APPROVED
By the Academic Council
LLC «Astana IT University»
Protocol № 13 dated
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Entrance Exam Program for Doctoral Candidates in the Educational Program Group "D094 Information Technology"

1. General Provisions

1. The program is prepared 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 Standard Rules for Admission to Educational Organizations Implementing Educational Programs of Higher and Postgraduate Education" (hereinafter – Standard Rules).

2. The entrance exam for doctoral studies consists of an interview, an essay, a subject exam related to the educational program group, and another interview.

№	Block	Points
1.	Interview	30
2.	Essay	20
3.	Subject exam related to the educational program group	50
	Total	100

2. Procedure for Conducting the Entrance Exam

1. Candidates for the doctoral program in the educational program group "D094 Information Technology" must write a problem-based or thematic essay. The essay must be at least 250-300 words.
2. The electronic exam ticket consists of 3 questions.

3. Essay Topics for Doctoral Candidates for the educational program group "D094 Information Technology"

№	Essay Topics
1	The role of artificial intelligence in modern computer engineering.
2	Methods for processing and storing big data: current trends and future directions.
3	Cybersecurity issues and solutions.
4	Opportunities of blockchain technology in systems engineering.
5	Application of machine learning methods in computer engineering.
6	Innovative developments in the field of information technology.
7	Quantum computing: theory and practice.
8	Methods for optimizing computer networks.
9	The internet of things (IoT) and its impact on everyday life.
10	Data visualization in big data analysis.
11	Advantages and disadvantages of cloud computing technologies.
12	The role of computer engineering in biomedical data processing.
13	The use of artificial intelligence in game development.
14	Ethical and privacy issues in information systems.
15	Robotics and automated systems.
16	Digital signal processing methods.
17	New technologies in combating cybercrime.

18	Language technologies and natural language processing.
19	Multi-agent systems and their applications.
20	The role of computer engineering in space data processing.

3. Topics for Preparing for the Exam related to the educational program group

№	Topics for Exam Preparation
1.	The concept of the turing machine and Its significance in computation theory.
2.	What are NP-complete problems? Provide examples.
3.	Principles of graph theory and Its application in computer science.
4.	Main sorting methods and their complexities.
5.	What is dynamic programming? Provide an example of a problem solved by this method.
6.	The concept of algorithmic complexity. What is the difference between best, average, and worst-case complexity of an algorithm?
7.	Main types of data structures and their applications.
8.	What is a database and what data models exist?
9.	What is a hash function? What are its main properties?
10.	Examples of graph applications in real-world problems.
11.	Principles of binary search trees.
12.	What is the difference between a stack and a queue and where are they used?
13.	The role and application of encryption and hashing algorithms.
14.	The QuickSort algorithm and its complexity.
15.	What is tree balancing and why is it necessary?
16.	Kruskal's algorithm for finding the minimum spanning tree.
17.	How is a binary heap implemented and where is it used?
18.	The difference between symmetric and asymmetric encryption.
19.	What methods exist for data protection in information systems?
20.	The principle of the RSA algorithm.
21.	What is a digital signature and how is it used?
22.	What methods exist for data integrity verification?
23.	What methods exist for reducing data dimensionality?
24.	The difference between supervised and unsupervised learning.
25.	How does the K-nearest neighbors algorithm work?
26.	What methodologies exist for software development?
27.	The principle of design patterns and their application.
28.	What is software integration and testing?
29.	The concept of virtual memory.
30.	How is process management in operating systems implemented?
31.	What methods exist for task scheduling in operating systems?
32.	Principles of file systems operation.
33.	Fundamental differences between supervised, unsupervised, and reinforcement learning algorithms and examples of their application in real-world scenarios.
34.	Your understanding of convolutional neural networks (CNNs) and their applications in computer vision tasks such as object recognition and image classification.
35.	Principles of recurrent neural networks (RNNs) and long short-term memory networks (LSTMs) and their use in sequence modeling and natural language processing.
36.	Challenges and opportunities in transfer learning and how to adapt pre-trained models for new tasks and domains.

37.	Your experience in developing algorithms for handling imbalanced datasets in machine learning and strategies for enhancing classifier performance in such scenarios.
38.	Principles of generative adversarial networks (GANs) and their application in creating realistic synthetic data, as well as their potential impact on areas such as data augmentation and privacy preservation.
39.	Limitations of traditional machine learning algorithms when dealing with large datasets and complex non-linear relationships and how deep learning approaches address these issues using techniques such as automatic feature learning and hierarchical representation.
40.	Evolution of networking technologies from traditional wired networks to modern wireless and mobile networks and the key challenges and opportunities at each stage.
41.	Principles of packet and circuit switching and their advantages and limitations in the context of various applications and use cases.
42.	Main principles of mobile computing and their impact on networking paradigms, including challenges such as mobility management, resource allocation, and energy efficiency.
43.	Principles of network protocols for mobile communication such as mobile IP and the IEEE 802.11 family of standards and how they provide seamless connectivity in heterogeneous wireless environments.
44.	Your experience in developing algorithms and protocols to enhance the performance and reliability of mobile networks, including techniques for transmission optimization, congestion control, and quality of service (QoS) assurance.
45.	Principles of mobile ad hoc networks (MANETs) and their application in scenarios where infrastructure-based communication is impossible or unavailable, such as emergency response and military operations.
46.	Challenges and opportunities in the field of fifth-generation (5G) networks and beyond, including technologies such as massive MIMO, millimeter-wave communication, and network slicing, and their potential impact on future mobile computing applications and services.
47.	The process of knowledge discovery in databases (KDD) and its various stages, including data preprocessing, pattern discovery, and knowledge interpretation, as well as challenges and methods associated with each stage.
48.	Your understanding of different types of data mining tasks such as classification, clustering, association rule discovery, and anomaly detection and examples of real-world applications for each task.
49.	Principles of machine learning algorithms commonly used in data mining such as decision trees, support vector machines, K-nearest neighbors, and neural networks and their strengths and weaknesses in different data mining scenarios.
50.	Challenges and opportunities in big data analytics, including methods for processing, storing, and analyzing large datasets, as well as tools and platforms for distributed computing and parallel processing.
51.	Your experience in developing algorithms and models for predictive analytics, including techniques for forecasting future trends, identifying patterns, and making data-driven decisions in areas such as finance, healthcare, and marketing.
52.	Principles of text analytics and natural language processing (NLP) techniques for extracting meaningful information from unstructured text data, including tasks such as sentiment analysis, topic modeling, and named entity recognition.
53.	Ethical and privacy issues in data mining and analytics, including topics such as data anonymization, consent management, and fairness and bias in algorithmic decision-making, and propose strategies for addressing these issues in your research.
54.	Principles and architecture of cloud computing, including key components such as virtualization, resource pooling, and on-demand self-service.

55.	Your understanding of different cloud service models (IaaS, PaaS, SaaS) and deployment models (public, private, hybrid) and examples of real-world applications for each model.
56.	Challenges and opportunities in cloud security, including techniques for ensuring data confidentiality, integrity, and availability in multi-tenant cloud environments.
57.	Principles of cloud resource management and optimization, including techniques for dynamic resource provisioning, workload scheduling, and performance monitoring in large distributed systems.
58.	Your experience in developing algorithms and frameworks for efficient data storage and processing in cloud environments, including techniques for data partitioning, replication, and parallelization.
59.	Principles of serverless computing and function-as-a-service (FaaS) architectures and their advantages and limitations compared to traditional cloud computing models.

List of Recommended Literature

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20. Boolos, G., & Jeffrey, R. (1989). Computability and Logic. Cambridge University Press.

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