APPROVED
at a meeting of the Academic Council of
NJSC «KazNU named after al-Farabi»
Protocol № 11 from 23. 05. 2025 y.

The program of the entrance exam for applicants to the PhD for the group of educational programs D012- «Teacher training in Computer Science» (8D01502-Computer Science)

I. General provisions

1. The program was drawn up in accordance with the Order of the Minister of Education and Science of the Republic of Kazakhstan dated October 31, 2018 No. 600 «On Approval of the Model Rules for Admission to Education in Educational Organizations Implementing Educational Programs of Higher and Postgraduate Education» (hereinafter referred to as the Model Rules).

2. The entrance exam for doctoral studies consists of writing an essay, an exam in the profile of a group of educational programs and an interview.

Блок	Баллы
1. Interview	30
2. Essay	20
3. Exam according to the profile of the group of the educational program	50
Total admission score	100/75

3.The duration of the entrance exam is 3 hours 10 minutes, during which the applicant writes an essay and answers the electronic examination ticket. The interview is conducted at the university premises before the entrance exam.

II. Procedure for the entrance examination

1. Applicants for doctoral studies in the group of educational programs D012- **«**Teacher training in Computer Science**»** write a problematic / thematic essay. The volume of the essay is at least 250words.

The purpose of the essay is to determine the level of analytical and creative abilities, expressed in the ability to build one's own argumentation based on theoretical knowledge, social and personal experience.

Types of essays:

- motivational essay revealing the motivation for research activities;
- scientific-analytical essay justifying the relevance and methodology of the planned research;

- problem/thematic essay reflecting various aspects of scientific knowledge in the subject area.

2. The electronic examination card consists of 3 questions

Topics for exam preparation according to the profile of the group of the educational program:

1. "Digital transformation of education"

The essence, goals and objectives of digital transformation in the education system. Factors influencing the process of digital transformation and its impact on education. The main directions and stages of the development of digital transformation in society. The place and role of the education system in the context of digital transformation, the impact of digital technologies on the content, methods and means of teaching education. Psychological and pedagogical foundations of learning in a digital environment, integration of personality-oriented and developmental teaching methods with digital tools. Features of effective management of digital resources and services in the education system, the use of cloud technologies and data centers. The use of Intranet/Internet/Extranet technologies in the management structure of educational organizations. Telecommunication and multimedia technologies used in the educational process, elements of virtual and augmented reality, distance learning systems. The content structure of electronic educational publications, interface solutions and quality criteria, as well as the pedagogical foundations of their development and use. The system of professional training of teachers in the context of digital transformation, digital competencies of teachers and their requirements. Data-based management decisions in educational activities, the role of digital tools in assessing and measuring learning outcomes. Organization of scientific and educational research activities using digital technologies, the use of databases and knowledge bases, educational analytics and artificial intelligence capabilities. Algorithmization in the educational process, Programming, data modeling, relational databases and their application in the educational context. Design and application of intelligent systems and expert systems for the education system. The potential of social networks, communication platforms, and interpersonal relationships in the digital environment. The security of personal and collective data in the field of education, the basics of cybersecurity and ways to form an information security culture in educational organizations. The study of pedagogical models and strategies based on digital technologies in the educational process. The possibilities and limitations of integrating artificial intelligence technologies, neural networks, machine and deep learning in the education system. The introduction of robotics tools into the educational practice of schools and universities. The use of parallel and high-performance computing systems for educational purposes. Grid and the impact and prospects of cloud computing on the education system. The role of open educational resources and platforms in the context of digital transformation, requirements for their quality and accessibility.

