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ENTRANCE EXAMINATION CONTENT
FOR THE MASTER'S DEGREE PROGRAM
CODE 09.04.01 Data Science / Анализ данных

Moscow 2025

Content

1. Explanatory Note

The purpose of the admission test

Assessment of the candidate's level of preparation, competencies, and background knowledge is required for admission to the master's program.

Format and Duration of the Admission Test

The entrance examination for the 09.04.01 "Computer Science and Engineering" program is conducted as an oral interview in English. The interview lasts 15–20 minutes, and 10 minutes are allocated beforehand for preparation. During this preparation time, candidates may make notes to assist with their responses.

Structure of the Interview

The oral examination consists of five questions, each drawn from different sections of computer science. A detailed list of topics and example questions is provided later in this document.

Evaluation and Scoring

The results of the entrance test are assessed on a 100-point scale.

The minimum passing score is 40 points, confirming successful completion of the examination.

Each of the five questions is worth up to 20 points, for a total maximum of 100 points.

Scoring Criteria

Each answer is evaluated according to the following criteria:

- Substantial completeness of the response
- Conclusions and validity of the reasoning
- Depth of understanding and awareness of the material
- Originality and independence of judgment

The maximum score for a fully correct and well-reasoned response is 20 points. No response, or a response that does not address the question, receives 0 points.

The list of accessories that applicant has the right to carry into the audience during the admission test: pen, pencil, eraser, not programmable calculator.

The structure of the oral exam

The oral exam for admission to the master's program in 09.04.01 – Computer Science and Engineering is designed to evaluate the following:

1. The applicant's level of scientific thinking and analytical skills.
2. Knowledge of fundamental concepts in computer science and computer engineering.
3. The ability to independently solve professional problems of varying nature and complexity.

A ticket contains five questions. These questions are derived from the core disciplines commonly taught in 09.00.00 – Computer Science and Engineering undergraduate programs. Specifically, the questions may cover any of the following areas:

1. Computer Science
2. Discrete Mathematics

3. Math modeling
4. Programming
5. Operating Systems
6. Computers and Peripheral Devices
7. Databases
8. Networks and Telecommunications
9. Computer Graphics
10. Systems of artificial intelligence
11. Data Mining Technology
12. Designing systems

By selecting questions from these core subject areas, the oral examination aims to thoroughly assess both theoretical knowledge and practical problem-solving capabilities, ensuring that candidates are well-prepared for the advanced studies required at the master's level.

2. Section Contents

Section 1. Computer science

Types and characteristics information. The presentation of information. Conversion of continuous messages. Sampling of continuous messages. Nyquist Theorem. The advantages of discrete shapes. The concept of entropy. The conditional entropy. The statistical definition of information. Entropy and information. Presentation of information in digital machines. Information and alphabet. Setting coding tasks. Examples of codes. Number systems. Translation numbers between positional number system. Translation numbers between radix - powers of two. Channel Communication specifications: bandwidth, bandwidth, data transmission speed. The impact of noise on the channel capacity. Ensuring the reliability of information transmission. Codes, detect errors. The parity bit. Hamming distance. Error-correcting codes. Classification of data. Presentation of the elementary data into RAM. Data structures and their representation in the RAM. Array list, stack. Features of the devices used to store information in computers. Presentation of data on external storage devices. File structure. The role of the operating system. The concept of the algorithm and its properties. The symbolic presentation of the algorithm. Graphic presentation of the algorithm. The structure theorem. Basic approaches to the development of algorithms. The efficiency of the algorithm. Verification program correctness.

Section 2. Discrete Math

The axioms of set theory. Relations. Operations on relations. The notion of algebraic systems. The superposition of systems. Completeness. Shannon's theorem. Minimizing the k-valued functions. Decomposition of k-valued functions. Differentiation of k-valued functions. Decomposition of k-valued functions. The construction of logical structures k-valued functions in different bases. The concept graphs. Types of graphs. Adjacency matrix and incidence. Path in the graph, the empty and full subgraphs. Network. Analysis of the cycles. Analysis sections. Differentiation graphs. The coloring of graphs. The embedding of graphs in space. Models based on graph theory. Algorithms for finding optimal routes in graphs. Definition of formal systems. First-order logic. The concept of logical inference. Predicates. Substitutions. Terms of MR and the syllogism. The principle of the resolution. Grammar. Turing machine. The concept of the machine. Classification. machine design stages. Algorithmic stage of construction. Minimizing, decomposition of automata. Coding of internal states. Triggers. Construction of functions describing the machine working. Design logical structures in a variety of topological bases.

