Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Algebra and Number Theory/Алгебра и теория чисел

Purpose of the course:

mastering the basic modern number theory.

Tasks of the course:

• students mastering basic knowledge (concepts, concepts, methods and models) in number theory;

• acquisition of theoretical knowledge and practical skills in number theory;

• providing advice and assistance to students in conducting their own theoretical studies in number theory.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

 fundamental concepts, laws, theories of algebraic methods in number theory;

 modern problems of the relevant sections of the theory of algebraic methods in number theory;

 concepts, axioms, methods of proof and proof of the main theorems in the sections included in the basic part of the cycle of the theory of algebraic methods in number theory;

 basic properties of the corresponding mathematical objects;

 analytical and numerical approaches and methods for solving typical applied problems of the theory of algebraic methods in number theory.

be able to:

 understand the task;

 use your knowledge to solve fundamental and applied problems;

 evaluate the correctness of the problem statements;

 strictly prove or disprove the statement;

 independently find algorithms for solving problems, including non-standard ones, and conduct their analysis;

 independently see the consequences of the results;

 accurately represent mathematical knowledge in topology orally and in writing.

master:

 skills of mastering a large amount of information and solving problems (including complex ones);

 skills of independent work and mastering new disciplines;

 the culture of the formulation, analysis and solution of mathematical and applied problems that require the use of mathematical approaches and methods for their solution;

 the subject language of topology and the skills of competent description of problem solving and presentation of the results.

Content of the course (training module), structured by topics (sections):

1. Theory of Divisibility. The greatest common factor. Least common multiple.

Equivalence relations. Theorem on equivalence classes.

2. Comparisons modulo. Properties of comparisons modulo.

Equations of one variable modulo. Systems of equations of one variable for different modules. Chinese remainder theorem. Equations of a single variable in a compound module.

3. Equations of the second degree modulo. The symbol of Legendre. The symbol of Jacobi. Compound module case.

Primitive roots in a simple module.

4. Equations of arbitrary degree modulo simple.

Indices by an arbitrary module.

5. Euclidean Algorithm. The main theorem of arithmetic.

Complete deduction systems. The reduced system of deductions. Euler and Fermat's theorem.

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Algorithms in Bioinformatics/Алгоритмы в биоинформатике

Purpose of the course:

to give students an idea of the formal formulations of problems arising in bioinformatics and of the algorithmic methods used to solve them.

Tasks of the course:

to acquaint the student with a number of important tasks of bioinformatics, in particular, such as finding functional sites; decoding of genome sequences; aligning sequences.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

• formal setting of tasks for some tasks of bioinformatics (search for motives, determination of the primary structure of biopolymers, alignment of sequences, restoration of the history of inversions);

• algorithms for solving these problems.

be able to:

• apply these algorithms to analyze the proposed data.

master:

• methods of effective choice of a formal model for solving meaningful problems of bioinformatics.

Content of the course (training module), structured by topics (sections):

1. Alignment of biological sequences.

The concept of paired alignment of biological sequences. Evolutionarily correct alignment. Reference protein alignments. Leveling weight. Penalty for deleting a character, penalty for

deleting a fragment. Algorithm for constructing the optimal alignment for various types of penalties for deleting a fragment. Optimal local alignment.

2. Search for motives in biological sequences.

The task of finding all pairs of similar fragments in two sequences. Search for exact matches. Search for inexact matches. Seeds. Seeding accuracy and selectivity. Construction of genome alignment based on the found local similarities.

The problem of finding a motive present in each of a given family of biological sequences. Search for the (L, d) -motive. Enumeration-based methods. Heuristic methods. Gibbs method.

3. Determination of the primary structure of biopolymers.

Determination of the primary structure of a protein using mass spectrography. Algorithmic problems associated with mass spectrometry of peptides. Enumeration algorithms. Branch and bound method. Various strategies for constructing candidate sets.

Determination of the primary structure of DNA. Assembling genomes from fragments. Formal statement of the problem. Count de Bruyne. Euler's theorem and Euler's graph traversal.

4. Reconstruction of the sequence of inversions in genomes.

Macro-genomic rearrangements. Reversals and their role in the evolution of genomes. Representation of the genome as a sequence of oriented genes. Breakpoints. Inverse distance between genomes. The problem of constructing the minimum sequence of inversions for two given genomes. Greedy algorithm. Multi-chromosomal genomes. Inversions, translocations, fusion and fission. Model of 2-discontinuous operations on graphs. Calculation of 2-break distance.

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Analytic Geometry/Аналитическая геометрия

Purpose of the course:

to provide students with foundations of analytic geometry that will help them to study advanced mathematical disciplines – differential equations, complex analysis, mathematical physics, functional analysis, analytical mechanics, theoretical physics, methods of optimal control, etc.

Tasks of the course:

- to provide students with theoretical knowledge and practical skills in geometry;

- to motivate students towards treatment of related mathematical disciplines;

- to equip students with skills to apply techniques of analytic geometry in physics and other natural sciences.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

- definition of vectors and vector operations (dot, vector, and triple product), their properties;

- equations of straight lines, planes, conics, and second-order surfaces;

- properties of curves and second-order surfaces;

- properties of affine and orthogonal transformations of plane.

be able to:

- to apply vector algebra to solve geometric and physical problems;

- to solve geometric problems by the coordinate method, use linear transformations to solve geometric problems;

- to perform matrix operations, to invert matrices, to compute determinants.

master:

- general concepts and definitions related to vectors: linear independence, basis, plane and space orientation;

- orthogonal and affine classification of lines and second-order surfaces.

Content of the course (training module), structured by topics (sections):

1. Straight line and plane in space

1.1. A line in space. Vector and coordinate equations of a line in space. A plane in space. Types of equations of a plane in space. Positional and metric problems of lines and planes in space. Transition from one form of line or plane equation in space to another. Bundle of lines. Bundle of planes and sheaf of planes. Linear inequalities.

2. Lines and surfaces of the second order

2.1. Coordinate equations of lines in plane and surfaces in space. Algebraic lines and surfaces. Invariance of order of algebraic curves in plane under linear changes of variables. Coordinate equations of curves in space. Invariance of order of algebraic curves and surfaces in space under linear changes of variables. Coordinate equations of some geometrical objects in plane and bodies in space.

2.2. Conics in plane and their orthogonal classification. Reduction of a conic equation to a standard form. Center lines. Conjugate diameters. Asymptotic direction. Invariants.

2.3. Ellipse, hyperbola, and parabola. Their properties. Tangents to an ellipse, a hyperbola, and a parabola. Equations of an ellipse, a hyperbola, and a parabola in the polar coordinate system.

2.4. Ellipsoids, hyperboloids, and paraboloids. Their basic properties. Rectilinear generators. Cylinders and cones. Surfaces of revolution. Classification and standard equations of second-order algebraic surfaces.

3. Convert the plane

3.1. Mappings and transformations of the plane. Composition of mappings. Inverse mapping. One-to-one mapping. Linear transformations of the plane and their properties. The coordinate representation of linear transformations of the plane.

3.2. Affine transformations and their geometric properties. The main directions of an affine transformation. Geometric meaning of the modulus and the sign of the determinant of an affine transformation matrix. Affine classification of conics in plane.

4. n-th order determinant

Definition and basic properties of determinants. Minors and cofactors. Cofactor expansion of a determinant along a row or a column. Determinant of matrix product.

5. Matrixes

Multiplication and inversion of matrices. Orthogonal matrices. Elementary row operations on matrices. Representation of row operations as multiplication by specific matrices.

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Applied Physical Education (Optional Sports)/Прикладная физическая культура (виды спорта по выбору)

Purpose of the course:

To form a worldview system of practical knowledge and attitude to physical culture.

Tasks of the course:

- To form an understanding of the social role of physical culture in the development of personality and its preparation for professional activities;

- to form the knowledge of the scientific, biological and practical foundations of physical education and a healthy lifestyle;

- to form a motivational-value attitude to physical culture, the attitude towards a healthy lifestyle, physical self-improvement and self-education, the need for regular exercise and sports.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

Scientific, practical and special foundations necessary for understanding the natural and social processes of the functioning of the physical culture of society and the individual, the ability to adapt and creatively use them for personal and professional development, self-improvement, and organizing a healthy lifestyle when performing educational, professional and sociocultural activities. Understand the role of physical culture in human development and specialist training.

be able to:

Use physical culture and sports activities to enhance their functional and motor capabilities, to achieve personal life and professional goals.

master:

A system of practical skills ensuring the preservation and strengthening of health, the development and improvement of psychophysical abilities and qualities (with the implementation of established standards for general physical and sports-technical training).

Content of the course (training module), structured by topics (sections):

1. General physical preparation

Education of physical qualities.

2. General physical preparation

Education of physical qualities.

3. General physical preparation

Education of physical qualities.

4. General physical preparation

Education of physical qualities.

5. General physical preparation

Education of physical qualities.

6. Special physical preparation

Special physical training

7. Special physical preparation

Special physical training

8. Special physical preparation

Special physical training

9. Special physical preparation

Special physical training

10. Special physical preparation

Special physical training

11. Professional and applied physical preparation

PROFESSIONAL'NO-PRIKLADNAYA FIZICHESKAYA PODGOTOVKA

12. Professional and applied physical preparation

PROFESSIONAL APPLIED PHYSICAL TRAINING

13. Professional and applied physical preparation

PROFESSIONAL APPLIED PHYSICAL TRAINING

14. Professional and applied physical preparation

PROFESSIONAL APPLIED PHYSICAL TRAINING

15. Professional and applied physical preparation

PROFESSIONAL APPLIED PHYSICAL TRAINING

16. Theoretical preparation

The material of the section provides for students to master the system of scientific, practical and special knowledge necessary to understand the natural and social processes of the functioning of the physical culture of society and the individual, their adaptive, creative use for personal and professional development, self-improvement, and the organization of a healthy lifestyle when performing educational, professional and socio-cultural activities.

17. Theoretical preparation

The material of the section provides for students to master the system of scientific, practical and special knowledge necessary to understand the natural and social processes of the functioning of the physical culture of society and the individual, their adaptive, creative use for personal and professional development, self-improvement, and the organization of a healthy lifestyle when performing educational, professional and socio-cultural activities.

18. Theoretical preparation

The material of the section provides for students to master the system of scientific, practical and special knowledge necessary to understand the natural and social processes of the functioning of the physical culture of society and the individual, their adaptive, creative use for personal and professional development, self-improvement, and the organization of a healthy lifestyle when performing educational, professional and socio-cultural activities.

19. Theoretical preparation

The material of the section provides for students to master the system of scientific, practical and special knowledge necessary to understand the natural and social processes of the functioning of the physical culture of society and the individual, their adaptive, creative use for personal and professional development, self-improvement, and the organization of a healthy lifestyle when performing educational, professional and socio-cultural activities.

20. Theoretical preparation

The material of the section provides for students to master the system of scientific, practical and special knowledge necessary to understand the natural and social processes of the functioning of the physical culture of society and the individual, their adaptive, creative use for personal and professional development, self-improvement, and the organization of a healthy lifestyle when performing educational, professional and socio-cultural activities.

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Basics of Mathematical logic I/Основы математической логики I

Purpose of the course:

- mastering general mathematical terminology (sets, relationships, functions).

Tasks of the course:

• Develop the skill of structured logical thinking.

• Learn to give formal definitions and give examples of defined objects.

• Learn to build formal records of mathematical statements and their proofs and work with these records.

• Learn to conduct mathematical reasoning, not based on the specific properties of the objects under consideration.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

 fundamental concepts, laws, theories of a part of discrete mathematics;

 modern problems of the corresponding sections of discrete mathematics;

 concepts, axioms, methods of proofs and proofs of the main theorems in the sections included in the basic part of the cycle;

 basic properties of the corresponding mathematical objects.

be able to:

 understand the task at hand;

 use your knowledge to solve fundamental and applied problems;

 evaluate the correctness of the problem setting;

 strictly prove or disprove the statement;

 independently find algorithms for solving problems, including non-standard ones, and analyze them;

 independently see the consequences of the results obtained;

 Accurately present mathematical knowledge in the field orally and in writing.

master:

 skills of mastering a large amount of information and solving problems (including complex ones);

 skills of independent work and mastering new disciplines;

 culture of formulation, analysis and solution of mathematical and applied problems that require the use of mathematical approaches and methods for their solution;

 the subject language of discrete mathematics and the skills of competently describing the solution of problems and presenting the results obtained.

Content of the course (training module), structured by topics (sections):

1. Methods of forming sets

Intuitive concept of a set. Elements of sets. Inclusion and equality of sets. The main ways of forming new sets are: enumeration of all elements, when there are certainly many of them; allocation of a subset by a property; degree (set of subsets) of a set; union of the set. Empty set, Russell's paradox, set intersection

2. Isomorphism and arithmetic on VUM

Isomorphism of structures. Any two countable dense linear orders without the least and largest element are isomorphic

3. Lemma Zorn.

Chains in a partially ordered set. Zorn's lemma and Zermelo's theorem. Their equivalence to the axiom of choice. Examples of application of Zorn's lemma. A theorem on the comparability of sets in terms of cardinality. The cardinalities of the union and product of two infinite sets.

4. Disjunctive normal forms. The logic of statements. Boolean function classes

Propositional formulas (i.e., over the set of connectives $\wedge$, $\vee$, $\neg$, $\rightarrow$,

$\leftrightarrow$,$>$, $\perp$). The logic of statements. Equivalence of propositional formulas. Substitutions and their preservation of equivalence. Basic equivalences. Tautologies and satisfiable formulas. Semantic (logical) consequence and its properties

5. Set operations

Operations of union, intersection and complement of sets. Basic identities of the algebra of sets. Set relations. Types of binary relations. Operations of inversion and composition of relations

6. Predicates

The theorem on the completeness of the predicate calculus (without equality) in various formulations. Extension of the theory by Genkin's axioms; Lindenbaum's lemma; model construction; the power of the signature and the power of the model. Completeness theorem for predicate calculus with equality. Compactness theorem

7. Algorithms

An intuitive concept of an algorithm. Computable functions. Decidable and enumerable sets. The connection between finiteness, decidability and enumerability. Solvable and enumerable sets under the action of the operations of the algebra of sets, Cartesian product and projection. Post's theorem. T-predicate for the algorithm and its intuitive meaning. Computable function graph theorem. Enumerability of the image and inverse image of a set under the action of a computable function. Semi-characteristic function. Equivalence of different definitions of an enumerable set

8. Properties of bijections. Set embedding

Properties of functionality, injectivity, surjectivity and totality of a relation. ... Injections, surjections and bijections. The criterion for the bijectivity of the relationship. Equal cardinality of sets. ABOUT

9. Equivalence classes

Equivalence ratio. Equivalence classes and quotient set. Partitioning a set.

