APPROVING:

Executive Secretary

of the Admissions Committee

_____ V.I.Skrytniy

January 15, 2026

Master's Entrance Examination Programme

for the degree programme

09.04.02 INFORMATION SYSTEMS AND TECHNOLOGIES

Mode of study

Full-time

GENERAL REMARKS

Master's degree entrance test program is based on the federal state educational standards of higher education.

Form of the test:

Master's degree entrance test is conducted in the form of an interview with mandatory written answers to the ticket questions. The interview is conducted in order to identify the applicant's knowledge required for master's degree level.

Test structure:

The test consists of the answers to the ticket questions together with the additional questions which are within the entrance test program.

Evaluation of the test:

The interview score is set on a 100-point scale. The minimum score required for successful pass of the interview and further participation in the competition is set annually by the admissions committee of the National Research Nuclear University MEPhI.

Criteria for evaluating test results:

100–95 points — the applicant provides thorough and well-grounded answers to the questions posed by the examination board, demonstrating deep theoretical knowledge, the ability to compare and assess various scientific approaches, and proficiency in using modern scientific terminology.

94–90 points — the applicant gives complete, quite deep, and well-reasoned answers to the questions posed by the examination board, showing good knowledge and the ability to use modern scientific terminology.

89–85 points — the applicant offers justified answers to the questions posed by the examination board, demonstrating good knowledge.

84–80 points — the applicant provides generally correct answers to the questions posed by the examination board, though the answers are not sufficiently reasonable.

79–0 points — the applicant shows a lack of understanding of the main content of the theoretical material, superficiality, and weak argumentation of judgments, or makes significant errors.

QUESTIONS TO PREPARE FOR THE ENTRANCE TEST

I. Information Systems (IS) and technologies (IT) mathematical foundations

1. Logical variables and functions. Basic and complex functions.
2. Elementary two-variable functions.
3. The concept of completeness (basis) in a system of logical functions.
4. Fundamental laws of Boolean algebra. Representation of logical functions using the "AND", "OR", "NOT" basis.
5. Normal and perfect normal disjunctive and conjunctive forms.
6. Representation of logical functions in the "NAND" and "NOR" bases.
7. Numeral systems. Selecting a numeral system. Methods of number representation (fixed-point and floating-point) and their formats.
8. Dependence of number format fields on the range and precision of number representation.
9. Forward, reverse and additional codes, modified codes: features of performing arithmetic operations.
10. Basic concepts of automata theory. Regular and context-free languages.
11. Deterministic and non-deterministic finite automata. Regular expressions and their relation to deterministic finite automata.
12. Automatic machines with store memory. The concept of grammar, classification of grammars according to Chomsky.
13. Parsing algorithms (ascending, descending). Chomsky normal form for context-free grammars, Kock-Younger-Kasami algorithms.
14. The concept of the Turing machine and its application.
15. Graphs: definition, oriented and undirected graphs, weighted graphs. The concept of a path in a graph, the length of the path. Graph representation.
16. Graph traversal algorithms: breadth-first search, depth-first search. Finding the shortest path in a graph. The Dijkstra algorithm.
17. Topological sorting. Search for strongly connected components.
18. Definition of probability and probability space. Definition and properties of conditional probability.
19. Probability of event multiplication. Event independence. The total probability formula. Bayesian probability. Bayes' theorem.
20. Definition of a random variable. Distribution function of a random variable and its properties. Joint distribution of random variables.
21. Expected value and variance of a random variable, their properties.
22. Initial and central moments of a random variable.
23. Covariance, correlation coefficient.
24. Independence of random variables. Independence of random variables that are functions of independent random variables.
25. Statistical hypothesis testing. The concept of a statistical test.
26. Vectors and matrices. Operations on vectors and matrices.
27. Matrix multiplication. Methods of fast matrix multiplication, Strassen and Winograd algorithms.
28. Inverse matrix. Matrix reversibility criterion. Properties of the inverse matrix. Matrix rank.

