and performance. Their choice of methods does not always match the task requirements, making problem solving difficult. Significant improvement in skills in selecting and applying methods for developing effective algorithms is needed.	uses standard algorithm development methods, but their accuracy and efficiency leave much to be desired. Algorithms solve problems, but in some cases, optimization or the use of more complex approaches is required to achieve better results. It is necessary to work on improving our methods and increasing the efficiency of algorithm development.	Successfully applies current methods for developing algorithms for mathematical models and achieves good results. Algorithms perform tasks correctly, but can be improved in terms of accuracy or performance. Proficient in existing approaches, but more complex situations may require the use of more specific methods to improve results.	He confidently utilizes cutting-edge methods for developing algorithms for mathematical models, achieving high accuracy and optimization. His developed algorithms solve complex problems and fully meet modern requirements. He effectively applies cutting-edge tools and

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				approaches, demonstrating a deep understanding of the subject and a capacity for innovation. His work not only solves current problems but also proposes new, more effective solutions.
Learning outcomes for the course (module): ID-3 PC -6 Uses modern programming languages to implement specific algorithms and mathematical models	Struggles to use modern programming languages to implement algorithms and mathematical models. Code is often inconsistent, poorly structured, and inappropriate for the task. Algorithm implementation results in poor performance, and the choice of tools is inappropriate. Significant effort is required to improve programming skills and optimize code.	It uses modern programming languages, but the implementation of algorithms and mathematical models leaves much to be desired. The code solves the problem, but has optimization or performance issues. The code structure and readability could be improved, and the choice of tools is not always optimal for the task. Further development is required to achieve a higher level.	Correctly uses modern programming languages to implement algorithms and mathematical models. The algorithms work, but could be improved in terms of performance and optimization. The code is readable and structured, but there is room for improvement. Overall, the approach is sound, but more suitable tools or methods could be used to improve efficiency.	She expertly utilizes modern programming languages to implement algorithms and mathematical models. Her code is highly performant, readable, and optimized. Her algorithms are implemented with all requirements in mind and deliver excellent results. Her choice of tools and methods is fully justified, allowing her to solve problems with maximum efficiency and

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				accuracy.
PC- 8 Capable of participating in the management of projects for the creation of information systems and software systems at various stages of the life cycle				
Learning outcomes for the course (module): ID-1 PC- 8 Manages the development, development and maintenance of information systems and software systems	Struggles to manage the development of information systems and software packages. The development process is disorganized , and errors are made in the design and maintenance of systems. Management and maintenance tasks are performed irregularly or with serious shortcomings, resulting in non-compliance with requirements. It is impossible to ensure the stable operation of software packages and timely support.	Manages the development of information systems and software packages, but with some errors in the process. System development and support are underway, but in some cases, there is a lack of organization or attention to detail. Project management sometimes fails to meet all standards, leading to slowdowns or some flaws in software packages.	Effectively manages the development, implementation, and maintenance of information systems and software systems. The development process is organized, tasks are accomplished effectively, but in some cases, improved interactions between the development and maintenance phases could be achieved. Project management complies with standards, but there is room for further process optimization and improved system maintenance.	Expertly manages the development, implementation, and maintenance of information systems and software suites. All stages of system development and maintenance are organized and executed to a high standard, using advanced methods and tools. The project management process is optimized, allowing for prompt response to changes and ensuring stable system operation.
Learning outcomes for the course (module): ID-2 PC- 8 Knows and applies software development trends in his/her	Struggles to identify and apply software development trends in their professional activities. Knowledge of current trends is limited, and	Has basic knowledge of software development trends, but their application in professional work is limited. Knowledge of	He is well-versed in software development trends and utilizes them in his professional work. His knowledge of current	She is knowledgeable and actively applies current software development trends in her professional work.