10. Mathematical induction. Recursion. Counting

Power properties of finite and countable sets. Fundamental orders. Induction principle. Equivalence of Funding Conditions, Finiteness of Decreasing Chains, and the Induction Principle

11. Axioms of countable and dependent choice. Formal languages

Words and formal languages. Concatenation of words, empty word. Prefixes and Suffixes. The "prefix" relation as a partial order. Operations on languages. Examples of inductive language definitions. Prefix-free languages. P

12. Universal computable function

Universal computable function (u.v.f .; in the class of computable functions N p → N). Unsolvable problems of self-applicability and stopping. Examples of enumerable undecidable and non-enumerable sets. An example of a computable function that has no computable totally extension. The domain of any such function is enumerable but undecidable. An example of disjoint enumerable sets that are not separated by any decidable set. Main universal computable function. Computable bijective coding of pairs of natural numbers. Building the main y. at. f. using arbitrary y. at. f. Kleene fixed point theorem. The infinity of the set of fixed points. Recursion theorem. Computability of the composition index of computable functions. Joint recursion; solution of "systems of equations"

13. Turing machines. Lambda calculus

Equivalence of model of partially recursive functions and lambda calculus. Specific computation models. Turing machines; examples of Turing computable functions. Primitive recursive and partially recursive functions; examples of such

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Combinatorics and Graphs/Комбинаторика и графы

Purpose of the course:

mastering the basic concepts of combinatorics and graphs

Tasks of the course:

• students mastering basic knowledge (concepts, concepts, methods and models) in the field of combinatorics and graphs;

• acquisition of theoretical knowledge and practical skills in the field of combinatorics and graphs;

• providing advice and assistance to students in conducting their own theoretical research in the field of combinatorics and graphs.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

 fundamental concepts, laws, theories of combinatorics and graphs;

 current problems of the relevant sections of combinatorics and graphs;

 concepts, axioms, methods of proof and proof of the main theorems in the sections included in the basic part of the cycle;

 basic properties of the corresponding mathematical objects;

 analytical and numerical approaches and methods for solving typical applied problems of combinatorics and graphs.

be able to:

 understand the task;

 use your knowledge to solve fundamental and applied problems of combinatorics and graphs;

 evaluate the correctness of the problem statements;

 strictly prove or disprove the statement;

 independently find algorithms for solving problems, including non-standard ones, and conduct their analysis;

 independently see the consequences of the results;

 accurately represent mathematical knowledge in the field of complex computing in oral and written form.

master:

 skills of mastering a large amount of information and solving problems (including complex ones);

 skills of independent work and mastering new disciplines;

 the culture of the formulation, analysis and solution of mathematical and applied problems requiring the use of mathematical approaches and methods of combinatorics and graphs for their solution;

 the subject language of complex calculations and the skills of competent description of problem solving and presentation of the results.

Content of the course (training module), structured by topics (sections):

1. Formal power series and generating functions. Generating functions for linear recurrences.

Extremal problems on graphs. Turán's theorem. More extremal problems: paths, trees and 4-cycles.

2. Generating functions (continued). Derivation of a formula for Catalan numbers. Generating functions and integer partitions.

Bounds for Ramsey numbers: a lower bound via counting, an upper bound by binomial coefficient.

3. Combinatorics of permutations. Cyclic structure of permutations. Permutation groups. Graph automorphism

Set families (hypergraphs). Systems of distinct representatives (connection with bipartite graph matchings), systems of common representatives, witnesses.

4. Other examples of groups. Cayley's theorem. Counting w.r.t. group actions.

Intersecting set families. Theorems of Erdos—Ko—Rado (with proof) and Ahlswede—Khachatrian (statement only).

5. Counting w.r.t. group actions (continued). Cauchy—Frobenius—Burnside lemma and Redfield—Polya counting framework. Counting graph colorings revisited.

Combinatorics on words. De Bruijn sequences via eulerian walks.

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Complex Networks/Сложные сети

Purpose of the course:

mastering basic concepts in the field of complex networks.

Tasks of the course:

• mastering by students of basic knowledge (concepts, concepts, methods and models) in the field of complex networks;

• acquisition of theoretical knowledge and practical skills in the field of complex networks;

• providing advice and assistance to students in their own theoretical research in the field of complex networks.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

 fundamental concepts, laws, theories of complex networks;

 modern problems of the corresponding sections of complex networks;

 concepts, axioms, methods of proofs and proofs of the main theorems in the sections included in the basic part of the cycle;

 basic properties of the corresponding mathematical objects;

 analytical and numerical approaches and methods for solving typical applied problems.

be able to:

 understand the task at hand;

 use your knowledge to solve fundamental and applied problems;

 evaluate the correctness of the problem setting;

 strictly prove or disprove the statement;

 independently find algorithms for solving problems, including non-standard ones, and analyze them;

 independently see the consequences of the results obtained;

 Accurately present mathematical knowledge in the field orally and in writing.

master:

 skills of mastering a large amount of information and solving problems (including complex ones);

 skills of independent work and mastering new disciplines;

 culture of setting, analyzing and solving mathematical and applied problems that require the use of mathematical approaches and methods for their solution;

 the subject language of complex networks and the skills of competently describing the solution of problems and presenting the results obtained.

Content of the course (training module), structured by topics (sections):

1. Dynamic evolution of complex networks

Comparative analysis of the percolation transition for the Bethe lattice and scale-invariant graphs

2. Classification of complex networks

Critical indices of the percolation transition for the Bethe lattice

3. Complex networks in problems of economics and finance

Relationships linking critical indicators.

4. Phase transitions on random networks

Properties of the one-dimensional Ising model

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Computability and Complexity/Вычислимость и вычислительная сложность

Purpose of the course:

mastering additional chapters of complex calculations.

Tasks of the course:

• students mastering basic knowledge (concepts, concepts, methods and models) in the field of complex computing;

• acquisition of theoretical knowledge and practical skills in the field of complex computing;

• providing advice and assistance to students in conducting their own theoretical research in the field of complex computing.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

 fundamental concepts, laws, theories of complex calculations;

 modern problems of the relevant sections of complex calculations;

 concepts, axioms, methods of proof and proof of the main theorems in the sections included in the basic part of the cycle;

 basic properties of the corresponding mathematical objects;

 analytical and numerical approaches and methods for solving typical applied problems of complex calculations.

be able to:

 understand the task;

 use your knowledge to solve fundamental and applied problems of EC;

 evaluate the correctness of task statements;

 strictly prove or disprove the statement;

 independently find algorithms for solving problems, including non-standard ones, and conduct their analysis;

 independently see the consequences of the results;

 accurately represent mathematical knowledge in the field of complex computing in oral and written form.

master:

 skills of mastering a large amount of information and solving problems (including complex ones);

 skills of independent work and mastering new disciplines;

 the culture of the formulation, analysis and solution of mathematical and applied problems requiring the use of mathematical approaches and EC methods for their solution;

 the subject language of complex calculations and the skills of competent description of problem solving and presentation of the results.

Content of the course (training module), structured by topics (sections):

1. What is an algorithm? Computation models. Computable functions. General purpose computable functions. Computing resources.

Decidable and enumerable sets. Several equivalent properties and basic properties. Post's theorem.

2. Algorithmically unsolvable problems: self-applicability problem, halting problem, “busy beavers”, etc.

The concept of m-reducibility. Construction of a non-enumerable set whose complement is also non-enumerable (the totality problem).

3. Links between computability and formal arithmetic. Gödel's Incompleteness Theorem.

Computing with an oracle: the concept and its properties. Relativization of computability. Non-deterministic computing. Complexity classes P, NP, coNP. The problem of equality between P and NP.

4. The concept of polynomial reducibility (according to Karp). NP-hardness and NP-completeness. Cook-Levin theorem and examples of NP complete problems from combinatorics, logic, graph theory, etc.

Spatial complexity. Complexity classes PSPACE, L and NL. Game-theoretic interpretation of PSPACE.

5. Probabilistic computing. Complexity classes BPP, RP and coRP. Reducing the error. Probabilistic tests of simplicity and equality of polynomials.

Interactive communication protocols and evidence systems. Complex IP class: examples and applications.

6. Average Difficulty and Foundations of Cryptography. One-way functions and pseudo-random number generators. Cryptographic protocols, their correctness and reliability.

Zero knowledge proofs. Perfectly, statistically and computationally zero knowledge properties.

7. Probabilistically verifiable proofs and their connection with the approximate solution of NP-hard problems.

Derandomization techniques and pseudo-random designs. Why are we confident that probabilistic algorithms do not expand computational power (i.e. P = BPP).

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Constraint Programming/Программирование в ограничениях

Purpose of the course:

The course is devoted to Constraint Programming (CP) - a discipline lying at the junction of mathematical modeling and computer programming, which can be considered a separate programming paradigm, close to logical and functional programming and clearly different from the most common imperative programming paradigm. Instead of describing elementary operations leading to the achievement of the result, that is, some object / configuration.

The main task in CP is to describe what elementary conditions an object must satisfy in order to be considered a result.

Tasks of the course:

The course is designed to provide an opportunity to practice modeling simplified and real discrete optimization problems in one of the standard modern CP-languages MiniZinc.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

In CP, the main task is to describe what elementary conditions an object must satisfy in order to be considered a result.

be able to:

Simulation of simplified and real discrete optimization problems in one of the standard modern CP-languages MiniZinc.

master:

Basic syntax of the MiniZinc language. Definition of variables and constants. Arrays. Model + data. Limitations. Output format.

Content of the course (training module), structured by topics (sections):

1. Constraint programming: its differences with imperative programming.

Models vs. programs, solvers vs. interpreters, constraints vs. commands/instructions, quantifiers vs. loops, etc.

2. Terminology and mathematical formalization of constraint satisfaction and optimization.

Feasible solutions, optimal solutions. Search space. Reduction of optimization to constraint satisfaction.

3. MiniZinc and FlatZinc syntax basics.

Variable and constant definitions. Models and data files. Constraints. Output statements.

4. Types of solvers: CP solvers, MILP solvers.

Their strengths and limitations. Examples of the same problem modelled differently for CP vs MILP solvers based on N-Queens problem.

5. Global constraints

Alldifferent, increasing and other typical global constraints. Implementation of alldifferent constraint.

6. Linear Programming as a modeling tool and mathematical subject

Modeling logical constraints with linear constraints and integer variables. Duality in linear programming. Duality as certifiability.

7. Symmetries of the search space. Breaking symmetries.

Symmetry breaking constraints vs. redundant constraints.

8. Search mechanics of CP solvers.

Variable choice and value choice. Restarts. Search annotations.

9. Industrial tools for CP and optimization.

Google OR tools. Interfacing with Python.

Practice of constraint programming.

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Convex Optimization/Выпуклая оптимизация

Purpose of the course:

mastering convex optimization.

Tasks of the course:

• mastering by students of basic knowledge (concepts, concepts, methods and models) in the field of convex optimization;

• acquisition of theoretical knowledge and practical skills in the field of convex optimization;

• providing advice and assistance to students in carrying out their own theoretical studies in the field of convex optimization.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

 fundamental concepts, laws, theory of convex optimization;

 modern problems of the corresponding sections of convex optimization;

 concepts, axioms, methods of proofs and proofs of the main theorems in the sections included in the basic part of the cycle;

 basic properties of the corresponding mathematical objects;

 analytical and numerical approaches and methods for solving typical applied problems of convex optimization.

be able to:

 understand the task at hand;

 use your knowledge to solve fundamental and applied problems of convex optimization;

 evaluate the correctness of the problem setting;

 strictly prove or disprove the statement;

 independently find algorithms for solving problems, including non-standard ones, and analyze them;

 independently see the consequences of the results obtained;

 Accurately represent mathematical knowledge in complex calculations, orally and in writing.

master:

 skills of mastering a large amount of information and solving problems (including complex ones);

 skills of independent work and mastering new disciplines;

 culture of formulation, analysis and solution of mathematical and applied problems, requiring the use of mathematical approaches and methods of convex optimization for their solution;

 subject language of complex calculations and skills of competent description of problem solving and presentation of the results obtained.

Content of the course (training module), structured by topics (sections):

1. Convergence analysis

Newton's method in a problem with equality constraints.

2. Convex sets.

Affine sets. Convex functions

3. Localization methods.

Метод отсекающих гиперплоскостей

4. Proximal operator

Proximal algorithms: minimization, gradient method, accelerated gradient method, directional multiplier method

5. Subgradient.

Subgradient methods

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Data Structures and Algorithms I/Структуры данных и алгоритмы I

Purpose of the course:

consists in introducing students to algorithms and data structure

Tasks of the course:

• Statement of the basic algorithms and data structures, their main applications in modern programming

• Providing the student with guidelines for further independent study of individual issues in specialized sections of mathematical logic and programming.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

• the role of programming in solving problems;

• The existing sets of programming tools, as well as trends and prospects for their development;

• Theory and practice of lambda calculus.

be able to:

• develop software applications for solving tasks in a programming language;

• develop algorithms for solving programming problems.

master:

• Up-to-date programming knowledge.

• Knowledge of the basics of lambda calculus;

• Skills in using lambda - calculus as a programming language;

• Skills in the basics of object-oriented programming.

Content of the course (training module), structured by topics (sections):

1. Points, rays, segments, angles

Lines: intersecting, perpendicular, parallel

2. Locus of points

Triangles: definition. types, properties

3. Basic theorems about similar triangles

Basic theorems about congruent triangles

4. Polygons

Elements of stereometry

5. Matrices. Arithmetic operations on matrices

Vectors. Basic properties

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Data Structures and Algorithms II/Структуры данных и алгоритмы II

Purpose of the course:

• form an understanding of the various computational problems in graph theory and the asymptotic complexity of their solutions;

• provide theoretical and practical knowledge about algorithms and data structures of graph theory with proof of the correctness of their work, about methods for assessing the complexity of algorithms.

Tasks of the course:

• teach to formulate tasks in terms of theories studied, choose the appropriate algorithm for the task;

• teach you how to develop combinations of algorithms to solve problems, evaluate the complexity of algorithms, their modifications and combinations, including using depreciation analysis, select the appropriate data structures for the tasks, implement the algorithms in a generalized form in the C ++ programming language.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

• Graph algorithms and data structures associated with them,

• Estimates of the complexity of standard algorithms.

• Standard graph algorithms and data structures used, approaches to the modification of classical algorithms.

• A variety of classical problems in graph theory and the asymptotic complexity of their solutions.

be able to:

• formulate tasks in terms of theories studied, choose the appropriate algorithm for the task;

• develop combinations of algorithms to solve the problem,

• evaluate the complexity of algorithms, their modifications and combinations, including using depreciation analysis,

• select the appropriate data structures for a specific task,

• implement the algorithm in a generalized form in the c ++ programming language;

• implement standard graph algorithms and data structures in the C ++ programming language.

master:

• Methods of decomposition of tasks in the field of information technology and the construction of a single solution using the studied algorithms.

• Methods for assessing the complexity of algorithms, their modifications and combinations.

Content of the course (training module), structured by topics (sections):

1. graph traversals

• Oriented graph, pseudograph. Undirected graph, pseudograph.

• Connectivity in neor. graph, connected components.