29. The concept of linear dependence. The criterion of linear dependence. Matrix degeneracy criterion
30. Elementary transformations on matrices. Singular matrix decomposition. Examples of the application of matrix calculations in IC problems.
31. The concept of a derivative for functions of one or more variables. Differentiability of a function, it's differential.
32. Properties of the derivative. Derivative and differential of complex and inverse functions.
33. Derivatives of basic elementary functions. Derivatives of parametrically defined functions.
34. Derivatives and differentials of higher orders. The concept of private the derivative. The original one. Basic properties of the primitive. The table of primordial forms.
35. Indefinite integral and its basic properties. Basic rules of integration.
36. Double and triple integrals. Curved integrals. Scalar and vector fields. Gradient, divergence, and rotor.
37. Linear programming. The canonical form of the linear programming problem. The basic solution. An example of solving a problem using the simplex method. A sign of an optimal solution.
38. Dual tasks of linear programming. The relationship of optimal solutions to the initial (direct) and dual problems. An example of solving a problem. Using the dual simplex method.
39. Transport task. Balanced (closed) and unbalanced (open) tasks. Reducing an open task to a closed one.
40. Approximate solution methods: the method of the northwest corner, the lowest cost (minimum element). Potentials method.
41. A random event. The algebra of events. The axiomatics.

Section literature I

1. Gorbatov V.A., Gorbatov A.V., Gorbatova M.V. Discrete Mathematics: A Textbook for Technical University Students. Moscow: AST, 2014. 448 p.
2. Gorbatov V.A., Gorbatov A.V., Gorbatova M.V. Automata Theory: A Textbook for Technical Universities. Moscow: AST, 2008. 559 p.
3. Kuznetsov O.P. Discrete Mathematics for Engineers. St. Petersburg [et al.]: Lan, 2009. Available at: https://nashol.com/2014071978989/diskretnaya-matematika-dlya-injenera-kuznecov-o-p-2009.html
4. Cormen T., Leiserson C., Rivest R., Stein C. Introduction to Algorithms. Moscow: Williams, 2007. 1296 p. (In the original order: Cormen, Leiserson, Rivest, Stein)
5. Rublev V.S. Fundamentals of Algorithm Theory. 2nd ed., revised. Moscow: Nauchny Mir, 2008. 128 p.
6. Stevens Rod. Algorithms: Theory and Practical Applications. World Computer Bestseller series. Moscow: Eksmo, 2017. 544 p.
7. Wentzel E.S. Probability Theory. 12th ed., stereotyped. Moscow: Yustitsiya, 2018. 658 p.
8. Gmurman V.E. Probability Theory and Mathematical Statistics. Moscow: Vysshaya Shkola, 2003.
9. Wentzel E.S., Ovcharov L.A. Problems and Exercises in Probability Theory. 5th ed., revised. Moscow: Academia, 2003. 448 p.
10. Gmurman V.E. Guide to Solving Problems in Probability Theory and Mathematical Statistics. Moscow: Vysshee Obrazovanie, 2006. 400 p.
11. Ivchenko G.I., Medvedev I.Yu. Introduction to Mathematical Statistics: A Study Guide. Moscow: LKI, 2010. 600 p.
12. Gantmacher F.R. Matrix Theory. Reprint of the original edition (Publishing house "Nauka", 2nd edition, 1966). 2012. 576 p.

13. Horn R.A. Matrix Analysis. Reprint of the original edition (Mir, 1989). 2012. 667 p.
14. Fikhtengolts G.M. A Course in Differential and Integral Calculus (in three volumes). Moscow: FIZMATLIT, 2008.
15. Abramovsky V.A., Arkhipov G.I., Nayda O.N. Differential and Integral Calculus of a Function of One Variable. Vol. 1. Mathematical Foundations of Physics series. Moscow: FIZMATLIT, 2019. 704 p.
16. Steklov V.A. Fundamentals of the Theory of Integrating Ordinary Differential Equations: A Study Guide. Moscow: Yurayt, 2017. 428 p.
17. Akulich I.L. Mathematical Programming in Examples and Problems. Lan, 2011.
18. Galereya E.M. Optimization: Theory, Examples, Problems. LENAND, 2015.
19. Salmin I.D. Mathematical Methods for Solving Optimization Problems. Moscow: MEPhI, 2004. 156 p.
20. Zholobov D.A. Introduction to Mathematical Programming. Moscow: MEPhI, 2008. 376 p.