2. "Learning challenges"

Representation and encoding of information using sign systems. Number systems and computer representation of data. Methods of encoding and measuring information, including probabilistic and alphabetical approaches. Natural and formal languages as forms of information representation. The logical foundations of computer operation: logical elements (encoders, decoders, adders, multiplexers, demultiplexers), graphical representation of logical circuits and truth tables, methods for analyzing logical structures using the example of 8-bit bit strings. The evolution of information processing technology and the stages of computer architecture development. Modern principles of computer system construction, including modular backbone architecture and hardware development trends. The main computer devices and their functions. Current directions of studying the architecture of computing systems in an educational environment. The concept and classification of information technologies. Historical and technological prerequisites for their development. Modern methodological approaches to the use of information technology in education. Software development: classification, features of modern operating systems, including server and cloud, and problems of their implementation in the educational process. Promising software platforms that support AI and distributed computing. Fundamentals of network technologies: the structure and components of computer networks, client-server architecture, Internet addressing system. Modern Internet services and methods of their use in educational activities: e-mail, messengers, video calls, chats, conferences, forums, social platforms and educational ecosystems. Prospects for the development of local, global and distributed networks, including 5G and quantum communications. Network topologies, ways to increase download speeds and save traffic, new data transfer protocols. Hardware and software networking tools. The use of wireless technologies and their evolution (Wi-Fi, Li-Fi, IoT). Information security issues: threats, protection methods, cryptographic technologies, malware protection, antivirus and legal aspects. Information ethics and pedagogical strategies for ensuring digital security in the educational environment. Modern methods of cryptographic protection, including symmetric and asymmetric algorithms, blockchain and quantum cryptography. The use of educational Internet resources and the effectiveness of hypertext and multimedia technologies. Development and use of educational web platforms and websites. Modern visualization and interaction tools in digital learning. Databases and database management systems: relational model, data objects, relationships, attributes, keys, data integrity, functional dependencies, triggers, transactions, as well as methods of their application and learning in an educational environment. Modern approaches to database training: visual interfaces, low-code and no-code platforms. Intelligent systems technologies: expert systems, knowledge bases, neural network models and their application in the educational process. The structure of intelligent systems and the design of educational AI models. Intelligent assistants and adaptive educational environments. Fundamentals of algorithmization and programming: data types, structures, operators, programming methods, including linear, nonlinear, and dynamic algorithms. Visual and text programming tools in educational practice. Approaches to teaching programming using modern languages and development environments. Modeling and simulation: stages of computer

modeling, design of digital twins and virtual laboratories. Information resources and digital educational resources, including interactive platforms, cloud-based educational environments, and AI training services. Robotics in education: types of educational robots, software, integration into school and university programs. The use of Arduino, Raspberry Pi, LEGO and ROS platforms in educational robotics. The use of distributed data in educational practice. Distributed database management systems and their architecture. Principles of open systems. Modern client-server architecture implementations in educational IT environments. Grid technologies and their evolution: concept, types, opportunities, problems and prospects of application in education. Cloud technologies: IaaS, PaaS, SaaS models, private and public clouds, containerization (Docker, Kubernetes) and their educational application. Parallel computing and high-performance computing systems: principles, architectures, software tools, prospects for implementation in educational and scientific activities. The current state and directions of development of supercomputers, their use in education and scientific research.

3. "Programming Languages"

Object-oriented programming. The type of data. Main components: the component class, the class constructor, the "new" operation, and static class members. Data transformation. Grouping of operators. Real estate operator. Operator shutdown. The interrupt operator. Continuation of the operator. The completion operator. The refund operator. The transition operator. The contract operator. Priorities of operations. Subprocesses: thread class, synchronization of subprocesses. Operators: cycle operator, cycle stop operator, selection operator. Arrays: an array and its characteristics, methods for declaring a static array, methods for working with dynamic arrays, declarations of arrays for placement, input and output of arrays. Functions: internal and external functions. The type of data. Actual and formal variables. General characteristics of programming languages. Types and structures of data. Algorithms. Algorithms and programming languages. Basic constructions of modern programming languages. Methods, technologies, and programming tools. Functions and methods. Procedural, logical, functional, and object-oriented programming. Methods of effective data storage and processing. Files, databases. Methodology of object-oriented programming. Classes and objects are an object-oriented programming technology. Matrices, vectors. String values. Files. Recursion. Graphs, trees. Combined tasks. Non-combined tasks. Modern programming paradigms: reactive programming, event-oriented programming, asynchronous programming. Exception handling and error management. Working with the API and integrating external libraries. Using standard and third-party frameworks. Data serialization protocols: JSON, XML, YAML. Software testing: unit, integration, and functional testing. Debugging and profiling of programs. Version Control Tools (Git). DevOps approaches to development. Programming using parallel and multithreaded computing. Using design patterns. Working with network protocols. Programming user interfaces. Interactive and graphical applications. Software security. Principles of code optimization. Using

containerization and virtualization in software solutions. Automation of assembly and deployment.

