

MINISTRY OF SCIENCE AND EDUCATION OF THE RUSSIAN
FEDERATION
NATIONAL RESEARCH TOMSK STATE UNIVERSITY

Institute of applied mathematics and computer science

APPROVED BY
Vice-rector on Educational activity

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PROGRAM
entrance examination for master's degree in the field of training
01.04.02 Applied mathematics and computer science
for the "Big Data & Data Science" program
intramural form of study

Tomsk 2020

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1. General provisions

1.1. The program of entrance examination in the field of 01.04.02 Applied mathematics and computer science for the program "Big Data & Data Science" includes an interview on the profile of the program Big Data & Data Science in the field of 01.04.02 Applied mathematics and computer science, which allows to assess the performance level of applicants for mastering Master's programs.

1.2. The program of entrance examination is based on the requirements for the basic knowledge of applicants in the field of applied mathematics and computer science with a focus on the field of data analysis. The purpose of the interview is to determine the practical and theoretical performance level of the bachelor, as well as the correspondence of knowledge, skills of students to the requirements of training in a master's program as well as English proficiency.

1.3. The entrance examination program contains a description of the procedure, the entrance examination program and the criteria for evaluating the answers.

1.4. Entrance examinations are conducted in English.

1.5. The organization and conduct of entrance examination is carried out in accordance with the Admission Rules, approved by order of the rector of NR TSU, valid for the current year of admission.

1.6. According to the results of entrance examination, the applicant has the right to appeal in the manner prescribed by the Admission Rules that are valid for the current year of admission.

1.7. The program of entrance examinations in the field of 01.04.02 Applied mathematics and computer science for the program "Big Data & Data Science" is annually reviewed and updated taking into account changes in the legal framework of the Russian Federation in the field of higher education and local documents governing the admission process at the NR TSU. Changes made to the program of entrance examinations are considered and approved at a meeting of the academic and methodical commission of the Institute of applied mathematics and computer science. The program of entrance examinations is approved by the vice-rector of educational activities.

1.8. The program of entrance examinations is published on the official website of NR TSU in the "Master's degree" section no later than the date specified in the Admission Rules valid for the current year of admission.

1.9. The program of entrance examinations of the field of 01.04.02 Applied mathematics and computer science for the program "Big Data & Data Science" is stored in the documents of the dean's office of the Institute of applied mathematics and computer science.

2. Goals and objectives of entrance examination

2.1. Entrance examinations are designed to determine the performance level of the applicant for mastering the selected basic educational professional master's

program and is carried out to determine the required competencies of the applicant needed to master this basic educational program "Big Data & Data Science" in the field of 01.04.02 Applied mathematics and computer science.

2.2. The main tasks of entrance examination on the profile of the program:

- verification of basic knowledge of the theoretical foundations of the prerequisite disciplines of the curriculum;
- identification of the ability to set a goal and formulate tasks related to the implementation of professional functions;
- knowledge of a culture of thinking, the ability to format correctly in written and spoken language the results.

3. Interview on the profile of the program: structure, procedure, program and criteria for evaluating the answers

3.1. Interview structure and procedure

3.1.1. The interview is conducted according to the profile of the master's program. The interview is conducted by the head of the program in person or using software such as Skype in the format of a conversation with an applicant. If necessary, the head of the program conducts an interview extramurally using software such as Moodle in the format of the applicant's answer to the interview questions.

The total duration of the interview is no more than 30 minutes, taking into account the individual characteristics of the applicant.

The maximum number of points for an interview is 100. The maximum number of points for a successful interview is 60. An applicant with less than 60 points for an interview cannot be enrolled in a master's program.

3.1.2. During the interview, the applicant must justify the purpose of studying in a master's program and demonstrate:

- - ability to make practical use of professional knowledge in the fields of applied mathematics and mathematical statistics, computer sciences and information technologies;
- - a tendency to conduct research and obtain new scientific and applied results;

3.2. Program of an interview

3.2.1. Questions for entrance examination for the master's program "Big Data & Data Science":

Higher mathematics:

Vector analysis

1. The scalar product of vectors.
2. Vector product of vectors.
3. The equation of a straight line in space.
4. The equation of the plane in space.

Matrices:

5. Operations on matrices.
6. Determinants, their properties. Inverse matrix.
7. Eigenvalues and eigenvectors of the matrix. Systems of linear algebraic equations
8. Kronecker-Capelli theorem.
9. The Cramer Method.
10. The inverse matrix method.

Mathematical analysis:

11. Continuity of function. Classification of break points.
12. The first and second special limits.
13. Derivatives of elementary functions.
14. Extreme functions of one variable. The largest and smallest function value.
15. Decomposition of a function in a power series. Taylor's formula.
16. The general scheme of the study of the function graph.
17. L'Hospital rule.
18. Antiderivative integral, simplest methods of integration.
19. A definite integral, its properties.
20. Partial derivatives. Derivative in direction. Gradient.
21. The number series. Signs of convergence.

Discrete mathematics:

22. Elements of graph theory, methods for their assignment.
23. Equivalence of Boolean formulas. The concept of derivability. Ordinary Differential Equations
24. Linear differential equations of the first order.
25. Linear differential equations of the second order with constant coefficients.