Weak and strong connectivity in op. column. Components of weak, strong connectivity.

• Walking in depth. The colors of the vertices. Entry and exit times. The white path lemma.

• Check connectivity of an undirected graph.

• Search for a loop in an undirected and oriented graph.

• Topological sorting.

• Finding components of strong connectivity. Kosarayu algorithm. Tarjan's algorithm.

• Components of rib biconnectedness. Bridges. Search for bridges.

• Components of vertex biconnectedness. Articulation points. Search for articulation points.

• Wave algorithm. Traversal in width (application of the queue in the wave algorithm).

• A criterion for the existence of the Euler path and cycle in an oriented and non-oriented graph. Search for the Euler path and cycle.

2. Shortest paths in a weighted graph

• Dijkstra's algorithm.

• The colors of the vertices. The tree of shortest paths.

• Potentials. The applicability condition for the Dijkstra algorithm for modified edge lengths. The potential $\pi(v) = \rho(v, t)$.

• Algorithm A *. Monotonicity condition on heuristics. Examples of heuristics.

• Two-way Dijkstra algorithm.

• Ford-Bellman Algorithm.

• Storage in the matrix: Dvk is equal to the length of the shortest path to the vertex v for exactly k edges (no more than k edges). Proof of correctness. Estimated work time.

• Restore the path.

• Detection of a negative weight cycle. Search for the cycle itself.

• Finding the shortest paths taking into account negative weight cycles.

• Floyd's algorithm. Evidence. Restoring the path.

• Finding a negative weight cycle.

• Johnson's algorithm. Adding a dummy root and dummy edges to run the Ford-Bellman algorithm.

3. Spanning trees

• Spanning tree. Build with a walk in depth and in width.

• Definition of a minimum spanning tree.

• Sectional theorem. Evidence.

• Prim's algorithm. Analogy with Dijkstra's algorithm.

• Proof using the cut theorem. Estimated runtime for various priority queue implementations: binary heap, Fibonacci heap (the latter without proof).

• Kruskal algorithm. Evidence. Estimated work time.

• A system of disjoint sets. Heuristic potentials with proof of an estimate of the run time.

• Heuristic compression paths without proof.

• Boruvka Algorithm. Evidence. Estimated work time.

• Approximation of the solution of the traveling salesman problem using a minimum spanning tree.

4. Network streams

• Network definition. Flow definition.

• Physical meaning. An analogy with the laws of Kirchhoff.

• Definition of section. The concepts of flow through a cut.

• Proof of the fact that the flow through any section is the same.

• The concept of a residual network. The concept of a complementary path.

• The need for a lack of a complementary path for maximum flow.

• Ford-Fulkerson theorem.

• Ford-Fulkerson Algorithm. Search for the minimum cut.

• An example of an integer network in which the algorithm runs for a long time.

• Edmonds-Karp algorithm.

• Proof that the shortest distance in a residual network does not decrease.

• General estimate of the running time of the Edmonds-Karp algorithm.

• Layered network. Algorithm Dinitsa.

• Matching. Maximum matching. The greatest matching. Perfect match.

• The task of finding the greatest matching. Examples of real problems.

• Alternating path. Berg's Lemma.

• The greatest matching in a bipartite graph. Rating.

5. Segment Data Structures

• RSQ and RMQ.

• Rarely-table.

• Segment tree.

• Processing requests from leaves.

• Processing requests from the root.

• Changing the values in the array, updating the tree of segments.

• Multiple operations.

• Fenwick tree.

• LCA. Binary lifting method.

• Reducing LCA to RMQ problem.

• Reducing RMQ to an LCA problem.

• Cartesian tree by implicit key.

• Multiple operations in a Cartesian tree using an implicit key.

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Data Structures and Algorithms III/Структуры данных и алгоритмы III

Purpose of the course:

• form an understanding of the various computational problems associated with streams in networks, tasks for finding strings with or without preliminary indexing, problems in the theory of pair games.

• provide theoretical and practical knowledge about algorithms and data structure, about algorithms and theoretical adjustments of their work, about parameters for evaluating the complexity of algorithms.

Tasks of the course:

• learn to interpret tasks in terms of theories studied, choose the appropriate algorithm for the task;

• development of algorithms for solving the tasks, assessment of the complexity of the algorithms, their modifications and combinations, the selection of suitable data structures for the tasks, the implementation of the algorithms in a generalized form in the C ++ programming language.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

• algorithms associated with processing streams in networks,

• string search algorithms and data structures related to indexing tasks,

• estimates of the complexity of standard algorithms.

be able to:

• Implement algorithms of varying complexity on graphs and indexing data structures in the C ++ programming language,

master:

• Methods of decomposition of tasks in the field of information technology and the construction of a single solution using the studied algorithms.

Content of the course (training module), structured by topics (sections):

1. String search

• The concept of prefix, suffix, substring.

• The concept of their own prefix and suffix.

• The task of finding a substring in a string.

• A trivial algorithm for finding a substring in a string.

• Definition of a prefix function.

• Trivial finding algorithm.

• Linear finding algorithm.

• Proof of operating time by the potential method.

• Counting the prefix function for the string q $ t, where q is the pattern and t is the text.

• Knut-Morris-Pratt Algorithm. Stream processing of text without storing the prefix function for the entire line q $ t.

• Finding the maximum palindrome prefix.

• Finding the number of occurrences of each sample prefix in the text.

• The concept of a functional graph. Type of functional graph.

• Acyclic functional graph is a tree.

• The task “palindrome factory”. It is required to find how many times a palindrome formed by the prefixes of a given sample enters. A palindrome is formed by string s if it has the form ss, where s is an inverted string. For example, the abaccaba palindrome is formed by the string abac.

• Reduction of the task to LCA search in the tree of the prefix function.

• Definition of the Z-function.

• Trivial search.

• Linear search of the Z-function. Invariants of the algorithm.

• Proof of operating time by the potential method.

• Application to search for substrings in a string.

• Storage of the Z-function only for the sample, and not for the entire line q $ t.

• Finding the maximum palindrome prefix.

• Finding the number of occurrences of each sample prefix in the text.

• Algorithm modification: search for the maximum substring of the palindrome.

• Statement of the problem of searching for several samples simultaneously. Examples from life.

• Estimation of operating time when using the ILC algorithm.

• The task of the algorithm that is being built is a one-time passage through the text.

• Description of boron data structure.

• Construction of boron, estimation of time and memory size.

• Different ways of storing wood children. Estimated amount of memory for each option.

• The concept of a suffix link. Example tree with suffix links.

• Analogy with the prefix function.

• Algorithm for constructing boron along with suffix links. Estimated work time.

• Algorithm Aho-Korasik. Estimated work time.

• Problems when one pattern is a suffix of another. An example of a problem.

• “Long” suffix links, that is, links going to the next terminal vertex, which is the suffix of the current one.

• Estimated runtime when using "long" suffix links.

• Counting the number of occurrences of each prefix in the text. Dynamic wood programming.

• Construction of automatic transitions. Construction of transitions by letters taking into account the movement of suffix links.

• Counting the number of lines over a given alphabet that contain exactly K occurrences of a given word.

• Generalization to counting the number of lines in a given alphabet that contain exactly K occurrences of given words.

• A set of forbidden words over a certain alphabet is given. Check for the existence of an infinite string over this alphabet that does not contain forbidden substrings.

2. String search 2

• Defining a suffix array.

• Construction in O (N 2 logN)

• Optimization using digital sorting to O (N 2)

• Search for a substring in the text in an already constructed suffix array.

• Building a suffix array in O (N log 2 N) by doubling the prefix by which sorting occurs.

• Optimization to O (N log N) using digital sorting for pairs.

• Kasai algorithm. Proof of work time.

• Finding the number of occurrences of a string in the text.

• Finding the maximum length of the prefix that is included in the text at least K times. (Binary search by answer. Using a segment tree.)

• Definition of a suffix tree.

• The concept of a compressed suffix tree.

• Trivial construction of a compressed suffix tree.

• Constructive proof of the linearity of the number of vertices and edges.

• The linearity of the number of vertices and edges gives hope that the tree can be built faster than in O (N 2).

• Storage of compressed suffix tree. Estimation of the total number of characters on the edges.

• A trivial tree update when adding one character to the end of a line. Two cases: the creation of a new sheet and the passage along the edge.

• Storing a list of vertices that are suffix.

• Heuristic sheet. Adding an infinite number of characters per edge when adding a sheet.

• The case of the existence of a position when adding a letter. Proof of the fact that all suffixes of a smaller size in this case are also contained in this tree.

• Refusal to store the list of suffix vertices.

• Suffix link. Support for the invariant that a suffix reference is calculated for all internal vertices.

• Proof of the fact that a suffix link always leads to the top.

• Move to a smaller suffix and count the suffix link for the newly created vertex.

• Fast descent, justification of its admissibility.

• Formulation of potentials to prove the operating time. The potential along the length of the word corresponding to the top. Potential by the number of intermediate vertices from the root.

• Proof of the total running time of fast descents.

• Proof of the fact that when following a suffix link, the potential of intermediate vertices decreases by no more than one.

• Proof of the running time of other operations.

• The task of finding the largest common substring of two strings O (N).

• A generalization to search for a common substring of K lines O (NK), where N is the total length of all lines.

• Algorithm for finding the number of different colors of sheets in all subtrees of a given tree.

• Search for the largest common substring K of strings O (N + K).

• Search for the largest substring palindrome.

• Search for the number of occurrences of a string in the text.

• Search for the number of disjoint occurrences of the string in the text.

• Search for the largest line that goes without intersections in the text at least K times. O (N 2 logN)

• Definition of a suffix automaton.

• The suffix tree is a suffix automaton, but with a very large number of vertices and edges.

• The concept of the right context. Physical meaning. Suffix numbering.

• Two representations of the right context: as many lines, as many suffix numbers.

• An example of constructing all right contexts for a string.

• Properties of strings that have the same right context.

• Machine states are right contexts.

• Constructing a transition from one state (right context) by a given letter.

• An example of constructing a suffix automaton. (Save the example on the board)

• Definition of terminal states.

• Rebuild the machine when adding a letter to the end. An analogy with the Ukkonen algorithm.

• Adding a new state that matches the entire row.

• The concept of a suffix link. Adding suffix links to the drawn example.

• Suffix path. Properties of the lines corresponding to the vertices of the path. Examples of intersections of suffix paths.

• Proof of the fact that only one state can be separated, that is, there is no more than one vertex that needs to be divided into two on a new line.

• Adding transitions by the added letter from terminal vertices that did not contain transitions by this letter.

• Clone vertices if necessary. An example of when this happens.

• Changing transitions by the added letter from terminal vertices that previously contained transitions by this letter.

• Potential formulation: Suffix path length from top to start vertex.

• Proof of the fact that the potential increases by no more than 1 when going through the letter.

• Estimation of the working time of the “first cycle”: that is, adding transitions from terminal vertices that did not contain this transition.

• Estimation of the operating time of the “second cycle”: that is, the change of transitions from terminal vertices that already contained this transition.

• General estimation of the running time of the algorithm.

• Finding the number of occurrences of a given string in the text.

• Finding the largest common substring of two strings.

• The text T is specified. Required to respond to requests. The queries specify a pattern Q and an arbitrary automaton A. Find the number of occurrences of pattern Q such in text T such that the suffix of text T is the next automaton after the occurrence of Q

3. Computational geometry

• Introduction. Lines, segments, planes. Scalar product, vector product.

• Convex hull 2D.

• Jarvis algorithm.

• Graham Algorithm and Andrew Algorithm.

• Convex hull 3D.

• Full search for O (n4).

• Gift wrapping for O (n2).

• The Divide and Conquer method for O (n log n).

• 2D calculations.

• Search for a pair of nearest points on the plane. Algorithm Drugs. O (n log n).

• Search for a triangle with a minimum perimeter beyond O (n log n).

• Search for the diameter of a set on a plane beyond O (n log n).

• Search for the covering rectangle of the minimum perimeter in O (n log n).

• Search for a covering rectangle of minimum area beyond O (n log n).

• Search for faces of a planar graph in O (n log n).

• Minkowski sum for O (n).

• The Minkowski sum of two convex polygons in O (m + n).

• Check for the intersection of two convex polygons in O (m + n).

• Scanning line.

• Verification of the intersection of the segments.

• The area of the union of the rectangles in O (n log n).

• KD-tree.

• Search for points in a rectangle.

• Search for the nearest neighbor.

• Delaunay triangulation.

• Iterative construction algorithm. Flips. Using the KD tree as a localization structure.

• The algorithm of construction by the method of “Divide and conquer” for O (n log n).

• EMOD - Euclidean minimal spanning tree. Sufficiency of using Delaunay triangulation ribs. O (V log V).

• Voronoi diagram.

• Fortune's algorithm.

• Equivalence of Delaunay triangulation.

4. Combinator games

• Math games. Intuitive concept of winning and losing games.

• Game with stones. There are N stones, a player can take from 1 to K stones. The player who takes the last stone wins.

• Modification: the player who takes the last stone loses.

• Playing coins at the round table. Players take turns placing round coins on a round table so that they do not intersect. A player who cannot make a move loses. Solution by the symmetric strategy method.

• The concept of playing on a graph. Winning and losing peaks.

• Normal and abnormal games. Normal is a game in which the leaves are losing. Reducing an abnormal game to normal.

• Fair and unfair games. Fair, when each player from one position can make the same moves as the opponent. An example of an unfair game: chess, checkers. Reduction of unfair to fair.

• The criterion of winning and losing strategies.

• Determining the optimal strategy based on the number of moves.

• Search for the optimal strategy in acyclic graphs.

• An example of a draw in cyclic graphs.

• The solution to an acyclic abnormal game, where the terminal vertices can be either winning or drawn.

• An iterative algorithm for solving a cyclic game.

• Proof by induction of the correctness of the algorithm.

• Retro analysis. Finding the move in optimal strategy during retro analysis.

• Game with stones. There are N stones, the player can take from a1, a2, ..., aK stones. The player who takes the last stone wins. Reduction to the game on the graph. Dynamic programming without explicit graph storage.

• View along reverse edges. In this case, you only need to look at the edges included in the losing vertices.

• Modification: the player who takes the last stone loses.

• Modification: ai does not exceed 10. In this case, only the previous 10 values are important. The frequency of the game. Estimation of the period.

• Given two piles of stones. The player can take any number of stones from one pile or take the same number of stones from both piles. The game is normal. Finding all losing positions with a total number of stones no more than N for O (N).

• Direct amount of games on the graph.

• Reduction to the usual game on the graph.

• An accurate estimate of the number of vertices and edges in a new graph.

• Inability to analyze such big games.

• Associativity and commutativity of the direct sum (within the meaning).

• A theorem on the possibility of replacing a game in direct sum with an equivalent one.

• The symmetric strategy theorem for acyclic games.

• The theorem that adding to the direct amount of a losing game does not affect the result.

• The theorem on the equivalence of all losing games to neem from zero stones.

• Neem equivalence criterion.