Section 3. Math modeling

Modeling concept. Modeling methods and types. Classification models. Construction of mathematical models. Petri nets. Concepts. Analysis. Modification of Petri nets. Random processes. Simulation of random variables. Queuing Systems. Types QS. Markov processes. Simulation. Modeling languages. Models of complex systems. Statistical models. Identification. Adaptation models. Multi-agent model. Models of knowledge representation in information systems.

Section 4. Programming

Main stages of the decision of problems on the computer, the quality criteria of the program, the life cycle of the program, user-friendliness. Programming Technologies. Comparative characteristics of high-level languages, structured approach to the development of algorithms, basic blocking structure used for writing algorithms. IO functions, preprocessor and his team, the program processing on the computer compiling and linking - the creation of an executable program module. Relational operations, logical operations assignment operator, data type conversion explicit and implicit, operator of the condition. Loop statements, multiple-choice operator - switch arrays. Functions that return a value, arguments to the function main (), recursive functions. Pointers link pointers and arrays, dynamic memory allocation. Functions formatted input-output. A compound statement block, the visibility of variables. Standard features for the work in graphical mode structure. File concept, writing and reading from a file.

Section 5. Operating Systems

The history of the development of computers and operating systems. Classification of operating systems. The architecture of operating systems. Core. Firmware. Hardware support multiprogramming mode. Memory organization. The concept of the process. Dispatching. File system. Parallelism in operating systems.

Section 6. Computers and peripheral devices

Block diagram of a computer. Purpose and major circuit blocks. Computer functions. The main characteristics of a computer. Applications of computers of different classes. Modes of operation of computers. The functional and structural organization of the processor. Classification processor. The main directions in architecture processors. Pipelining calculations. Synchronous linear conveyors. Metrics efficiency conveyors. Non-linear conveyors. Super pipelined processors. Architecture with full and reduced instruction set. The main features RISC- architecture. The registers in the RISC-processor. Advantages and disadvantages of RISC. Superscalar processors. Features of the superscalar processors. Hardware support superscalar operation. The functions and structure of the central control device. Firmware machine with rigid logic. Firmware machine with programmable logic. Management principles The firmware stored in the memory. Structure operating devices. Operating the device with a rigid structure. Operating device with a backbone structure. The basis of integral operating device. Addition and subtraction. Integer multiplication. Multiply unsigned. Multiplication of numbers with a sign. Multiplication of integers and proper fractions. Operating the device with floating point. Systems teams. The main stages of instruction execution. Classification of the command system architectures. Classification but the composition and complexity of commands. Classification by place of storage operands. Types and formats of the operands. The numerical information. The symbol information. Logical data. Rows. Other types of information. The types of commands. data transfer commands.

arithmetic and logical processing commands. SIMD-instructions. Commands for working with strings. conversion commands. I / O command. System Management Commands. Flow Control Commands Command. Format commands. Command length. Bit command fields. The number of addresses in the team. Selecting the targeting commands. Methods of addressing operands. Methods for addressing commands to flow control commands. Hardware and software information exchange. Classification and assignment of input-output channels. Organization of system interrupts. Interrupt Priorities. Interrupt Controller. The controller and its role in the computer; types of controllers; organization of local and system buses. Types of tires. Bus "processor-memory". I / O bus. The system bus. The hierarchy of buses. The physical implementation of the tires. Mechanical aspects. Electrical aspects of the distribution of bus lines. Dedicated and multiplexed line. Bus arbitration. prioritization schemes. Arbitration Scheme. Bus protocol. Simultaneous protocol. Asynchronous protocol. Appointments and variety of peripheral devices. Keyboard and mouse: structure and functioning. Scan codes. Display. Structure and operating in text and graphic modes. Devices specified pixel. Printing devices. Appointments and classification. Signs-synthesizing stressed and unstressed types of printers. Inkjet and laser printers. scanning devices. Hand and Tablet. External storage devices on magnetic media. Designation and classification. Floppy disk drives and type "hard drive." Optical disk drives. Physical and logical structure of disks. Organization of computer memory. The main characteristics of the memory; memory hierarchy in a computer. Organization and management of main memory (RAM); block, multiport OP, OP with a bundle of applications. Static and dynamic memory. The buffer memory. Organization of the cache memory; the main elements of the cache memory. Continuously-only memory (ROM); the main elements of the ROM; ROM organization. Addressing memory; organization of virtual memory; paged memory addressing; segmentation of the memory. Models shared memory architectures. Models of distributed memory architectures. Symmetric multi-processor systems. Architecture SMP system. Cluster computing systems. Classification of cluster systems architectures. Cluster topology. Systems with a massively parallel processing (MPP). Matrix computing systems. VM interface. array processor controller. The array of processors. Vector and vector-conveyor computer systems. The concept of the vector and the arrangement of data in memory. The structure of the vector processor. type "memory - the memory" structures and "Register - Register." Processing of long vectors and matrices. Associative Computing. Computer systems with systolic structure. Computer systems with ultra-length instruction word (VLIW).