III List of references

Main literature:

1. Современные инновационные технологии в информатизации образования: монография / Н.Н. Керимбаев. – Алматы: Қазақ университеті, 2020. – 126 с.
2. Софронова, Н. В. Теория и методика обучения информатике : учебное пособие для вузов / Н. В. Софронова, А. А. Бельчусов. — 2-е изд., перераб. и доп. — Москва : Издательство Юрайт, 2019. — 401 с.
3. Семакин, И.Г. Основы алгоритмизации и программирования: Учебник / И.Г. Семакин. - М.: Academia, 2017. - 384 с.
4. Steven M. La Valle. VIRTUAL REALITY, University of Illinois, Cambridge University Press, Copyright Steven M. La Valle, 2017
5. Бидайбеков Е. Ы. Информатизация образования и проблемы обучения: /Автор. колл: Е. Ы. Бидайбеков, В. В. Гриншкун, Г. Б. Камалова, Д. Н. Исабаева, Б. Ғ. Бостанов/ учебник. – Алматы, 2014. – 352 с
6. Чернобай Е.В. Проектирование учебного процесса учителем в современной информационной образовательной среде / 2-е изд., перераб. и доп. — Москва, 2017. — 122 с
7. Информационные и коммуникационные технологии в образовании / Под.редакцией: Бадарча Дендева – М. : ИИТО ЮНЕСКО, 2018. – 320 стр.
8. Бидайбеков Е.Ы., Балыкбаев Т.О., Ибрагимова Н.Ж. Методические основы измерения результатов обучения школьников по информатике // Алматы, 2017. - 152 б.
9. Карр, Николас Великий переход. Революция облачных технологий / Николас Карр. - М.: Манн, Иванов и Фербер, 2017. - 737 с.
10. Магомедова Х.А. «Технические средства информатизации» для специальности среднего профессионального образования. Учебное пособие – Махачкала: ДГУНХ, 2017. – 117 с.
11. Баранова, Е.К. Основы информатики и защиты информации: Учебное пособие / Е.К. Баранова. - М.: Риор, 2016. - 199 с.
12. Э. Танунбаум. Архитектура компьютера. Москва: 2018, 5-е издание - 199 с.
13. В. Олифер, Н. Олифер "Компьютерные сети. Принципы, технологии, протоколы. Учебник" 2016 -992 с.
14. Алёшина, О. Г. Использование интернет-ресурсов в преподавании специальных дисциплин / О. Г. Алёшина. — Текст : непосредственный // Молодой ученый. — 2016. — № 23 (127). — С. 449-451.
15. Крёнке Д. Теория и практика построения баз данных, 8-е изд. "Питер", Издано: 2017, 800 стр.
16. Интеллектуальные информационные системы и технологии :учебное пособие / Ю.Ю. Громов, О.Г. Иванова, В.В. Алексеев и др. – Тамбов : Изд-во ФГБОУ ВПО «ТГТУ», 2013. – 244 с.
17. Майкл Мейн, Уолтер Савитч. Структуры данных и другие объекты в C++ 2-е издание 2002. -832 стр.
18. Струченков В. Методы оптимизации: основы теории, задачи, обучающие компьютерные программы. Издательство: Директ-Медиа, 2015 -266 стр.
19. А.Л. Королев Компьютерное моделирование. Учебное пособие Челябинск- 2019 -189 стр.
20. Kerimbayev N. et al. Modeling and feedback control for development of mobile technologies in virtual education environments //Complex systems: Spanning control and computational