• A theorem on the equivalence of neem games, of which moves are only nym.

• The direct sum of two nims.

• The nonequivalence theorem of two different nims.

• Examples of games with cycles that are not equivalent to neem. Loop, Save.

• A generalization of the neem equivalence theorem to the case when there are moves to games that are not equivalent to neem.

• An iterative algorithm for finding all games equivalent to neem in a cyclic graph.

• Proof that at the end of the algorithm, all unmarked vertices are not equivalent to neem. Induction along the length of the optimal strategy.

• Proof of the fact that uncertain vertices are not losing.

• The direct sum of the two uncertainties of a draw.

• Classification of uncertainties, selection of representatives. Proof that the uncertainty is equivalent to the corresponding representative of the equivalence class.

• Completion of the algebra of direct sums of games.

• Game with stones. There are N stones, the player can take from a1, a2, ..., aK stones. The player who takes the last stone wins. Calculation of the Grandi function.

• Modification: the player who takes the last stone loses.

• Acceptance of graph modifications for abnormal games. The ability to analyze the direct amount only if the player loses when taking the last stone in any pile. Generalization to acyclic graph.

• Modification: ai does not exceed 10. In this case, only the previous 10 values are important. The frequency of the game. Estimation of the period depending on K.

• Game chords. There are N points on the circle, the player connects two points so that the chords do not have common points. The game is normal. This is an example of a game that comes down to a direct sum during the game.

• Oktal games. The decision of an arbitrary octal game.

• An example of a non-octal game. There are a bunch of stones, it is allowed to divide the pile into two not empty and not equal piles.

• Classification of vertices of a functional graph depending on the parity of the cycle.

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Databases/Базы данных

Purpose of the course:

The course "Database" is designed for students who have the basics of programming and requires knowledge of the basic principles of computer operation - working with memory and disk subsystem. Students get acquainted with the basics of relational algebra, the SQL language, get acquainted with the general DBMS device, learn to design a database schema for solving an applied problem, learn the principles of the query optimizer, get acquainted with the mechanisms for ensuring fault tolerance and correct competitive access.

Tasks of the course:

 familiarization of students with tasks that require the use of a database;

 study of existing relational databases;

 the acquisition by students of the skill of using SQL queries.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

 fundamentals of relational algebra;

 principles of database design;

 definition of normal forms;

 general database device;

 basics of SQL;

 basic principles of the query optimizer;

 fault tolerance algorithms;

 isolation levels;

 operating principles of the blocking and multi-version scheduler.

be able to:

- design a database with ER charts;
- write efficient SQL queries;
- create transactions taking into account parallel execution;
- identify and eliminate the causes of deadlocks.

master:

- tools for working with the database;
- tools for database design.

Content of the course (training module), structured by topics (sections):

1. Introduction to the theory of databases

The concept of a database. Relational data model. Data types and domains. Relations. Modern relational DBMS

2. Data logical models

SQL language overview. The SELECT construct. Grouping and aggregate functions.

3. Entity-Relation diagram

Three-valued logic. NULL values. Predicates.

4. Table-Relation diagram

Data integrity. The first, second, third normal forms. The keys. Normalization of databases: theory and practice.

5. Relational Algebra

Constructs UPDATE, INSERT, DELETE.

6. Database schema and data

Locks. Transactions ACID requirements. Isolation levels. The causes of deadlocks and methods of dealing with them.

7. Integrity constraints

Query performance. Optimization methods. The physical device of a relational database.

8. Triggers

Database Administration. The role of DBA. Providing fault tolerance and disaster tolerance. Stages of certification. DDL

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Discrete Mathematics/Дискретная математика

Purpose of the course:

The purpose of the discipline "Discrete Mathematics" is to form:

- world outlook in thematic areas of natural science, associated with the study of the properties of finite or infinite structures with discontinuous processes or the separability of their constituent elements;

- basic knowledge for further use in other areas of mathematics and disciplines of natural science content;

- mathematical culture, research skills and the ability to understand, improve and apply in practice modern mathematical apparatus.

Tasks of the course:

- acquainting students with the main thematic areas of discrete mathematics and the formulation of typical mathematical problems;

- the formation of students' basic knowledge and skills in the application of basic methods for solving typical mathematical problems of discrete mathematics;

- the formation of a general mathematical culture, the ability to think logically, to prove the main statements, to establish logical connections and analogies between concepts;

- the formation of skills and abilities to apply the acquired knowledge for independent problem solving and analysis of the results.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

- operations on sets, basic identities of the algebra of sets;

- addition and multiplication theorems for finite sets;

- the main types of finite samples (permutations, placement, combination, placement and combination with repetitions, permutation with repetitions) and expressions for counting their quantities;

- generalization of the formula for inclusion and exclusion for counting the number of elements with exactly r properties;

- definition of a Boolean function, ways of specifying Boolean functions, elementary Boolean functions of one and two variables;

- canonical types of a Boolean function (SDNF, SKNF, Zhegalkin polynomial), the duality principle;

- definitions of closed and complete systems of Boolean functions, Post's completeness theorem;

- a way to implement a Boolean function in the form of a switch circuit conductance function;

- operations on statements, basic identities of the algebra of statements;

- definitions of the main types of graphs (graph, multigraph, directed and undirected graphs), ways to define them using matrices, definition of isomorphism and connectivity;

- the main types of subgraphs (paths, chains, cycles);

- definitions of Euler, Hamiltonian, semi-Hamiltonian, planar graphs;

- criteria for the Euler and planarity of graphs, an algorithm for constructing an Euler cycle;

- determination of a weighted graph, algorithms of the "wave front" and Dijkstra for finding the shortest paths from the selected vertex of the graph to the rest;

- definitions of a “tree”, “forest”, “spanning tree” of a graph, a “greedy” algorithm for constructing a minimal “spanning tree” of a weighted undirected graph;

- definition of the transport network, full and maximum flows, algorithms for their construction, the theorem on the minimum cut;

- definitions of the code, alphabetical code, properties of one-to-one code;

- definition of the prefix code and the theorem on its one-to-one;

- Kraft - Macmillan inequality;

- algorithms for constructing Fano and Huffman codes;

- determination of a self-correcting code, its geometric interpretation on a unit n-dimensional cube, estimates for the Gil lower bound and the Hamming upper bound;

- definition and properties of the Hamming code.

be able to:

- perform identical transformations according to the rules of set algebra;

- to use the main types of finite samples when solving the simplest combinatorial problems;

- apply the theorems of addition and multiplication for finite sets, generalization of the formula for inclusion and exclusion;

- to reduce the Boolean function to canonical forms (SDNF, SKNF, Zhegalkin polynomial) using the table and the method of algebraic transformations;

- to study the closedness and completeness of the systems of Boolean functions;

- to analyze and synthesize switching circuits, to minimize their conductance function in the DNF class;

- perform identical transformations according to the rules of propositional algebra, establish the truth of complex propositions;

- to specify the main types of graphs using matrices, to investigate the isomorphism of pairs of graphs;

- to apply the criteria of the Euler and planarity of the graphs, to construct the Euler cycle;

- investigate the graph for Hamiltonian and semi-Hamiltonian;

- find the shortest paths from the selected vertex of the weighted graph to the rest;

- find the minimum "spanning tree" of a weighted undirected graph;

- find the full flow in the transport network;

- compile a graph of increments for a flow in a transport network and find the maximum flow;

- find the minimum section of the transport network;

- apply the Craft - Macmillan inequality, build a "tree" of the prefix code;

- build "trees" for Fano and Huffman codes;

- using the Hamming code, encrypt, search for an error and correct it for information messages of arbitrary length.

master:

- methods for solving combinatorial problems;

- methods for solving problems of graph theory, in particular:

- an algorithm for constructing an Euler cycle;

- algorithms of the "wave front" and Dijkstra of finding the shortest paths from the selected vertex of the graph to the rest;

- a “greedy” algorithm for constructing a minimal “spanning tree” of a weighted undirected graph;

- the method of constructing a complete flow in the transport network;

- by the method of constructing the maximum flow in the transport network using the increment graph;

- methods for solving problems of coding theory, in particular:

- algorithms for constructing Fano and Huffman codes;

- the method of applying self-correcting codes.

Content of the course (training module), structured by topics (sections):

1. Algebra of propositions.

Statements and operations on them. Functions, formulas and basic identities of the algebra of logic.

2. An introduction to boolean functions.

Boolean functions: definition, tabular way of assigning, lexicographic order of listing all sets of variables, elementary Boolean functions of one and two variables. Substantial and dummy variables. Representation of Boolean functions by formulas. Equivalence of formulas, basic identities of binary Boolean algebra. A theorem on the (disjunctive) expansion of a Boolean function in the first m variables. SDNF of a nonzero Boolean function. Dual boolean function. Duality principle. A theorem on the (conjunctive) expansion of a Boolean function in the first m variables. The SKNF is not identically equal to one of the Boolean function. Zhegalkin polynomials. Existence and uniqueness of the representation of an arbitrary Boolean function by the canonical Zhegalkin polynomial. Closed and complete systems of Boolean functions. Five classes of Fasting. Post's completeness theorem. Analysis and synthesis of switching circuits. Minimization of Boolean functions in the DNF class.

3. Elements of combinatorics.

Finite sets. Addition and multiplication theorems. Sampling, rearrangement, placement, combination. Placements and combinations with reps. Permutations with repetitions, a polynomial theorem. Inclusion and exclusion formula. Generalization of the inclusion and exclusion formula for counting the number of elements with exactly r properties.

4. Elements of graph theory.

The concept of a graph, methods of assignment. Directed and undirected graphs. Graph isomorphism. Subgraphs, paths, chains, cycles. Graph connectivity. Euler graphs: a criterion, an algorithm for constructing an Euler cycle. Hamiltonian and semi-Hamiltonian graphs. Planar graphs, planarity criterion. Weighted undirected and directed graphs. Algorithms of the "wave front" and Dijkstra for finding the shortest paths from the selected vertex of the graph to the rest. Trees. The spanning tree of the graph. A "greedy" algorithm for constructing the minimum spanning tree of a weighted undirected graph. Transport networks. Full and maximum flows. Algorithm for constructing a complete stream. Increment graph. Algorithm for constructing the maximum flow. Transport network sections. Minimum cut theorem.

5. Elements of coding theory.

The code. Alphabetic coding. Prefix code, its one-to-one. Craft-Macmillan inequality. Fano and Huffman codes, algorithms for their construction. Hamming code. Bug fix. Self-correcting codes. Partitioning the set of vertices of an n-dimensional cube into balls.

6. Elements of set theory.

Sets, operations on sets. Euler - Venn diagrams. Algebra of sets. Basic identities of the algebra of sets.

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Elementary Number Theory and Number System/Элементарная теория чисел и системы счисления

Purpose of the course:

- mastering general mathematical terminology (sets, relationships, functions).

Tasks of the course:

• Develop the skill of structured logical thinking.

• Learn to give formal definitions and give examples of defined objects.

• Learn to build formal records of mathematical statements and their proofs and work with these records.

• Learn to conduct mathematical reasoning, not based on the specific properties of the objects under consideration.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

 fundamental concepts, laws, theories of a part of discrete mathematics;

 modern problems of the corresponding sections of discrete mathematics;

 concepts, axioms, methods of proofs and proofs of the main theorems in the sections included in the basic part of the cycle;

 basic properties of the corresponding mathematical objects.

be able to:

 understand the task at hand;

 use your knowledge to solve fundamental and applied problems;

 evaluate the correctness of the problem setting;

 strictly prove or disprove the statement;

 independently find algorithms for solving problems, including non-standard ones, and analyze them;

 independently see the consequences of the results obtained;

 Accurately present mathematical knowledge in the field orally and in writing.

master:

 skills of mastering a large amount of information and solving problems (including complex ones);

 skills of independent work and mastering new disciplines;

 culture of formulation, analysis and solution of mathematical and applied problems that require the use of mathematical approaches and methods for their solution;

 the subject language of discrete mathematics and the skills of competently describing the solution of problems and presenting the results obtained.

Content of the course (training module), structured by topics (sections):

1. Methods of forming sets

Intuitive concept of a set. Elements of sets. Inclusion and equality of sets. The main ways of forming new sets are: enumeration of all elements, when there are certainly many of them; allocation of a subset by a property; degree (set of subsets) of a set; union of the set. Empty set, Russell's paradox, set intersection

2. Set operations

Operations of union, intersection and complement of sets. Basic identities of the algebra of sets. Set relations. Types of binary relations. Operations of inversion and composition of relations

3. Properties of bijections. Set embedding

Properties of functionality, injectivity, surjectivity and totality of a relation. ... Injections, surjections and bijections. The criterion for the bijectivity of the relationship. Equal cardinality of sets. ABOUT

4. Equivalence classes

Equivalence ratio. Equivalence classes and quotient set. Partitioning a set.

5. Mathematical induction. Recursion. Counting

Power properties of finite and countable sets. Fundamental orders. Induction principle. Equivalence of Funding Conditions, Finiteness of Decreasing Chains, and the Induction Principle

6. Axioms of countable and dependent choice. Formal languages

Words and formal languages. Concatenation of words, empty word. Prefixes and Suffixes. The "prefix" relation as a partial order. Operations on languages. Examples of inductive language definitions. Prefix-free languages. P

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

English I/Английский язык I

Purpose of the course:

the formation and development of intercultural, professionally-oriented communicative competence at the B2/C1 level on the Pan-European scale of foreign language proficiency levels for solving communicative tasks in the sociocultural, academic and professional-business areas, as well as developing professional and personal qualities of bachelor graduates.

Tasks of the course:

- linguistic competence: the ability to understand the speech of other people and express their own thoughts based on knowledge of the language system;

- socio-cultural competence: the ability to take into account in communication speech and nonverbal behavior adopted in the country of the language being studied;

- social competence: the ability to interact with communication partners, working knowledge of relevant strategies;

- discursive competence: knowledge of the rules for constructing of oral and written discourse messages, the ability to build such messages and understand their meaning in the speech of other people;

- strategic competence: the ability to use the most effective strategies in solving communication tasks;

- subject competence: knowledge of subject information in organizing one's own utterance or understanding the utterance of other people;

- compensatory competence: the ability to overcome the communication barrier through the use of well-known speech and meta-language means;

- pragmatic competence: the ability to choose the most effective and expedient way of expressing thoughts, depending on the conditions of the communicative act and the task.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

- basic facts, realities, names, attractions, traditions of English-speaking countries;

- achievements, discoveries, events in the field of history, culture, politics, social life of English-speaking countries;

- Basic phonetic, lexical and grammatical, stylistic features of the English language and its difference from the native language;

- main differences between written and oral speech;

- basic characteristics of the language of a particular area of professional training.

be able to:

- generate adequate, oral and written texts in a specific situation of communication;

- realize the communicative intention with the aim of influencing the communication partner;

- adequately understand and interpret the meaning and intention of the author in perception of oral and written authentic texts;

- identify similarities and differences in native and English language systems;

- show tolerance, empathy, openness and friendliness when communicating with representatives of another culture.

master:

- intercultural professionally oriented communicative competence in various types of speech activity at the B2/C1 level;

- sociocultural competence for successful mutual understanding in terms of communication with representatives of another culture;

- various communication strategies;

- learning strategies for organizing their learning activities;

- strategies of reflection and self-esteem in order to self-improve personal qualities and achievements;

- different methods of memorizing and structuring digestible material;

- Internet technologies to select the optimal mode of obtaining information;

- presentation technologies for providing information.

