State doctoral exam topics

Mathematical Engineering

1. Discrete Mathematics
    1. Graph Theory and its applications
    2. Combinatorial algorithms
    3. Complexity Theory
    4. Automata Theory and its applications
    5. Languages and grammars, decidability
2. Applied Algebra
    1. The notion of a group, its generalizations and applications
    2. Lattices, Boolean algebras and their application in logics
    3. Universal algebra, varieties and quasivarieties
    4. Matrix calculus, applications to signal processing
    5. The spectral decomposition of a matrix, singular value decomposition of a matrix (SVD).
    6. Computational algebraic geometry
3. Numerical Analysis
    1. Basic algorithms of matrix algebra and their computational complexity
    2. Numerical methods of computation of the spectrum of matrix
    3. Principle of iterative methods, examples of applications in linear algebra and calculus
    4. Least Squares Method. Minimization o functions.
    5. Solution to the Cauchy problem for ordinary differential equations
4. Functional Analysis
    1. Duality and linear operators on Banach spaces
    2. Banach algebras
    3. Spectral theory of operators on Hilbert spaces
    4. Distributions and Fourier transform
    5. Measures and probabilities on infinitedimensional spaces
5. Theory of Operator Algebras
    1. C*-algebras
    2. Von Neumann algebras
    3. Noncommutative measure and probability theory
    4. Jordan algebras
6. Axiomatic foundations of Quantum theory
    1. Operator-algebraic approach
    2. Convex approach
7. Quantum Structures
    1. Quantum logics and effect algebras
    2. Measures on quantum structures
8. Probability and Statistics
    1. Multidimensional statistical analysis
    2. Linear and non-linear regression
    3. Estimation and approximation of probability density functions
    4. Statistical methods based on information theory
9. Mathematical Methods in Signal and System Theory
    1. Multidimensional signals and systems

2. Wavelet basis and wavelet transform

10. Algebraic Methods of Computer Science
    1. Domain theory and its application to semantics of programming languages
    2. Algebraic and coalgebraic specification
11. Algebraical Structures
    1. Lie groups and algebras. Representations of semisimple algebras.
    2. Nonassociative algebras. Alternative and composition algebras.
12. Logic
    1. Deductive systems and matrix semantics.
    2. Algebraisable logics.
    3. Modal logics and Kripke semantics.
    4. First-order definability of modal logics.
13. Category Theory
    1. Adjunctions, monads, Beck's Theorem.
    2. Basics of enriched category theory, weighted limits and colimits, categories of presheaves.
    3. Free cocompletions under a class of colimits.
    4. Two-dimensional monads and two-dimensional Beck's Theorem.
14. Non-linear functional analysis
    1. Structure of Banach Spaces.
    2. Differentiability of functions and null sets in Banach Spaces.
    3. Linearization of a mapping between Banach Spaces.
    4. Lipschitz-Free spaces and their applications.
    5. Uniform homeomorphisms between Banach Spaces.