Computer systems with explicit parallelism teams (EPIC). Computing systems with control computations on the data stream. Multiprocessor computer systems. Computer systems with programmable structure.

Section 7. Databases

The information and data. Information systems that use the database. Advantages and disadvantages of centralized data management. The database administrator and its function. Independence from application data. Multi-user access to databases: problems and methods of their solutions. Information domain model. Levels of representation of databases, architecture ANSI SPARC. Mappings between levels. Functional, and Infological datologicheskie domain model. Database Lifecycle. Database design stages. The client-server model, access to databases. Infological design database. The method of "entity-relationship», ER-diagrams and notations. The types of entities, types of bonds. Data models. Composition data model data structures, integrity constraints, the operations on the data. The concepts of circuits and subcircuits. The hierarchical and network data models. The data structures and operations on the data in a hierarchical and network models. The object-oriented data model. OO DBMS. ODMG standard. Object relational DBMS extensions. The relational data model. domain concepts, relationships, attribute, tuple.

Scheme relations. Keys relations. Representation of bonds in the RDB. foreign keys. Data manipulation language for relational model. relational algebra operations. Relational calculus with variable to your domain and variable-tuples. Design of a relational database. Anomalies inclusion and deletion of data. Functional Dependencies (FL) FL axioms. sets FZ circuit. FZ coating sets. The axioms of Armstrong. Decomposition of relations schemes. Decomposition lossless. Heath's Theorem. The normalization of relations. Normal forms of relations schemes: first, second, third. Boyce-Codd. Multivalued Dependencies (M3), M3 axiom closure of M3. The fourth and fifth normal forms. Scope normalization methods. SQL Language standards, the group functions. SQL statements. SQL data types. Requests for data sampling. Single-table queries. sampling conditions. Connection, union, intersection and difference relations. Sorting, aggregation, and subqueries. Calculations inside a SELECT. Sorting and grouping results. aggregation functions. Nested queries. Keywords ANY, ALL, EXISTS. Requests for the addition, modification and deletion of data in SQL. Ensuring integrity of data modification. Constraints in SQL. The definition of unique constraints, data validation, foreign key, default values in SQL. Stored procedures, triggers, and views. Forms triggers. Using views to restrict access. Accessing data from applications. Physical database organization. Keeping relationships and indexing. Finding and sorting data in a relationship. Types of indexes. Indexes B-tree. Hashing. Privacy, integrity and security of the database. DB Access Control. Backing up and restoring databases.

Section 8. Networks and Telecommunications

Classification of information networks. Peer 'client-server' network and the network. Levels and protocols. Cable and wireless data transmission medium. Circuit switching, messages, packets. Virtual channels. OSI Reference Model Open Systems Interconnection. The hierarchy of levels, protocols, protocol stacks. Service with a permanent connection and without permanent connection. TCP / IP model: levels and functions. Analog data channels. modulation methods. Modems. Classification modems. Methods of transmission (simplex, duplex, half duplex). Asynchronous and synchronous transmission. Digital data channels. Frequency and time division multiplexing. Specifications of wired communication lines. Wireless link. Satellite Channels. Cellular communication systems. Quality of service. The capacity and its limitations. The maximum transmission rate. Delay time. Logic encoding. Scrambling. Self-synchronizing codes. Ways to control the correctness of the data. Resettable codes. Systematic codes. Data compression algorithms. Local area networks. The network topology. Access Methods. Selective, casual, ring access method and access method with redundant time. High-speed local networks. Peer and client-server access methods. Multiple Access with Collision Detection carrier (CSMA / CD). Marker access methods: Token Ring, Token Bus. Network LAN. Network adapters, repeaters, hubs, bridges. The algorithm of the bridge. Varieties switches. Spanning Tree Algorithm. Network Operating Systems. Functions of network operating systems: local resource management, organization of networking. distributed computing technologies. Structure and information services to regional networks. Application Layer Protocols.

Section 9. Computer graphics

The history of computer graphics development. Three-dimensional modeling. Modeling primitives. Modeling splines. Polygonal modeling. Solid modeling. Materials. Creating and processing two-dimensional images. Lighting. Visualization. Dynamic models. Interactive models. A virtual reality. Introduction to engineering design.