Content of the course (training module), structured by topics (sections):

1. Change

Human activity and its changes in history. The main trends in doing business. Comparison of life yesterday and today.

Communicative tasks: describe and compare life styles in the 20th and 21st centuries from the point of view of: transport, communication, work, study, prepare a mini-presentation on changes

in the proposed company's work in modern business realities, discuss the main trends in the modernization and development of the city or countries, practice taking notes while reading the text, develop skills for transmitting graphic information in oral and written form.

Vocabulary: phrases, idioms that describe the time, terms used in the management of personal vocabulary, competent work with existing Internet sources to determine the necessary meaning of the searched word, speech cliches typical for describing graphics, histograms, working with phrasal verbs, determining the correct and necessary word meanings in the dictionary.

Grammar: ways and types of comparison of adjectives and adverbs, Continuous forms.

Writing: write a report on population growth in the three proposed countries based on graphs.

EAP (English for Academic Purposes): the use of adverbs, introductory constructions in a scientific and technical text.

2. Feats

Interesting and unusual creatures from the wild. Engineering achievements of the past and present. Informal messages on the topics of everyday life: relocation, successful career, maintaining the balance of work and personal life, acquisitions.

Communicative tasks: use adverbial expressions to describe unusual things in nature, conduct partner interviews on the subject of engineering achievements, determine the level of complexity of proposed communicative situations: a lecture, informal communication, participate in a formal conversation, be able to take notes while listening to an authentic text, discuss what was heard with a partner, briefly report personal achievements based on the vocabulary learned.

Vocabulary: collocations, speech clichés used to describe problems and ways to solve them, work with a dictionary and Internet resources to choose the right word in a phrase, phrases used in conducting interviews, surveys or interviews.

Grammar: noun phrases, phrases with adverbs, Perfect forms.

Writing: write a summary of what you have heard, be able to combine and summarize a concise message about information in the audition and the text.

EAP (English for Academic Purposes): the use of text-phrases, for-phrases in a scientific text.

3. Team

Discussion of human behavior in the proposed situations. Various ways of expressing attitudes towards circumstances and problems. Success and failure in work and personal life.

Communicative tasks: use idioms/phrases with fixed prepositions, discuss in pairs or mini-groups achievements in work and/or study, use auxiliary verbs with correct intonation to strengthen the statement, interview the partner on topics related to work, successes and failures.

Vocabulary: collocations used to describe success and failure, phrasal verbs synonymous in meaning of academic English verbs, associative correlation of synonyms based on context and without using a dictionary, definition of the phrase/collocation value, modified by the preposition used.

Grammar: auxiliary verbs for constructing interrogative/negative sentences and for affirmative sentences in order to strengthen the utterance.

Writing: write a proposal to improve the work of the company.

EAP (English for Academic Purposes): the use of complex sentences in a scientific and technical text.

4. Power

The power of individuals in society. The power and influence of natural phenomena on human activity. Dependence on the Internet, Internet technologies. The contribution of information technology in the development of human activities.

Communicative tasks: describe the advantages and disadvantages of urbanization, using the words and expressions proposed by the TMC (training and methodology complex) for quantitative and qualitative characteristics, use compound adjectives and nouns and then incorporate them into a discussion of statements in pairs and small groups, be able to have a conversation with a partner with the consent, disagreement, contradictions, outrage, resentment and other emotions.

Vocabulary: phrases that indicate the correct use of a union in a complex sentence, expressions with the preposition of for expressing the amount/number of something omeone, compound adjectives and nouns for describing innovation on the Internet.

Grammar: subordinate clauses in a series of complex sentences, quantifiers, emphasis.

Writing: write a forum post on the proposed topics with the obligatory use of the active grammar section.

EAP (English for Academic Purposes): the use of relative subordinates in a scientific and technical text.

5. Emotion and Reason

Discussion of emotions. Suggestion of hypotheses. Reaction to events. The use of linking words and constructions in the text or statement. Metaphorical description of events in academic English.

Communicative tasks: express probability in the past, present and future, make statements using adjectives and participles that describe the emotional coloring of the statement, be able to operate with speech cliches for an instant, as well as deliberate reaction to events, statements, analyze and understand metaphorical constructions.

Vocabulary: a set of phrases to participate in official negotiations on topics related to business, study and work, adverbs that support the statement of both negative and positive phrasal verbs, often used in the description of mental activity and emotional expressions.

Grammar: an expression of unreality, linkers.

Writing: write paragraphs for a website that present recommendations in difficult life situations.

EAP (English for Academic Purposes): the use of linkers in a scientific and technical text.

6. Plastic

Description of the properties of materials. Proper use of academic and spoken language, depending on the situation. The ability to concentrate on the main thing in listening. The reasoning, comparison and comparison of facts and details.

Communicative tasks: discuss differences in medicine, clothing and households in the past and present, talk with a partner using phrasal verbs, speculate with a partner about the importance of body language in a public speech, identify differences in the expression of probability and possibility.

Vocabulary: adjectives, describing the properties of materials, phrasal verbs to describe past habits, various colocations, characteristic of the spoken language, applicable in academic.

Grammar: participle clauses.

Writing: write a problem-solution essay.

EAP (English for Academic Purposes): the use of participles in scientific and technical texts.

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Foundations of Programming I/Основы программирования I

Purpose of the course:

is to learn the practical skills of applying this knowledge.

Tasks of the course:

• Statement of the basic principles of functional programming, their main applications in modern programming

• Providing the student with guidelines for further independent study of individual issues in specialized sections of mathematical logic and programming.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

• the role of programming in solving problems;

• The existing sets of programming tools, as well as trends and prospects for their development;

• Theory and practice of lambda calculus.

be able to:

• develop software applications for solving tasks in a programming language;

• develop algorithms for solving programming problems.

master:

• Up-to-date programming knowledge.

• Knowledge of the basics of lambda calculus;

• Skills in using lambda - calculus as a programming language;

• Skills in the basics of object-oriented programming.

Content of the course (training module), structured by topics (sections):

1. Programming basics

Operators and type casting

Program structure: functions, procedures and scopes

2. Arrays and strings

Pointers and relationship to arrays

Advanced data types

3. Basic data structures: vector, stack, queue and deque

Debugging techniques

Memory management

4. Bitwise operations

Hash functions and hash tables

Standard library overview

5. Build systems and continuous integration

Version control systems

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Foundations of Programming II/Основы программирования II

Purpose of the course:

is to learn the practical skills of applying this knowledge.

Tasks of the course:

• Statement of the basic principles of functional programming, their main applications in modern programming

• Providing the student with guidelines for further independent study of individual issues in specialized sections of mathematical logic and programming.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

• the role of programming in solving problems;

• The existing sets of programming tools, as well as trends and prospects for their development;

• Theory and practice of lambda calculus.

be able to:

• develop software applications for solving tasks in a programming language;

• develop algorithms for solving programming problems.

master:

• Up-to-date programming knowledge.

• Knowledge of the basics of lambda calculus;

• Skills in using lambda - calculus as a programming language;

• Skills in the basics of object-oriented programming.

Content of the course (training module), structured by topics (sections):

1. Build systems and continuous integration

Version control systems

2. Introduction to Object-oriented programming

Objects and classes. Encapsulation

3. Template functions and template classes

Iterators: usage and implementation

4. Standard Template Library design and implementation overview

String classes. One byte and wide char strings

5. Exceptions and error handling. Input/Output classes

Object lifetime management. Smart pointers

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Fourier Analysis/Фурье анализ

Purpose of the course:

the formation of systematic knowledge about the methods of mathematical analysis, the expansion and deepening of concepts such as function and series.

Tasks of the course:

• formation of students' theoretical knowledge and practical skills in the theory of trigonometric Fourier series and the principles of functional analysis;

• preparing students for the study of related mathematical disciplines;

• acquisition of skills in the application of methods of mathematical analysis in physics and other natural science disciplines.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

- basic facts of the theory of trigonometric Fourier series of absolutely integrable functions: sufficient conditions for pointwise and uniform convergence;

- theorems on term-by-term integration and differentiation, order of decreasing coefficients, a theorem on the summation of Fourier series by the method of arithmetic means and its application;

- definition of convergence in metric and linear normed spaces, examples of complete and incomplete spaces;

- examples of complete systems in normed linear spaces;

- basic concepts of the theory of Fourier series in an orthonormal system in an infinite-dimensional Euclidean space;

- definition of proper and improper integrals depending on a parameter, their properties; theorems on continuity, differentiation and integration with respect to the parameter of improper integrals, their application to the calculation of integrals;

- a sufficient condition for the representation of a function by the Fourier integral;

- Fourier transform of an absolutely integrable function and its properties;

- basic concepts of the theory of generalized functions, the Fourier transform of generalized functions, its properties.

be able to:

- to expand functions in trigonometric Fourier series, to investigate it for uniform convergence, to determine the order of decreasing of Fourier coefficients;

- to investigate the completeness of systems in functional spaces;

- investigate the convergence and uniform convergence of improper integrals with a parameter, differentiate and integrate them with respect to the parameter;

- to represent functions by the Fourier integral; perform Fourier transforms;

- operate with generalized functions.

master:

- thinking, methods of proof of mathematical statements;

- skills of working with Fourier series and integrals in various forms;

- the skills of applying the studied theory in mathematical and physical applications;

- the ability to use the necessary literature to solve problems.

Content of the course (training module), structured by topics (sections):

1. Summation of Fourier series by the method of arithmetic means.

Riemann's lemma. Trigonometric Fourier series for absolutely integrable functions, the tendency of their coefficients to zero. Representation of the partial sum of the Fourier series by an integral in terms of the Dirichlet kernel. Localization principle. Dini and Lipschitz tests for convergence of Fourier series, consequences of the Lipschitz test. Uniform convergence of Fourier series. Term-by-term integration and differentiation of Fourier series. Decreasing order of Fourier coefficients. Fourier series in complex form.

2. Metric and linear normed spaces.

Summation of Fourier series by the method of arithmetic means. Weierstrass' theorems on the approximation of continuous functions by trigonometric and algebraic polynomials.

3. Infinite-dimensional Euclidean spaces.

Metric and linear normed spaces. Convergence in metric spaces. Complete metric spaces, complete normed linear (Banach) spaces. Completeness of space Incompleteness of the space of continuous functions on an interval with integral norms. Comparison of norms: comparison of uniform convergence, convergence in mean and mean square. Complete systems in normed linear spaces.

4. Trigonometric Fourier series for functions absolutely square integrable.

Infinite-dimensional Euclidean spaces. Fourier series in the orthonormal system. Minimal property of Fourier coefficients, Bessel inequality. Parseval's equality. Orthonormal basis in infinite-dimensional Euclidean space. Hilbert spaces. A necessary and sufficient condition for a sequence of numbers to be a sequence of Fourier coefficients of an element of a Hilbert space with a fixed orthonormal basis. Relationship between the concepts of completeness and closedness of an orthonormal system.

5. Proper integrals and improper integrals.

Trigonometric Fourier series for functions that are absolutely square integrable. Completeness of the trigonometric system, Parseval's equality. Completeness of the system of Legendre polynomials.

6. Fourier integral.

Eigen integrals depending on a parameter and their properties. Improper integrals depending on a parameter; uniform convergence. Cauchy criterion for uniform convergence, Weierstrass test. Dirichlet test. Continuity, differentiation and integration with respect to the parameter of improper integrals. Application of the theory of integrals depending on a parameter to the calculation of definite integrals. Dirichlet and Laplace integrals. Euler's integrals - gamma and beta functions.

7. The space of basic functions and the space of generalized functions.

Fourier integral. Representation of a function by the Fourier integral. Fourier transform of an absolutely integrable function and its properties: continuity, tending to zero at infinity. Conversion formulas. The Fourier transform of the derivative and the derivative of the Fourier transform.

8. Fourier transform of generalized functions.

Space of basic functions and space of generalized functions. Regular and singular generalized functions. Delta function. Multiplication of generalized by infinitely differentiable. Convergence in the space of generalized functions. Differentiation of generalized functions.

9. Trigonometric Fourier series for absolutely integrable functions.

Fourier transform of generalized functions. The Fourier transform of the derivative and the derivative of the Fourier transform.

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Functions of One Complex Variable/Теория функций комплексного переменного

Purpose of the course:

• studying methods and mastering the apparatus for analyzing functions of a complex variable for their application in solving problems of mathematical physics, hydrodynamics, aerodynamics, etc.

Tasks of the course:

• study of the properties of regular functions, expansion of regular functions in a ring in the form of a sum of a Laurent series;

• the ability to investigate isolated singular points of a function and apply the theory of residues to calculate integrals, including improper integrals of functions of a real variable;

• possession of the method of conformal mappings when solving problems of equations of mathematical physics on a plane.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

- Cauchy-Riemann conditions, Cauchy integral theorem, Cauchy integral formula;

- criteria for the regularity of functions: the Morer and Weierstrass theorems, the representation of a regular function given in an annulus as a sum of a Laurent series; types of isolated feature points;

- the concept of a deduction at an isolated singular point;

- Cauchy's theorem on the calculation of integrals in terms of the sum of residues;

- the concept of a regular branch of a multivalued function;

- the concept of conformal mapping, linear fractional functions and Zhukovsky functions;

- Riemann's theorem on the conformal equivalence of simply connected domains;

- the solution of the classical Dirichlet problem for the Laplace equation on the plane by the method of conformal mappings.

be able to:

- represent a regular function defined in a ring as the sum of a Laurent series;

- find and investigate isolated singular points of a function;

- apply the theory of residues to calculate integrals, including improper integrals of functions of a real variable;

- find functions that carry out conformal mapping of given areas;

- to apply the method of conformal mappings when solving the Dirichlet problem for the Laplace equation on the plane.

master:

- methods of complex analysis used in calculating integrals using residues;

- methods of complex analysis used in solving problems of hydrodynamics, aerodynamics, mathematical physics, etc.

Content of the course (training module), structured by topics (sections):

1. Elementary functions of a complex variable, their differentiability and integrability along a contour. Cauchy-Riemann conditions. Inverse function theorem. Multivalued functions. Main regular branches of functions. Integral Cauchy theorem. Integral Cauchy formula.

1.1. Complex numbers. Extended complex plane. Riemann sphere. Sequences and Rows. The concept of a function of a complex variable. Continuous functions.

1.2. Differentiation with respect to a complex variable. Cauchy - Riemann conditions. The concept of a function that is regular in a domain. Conjugate harmonic functions of two variables.