II. Architecture, trends in IS development and design

1. The concept of IS. Tasks addressed using IS. Trends in IS development. Decision Support Systems (DSS) and content management systems.
2. The structure and main components of the IS. IS properties. IS models.
3. IS lifecycle, life cycle models, and the standards.
4. Information resources
5. Classification of IS: by scale; nature of tasks to be solved; subject areas served; types of management facilities; levels of organization management; supported management concepts (standards).
6. Architecture of "client-server", "client-agent-server" and "without server": basic concepts and definitions. The general structure of the application, its correspondence to different architectures.
7. The concept of a data model. Purpose of data models; structural, integrated, and operational parts of the data model. Classification of data models.
8. Physical data models. Datalogical data models.
9. Key-value model, hierarchical model, network model. General characteristics, features of data structure representation by means of data models.
10. The "entity-relationship-properties" model (ER-model). Relational (SQL) data model: general characteristics, main structural components. Methods of data storage and access. Data administration.
11. Types of non-relational data models (NoSQL), their characteristics and basic operations on stored data
12. The concept of databases, database systems, database management systems. Assignment and main components of the database system, database management system.

13. SQL language: general characteristics. Language tools for describing database structure and integrity constraints; data modification and data query generation.
14. Relational database design. Functional dependencies, relationship decomposition. The normalization of relations concept. Normal forms.
15. Physical organization of a relational database. Organization of data access. The concept of indexes. Indexes variety (tree indexes and hash indexes).

16. Protecting the completeness and integrity of databases. The concept of a transaction. Transaction properties.
17. OLTP and OLAP systems; In Memory Data Base and Data Grid.
18. Data storage: general characteristics, ETL architecture; tasks to be solved. Access means for the end users. Historical data.
19. Information security (IB). Data access control and authorization methods, authentication. IS verification tests for information security.
20. Requirements for design technologies, developing and maintenance information systems.
21. IS design models and methodologies.
22. The concept of CASE technology. The advantages of using CASE tools to create IS.
23. Canonical and standard IS design. Typical design methods.
24. Methods and means of prototype IS design (digital twins).

Section Literature II

1. Fedotova E.L. Information Technologies and Systems. Higher Education series. Moscow: Forum, Infra M, 2009. 352 p.
2. Vodyakho A.I., Dubenetsky V.A., Sovetov B.Ya. et al. Architecture of Information Systems. Higher Professional Education series. Moscow: Academia, 2012. 288 p.
3. Zakharov A. Datalogy: Probabilistic Models and Data Generation. Saarbrücken: Lambert Academic Publishing, 2018. 96 p.
4. Date C.J. An Introduction to Database Systems. Moscow: Williams, 2018. 1328 p.
5. Arnold Tammemägi, Gennady Gromov. Research of NoSQL Database Management Systems. Moscow: Knigozal LLC 2019. 60 p.
6. Eric Redmond, Jim R. Wilson. Seven Databases in Seven Weeks: A Guide to Modern Databases and the NoSQL Movement. Pragmatic Programmers series. Moscow: DMK Press, 2018. 384 p.
7. Ben Forta. SQt in 10 Minutes. 4th ed. Moscow: Williams, 2019. 288 p.
8. Arkhipenkov S.Ya., Golubev D.V., Maksimenko O.B. Data Warehouses. Moscow: Dialog MEPhI, 2002. 528 p.
9. Parfenov Yu.P., Papulovskaya N.V. Post-Relational Data Warehouses: A Study Guide for Universities. Digital book. Moscow: Yurayt, 2018. 122 p.
10. Nesterov S.A. Fundamentals of Information Security: A Study Guide. St. Petersburg: Lan, 2016. 324 p.
11. Lavrishcheva E.M. Software Engineering: Paradigms, Technologies, and CASE Tools. University of Russia series. Moscow: Yurayt, 2017. 280 p.
12. Ipatov Yu.V., Ipatova E.R. Methodologies and Technologies of System Design for Information Systems: A Textbook. Moscow: Flinta: MPSI, 2008. 256 p.

III. Software development and data communication networks

1. Standard data types. Logical and physical levels of data representation. Data presentation with different types and structures in various programming languages.
2. Programming language instructions for describing algorithms. The program structure is in accordance with the methodology of structured programming.

