ENTRANCE EXAMINATION IN MATHEMATICS AND INFORMATICS FOR APPLICANTS ENTERING MASTER'S PROGRAMS OF PHYSTECH SCHOOL OF APPLIED MATHEMATICS AND COMPUTER SCIENCE

Regulations

The admission process includes three main steps: a programming contest, a written exam and an oral exam.
The programming contest consists of 4-7 problems which are evaluated and graded automatically. The contest duration is 3 hours (180 minutes).
The written exam consists of 6-10 problems of different complexity. All problems require a complete solution with a detailed proof and/or explanation. It is legal to use the following online resources during the written exam:

- Wikipedia.org
- Wolframalpha.com
- Live.sympy.org
- Python.org/shell

Computational results based on one of these systems are not accepted as a complete solution or a proof. These resources can only be used to get a hint or recap some main facts and properties.
The written exam duration is 3 hours (180 minutes).
The oral exam includes discussion of applicant's experience and motivation, theoretical questions and may include questions on the provided written exam solutions.

Programming contest program

1. Data types and basic operations in Python
2. Data structures in Python
3. Linear operations and computations with matrices
4. Random numbers
5. Basic data processing

Written and oral exams program

1. Sequences. Limits of sequences. Examples of convergent and divergent sequences.
2. Continuous functions of one variable. Limits of functions.
3. Derivative. Differentiable functions. Mean value theorems: Fermat, Roll, Lagrange, Cauchy.
4. Infinitely small and limited quantities. Big-O notation.
5. Taylor series.
6. Indefinite integrals. Antiderivative.
7. Definite integrals.
8. Newton Leibnitz theorem.

9. Multivariate calculus.
10. Gradient. Jacobian matrix.
11. Systems of linear equations and the Gaussian elimination.
12. Vector spaces. Definition, examples: a space of rows, spaces of square matrices, spaces of symmetric and skew-symmetric square matrices, spaces of polynomials of one variable.
13. Linearly independent and linearly dependent systems of vectors.
14. A basis and the dimension of a vector space.
15. Matrix determinant. Trace.
16. Inverse matrix.
17. Orthogonal matrices and unary operators.
18. Eigendecomposition. Eigenvectors and eigenvalues.
19. Elementary events and finite sample spaces. The classical definition of probability. Computation of probabilities in classical settings.
20. Standard counting rules: the rule of sum and the rule of product.
21. Combinations, placements and permutations.
22. Newton's binomial theorem.
23. Continuous and discrete random variables. CDF and PDF.
24. Mathematical expectation and variance

References

1. E.B. Vinberg, «A Course in Algebra», Graduate Studies in Mathematics, AMS, Vol. 56, 2003.
2. W. Rudin, «Principles of Mathematical Analysis», International Series in Pure and Applied Mathematics, McGraw-Hill Education, 1976, 3rd Edition.
3. L.B. Koralov, Ya.G. Sinai, «Theory of Probability and Random Processes», Springer-Verlag Berlin Heidelberg, 2007.
4. Ian Goodfellow and Yoshua Bengio and Aaron Courville. “Deep Learning”. MIT Press, 2016
5. Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong. "Mathematics for Machine Learning". Cambridge University Press, 2020