1.3. Elementary functions of a complex variable: power, rational, exponential and trigonometric, their properties. Inverse function theorem (non-degenerate case). The concept of a multivalued function and its regular branches. Main regular branches of multivalued functions.

1.4. Integration over a complex variable. Integral Cauchy theorem for regular functions (proof for the case of a piecewise smooth contour in a simply connected domain). Cauchy integral formula (Cauchy integral). Integral of Cauchy type, its regularity.

1.5. Antiderivative. A sufficient condition for the existence of an antiderivative. Formula of Newton - Leibniz. Morer's theorem.

1.6. Increment of the argument z along a smooth contour, its integral representation and properties. Increment of the argument of the function f (z) along a continuous contour and its properties. General view of regular branches of multivalued functions in a simply connected domain that does not contain zero. Existence conditions and general form of regular branches of multivalued functions.

2. Power series. Taylor series for a regular function. Laurent series for a regular function in a ring.

2.1. Power series, Abel's first theorem, radius and circle of convergence. Expansion in a power series of a function regular in a circle. Weierstrass theorems for uniformly converging series of regular functions.

2.2. Laurent series and its ring of convergence. Laurent series expansion of a function regular in an annulus, its uniqueness and Cauchy inequality for the coefficients of the Laurent series. Uniqueness theorem for regular functions.

3. Isolated singular points. Deductions. Calculation of integrals.

3.1. Isolated singular points of an unambiguous nature, their classification. Determination of the nature of the singular point by the main part of the Laurent series.

3.2. Deductions. Calculation of integrals using residues. Lemma Jordan.

4. Entire and meromorphic functions. Their properties. The concept of analytic continuation. Singular points of analytic functions. The principle of argument. Rouche's theorem.

4.1. Entire functions. Liouville's theorem. The theorems of Sokhotskii-Weierstrass and Picard (the latter without proof) for entire functions.

4.2. Meromorphic functions. Expansion of meromorphic functions into a finite sum of elementary fractions.

4.3. The concept of the analytic continuation of elements into each other using a finite chain of circles and along a contour, the equivalence of these concepts. Uniqueness of the analytic continuation. The concept of an analytic function and its Riemann surface. The monodromy theorem (without proof).

4.4. Singular points of analytic functions, branch points. The Cauchy-Hadamard theorem on the presence of a singular point on the boundary of the circle of convergence of a power series.

4.5. The principle of argument. Rouche's theorem. The main theorem of algebra.

5. Geometric principles of regular functions. Conformal mappings in the extended complex plane.

5.1. Openness lemma. The principle of preserving the area. Univalence and multi-sheet in small. The principle of maximum modulus of a regular function. Principle of maximum and minimum of a harmonic function. Schwarz's lemma.

5.2. The geometric meaning of the modulus and argument of the derivative. The concept of conformal mapping in the extended complex domain.

5.3. Fractional linear functions and their properties.

5.4. Conformal mappings using elementary functions. Zhukovsky function and its properties. Riemann's theorem on the conformal equivalence of simply connected domains and the principle of boundary correspondence (without proof).

5.5. Cut erasure theorem. Symmetry principle for conformal mappings.

6. The classical Dirichlet problem for the Laplace equation in the plane.

6.1. The classical Dirichlet problem for the Laplace equation. Uniqueness of the solution. Poisson's integral for a circle. Existence of a solution to the Dirichlet problem for the Laplace equation.

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Fundamentals of Financial and Economic Analysis and Planning/Основы финансово-экономического анализа и планирования

Purpose of the course:

- to introduce students to the methods of financial calculations to improve their financial literacy;

– formation of skills for analyzing financial and economic problems at micro and macro levels;

– acquisition of skills for making informed economic decisions in the areas of life.

Tasks of the course:

As a result of studying the course, the student must:

- know the main results of the financial aspects of micro- and macroeconomic theory

– have the skills of economic modeling to make informed economic decisions.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

- the key provisions of the sections of micro- and macroeconomic theory related to financial analysis, as well as to have an idea of the possibilities of applying the theory to analyze the financial and economic consequences of decisions made;

be able to:

Be able to: - to model and analyze situations using micro- and macroeconomic financial tools, as well as to interpret the results obtained;

master:

- the logic of economic analysis and approaches to solving financial and economic problems.

Content of the course (training module), structured by topics (sections):

1. The basics of an individual's financial literacy

Efficiency of investing available funds in the banking sector: deposits, interest rates. Alternative options for investing money (bonds, stocks, promissory notes). Discounting as a financial computing tool. The behavior of an individual in conditions of uncertainty. The task of forming an optimal investment portfolio. Insurance demand model. The utility function of the consumer. Constructing a utility function based on indifference curves. Examples of utility functions for basic preference types. Consumer choice. The task of maximizing utility under budget constraints. Demand functions. The concept of revealed preference. A weak axiom of revealed preferences.

2. Macroeconomic aspects of financial activity Modern financial markets.

Capital markets and money markets. Financial market instruments. Global financial centers and exchanges. The demand for money and the supply of money. Money supply (aggregates H0, M0, M1, M2, M3). Creation of deposits in the banking system. Money multiplier. Banks and the banking system. Banks in the era of globalization and the digital economy. The Central Bank and its functions. Instruments the influence of the state on the supply of money (operations on the open market, changes in the key interest rate, changes in the reserve rate). Current trends in financial markets: Bitcoins. Inflation: causes, its types and impact on the economy of consumption and the economy of development. Exchange rates: how they are formed and their impact on economic dynamics. The problem of capital outflow for the Russian Federation.

3. State regulation of the economy and finance GNP as the sum of incomes of economic entities.

State regulation of the economy and finance GNP as the sum of incomes of economic entities. Investments and savings. Budget deficit. The equilibrium level of GDP. Keynes multipliers. The State budget of the Russian Federation: sources of replenishment and spending directions. Taxes and other mandatory payments. Economic models to demonstrate the consequences of government decisions. The AD-AS (closed economy) model. The formula of the country's trade balance. The balance of payments. The IS-LM-BP (Open Economy) model.

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Fundamentals of Topology/Основы топологии

Purpose of the course:

mastering the main modern methods of topology

Tasks of the course:

• mastering by students of basic knowledge (concepts, concepts, methods and models) in topology;

• acquisition of theoretical knowledge and practical skills in topology;

• providing advice and assistance to students in conducting their own theoretical research in topology.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

 fundamental concepts, laws, theory of topology;

 modern problems of the relevant sections of topology;

 concepts, axioms, methods of proofs and proofs of theorems in the sections included in the basic part of the topology cycle;

 basic properties of the corresponding mathematical objects;

 analytical and numerical approaches and methods for typical applied topology problems.

be able to:

 understand the task at hand;

 use your knowledge to solve fundamental and applied problems;

 evaluate the correctness of the problem setting;

 strictly prove or disprove the statement;

 independently find algorithms for solving problems, including non-standard ones, and analyze them;

 independently see the consequences of the results obtained;

 Accurately represent mathematical knowledge in topology orally and in writing.

master:

 skills of mastering a large amount of information and solving topology problems (including complex ones);

 skills of independent work and mastering new disciplines;

 culture of formulation, analysis and solution of mathematical and applied problems that require the use of mathematical approaches and methods for their solution;

 the subject language of topology and the skills of competently describing the solution of problems and presenting the results obtained.

Content of the course (training module), structured by topics (sections):

1. Topological spaces.

open and closed sets. Continuous displays

2. Linear connectivity.

Fundamental group of space with selected point

3. Hausdorff property.

The concept of a cell complex. Various options for the formulation of axiom (W)

4. One-dimensional and two-dimensional manifolds.

Classification of one-dimensional manifolds

5. Planarity of graphs and flat graphs.

Proof of nonplanarity of graphs K5 and K3,3

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Geometry/Геометрия

Purpose of the course:

to provide students with foundations of analytic geometry that will help them to study advanced mathematical disciplines – differential equations, complex analysis, mathematical physics, functional analysis, analytical mechanics, theoretical physics, methods of optimal control, etc.

Tasks of the course:

- to provide students with theoretical knowledge and practical skills in geometry;

- to motivate students towards treatment of related mathematical disciplines;

- to equip students with skills to apply techniques of analytic geometry in physics and other natural sciences.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

- methodical foundations of study and use of mathematical statements;

- foundations of the course.

be able to:

- develop, use and apply definitions and theorems;

- study and form systems of mathematical knowledge;

- prove main theorems of the course;

- solve standard problems on topics covered in the course.

master:

- the essential concept of the course.

Content of the course (training module), structured by topics (sections):

1. The initial geometric information

Points, lines, line segments. Ray. Angle. Comparison of segments and angles. Measurement of segments. Measurement of angles. Adjacent and vertical angles. Perpendicular lines. Parallel lines.

2. Triangle

Signs of equality of triangles. Medians, bisectors and heights of a triangle. Properties of an isosceles triangle. Sum of the angles of a triangle. Equilateral triangles. Area of a triangle. Pythagorean theorem. Similar triangles. Law of sines. Law of cosines.

3. Polygons

Convexpolygon. Quadrilateral. Parallelogram. Characteristics of a parallelogram. Trapezoid. Rectangle. Rhombus. Square.

4. Circle

Tangent to a circle. Degree measure of an arc of a circle. Inscribed angle theorem. Inscribed circle. Circumscribed circle. Length of a circle and area of a circle.

5. Elements of stereometry

Polyhedron. Parallelepiped. Prism. Cylinder. Cone. Sphereandball. Bodyvolume.

6. Matrixes

Operations of addition of matrices and multiplication of matrices by numbers. Matrix multiplication and inversion. Determinants of square matrices of 2-nd and 3-rd orders. Solving systems of linear equations by the Cramer method.

7. Vector space

Linear spaces and their basic properties. Directed segments and actions on them. Operations of adding directed segments and multiplying them by numbers. Their property. Commutativity, associativity and distributivity of vector operations.

8. Basis

Linearly dependent and linearly independent systems of vectors. Basis, coordinates of vectors in the basis. Coordinate representation of vectors. Operations with vectors in coordinate representation. Changing the coordinates of the vector when replacing the basis. Necessary and sufficient condition for linear dependence of vectors in coordinate form.

9. Cartesian coordinate system

Linearly dependent and linearly independent systems of vectors. Basis, coordinates of vectors in the basis. Coordinate representation of vectors. Operations with vectors in coordinate representation. Changing the coordinates of the vector when replacing the basis. Necessary and sufficient condition for linear dependence of vectors in coordinate form.

10. Scalar product

Orthogonal projections of vectors and their properties. Scalar product: properties, coordinate expression. Formulas for the distance between two points and the angle between two directions.

11. Vector product

Oriented set of vectors. Vector product, its properties, expression in orthonormal basis. Geometric meaning of the vector product. Expression of a vector product in an arbitrary basis.

12. Mixed product

Triple product of vectors, its properties, expression in arbitrary and orthonormal bases. The geometric meaning of the triple product. Conditions of collinearity and coplanarity of vectors. The formula of a double vector product. Derivation of the double vector product formula.

13. Algebraic lines and surfaces

Coordinate equation of lines on the plane, surfaces in space. Invariance of the order of algebraic lines on the plane when replacing the Cartesian coordinate system. Coordinate equation of a lines in space. Invariance of the order of algebraic lines and surfaces in space when replacing the Cartesian coordinate system. Coordinate equations of figures on the plane and bodies in space.

14. Straight and planes

A line on a plane. Vector and coordinate equations of a line. Positional and metric problems on lines on a plane. Translation of one form of description of lines on a plane into other form.

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Health Concepts & Strategies/Физическая культура

Purpose of the course:

To form a worldview system of practical knowledge and attitude to physical culture.

Tasks of the course:

- To form an understanding of the social role of physical culture in the development of personality and its preparation for professional activities;

- to form the knowledge of the scientific, biological and practical foundations of physical education and a healthy lifestyle;

- to form a motivational-value attitude to physical culture, the attitude towards a healthy lifestyle, physical self-improvement and self-education, the need for regular exercise and sports.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

Scientific, practical and special foundations necessary for understanding the natural and social processes of the functioning of the physical culture of society and the individual, the ability to adapt and creatively use them for personal and professional development, self-improvement, and organizing a healthy lifestyle when performing educational, professional and sociocultural activities. Understand the role of physical culture in human development and specialist training.

be able to:

Use physical culture and sports activities to enhance their functional and motor capabilities, to achieve personal life and professional goals.

master:

A system of practical skills ensuring the preservation and strengthening of health, the development and improvement of psychophysical abilities and qualities (with the implementation of established standards for general physical and sports-technical training).

Content of the course (training module), structured by topics (sections):

1. General physical preparation.

Education of physical qualities.

2. Special physical preparation.

Special physical training

3. Professional and applied physical preparation

PROFESSIONAL APPLIED PHYSICAL TRAINING

4. Theoretical preparation.

The material of the section provides for the students to master the system of scientific, practical and special knowledge necessary for understanding the natural and social processes of the functioning of the physical culture of society and the individual, the ability to adapt and use them creatively for personal and professional development,

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

History/История

Purpose of the course:

The formation of a comprehensive understanding among students about the historical development of Russia, its place in world and European civilization, systematic knowledge of the basic laws and features of the world-historical process, with an emphasis on studying the his-tory of Russia.

Tasks of the course:

• Knowledge of the driving forces and patterns of the historical process; a person's place in the his-torical process, political organization of society; • understanding of citizenship and patriotism as devotion to their Fatherland, the desire to serve its interests with its actions, including and protect-ing the national interests of Russia;

• formation of the spirit of morality and toler-ance;

• understanding the diversity of cultures and civilizations in their interaction, the multivariance of the historical process;

• understanding of the place and role of the graduate's field of activity in social development, interconnection with other social institutions;

• development of skills for obtaining, analyzing and summarizing historical information, the ability to think logically;

• creative thinking, independent judgments, interest in domestic and world cultural and scientific heritage, its preservation and enhancement.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

The basic laws of the historical process;

stages of historical development of Russia, periodiza-tion and chronology of its history;

the place and role of Russia in the history of mankind and in the modern world;

the main facts, events, phenomena and processes, key dates, geographical realities and personalities of the history of Russia in their relationship and in chrono-logical sequence;

 concepts and terms related to the history of Russia;

 the main problems and historiographic concepts of domestic history.

be able to:

 Analyze the problems of the history of Russia, establish causal relationships;

 analyze and evaluate social and economic infor-mation;

 plan and carry out their activities taking into account the results of this analysis;

 make essays on a given topic;

 correctly evaluate and select the necessary infor-mation, analyze, systematize and generalize it.

master:

 General scientific and special historical methods, ways and means of research in the field of domestic history;

 ideas about the events of Russian and world history, based on the principle of historicism;

 skills of analysis of historical sources;

 skills of written reasoned presentation of their own point of view;

 skills of critical perception of information;

 basic terminology and conceptual apparatus in the field of Russian history.