cybernetics: Applications: Dedicated to professor Georgi M. Dimirovski on his anniversary. – Cham : Springer International Publishing, 2022. – С. 389-412.
21. Керимбаев Н.Н. Виртуальный интеллектуальный помощник преподавателя: монография / - Алматы: Қазақ университеті, 2023. – 166 с.
22. Современные инновационные технологии в информатизации образования: монография Н.Н. Керимбаев. – Алматы: Қазақ университеті, 2020. – 126 с.
23. Чупин Д.Ю., Ступин А.А., Ступина Е.Е., Классов А.Б. Образовательная робототехника: учебное пособие. — Новосибирск: Агентство «Сибпринт», 2019. — 114 с.
24. Кузнецов, С. Д. Основы баз данных / С.Д. Кузнецов. - М.: Бином. Лаборатория знаний, Интернет-университет информационных технологий, 2017. - 488 с.
25. Карр, Николас Великий переход. Революция облачных технологий / Николас Карр. - М.: Манн, Иванов и Фербер, 2017. - 737 с.
26. Семакин, И.Г. Основы алгоритмизации и программирования: Учебник / И.Г. Семакин. - М.: Academia, 2017. - 384 с.
27. Баррон Введение в языки программирования / Баррон, Дэвид. - М.: Мир, 2016. - 192 с.
28. Альфред, В. Ахо Структуры данных и алгоритмы / Альфред В. Ахо, Джон Э. Хопкрофт, Джеффри Д. Ульман. - М.: Вильямс, 2016. - 400 с.
29. Вирт, Н. Алгоритмы и структуры данных / Н. Вирт. - М.: Мир, 2016. - 360
30. Абрамов, С.А. Математические построения и программирование / С.А. Абрамов. - М.: Наука, 2016. - 192 с.
31. Anaya M. Clean Code in Python: Develop maintainable and efficient code. – Packt Publishing Ltd, 2021.
32. Stroustrup B. Programming: Principles and Practice Using C++. – Addison-Wesley Professional, 2024.
33. Romano F., Kruger H. Learn Python Programming: An in-depth introduction to the fundamentals of Python. – Packt Publishing Ltd, 2021.

Additional literature:

1. Голицына, О.Л. Основы алгоритмизации и программирования: Учебное пособие / О.Л. Голицына, И.И. Попов. - М.: Форум; Издание 2-е, 2015. - 432 с.
2. Черпаков, И. В. Основы программирования. Учебник и практикум / И.В. Черпаков. - М.: Юрайт, 2016. - 220 с.
3. Захарова, И.Г. Информационные технологии в образовании: / И.Г. Захарова. - М.: Academia, 2016. - 543 с.
4. Цветкова М.С. Информационная активность педагогов [Текст] / М.С. Цветкова. - М. : БИНОМ. Лаборатория знаний, 2015. – 352 с : ил.
5. Шарипов Ф.В., Ушаков В.Д. Педагогические технологии дистанционного обучения. Учебное пособие Издательство: Университетская книга, 2016 г.304с.
6. Бурда А. Г. Основы научно-исследовательской деятельности : учеб. пособие (курс лекций) / А. Г. Бурда; Кубан. гос. аграр. ун-т. – Краснодар,2015. – 145 с.
7. Назмутдинов В.Я., Яруллин И.Ф. Управленческая деятельность и менеджмент в системе образования личности. – Казань: ТРИ «Школа», 2013. – 360 с.
8. Дэвид М. Харрис и Сара Л. Харрис Цифровая схемотехника и архитектура компьютера. Второе издание. Издательство: Morgan Kaufman, 2018
9. Кузнецов, С. Д. Основы баз данных / С.Д. Кузнецов. - М.: Бином. Лаборатория знаний, Интернет-университет информационных технологий, 2017. - 488 с.
10. Параллельные методы и алгоритмы [Электронный ресурс]: учебное пособие/ А.В. Волосова – М.: МАДИ, Электронные текстовые и графические данные (5,35 Мбайт). 2020.
11. Габасов Р.Ф., Кириллова Ф.М. Основы динамического программирования. 2019 -264 стр.