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professional activities	their use in work is minimal. Unable to adapt their work to new technologies and approaches, which reduces the effectiveness of their work with software. Significant improvement is required in understanding and applying current software trends.	current trends is not always fully utilized. Sometimes, new technologies and methods fail to be effectively applied, which can reduce the effectiveness of software development and support processes. Potential exists for improvement and more active implementation of new approaches.	trends is often applied to project work, but could be further enhanced by deepening the implementation of new technologies or more widely applying advanced methods. Overall, he utilizes trends effectively, but there is room for further growth and improvement in this area.	Knowledge of trends and the latest technologies is integrated into development processes, allowing for increased efficiency and innovation . Her application of new technologies and methods fully meets modern requirements and is actively implemented into projects to improve their quality and performance.
PC- 9 Able to take into account knowledge of problems and trends in the development of the software market in professional activities				
Learning outcomes for the course (module): ID-1 PC- 9 Selects software for their professional activities, taking into account market development trends.	Struggles to select software for their professional activities without considering current market trends. They often choose outdated or inappropriate software, which reduces work efficiency. They lack a deep understanding of current trends, and their software choices don't align	They select software for their professional activities, but to some extent ignore current market trends. Sometimes, the chosen solutions do not meet all the requirements of the modern industry, which can reduce their effectiveness. Knowledge of market trends is applied to a limited extent, and the	Selects software appropriately for their professional activities, taking into account market trends. Knowledge of current software trends is used to inform decision-making, but new or more suitable solutions may sometimes be missed. Overall,	She wisely selects software for her professional work, taking into account current market trends. She carefully analyzes current and emerging developments, enabling her to select the most effective and innovative solutions.

Levels of development competencies (ies), indicator (s) Indicators	Descriptors			
	The minimum level has not been reached (Unsatisfactory) 2 points	Minimum level (satisfactory) 3 points	Intermediate level (good) 4 points	High level (excellent) 5 points
	with the needs of the modern market. Significant improvements are needed in selecting software solutions based on market dynamics.	software choice is not always optimal from a long-term perspective.	software selection is up-to-date, but there is room for improvement by considering a broader picture of trends.	She skillfully adapts her solutions to changes in the software market, which helps increase productivity and maintain a high level of work.
Learning outcomes for the course (module): ID-2 PC- 9 Takes into account the development trends of the software market and applies these development trends in professional activities	Fails to consider software market development trends in their professional activities. Lack of understanding of current software trends leads to the selection of outdated and ineffective solutions. New technologies are not implemented, reducing professional effectiveness. Significant improvement is needed in the analysis and application of software market development trends.	While it takes into account certain software market development trends, the application of these trends in professional work is limited. Knowledge of new technologies and trends is not always used effectively. In some cases, it is not possible to fully integrate modern approaches and methods into work, which hinders the improvement of work processes. The application of development trends requires further development.	Considers current software market trends and applies them to their professional work. Modern technologies and methods are integrated into work processes, but there are sometimes opportunities for deeper implementation of new solutions. Adopting software development trends contributes to improved work results, but there is room for further refinement.	She intelligently considers and actively applies current software market trends in her professional work. She continuously analyzes market changes and implements cutting-edge technologies and methods, which contributes to increased efficiency and innovation . Applying these trends leads to significant improvements in professional performance, ensuring high results and competitiveness.

2.1 Criteria for assessing competencies in the state examination

An "excellent" grade is awarded to a student if: the student provides comprehensive and well-reasoned answers to the questions posed in the examination paper; demonstrates the ability to competently apply acquired theoretical knowledge in analyzing real-life events; demonstrates a deep and creative mastery of primary and secondary literature; and presents the material in a well-reasoned and logical manner.

A "good" grade is awarded to a student if: the student provides complete, sufficiently in-depth, and well-founded answers to the questions posed in the examination ticket; demonstrates sufficiently robust practical skills; provides complete, but insufficiently well-founded answers to additional questions; demonstrates a thorough knowledge of the primary literature and insufficient familiarity with additional literature; demonstrates the ability to theoretically justify stated positions; answers were generally brief, but did not always maintain a logical sequence.