Content of the course (training module), structured by topics (sections):

1. History in the system of social sci-ences and humanities. Foundations of the methodology of history

The place of history in the system of sciences. The object and subject of historical science. The role of theory in the knowledge of the past. Theory and methodology of his-torical science. The essence, forms, functions of histori-cal knowledge. The history of Russia is an integral part of world history: general and special in historical devel-opment. The main directions of modern historical sci-ence. The formation and development of historiography as a scientific discipline. Sources on domestic history. Methods and forms of obtaining, analyzing and preserv-ing historical information. Factors of historical develop-ment: climatic, ethnic, economic, cultural and political.

2. Eastern Slavs. Ancient Rus

Settlement of Eastern Europe. Northern Black Sea Coast in the 1st millennium BC - beginning of I millennium AD Slavs and the Great Migration of Peoples (IV – VI centuries). Slavic tribes in Europe and their neighbors. Byzantium and the peoples of Eastern Europe. Life and economy of the Eastern Slavs. Public relations and be-liefs. Slavic pantheon and pagan rites. Problems of eth-nogenesis and the early history of the Slavs in historical science.

The formation of Russian state. Formation of tribal un-ions. Veche and its role in ancient Slavic society. Prince and “druzhina”. The trade route "from the Vikings to the Greeks." The legend of the calling of the Varangians and its historical foundations.

The first Russian princes and their activities: military campaigns and reforms. Tributes.

The formation of the Old Russian state. The evolution of Old Russian statehood in the XI – XII centuries: from au-tocracy to civil strife. Old Russian city. Military, diplo-matic and trade contacts of Russia and Byzantium in the IX – X centuries. St. Vladimir. The introduction of Christianity and its cultural and historical significance.

The Middle Ages as a stage of the historical process in Western Europe, the East and Russia: technologies, in-dustrial relations and methods of exploitation, political systems. Feudalism of Western Europe and the socio-economic system of Ancient Russia: similarities and dif-ferences. Dominant traditions and institutions in the states of Eastern, Central and Northern Europe in the ear-ly Middle Ages. Neighbors of Ancient Russia in the 9th – 12th centuries: Byzantium, Slavic countries, Western Europe, Khazaria, Volga Bulgaria. International relations of the ancient Russian lands. Cultural influences of East and West.

The Ancient Russian state in the assessments of modern historians. Discussion on the nature of socio-economic formation in domestic science.

Yaroslav the Wise. "Russian truth." Power and property. The main categories of the population. Prince and boyars. The origins of Russian culture. The formation of national culture. Folklore. Slavic writing. Ancient Russian litera-ture.

The reasons for the divisions in independent principali-ties. The internecine strife of the princes. The largest lands and principalities of Russia, their features. Velikiy Novgorod. Economic, social and political development. Vladimir-Suzdal principality. The role of cities and crafts. Political structure. Galicia-Volyn principality. Ag-riculture, cities and crafts. The role of the boyars. The unification of the principalities under Roman Mstislavich and Daniil of Galich.

3. Mongol conquest and yoke. Rus-sian lands in the XIII-XIV centu-ries and European Middle Ages

The socio-economic system of the Mongol tribes. The formation of the Mongol power. Reasons and directions of Mongolian expansion. Ulug Ulus. Horde invasion of Russia. The formation of the Golden Horde, its socio-economic and political structure. Russia under the rule of the Golden Horde. Alexander Nevsky and Daniil Galitsky. Imperial order. The mongol yoke and the dis-cussion of its role in the formation of the Russian state. Islamization of the Horde and the position of the Ortho-dox Church.

Aggression of the crusaders in the Baltic lands. Knightly orders. The struggle of the peoples of the Baltic and Rus against the crusaders. The defeat of the Swedes on the Neva. Battle on the Ice. The unification of Lithuanian lands and the formation of the Lithuanian state. Russian lands as part of the Grand Duchy of Lithuania.

Recovery of the economic level after the invasion of the Mongol-Tatars. Forms of ownership and population cat-egories. Prince and nobility. City and craft. Church and clergy, heretical movements.

Russia and the Golden Horde in the 14th century: the struggle for a great reign. Economic and political strengthening of the Moscow principality. The struggle of Moscow and Tver. Ivan Kalita. Dmitry Donskoy and the beginning of the struggle for the overthrow of the Horde yoke. Battle on the Vozha river. The Kulikovo battle and its significance. Separation of the western terri-tories of Russia. Grand Duchy of Lithuania and Poland. The special situation of the Novgorod Republic. Rela-tions with Moscow.

4. Russia in the XV-XVII centuries in the context of the development of European civilization

Strengthening the Moscow state. The completion of the process of collecting eastern Russian lands. Ivan III. Ac-cession of Novgorod and other lands. Great Stand on the Ugra river. The formation of a single Russian state. Polit-ical system. Formation of central and local authorities. Judicial Code of 1497 Boyar Duma. Sovereign Court. Orders. Compensation as a form of remuneration for "of-ficials". Organization of the troops. Church and Grand Duchy. The struggle between the Josephites and non-possessors. Neil Sorsky and Joseph Volotsky. Church Council of 1503

The territory and population of Russia in the XVI centu-ry. Vasily III and his politics. Elena Glinskaya. Boyar rule. The coronation of Ivan the Terrible, the formation of autocratic ideology. The «Chosen Council» and its re-forms. Zemsky Council. Judgment book of 1550. Church and state. The Stoglavy Synod. Military reform.

The main directions of foreign policy of Ivan IV. The in-clusion of Kazan, Astrakhan Khanate in Russia and the beginning of the annexation of Siberia. Strengthening Russia's position in the Caucasus. Relations with the Crimean Khanate. "Wild field." Cossacks. The struggle for access to the Baltic Sea. Livonian war (1558-1583). Formation of the Commonwealth (1569).

Oprichnina and the reasons for its introduction. Oprich-nina and terror. Socio-economic and political conse-quences of the oprichnina.

Fedor Ioannovich. Russian foreign policy at the end of the 16th century The establishment of the patriarchate. The construction of fortifications on the southern and western borders. The problem of succession. Boris Go-dunov and his politics. The establishment of the patriar-chate.

Ecological crisis and uprisings of the beginning of the XVII century. XVII century - the era of the general Euro-pean crisis. The synchronism of crisis situations in dif-ferent countries. The beginning of the Troubles. Impos-tors. The participation of Poland and Sweden in the Time of Troubles. Seven Boyars. Intervention. The first and second militias. Kuzma Minin and Dmitry Pozharsky. Zemsky Council in 1613 and the beginning of the Ro-manov reign.

The territory and population of Russia in the XVII centu-ry. Domestic and foreign policy of the first Romanovs. Cathedral Code of 1649. Legal registration of serfdom and estate functions. Urban uprisings of the middle of the XVII century. The political system of Russia. The devel-opment of the command system. The fall of the role of the Boyar Duma and Zemsky Council. Features of the es-tate-representative monarchy in Russia. Discussions on the genesis of autocracy. Nikon reforms and church schism. Cultural and political significance. Peasant war led by Stepan Razin.

The main directions of Russian foreign policy in the XVII century. Joining of the Left-Bank Ukraine. Wars with Sweden and Turkey. The development of Siberia and the Far East.

The "secularization" of Russian culture in the 17th centu-ry Expanding of cultural ties with Western Europe. Crea-tion of schools. Slavic-Greek-Latin Academy. New gen-res in literature.

5. Russia and the outer world in the XVIII-XIX centuries: attempts of modernization and the industrial revolution

The process of modernization of the Western world. The emergence of a new economic structure in the economy. Peter I: the struggle for the transformation of traditional society in Russia. The main directions of "Europeaniza-tion" of the country. The evolution of the social structure of society. The development of heavy and light industry. Creation of the Baltic Fleet and regular army. Church re-form. Proclamation of Russia by the empire. The assimi-lation of European technical culture and the principles of effective public administration. The foreign policy of Russia under Peter I. Azov campaigns. Great Embassy. The participation of Russia in the Northern War. Treaty of Nystad. Prut campaign. Strengthening of Russia's po-sition in the Black Sea region. Views on Peter's reforms in modern Russian historiography.

The era of palace coups. Catherine I. Supreme Privy Council. Peter II. "The Plan" of the leaders and the reign of Anna Ioannovna. Bironovschina. The political strug-gle and the palace coup of 1741. Socio-economic policy of Elizabeth Petrovna. Russia's participation in the Seven Years War. The reign of Peter III. The palace coup of 1762 and the accession of Catherine II to the throne.

"Enlightened absolutism" and its features in Austria, Prussia, and Russia. Russia's participation in pan-European conflicts - wars for the Polish and Austrian in-heritance, in the Seven Years War. "Ottoman factor" of European politics; Russia's contribution to the fight against the Turkish threat. Strengthening of the interna-tional authority of the country.

Catherine II: the origins and essence of the "dualism" in her domestic politics. "Enlightened absolutism." The up-rising led by Emelyan Pugachev. The nature and orienta-tion of the reforms of Catherine the Great. The new legal status of the nobility. Sections of Poland. The annexation of Crimea and a number of other territories in the south. Domestic and foreign policy of Paul I. Russian culture in the middle of the XVIII century. Enlightenment ideas and "Enlightened society" in Russia. Achievements of architecture and fine art. Baroque and classicism in Rus-sia.

The territory and population of the Russian empire. Fea-tures of Russian colonization. The role of the geograph-ical factor in the socio-economic and political develop-ment of Russia. The national question. Social structure. Nobility. Clergy. Urban population. Peasantry. Cossacks. Social and cultural gap between estates. Aristocratic cul-ture and the "culture of the silent majority."

Reforms of the beginning of the reign of Alexander I. Ideological struggle. M.M. Speransky, N.N. Novosiltsev, N.M. Karamzin. The French Revolution and its influence on the political and sociocultural development of Euro-pean countries. World War 1812. Russia in 1815–1825. Constitutional drafts. The reasons for the failure of the reforms of Alexander I. A.A. Arakcheev. Military settle-ments. Social movements and the Decembrist uprising. The significance of Russia's victory in the war against Napoleon and the liberation campaign of Russia in Eu-rope to strengthen Russia's international position. Rus-sian autocracy and the "Holy Union". Change in political course in the early 1820s: causes and consequences.

Nicholas I. Change of political priorities. The role of bu-reaucracy. Official nationalism. Conservatism in the state legal and ideological spheres. Domestic policy of Nicho-las I. Russian legal system. Code of laws of the Russian Empire. State. Features of the Russian monarchy. The system of ministries. Russia and the Christian peoples of the Balkan Peninsula. Russian Empire

and Muslim peo-ples of the Caucasus. Caucasian war. Transcaucasia in the politics of the Russian Empire; struggle with Iran for territory and influence. The entry of Transcaucasia into Russia. Russia and the European Revolutions of 1830–1831, 1848–1849. The Crimean War and the collapse of the "Vienna System".

Reforms of Alexander II. Peasant question: stages of so-lution. Reasons for the abolition of serfdom. Discussion on the economic crisis of the system of serfdom in Rus-sia. The abolition of serfdom and its outcome: economic and social aspects. Judicial and military reforms. Zem-stvo. Financial reforms. Reforms in the field of education and the press. The results of the reforms, their historical significance. Liberals and conservatives. Socialist ideas in Russia. Russian radicals: from nihilists to rebels, propagandists and conspirators. From Narodniki circles to "Narodnaya Volya". Government repressions and rev-olutionary terror. The assassination of Alexander II.

The industrial revolution in Europe and Russia: general and special features. Approval of a multi-ethnic and mul-ti-confessional state. The Russian economy of the late XIX - early XX centuries: booms and crises, their causes. The share of foreign capital in the Russian mining and manufacturing industries. The completion of the indus-trial revolution. Changes in the social structure of society in the context of industrial development. The crisis of the nobility and peasantry. The formation of new social stra-ta. The bourgeoisie and the proletariat.

Conservative course of Alexander III. Restriction of re-form. Tighter censorship. Estates and national govern-ment policies. Social movement: recession and new rise.

Cancellation of the conditions of the Paris peace agree-ment. "Union of the Three Emperors." Russia and the East. Russia and the Slavic question. The Russo-Turkish War of 1877–1878 and its results. Russia and the Euro-pean powers. Annexation of Central Asia.

The search for national-political identity. Slavophiles. Westerners. Government ideology and the birth of the of-ficial theory of “national identity”. The development of science and technology in Russia in the first half of the XIX century. Discoveries and technical inventions. Liter-ature and book publishing. Styles and trends in literature: sentimentalism, romanticism, realism. Musical culture.

Painting: from classicism to romanticism and realism. Architecture. Theatre. Great reforms and Russian culture. Changes in the education system: Church schools, gym-nasiums, universities. The development of science and technology. The Golden Age of Russian Literature. En-lightened nobleman and "wild" landowner. The value of the nobility culture in the history of Russia.

6. Russia and the outer world in the XX century.

Russia in the early twentieth century. The contradictions of "Russian capitalism". Russian-Japanese war. Public life. Liberalism and conservatism. The revolution of 1905-1907. The formation of Russian parliamentarism. Political parties in Russia at the beginning of the century: genesis, classification, programs, tactics. State Duma and State Council. Regional management structure. Local government. Strengthening government regulation of the economy. Economic reforms S.Yu. Witte and P.A. Sto-lypin.

Russia in the system of international relations. Problems of catching up in modernization. "Eastern Question" in the foreign policy of the Russian Empire. Capitalist wars of the late XIX - early XX centuries for sales markets and sources of raw materials. The completion of the division of the world and the struggle for the colonies.

Russia in the First World War. The origins of a nation-wide crisis. The crisis of power during the war years and its origins. February revolution. The Provisional Gov-ernment and the Petrograd Soviet. Socio-economic poli-cy of the new government. Crises of power. Bolshevik strategy: reasons for victory. October 1917. The econom-ic program of the Bolsheviks. Civil war and the interven-tion. The first steps of Soviet power. Transformation of the pre-revolutionary ideas of the Bolsheviks: public ad-ministration, army, economy. The formation of a one-party system. The formation of a new legal system: from the first decrees to the Constitution of 1918.

Government structure. "Soviet democracy" and party bodies. Replacing constitutional authorities with extraor-dinary ones. Centralization of power. Economic, social and political aspects of the policy of "war communism". The crisis of "war communism." New Economic Policy (NEP): essence and directions.

Civil war: reasons, actors, political programs of the par-ties. Red and white terror. The reasons of the defeat of the anti-Bolshevik forces. Russian emigration. Soviet Russia in the international arena. Brest peace. Military intervention of the Entente. Isolation of Soviet Russia. Comintern. Anti-Comintern Pact.

The main directions of socio-political and state develop-ment of the USSR in the 1920-30s. Intra-party struggle: discussions about the ways of socialist modernization of society. Political ascent of I.V. Stalin. The economic foundations of the Soviet political regime. The World Economic Crisis of 1929 and the Great Depression. Dis-cussions about totalitarianism in modern historiography. Forced industrialization: prerequisites, sources of accu-mulation, method, tempos. The policy of total collectivi-zation of agriculture, its economic and social conse-quences. Attempts to return to the borders of the Russian Empire: the Soviet-Finnish war; annexation of the Baltic states, of Bessarabia and Northern Bukovina, of the Western Ukraine.