Section 10. Systems of artificial intelligence

The basic concepts of artificial intelligence. Means of intellectualization of information systems. Inference in the processing of knowledge. Deductive inference (forward and reverse) Knowledge Engineering. Methods and stages of building knowledge bases. Fuzzy models in the management and design of systems. Models of decision-making. Design inference mechanisms. Expert systems. Models of knowledge representation in technical systems. The accumulation of knowledge and their processing to create FIC. Development tools of expert systems. Programming languages are artificial intelligence systems. Intelligent technical objects. Neural network models and control algorithms based on ANN. Forms INS. Applications ANN.

Section 11. Data Mining Technology

Automated acquisition of knowledge. Machine learning. The inductive inference based on precedents. Tracing system and explanations. Introduction to data warehousing, data warehouse basics of the concept. Technology development and implementation of data warehouse: the stages of the project, the choice of a data model, the choice of a data warehouse structure. Metadata Repository (repository). Loading data storage. Data analysis: OLAP. Introduction to Data Mining. Data Mining as part of the information technology market. Classification of analytical systems. Data Mining Differences from other methods of data analysis. Data Mining technology prospects. Objects, attributes, their characteristics. Measurements and scales. Types of data sets. Storage Formats. The classification of these species. Metadata. Classification Data Mining stages. Identify laws (free search). Predictive modeling. Classification Data Mining methods. Statistical and cybernetic methods Data Mining. Properties of Data Mining methods. Classification and clustering: common and differences. Forecasting. Statistical methods. Decision trees. GIS technology. Models of data and knowledge in GIS.

Section 12. Designing systems

The concept of complex systems. The approaches to the analysis and design of complex systems. The life cycle of software. Basic standards. CASE-technologies. CASE- tools. Features of the application. The development of technical specifications for an automated system (AS). Functional modeling system. IDEF0 standard. Methodology for functional simulation. Analysis of IDEF0 models. Functionally-value analysis of the ABC. Approach data streams. workflow models. DFD. Design data and knowledge bases. Normalization. Simulation data structures and the generation of databases on the basis of ER-diagrams. Object-oriented approach. UML. Structural diagrams and behavior diagrams. Classes. Generation of the source code of classes. Expansion of the UML. Profiles. Templates. Framework. Flexible development methodology. Rational Unified Process. Open Unified Process. Process approach. Notation BPMN, eEPC, Ericsson-Penker. Elements of the project management. Gantt. PERT Chart. Simulation Systems.

3. Recommended literature

Main literature

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3. Seymour Lipschutz. Schaum's Outline of Set Theory and Related Topics. McGraw-Hill Education, 1998.
4. James Lyle Peterson. Petri Net Theory and the Modeling of Systems. Prentice Hall, 1981.
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10. Richard Anthony. Systems Programming: Designing and Developing Distributed Applications. Morgan Kaufmann, 2015.
11. Jason Andress. The Basics of Information Security: Understanding the Fundamentals of InfoSec in Theory and Practice. Syngress, 2011.
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17. Tanenbaum A., Austin T. Structured Computer Organization. Publisher: Pearson, 2012, 801 p.
18. Ian W., Elbe F. Data Mining: Practical Machine Learning Tools and Techniques with Java Implementations. University of Waikato, 2011. ISBN 978-0-123-74856-0
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20. Mohri M., Rostamizadeh A., Talwalkar A. Foundations of Machine Learning. MIT Press, 2018. ISBN 978-0-262-03940-6
21. Elmer P. Dadios. Fuzzy Logic - Controls, Concepts, Theories and Applications. InTechOpen, 2012. ISBN 978-953-51-0396-7
22. Eagle C., Nance V. The Ghidra Book: The Definitive Guide. No Starch Press, 2020. 608 p.
23. Easttom W. Computer Security Fundamentals. 4th Edition. Pearson IT Certification; 4th edition, 2019. 512 p.
24. Ferguson N., Schneier B., Kohno T. Cryptography Engineering: Design Principles and Practical Applications 1st Edition, Wiley, 2011. 386 p.
25. Rhodes-Ousley M. Information Security: The Complete Reference, Second Edition 2nd

Edition Publisher: McGraw-Hill Education; 2nd edition, 2013. 896 p.

26. Schultz C. P., Perciaccante B. Kali Linux Cookbook - Second Edition: Effective penetration testing solutions. Packt Publishing; 2nd Revised edition, 2017. 438 p.

27. Bass L., Clements P., Kazman R. Software Architecture in Practice, 3rd ed., Addison-Wesley Professional, 2013.

Additional literature

1. Durrett R. Probability: Theory and Examples (Cambridge Series in Statistical and Probabilistic Mathematics Book 49) 5th Edition ISBN: 978-1108473682

2. Hopcroft J.E., Motwani R., Ullman J.D. Introduction to Automata Theory, Languages, and Computation (3rd ed.). Pearson, 2013. ISBN 978-1292039053.

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