The grade "satisfactory" is given to a student if: • the answers to all questions on the examination ticket are generally correct, but without the necessary depth and justification, and insufficiently strong practical skills are demonstrated; positive answers are not given to some additional questions; insufficient knowledge of the basic literature is demonstrated; the answers were verbose, thoughts were not expressed clearly enough and without the necessary logical sequence.

The grade "unsatisfactory" is given to a student if: it is given in cases where the conditions allowing for a grade of "satisfactory" are not met, when the student has not mastered the main content of the subject and has poor knowledge of the recommended literature, and the necessary competencies have not been developed.

2.2 Criteria for assessing competencies during the defense of a final qualifying work

A student receives an "Excellent" grade if: the topic's relevance is comprehensively substantiated, the goals and objectives are clearly defined, and an interest in the relevant literature is demonstrated. The scope and execution of the work meet the requirements. The bibliography is complete, with accurate bibliographical descriptions, and the references are accurately cited. The structure of the work corresponds to the author's stated goals, the topic is comprehensively and thoroughly covered, at a high scientific level, and the requirement for proportionality in covering the plan's topics is logically and correctly met. The author uses research methods correctly and is able to analyze and summarize scientific advances on the chosen topic. The presentation is clearly reconstructive, and the conclusions and proposals are consistent with the goals and objectives of the study. During the defense, the student demonstrated skill in professionally presenting the research results and convincingly answering the questions posed.

A "good" grade is awarded to a student if: the thesis is research-based, has a well-articulated theoretical framework, presents a sufficiently detailed analysis, a logical, coherent presentation of the material, and appropriate conclusions, although some proposals are not fully substantiated. It has received positive feedback from the academic supervisor, but contains some errors. During the defense, the student demonstrates a thorough understanding of the topic, handles research data fluently, makes well-founded proposals, and utilizes presentations or handouts during the presentation, answering questions easily.

A "satisfactory" grade is awarded to a student if: the relevance of the final qualifying thesis is weakly argued. There are significant deficiencies in the formatting. There are violations of the rules for bibliographical description of references and source citations. The structure of the thesis does not sufficiently correspond to the goals and objectives. The student has a poor command of research methods, and superficially analyzes and summarizes experience. During the defense, the student failed to highlight the main strengths of their thesis. The answers to the questions are insufficiently convincing.

A student receives a "failing" grade if: the topic's relevance is poorly substantiated, the goals and objectives are unclear, and the research methodology is poorly developed. The work's formatting contains serious flaws (one of the main sections is missing: literature review, experimental section, conclusions and recommendations). The bibliography is poorly formatted, and references are missing. This grade is assigned if the work is not independently completed, the presentation is repetitive (mechanically copied from sources), and contains serious logical flaws. Conclusions and proposals are unfounded and distrustful. The student has a vague understanding of the essence of their work and has difficulty answering questions during the defense.

3. Standard test assignments or other materials necessary for assessing the results of mastering the educational program

3.1 Questions for the state exam

1. Fundamental directions in the development of mathematics. The history of the emergence and development of mathematics.
2. Development of parallel mathematics, the system of residual classes and its problems.
3. Congruences of the second degree modulo a prime in the ring Z .
4. Problems of space dimensionality.
5. Statement of the linear programming (LP) problem.
6. Construction of a system of residue classes in the domain of integers. The role of the Chinese remainder theorem in the representation of a number in RNS.
7. Modular operations in a system of information systems. Advantages and disadvantages of representing information in a system of information systems.
8. Introducing a sign into the ROC when the base is even. Rule for adding numbers with different signs into the ROC.
9. Methods for introducing negative numbers into the residual class system. Rule for multiplying numbers of different signs in the RNS.
10. Method of direct modular transformation of decimal code into code of residual class system and its modifications.
11. Transformation of binary code into RNS code. Horner's method. Recursive doubling method. Their comparative analysis.
12. Reducing the bit depth when converting to a standardized encoding (SOC) code. Conversion of a polyadic code to a standardized encoding (SOC) code.
13. Comparative analysis of methods for converting numbers from the RNS to the positional number system (PNS). The orthogonal bases method. Conversion to the generalized positional number system (GPNS).
14. Comparative analysis of methods for converting numbers from the RNS to the positional number system (PNS). Interval conversion methods.
15. Non-modular operations in RNS. The operation of base extension and its role in organizing division of numbers. Division by the modulus and product of the modulus of the base system. The general case of division.
16. Non-modular operations in RNS. Comparing numbers in RNS and determining the sign of a number.
17. Evaluation of the self-correcting capabilities of SOC codes. Self-correcting capabilities of SOC codes.
18. Conditions for detecting, localizing, and correcting errors. Methods for using positional characteristics for error detection.
19. Gaussian integers, comparison of complex integers. Construction of a random number generator in the complex domain based on Gauss's theorem.
20. Construction of a system of residual classes in the complex domain: mapping a complex number onto pairs of real numbers.
21. Mapping the neural network architecture to the arithmetic structure of computations in the RNS.