Probability theory:

26. Statistical probability determination, classical probability determination.
27. Theorem of addition of probabilities.
28. Theorem of multiplication of probabilities.
29. Full probability formula and Bayes formula.

Numerical methods:

30. Gauss method for numerical solution of a system of algebraic equations.
31. Methods of numerical integration (for the trapezoidal rule and Simpson).
32. Runge-Kutta Scheme for solving ordinary differential equations.

Computer sciences. Algorithmization and programming

33. The concepts of algorithmization and algorithm
34. Static data structures: vectors, arrays, tables.
35. Data structures: lists (stack / queue / deque, operations, application).
36. Hierarchical data structure – data tree (tree types, presentation methods, operations on trees).
37. Data structure: heap (types, construction, algorithms). Hashing.

- 38.Data structure: graph (presentation methods, basic algorithms on graphs).
- 39.Object-oriented programming.
- 40.Types of programming languages.
- 41.9. Demonstration of skills in any programming language (C / C # / C ++, Java, Pascal, Delphi, Python, Basic, etc.).

Computer sciences.

- 42.DB technology. The concept of database and DBMS.
- 43.Data Models: Relational, Hierarchical, Network Model, and Object Oriented Data
- 44.The entity-relationship model (ER-model).
- 45.Elements of the ER-model: entities, attributes, relationships. ER charts.
- 46.Relational data model. Relations, domains, attributes, tuples, schemes.
- 47.Relational algebra Set-theoretic operations on relations.
- 48.Relational algebra Selection, projection, connection, division.
- 49.Structured Query Language (SQL).
- 50.General characteristics of NoSQL databases and their advantages. Classification of NoSQL databases.

Computer sciences.

- 51.Computer networks and their varieties, network topologies
- 52.ISO OSI Network Access Model
- 53.TCP / IP Protocol Stack
- 54.UDP User Datagram Delivery Protocol
- 55.IP Interworking Protocol
- 56.IPv4 Addressing on Networks
- 57.VPN technology
- 58.Components of Internet technology
- 59.Hierarchy of Internet domain names

3.3. Criteria for evaluation of interview responses

3.3.1. Applicant is asked 5 questions from different fields of knowledge. Each question is evaluated, depending on the completeness and accuracy, from 0 to 20 points.

The maximum number of points that a test subject can get for each member of the commission is 100.

The overall score is defined as the average score given by all members of the certification commission based on the results of the interview.

3.3.2. Evaluation "excellent" (80-100 points) deserves an answer containing a distinct and fluent knowledge of the conceptual questions, scientific language and terminology; logically correct and convincing presentation of the answer.

Evaluation "good" (70–80 points) deserves an answer containing the ability to use the conceptual apparatus; generally logically correct, but not always accurate and reasoned presentation of the answer.

Evaluation "satisfactory" (60–70 points) deserves an answer containing

difficulties using the conceptual apparatus and terminology; the desire to state logically clearly and consistently the answer.

Evaluation “unsatisfactory” (less than 60 points) is given if you do not know or have a fragmentary presentation of the material included in the question; inability to logically definitely and consistently state the answer.

3.3.3. Evaluation of answers to entrance examinations is carried out by the certification committee acting on the basis of the order of the rector of TSU.

The results of the entrance test are announced on the official website no later than the third business day after the entrance test.

Literature:

Higher mathematics:

1. Carl D. Meyer, Matrix Analysis and Applied Linear Algebra, 2010
2. Eric Lehman, F Thomson Leighton, Albert R Meyer, Mathematics for Computer Science Hardcover, 2017
3. David C. Lay, Steven R. Lay, et al. Linear Algebra and Its Applications (5th Edition), 2015
4. Hossein Pishro-Nik, Introduction to Probability, Statistics, and Random Processes, 2014
5. Richard L. Burden, J. Douglas Faires, et al., Numerical Analysis, 2015
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7. Tom M. Apostol, Mathematical Analysis, Second Edition, 1974
8. V. K. Balakrishnan, Introductory Discrete Mathematics (Dover Books on Computer Science), 2010
9. Walter Rudin, Principles of Mathematical Analysis, 2013
10. "Electronic resource: <http://www.freebookcentre.net/maths-books-download>

Computer sciences

1. Abraham Silberschatz , Henry Korth, Database System Concepts, et al., 2010
2. Cormen, T. H., C. Leiserson, R. Rivest, and C. Stein, Introduction to Algorithms. Third Edition. MIT Press, 2009.
3. Elmasri Ramez, And Navathe Shamkant, Fundamentals Of Database System, 7Th Edn, 2017
4. George T. Heineman, Gary Pollice & Stanley Selkow, Algorithms in a Nutshell. Second Edition. Beijing • Boston • Farnham • Sebastopol «Tokyo O'REILLY, 2016
5. Jill West, Tamara Dean, Jean Andrews, Network+ Guide to Networks 8th Edition, 2018
6. Ramez Elmasri, Shamkant, B. Navathe, Fundamentals of Database Systems (7th Edition), 2015
7. William C. Easttom II, Richard M. Roberts, Networking Fundamentals Third Edition, Revised, Student Textbook, 2018