EXAMINATION QUESTIONS

The Department of High Performance Computing (HPC) at ITMO University

Differential Equations and the Theory of Probability

1. Ordinary differential equations (ODE). The Cauchy problem.

ODEs of Higher order and ODEs systems.

2. Linear homogeneous differential equations with constant rates. Fundamental solution system and a general solution.

3. Linear heterogeneous differential equations with constant rates: a general homogeneous solution and a particular heterogeneous solution.

4. Autonomous systems in two-dimensional Euclidean space. The phase plane. Stationary (special) points. Vector field.

5. Differential Equations in Partial Differential coefficient of the First Order . First integrals. General solution. The Cauchy problem.

6. Combinations: repositioning, permutation, combinations.

7. Classical definition of probability, random events, reference sets, properties of classical probability.

8. Conditional probability. A theorem on total probability formula, Bayes' rule.

9. Random values: definition, distribution function of a random value and its properties, independent random values.

10. Definitions of numerical characteristics for discrete and continuous random values: mathematical expectation, variance, mode, median, central and ordinary moments.

Numerical and optimization methods

1. Approximation and interpolation of functions.

2. Numerical methods for solving algebraic equations.

3. Numerical integration.

4. Numerical methods for solving a system of linear algebraic equations.

5. Numerical methods for solving a system of nonlinear equations.

6. General concepts of optimization problems. Types of optimization problems.

7. Linear programming problems. The dual problem. Applications.

8. One-dimensional nonlinear programming problem. Methods of local and global optimization.

9. Methods for searching of a local extremum for the multidimensional optimization problem.

10. Methods for searching of a global extremum for the multidimensional optimization problem.

Algorithmization and programming

1. Algorithmic abstractions. Turing machine. Normal Markov' algorithms.

2. Algorithmic compositions (composite algorithms). Algorithmic insolubility.

3. Static data structures: vectors, arrays, tables.

4. Data structures: lists (stack / queue / deque, operations, application).

5. Hierarchical data structure –data tree (tree types, presentation methods, operations on trees).

6. Data structure: heap (types, construction, algorithms). Hashing.

7. Data structure: graph (presentation methods, basic algorithms on graphs).

8. Algorithms complexity (concept, an estimation of complexity with the examples of ordering and search algorithms)

9. Object-oriented programming. Encapsulation. Extending. Polymorphism.

10. Patterns of design: generative, structural and patterns of behavior.