22. Ensuring fault tolerance of a neurocomputer operating in a system of residual classes.
23. Mathematical formulation of the problem of optimizing the structure of a neurocomputer operating in a system of information systems.
24. Development of a neural algorithm for reconfiguring the structure of a non-positional neurocomputer.
25. Basic concepts and definitions of information security for computer systems. Security policy. Fundamental principles of security system design.
26. Basic terms and definitions of cryptography. Confidentiality, integrity, authentication, digital signature. Requirements for cryptographic systems.
27. Symmetric encryption systems. An overview of modern symmetric encryption systems.
28. The general concept of asymmetric encryption. One-way functions and examples. Basic mathematical algorithms for public-key encryption.
29. User authentication. Simple authentication. Strong authentication. Zero-knowledge authentication protocols.
30. Basic concepts of message authentication. Digital signature. Hash functions. Mathematical algorithms for creating digital signatures.
31. Cryptographic protocols. Key distribution protocols based on symmetric and asymmetric encryption. Public key certificates.
32. Cryptographic protocols. Secret sharing schemes: basic concepts. Threshold cryptosystems, examples. The concept of active security.
33. Cryptographic methods of information protection. Requirements for cryptographic systems.
34. Authentication technologies. Basic concepts and definitions.
35. Ensuring operating system security. Firewall technologies. Firewall functions and features.
36. The main directions, functions, and classification of intelligent information systems (IIS). Areas of application of IIS; characteristics of IIS classification; the concept of an expert system
37. Data analysis technologies. Principles of data analysis; preparing data for analysis. Association. Clustering.
38. Expert systems. Knowledge-based systems: the concept of an expert system; the structure and development technology of an expert system.
39. Basic concepts of genetic algorithms. How a genetic algorithm works.
40. Algorithms for training and using fuzzy neural networks; fuzzy neural classifier.
41. Hybrid networks: a hybrid algorithm for training fuzzy neural networks;
42. Digital filtering. Signal types and their transformation.
43. Digital filters; types of digital filters; filter structures
44. Digital signal processing algorithms. Discrete Fourier transform (DFT), fast Fourier transform (FFT), Winograd algorithm (WIA).
45. Indicators and criteria for assessing the performance quality of digital filters.
46. Neural network algorithms for the operation of the main digital filtering units. Approximation of a neural network to a random number generator. Adequacy of mathematical models of neural networks and digital signal processing.
47. Structure of a neural-like digital filter in a RNS.
48. Finite fields F_p .
49. Ring of square matrices over F_p .
50. Systems of linear equations over F_p .
51. Additive group of arithmetic n-dimensional vectors over F_p .