3. Recursive definitions and algorithms. Programming recursive algorithms. Approaches to constructing and verifying programs.
4. Fundamentals of object-oriented programming. General characteristics of object-oriented programming languages.
5. Basic concepts of the object-oriented approach. The program structure in accordance with the methodology of object-oriented programming.
6. The purpose and use of overloading functions mechanism, operators, using the example of an object-oriented programming language.
7. Using the inheritance mechanism in object-oriented programming languages. The concept of static and dynamic linking.
8. Dynamic data structures using linear lists as an example. A linear list as an abstract data type.
9. Computer networks basic concepts, their advantages and disadvantages. The evolution of computer networks.
10. Principles of construction, computer networks basic models and structures.
11. Architecture and networks standardization. The OSI model.
12. Assignment of OSI model levels.
13. Telecom operators networks, corporate networks, Internet, their structure and features.
14. Basic network characteristics
15. Modern protocols for wired networks (Ethernet, FibreChannel, converged networks, etc.).
16. Ethernet: tasks, limitations, frame structure.
17. Basic TCP/IP protocols
18. Wireless data transmission: advantages and disadvantages.
19. Global network technologies (Frame Relay, ATM, etc.)
20. Distributed information processing model. Basic mechanisms.
21. Distributed processing and data using message brokers.
22. Streaming information processing and analysis. Mechanisms and models.
23. IP Security protocol stack. The main protocols (AH, ESP, ISAKMP), their tasks, application features, package structure.
24. Cloud computing technologies for IP creation (within IaaS, PaaS, SaaS, XaaS service models), their advantages and features.

Section Literature III

1. Basic Data Types in Programming Languages. Department of Algorithmic Languages, Faculty of Computational Mathematics and Cybernetics, Lomonosov Moscow State University [Electronic resource]. 63 p. Available at: http://al.cs.msu.su/system/files/19-BaseTypesADT.pdf
2. Semakin I.G. Fundamentals of Programming and Databases: A Textbook. Moscow: Academia, 2014. 224 p.
3. Fundamentals of Programming:
Video lesson #3: Data Types. Available at: https://loftblog.ru/material/3-tipy-dannyx/
Video lesson #9: Tools for Programmers. Available at: https://loftblog.ru/material/9-instrumentydlya-programmista
4. Bertrand Meyer. Become an Object Thinker: Learning to Program Well with Objects and Contracts. Moscow: National Open University «INTUIT»: BINOM. Knowledge Laboratory, 2011. 775 p.

5. Matt Weissfeld. Object-Oriented Thinking. Programmer's Library series. St. Petersburg: Piter, 2014. 304 p.
6. Simonova E.V. Data Structures in C#: Linear and Non-Linear Dynamic Structures. St. Petersburg: Lan, 2018. 152 p.
7. Olifer V., Olifer N. Computer Networks: Principles, Technologies, and Protocols. 5th ed. St. Petersburg: Piter, 2016. 992 p. Available at:
8. Caulman E. A Secure Network: Rules for Maintaining Reputation in the Age of Social Media and Total Publicity. Moscow: Alpina Publisher, 2017. 214 p.
9. Zinkina Yu.V., Shulgin S.G., Korotaev A.V. Evolution of Global Networks: Patterns, Trends, and Models. Moscow: URSS: LENAND, 2016. 277 p.
10. Tsarev R.Yu., Prokopenko A.V., Nikiforov A.Yu. Fundamentals of Distributed Information Processing: A Study Guide. Informatics series. 2015. 180 p.
11. Narkhida Niya, Gwen Shapira, Todd Palino. Apache Kafka: Stream Processing and Data Analytics. O'Reilly Bestsellers series. St. Petersburg: Piter, 2019. 320 p.
12. Pseltis Andrew J. Stream Data Processing: Real-Time Pipeline. Moscow: DMK Press, 2017.
13. George Reese. Cloud Computing. St. Petersburg: BVKh-Petersburg, 2011. 288 p.
14. Gubarev V.V., Savulchik S.A., Chistyakov N.A. Introduction to Cloud Computing and Technologies: A Digital Book. Novosibirsk State Technical University (NGTU), 2016.