52. Subspaces in F_p^n .
53. The concept of information coding. The purposes of information coding.
54. Coding processes. Equivalent codes. Information and check symbols. The concept of a systematic code.
55. Hamming codes. The process of correcting errors when using a Hamming code.
56. Fundamentals of Higher Education Didactics.
57. Fostering academic mobility and a culture of intellectual work. Developing the ability to conduct methodological and expert work in the field of mathematics.
58. The place of innovative psychological and pedagogical technologies in the professional and personal development of future professionals and the formation of their general cultural and professional competencies.
59. Open problems in number theory.
60. Various forms of linear programming problem.
61. New conceptual ideas and directions of development of the theory of numerical systems.
62. Ranges of number representation. Selecting a base system for ROC.
63. Introduction of a sign into the odd-base arithmetic system.
64. Positional characteristics of a modular code generated by methods of translation from the RNS to the PSS (rank of the number, digits of the OPSS, interval number).
65. Redundancy of the ROC code, geometric model of the redundant ROC code.
66. Application of the projection method to correct errors in RNS.
67. A method of representing complex numbers in RNS based on their representation as a matrix.
68. Mapping the neural network architecture to the arithmetic structure of computations in the RNS.
69. Evaluation of the potential ability of the structure of a non-positional neurocomputer to failure due to hardware defects.
70. Merkle–Hellman cryptosystem, cryptosystems based on elliptic curves.
71. Public key distribution: Diffie-Hellman algorithm and MTI protocol.
72. Virtual secure VPN networks.
73. Data link and network layer security. Application layer security.
74. Self-learning systems.
75. Classification and regression; multilayer perceptrons in classification and regression problems.
76. Production and logical models of knowledge representation; deductive methods of finding solutions; methods of inference and finding solutions in production systems.
77. Knowledge representation in databases based on frames and semantic networks: frame models; semantic networks; inference on frames and in semantic networks.
78. Crossover and mutation operators in genetic algorithm; stopping criteria.
79. Application of self-organizing algorithm for training fuzzy neural networks.
80. Description of digital filters using difference equation and transfer function.
81. Modified Winograd algorithm (MWA), number-theoretic transformations (NMT), linear and cyclic convolution of sequences.
82. Comparative assessment of the accuracy and frequency characteristics of digital filters operating in the positional number system and RNS.
83. The multiplicative group of the ring of square matrices over F_p . Conditions for the existence and methods for finding inverse matrices over F_p .
84. Fundamental system of solutions of homogeneous systems of linear equations over F_p .

85. The factor is the space of space F_p^n .
86. Construction of decoding tables for a linear (n, k) -code over a field F_p generated by a finite system of vectors.
87. Definition of a cyclic code. A necessary and sufficient condition for a linear (n, k) -code over a field F_p to be cyclic.
88. Development of a neural algorithm for reconfiguring the structure of a non-positional neurocomputer.
89. Evaluation of the potential ability of the structure of a non-positional neurocomputer to failure due to hardware defects.
90. Simulation and gaming technologies in the formation of changes in the modeling of a professional situation and discussion of various ways to solve it.

4.2 Assessment tools for final certification of the final qualifying work

4.2.1 List of topics for final qualifying papers

No. p/p	Topics of final qualifying works
1.	Development of algebraic and theoretical-number lines in the development of educational courses in higher education
2.	Using linear coding algebra to create error-correcting codes.
3.	Analysis of algorithms for performing non-modular operations in the system of residual classes for numbers of different signs
4.	Comparative analysis of error correction methods in error-correcting codes
5.	Research of mathematical foundations of construction of knapsack encryption systems.
6.	Study of the possibilities of using an erasure signal to improve the probabilistic characteristics of a discrete information transmission system
7.	Development of methods and algorithms for storing data in clouds using threshold access structures
8.	Analysis of approaches to selecting the threshold level of the first decision circuit of a discrete information transmission system.
9.	Development of mathematical methods and algorithms for increasing the reliability of computing in distributed virtual environments
10.	Solution of the Cauchy problem for linear integro-differential equations
11.	Mathematical modeling of securities price dynamics
12.	Multivariate random optimization methods
13.	Development of methods and algorithms for non-modular operations in the system of residual classes
14.	Development of high-performance algorithms for operations with elliptic curve points using a residual class system
15.	Methods of multivariate unconstrained gradient-free optimization
16.	Solving complex combinatorial problems using a discrete Hopfield neural network
17.	Statistical analysis of the effectiveness of an information resource
18.	Comparative analysis of error correction methods in the residual class system

4.2.2 Structure of the work

Section 1 Theoretical foundations of the problem being solved

Level training	Formulation of the task	Controlled competencies or their parts		
Know	- Describe the relevance of the work, the object and subject of the research, the purpose,	UK-1 UK-4 UK-5	OPK-1 OPK-2 OPK-3	

	objectives, scientific and practical significance - Consider a brief history of the problem, accepted concepts and classifications, the degree of development of the problem abroad and in Russia, i.e. the essence of the problem under study. - Analyze methods and techniques for solving assigned tasks.	UK-6		
Be able to	To analyze different approaches to solving the research problem.	UK-1 UK-4 UK-5 UK-6	OPK-1 OPK-2 OPK-3	PC-4 PC- 7 PC- 6 PC- 8 PC- 9
To own	Describe the methodology for solving the given problems.	UK-1 UK-4 UK-5 UK-6	OPK-1 OPK-2 OPK-3	PC-4 PC- 7 PC- 6 PC- 8 PC- 9

No graphic material required

Section 2 Analytical part (research and construction of a solution to the problem)

Level of training	Formulation of the task	Controlled competencies or their parts		
Know	Analyze specific material on a chosen topic, collected during work on my master's thesis	UK-1 UK-4 UK-5 UK-6	OPK-1 OPK-2 OPK-3	
Be able to	Give a comprehensive characterization of the research object, justify the need for improvement existing practice of solving the given problem	UK-1 UK-4 UK-5 UK-6	OPK-1 OPK-2 OPK-3	
To own	Formulate specific practical recommendations and proposals for improving the phenomena and processes under study, using new methodologies and technologies for solving them	UK-1 UK-4 UK-5 UK-6	OPK-1 OPK-2 OPK-3	PC-4 PC- 7 PC- 6 PC- 8 PC- 9

No graphic material required

Section 3 Practical part (implementation of software, suggestions and recommendations)

Level of training	Formulation of the task	Controlled competencies or their parts		
Know	Task 1: develop models, methods, algorithms.	UK-1 UK-4	OPK-1 OPK-2	PC-4 PC- 7

	Task 2: Conduct an analysis of the experimental results Task 3: Based on a comparison of the obtained results with the data of natural experiments and known results of theoretical studies, refine the mathematical models.	UK-5 UK-6	OPK-3	PC- 6 PC- 8 PC- 9
Be able to	Task 1: Conduct a comparative analysis of the effectiveness of the developed models, methods, and algorithms Task 2: carry out calculations based on the developed computational algorithms and corresponding software within the framework of accepted mathematical models.	UK-1 UK-4 UK-5 UK-6	OPK-1 OPK-2 OPK-3	PC-4 PC- 7 PC- 6 PC- 8 PC- 9
To own	Task 1: Plan calculations to obtain the required results in the minimum time. Task 2: Conduct testing of computational algorithms. Task 3: Provide justification for specific proposals and recommendations improving the current practice of solving the problem posed in the object under study.	UK-1 UK-4 UK-5 UK-6	OPK-1 OPK-2 OPK-3	PC-4 PC- 7 PC- 6 PC- 8 PC- 9

No graphic material required

Section 4 Conclusion

Level training	Formulation of the task	Controlled competencies or their parts		
Know	The problematic area of knowledge and the nature of the scientific problem; theoretical and methodological foundations of the research; the result obtained and the conditions for obtaining it	UK-1 UK-4 UK-5 UK-6	OPK-1 OPK-2 OPK-3	PC-4 PC- 7 PC- 6 PC- 8 PC- 9
Be able to	Formulate clear conclusions about the work implement the priorities of one's own activities and ways to improve them based on self-assessment	UK-1 UK-4 UK-5 UK-6	OPK-1 OPK-2 OPK-3	PC-4 PC- 7 PC- 6 PC- 8 PC- 9
To own	- the skill of combining and adapting existing information and communication technologies to solve problems in the field of professional	UK-1 UK-4 UK-5 UK-6	OPK-1 OPK-2 OPK-3	PC-4 PC- 7 PC- 6 PC- 8 PC- 9

	activity, taking into account the requirements of information security. - skills to conduct scientific research and obtain new scientific and applied results independently and as part of a scientific team based on existing methods in a specific area of professional activity. - skills in development, debugging, modification and support of system software.			
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No graphic material required

5. Methodological materials defining the procedures for assessing the results of mastering the educational program.

5.1 Methodological materials defining the procedures for assessing the results of mastering the educational program at the final exam

The procedure for conducting the final examination is determined in accordance with the Regulation on the procedure for conducting final certification for educational programs of higher education - bachelor's programs, specialist programs and master's programs in the Federal State Autonomous Educational Institution of Higher Education "North Caucasus Federal University" and the Regulation on the procedure for completing graduation projects in the Federal State Autonomous Educational Institution of Higher Education "North Caucasus Federal University", the Regulation on the procedure for final certification of graduates of the Federal State Autonomous Educational Institution of Higher Education "North Caucasus Federal University".

The examination ticket includes: three questions.

Each student independently selects an exam ticket once through random drawing. The ticket number is recorded by the State Attestation Commission secretary in the corresponding protocol.

The student is given 30 minutes to prepare the answer to the examination ticket.

During preparation, the student has the right to use the exam program, as well as, with the permission of the State Attestation Commission, reference literature.

5.2 Methodological materials defining the procedures for assessing the results of mastering the educational program during the defense of the final qualifying work

The final assessment of the final qualifying work is given by the members of the State Attestation Commission during its public defense, during which the results of the research are discussed and a general assessment of the final qualifying work is given, taking into account its novelty, relevance, originality, scientific and practical significance.

The decision of the State Attestation Commission on the final assessment is based on the assessments:

- members of the State Attestation Commission (for the content of the work, its defense, including the report, answers to questions and comments of the supervisor);
- recall of the manager;
- a representative of the employer (if there is a conclusion or certificates of implementation).

The following criteria are taken into account, taking into account the degree of mastery of competencies:

- relevance of the research topic and the validity of its choice;
- the correctness of the formulated title, purpose and objectives of the work and the correspondence of the content of the work to them;

- independence of approach to revealing the topic, including the formulation and justification of one's own approach to solving problems or choosing a model, the availability of one's own and unique data;
- logical and structured presentation of the material, including the quality of the introduction and conclusion, the relationship between parts of the work, between the theoretical and practical aspects of the research;
- the quality of the analysis carried out and the ability to use scientific research methods, including the quality of the analysis of approaches to the study of the problems under consideration available in the literature, the validity and quality of the application of quantitative and qualitative research methods;
- the practical significance of the dissertation, including the connection of the theoretical provisions considered in the dissertation with scientific practice, as well as the presence of substantiated recommendations in the work and their compliance with the purpose and objectives of the work, as well as the analysis carried out;
- correct use of sources, including compliance with the rules for compiling a list of references, relevance of sources, use of sources in foreign languages;
- absence of violations of professional ethics;
- dissertation design (compliance with the rules for the design of master's dissertations, neat design, absence of spelling and grammatical errors in the text (especially when using special terminology);
- understanding of the questions asked to the student by members of the State Attestation Commission, the ability to conduct a scientific discussion and the general level of communication culture with the audience during the defense.

A master's thesis acquires particular significance if it meets the criteria for implementation. A final qualifying work is considered implemented if:

- 1) the enterprise (organization) provided certificates of implementation of the results of the final qualifying work into industrial or pilot operation;
- 2) the materials of the final qualifying work are included in the deposited report of the department on state budget or business contract work;
- 3) the results obtained during the work were published in the form of an article or were reported by the student at scientific conferences and seminars;
- 4) the final qualifying work materials are included in the reports or publications of the enterprise, organization, or research institute where the master's student completed his internship;
- 5) there is a certificate that the student personally or in collaboration has submitted a rationalization proposal;
- 6) there is a copyright certificate, diploma, or certificate for the exhibits that are the subject of the final qualifying work;
- 7) the developed software product is used in the educational process or research work of the department.