USSR in the Second World War and the Great Patriotic War. Society during the war. Partisan movement. The main stages of hostilities. Soviet military art. The hero-ism of Soviet people during the war. The role of the So-viet rear. Political system. The militarization of the appa-ratus. Economic management in wartime. The influence of pre-war modernization of the economy on the course of hostilities. The decisive contribution of the Soviet Un-ion to the defeat of fascism. Conferences in Tehran, Yal-ta, and Potsdam.

The restoration of the national economy and the elimina-tion of the atomic monopoly of the United States. The in-fluence of the international situation on the direction of economic development. Military-industrial complex. Power and society in the first post-war years. The strug-gle for power after the death of I.V. Stalin. The coming to power of N.S. Khrushchev. Attempts to update the so-cialist system. Economic reforms of the 1950-1960s, the reasons for their failures. Industry: slowdown in modern-ization. "Thaw" in the cultural realm. The significance of the XX and XXII congresses of the CPSU.

Place of the USSR in the post-war world. Turning the USA into a superpower. The beginning of the Cold War and its impact on the economy and foreign policy. The collapse of the colonial system. Creation of NATO and the Warsaw Pact. The formation of the socialist camp and the police department. Creation and development of international financial structures (World Bank, IMF, IBRD). Politico-military crises as part of the Cold War. Socialist camp. Conflicts due to differences in the per-ception of the “de-Stalinization” course: Hungary and Poland versus China and Albania. Liberalization of for-eign policy of the USSR. Attempts of dialogue with the West. International crises. The transformation of neoco-lonialism and economic globalization. Integration pro-cesses in post-war Europe. The Caribbean Crisis (1962).

USSR in 1964-1985. The theory of developed socialism. The role of raw materials. Stagnation in the USSR econ-omy and pre-crisis phenomena in the late 1970s - early 1980s. Dependence on Western high technology. The de-pendence of agriculture on public investment. Attempts of modernization: reform of A.N. Kosygin. Tensions in relations with Western countries. Yu.V. Andropov and an attempt to administratively solve the crisis problems.

The international situation. The war in Vietnam. Arab-Israeli conflict. The socialist movement in the countries of the West and East. Attempts to preserve the existing world order in the early 1970s. "Relaxation of tensions". Improving relations with the West. Helsinki Agreements. The aggravation of relations with the West in the late 1970s - early 1980s. The war in Afghanistan. The final stage of the "Cold War".

Reasons and first attempts of the comprehensive reform of the Soviet system in the 1980s. Goals and main stages of "perestroika". "New political thinking" and a change in the geopolitical position of the USSR.

Foreign policy of the USSR in 1985–1991. The end of the Cold War. The withdrawal of Soviet troops from Af-ghanistan. The collapse of the Warsaw Pact and the crisis of the world socialist system. The collapse of the bipolar world. State Emergency Committee and the collapse of socialist reformism in the USSR. The collapse of the USSR. The creation of CIS.

7. Russia and the outer world in the end of XX and the beginning of XXI century

Changes in the economic and political system in Russia in the 1990s. The liberal concept of Russian reforms: the transition to a market, the formation of civil society and the rule of law. "Shock therapy" of economic reforms in the early 1990's. The sharp polarization of society in Russia. Deterioration of the economic situation of a sig-nificant part of the population. The role of raw materials. Russian economy in the global economic system.

The constitutional crisis in Russia in 1993 and the dis-mantling of the power system of the Soviets. 1993 Con-stitution of the Russian Federation. System of separation of powers. The president. The State Duma. The princi-ples of federalism. Science, culture, education in market conditions. The first results of reforms and their social consequences.

The military-political crisis in Chechnya. Foreign policy of the Russian Federation in 1991–1999.

Political parties and social movements of Russia at the present stage. Presidential Elections of 2000, 2004, 2008 and 2012. The course of strengthening the interests of the state, economic recovery, social and political stability, and national security.

Russia in world integration processes and the formation of a modern international legal system. Relapses of the Cold War. Russia's place in international conflicts at the beginning of the 21st century. Russia and the CIS. Rus-sia in the system of world economy and international re-lations. Globalization of the world economic, political and cultural space. The end of the unipolar world. The increasing role of China in the global economy and poli-tics. EU expansion to the east. The role of the Russian Federation in the modern world community. Regional and global interests of Russia. The reunification of Cri-mea with Russia and the growth of international tensions in the 2010s.

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Information Theory/Теория информации

Purpose of the course:

Mastering the basic modern methods of information theory.

Tasks of the course:

• mastering by students of basic knowledge (concepts, concepts, methods and models) in information theory;

• acquisition of theoretical knowledge and practical skills in information theory;

• providing advice and assistance to students in conducting their own theoretical research in information theory.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

 fundamental concepts, laws, theories of a part of discrete mathematics;

 modern problems of the relevant sections of information theory;

 concepts, axioms, methods of proofs and proofs of the main theorems in the sections included in the basic part of the cycle;

 basic properties of the corresponding mathematical objects;

 analytical and numerical approaches and methods for solving typical applied problems of information theory.

be able to:

 understand the task at hand;

 use your knowledge to solve fundamental and applied problems;

 evaluate the correctness of the problem setting;

 strictly prove or disprove the statement;

 independently find algorithms for solving problems, including non-standard ones, and analyze them;

 independently see the consequences of the results obtained;

 Accurately present mathematical knowledge in the field orally and in writing.

master:

 skills of mastering a large amount of information and solving problems (including complex ones);

 skills of independent work and mastering new disciplines;

 the culture of formulating, analyzing and solving mathematical and applied problems that require the use of mathematical approaches and EC methods for their solution;

 the subject language of information theory and the skills of competently describing the solution of problems and presenting the results obtained.

Content of the course (training module), structured by topics (sections):

1. Combinatorial concept of information

Combinatorial concept of information (information on Hartley), lower bounds for the operating time of sorting, binary search, information methods for solving various combinatorial problems

2. Probabilistic approach to the concept of information

Probabilistic concept of information. Shannon's entropy, its properties, applications to problems of coding and information transfer

3. The task of transferring information

The task of transmitting information through a channel with noise, the concept of channel capacity. Error correcting codes, upper and lower estimates.

4. Communication complexity

Communication complexity and its application to obtain lower grades in various tasks.

5. Application of information theory

Application of information theory to obtaining lower bounds for data structures and algorithms.

Kolmogorov complexity and its applications

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Introduction to Mathematical Analysis/Введение в математический анализ

Purpose of the course:

Formation of basic knowledge in mathematical analysis for further use in other areas of mathematical knowledge and disciplines with natural science content; the formation of a mathematical culture, research skills and the ability to apply knowledge in practice.

Tasks of the course:

- Acquisition of theoretical knowledge and practical skills by students in the field of the theory of limits, differential and integral calculus, the theory of series;

- preparing students for the study of related mathematical disciplines;

- acquisition of skills in the application of methods of mathematical analysis in physics and other natural science disciplines

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

- basic properties of the limits of sequences and functions of a real variable, derivative, differential, indefinite integral; properties of functions that are continuous on a segment;

- basic "remarkable limits", tabular formulas for derivatives, formulas for differentiation.

be able to:

- write down statements using logical symbols;

- calculate the limits of sequences and functions of a real variable;

- calculate the derivatives of elementary functions, expand elementary functions according to the Taylor formula; calculate the limits of functions using L'Hôpital's rule.

master:

- the subject language of classical mathematical analysis, used in the construction of the theory of limits;

- the apparatus of the theory of limits, differential and integral calculus for solving various problems arising in physics, technology, economics and other applied disciplines.

Content of the course (training module), structured by topics (sections):

1. Algebraic equations and inequalities

1.1. Quadratic equations. Vieta's theorem. Graph of a quadratic function. Biquadratic equations. The main theorem of algebra. Method of intervals for solving inequalities

2. Progression

2.1. Arithmetic and geometric progressions. Sum of arithmetic and geometric progression.

3. Trigonometry

3.1. Unit circle, trigonometric functions of an arbitrary argument. Trigonometric formulas. Trigonometric function graphs. The simplest trigonometric equations and inequalities

4. Exponential and logarithmic functions

4.1. Exponential function, its properties and graph. Logarithms. Number e and natural logarithm. Exponential equations and inequalities. Logarithmic function, logarithmic equations and inequalities.

5. Method of mathematical induction

5.1. Formulation of the principle of mathematical induction. Proofs of equalities, inequalities and various statements from elementary algebra and geometry.

6. Real numbers

6.1. Real numbers. Inequality relations between real numbers. Archimedes property. The density of the set of real numbers. The theorem on the existence and uniqueness of the exact upper (lower) bound on a numerical set bounded above (below). Arithmetic operations with real numbers. Infinite decimal representation of real numbers. The countability of the set of rational numbers, the uncountability of the set of real numbers.

7. Sequence limits

7.1. Limit of a numerical sequence. Cantor's nested line segment theorem. Uniqueness of the limit. Infinitesimal sequences and their properties. Limit properties related to inequalities. Arithmetic operations with converging sequences. Weierstrass' theorem on the limit of a monotone bounded sequence. The number e. Infinitely large sequences and their properties.

7.2. Subsequences, partial limits. Upper and lower limits of a number sequence. Bolzano-Weierstrass theorem. Cauchy's criterion for the convergence of a sequence.

8. Limit and continuity of functions

8.1 Theorem on the one-sided limit of a monotone function. Weierstrass' extreme value theorem. Intermediate value theorem. Uniform continuity.

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Introduction to Optimization/Введение в оптимизацию

Purpose of the course:

mastering theoretical and numerical methods for solving problems of finite-dimensional optimization (MO): the theory of necessary and sufficient conditions for a local extremum of a smooth function over a set and some numerical methods for finding local extrema in problems of unconditional and conditional optimization.

Tasks of the course:

• mastering by students of basic knowledge (concepts, concepts and methods) in the field of ML;

• the acquisition of theoretical knowledge and practical skills in the field of ML;

• providing advice and assistance to students in conducting their own theoretical research in the field of ML.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

 fundamental concepts, theorems, numerical algorithms of optimization methods (ML);

 modern problems of the corresponding sections of the Ministry of Defense;

 concepts, theorems, methods of proofs and proofs of the main theorems in the sections included in the basic part of the ML cycle;

 basic numerical algorithms for ML with justification of their convergence;

 basic properties of the corresponding mathematical objects;

 analytical and numerical approaches and methods for solving typical applied problems (ML).

be able to:

 understand the task at hand;

 use your knowledge to solve fundamental and applied problems of the Ministry of Defense;

 evaluate the correctness of the problem setting;

 strictly prove or disprove the statement;

 independently find algorithms for solving ML problems, including non-standard ones, and analyze them;

 independently see the consequences of the results obtained;

 Accurately present mathematical knowledge in ML field orally and in writing.

master:

 skills of mastering a large amount of information and solving problems of medical science (including complex ones);

 skills of independent work and mastering new disciplines;

 culture of formulation, analysis and solution of mathematical and applied problems that require the use of mathematical approaches and methods of ML for their solution;

 the subject language of MO and the skills of competently describing the solution of problems and presenting the results obtained.

Content of the course (training module), structured by topics (sections):

1. Convex sets and affine sets.

Mathematical notation for sets, sequences, sums and products. Working with summation and product operators. Mathematical induction on integers.

2. Separation theorems. Convex functions

Division with remainder. Divisibility. Representation of integers. Positional number systems. Conversion between binary, hexadecimal and octal systems.

3. Duality theory

Prime numbers. Facts on distribution of primes. Greatest common divisor and least common multiple. Euclidean algorithm.

4. Subdifferential

The Fundamental theorem of arithmetic. Linear Diophantine equations. Linear congruences. Chinese remainder theorem. Applications of congruences.

5. Introduction to linear programming

Wilson’s theorem, Fermat’s little theorem and Euler’s theorem. Primitive roots. Existence of primitive roots. Corollaries. Quadratic residues. The Jacobi symbol. Applications of number theory in cryptography.

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Java/Язык программирования JAVA

Purpose of the course:

Mastering the rules of the Java programming language and the techniques of using the Java language in programming practice.

Tasks of the course:

The acquisition by students of skills in the design and implementation of applications in the Java language using the techniques of object-oriented programming, multithreading primitives and web technologies; mastering by students of modern development practices: using IDE, version control systems, unit testing.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

1. The principle of executing Java programs using the JVM; how garbage collection works in Java;

2. Java data types;

3. Execution flow control in Java;

4. Main classes and capabilities of the standard library;

5. Rules for working with exceptions;

6. Principles of development of parameterized classes and methods (generics);

7. The internal structure of the standard library containers and the time complexity of their operations;

8. Stream API data processing;

9. Interaction with relational DBMS using JDBC API;

10. Principles of development of multithreaded code in Java and tools of the standard library; Java memory model;

11. Java Reflection API capabilities;

12. Applying annotations and processing annotations at the Reflection API level;

13. How the DI container works.

be able to:

1. Implement a general-purpose library in the Java language using specified interfaces;

2. Add support for multithreading to the application, analyze the thread safety of the implementation;

3. Cover code with unit tests using the JUnit framework, analyze code coverage with tests;

4. Work with a distributed version control system git;

5. Use code review tools on the Github service;

6. Implement an application that provides an HTTP API using the Spring framework.

master:

Skills in working with objects and flows and outlook in choosing an architectural solution to the task.

Content of the course (training module), structured by topics (sections):

1. Java syntax

This module is aimed to introduce the students to the Java syntax. Keywords, identifiers, data types, literals, branches, cycles, primitive types and objects, Input-output are covered.

2. Arrays, Collections

This module gives the overview on arrays, Collections and Strings in Java, their functionality and operations' time complexity.

3. OOP

Object-Oriented Programming principles and best practices are discussed in this module. Also, structure of classes and interfaces in Java are taken into account.

4. General-purpose instruments

This module is dedicated to working with date and time, generics, enums, regular expressions, JavaDoc and other general purpose instruments

5. Application testing, Java build tools

Application building with Maven and testing & continuous integration

6. Stream API

This module is devoted to data streams in Java, their abilities and management

7. Multithreading & Concurrency

Multithreaded java programming, starting from the theory of concurrency and Java memory model. Also, low-level and high-level instruments of synchronization, Runnable and Callable interfaces, Executors and concurrent data structures are discussed.

8. Databases

Communication between Java applications and databases. Sql fundamentals and DB principles

9. Spring framework

An overview on Spring framework, including HTTP API application implementation.

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Life Safety/Безопасность жизнедеятельности

Purpose of the course:

The discipline enables the students to develop integral soft skills and acquire general professional and special undergraduate-level competencies in all the academic fields at MIPT. In addition, students will achieve competencies in the Health and Safety field, including the following:

- in human-mediated interactions with natural, anthropogenic, and socioeconomic environments, as well as protection of the human body from adverse external and internal factors;

- safe individual and collective behavior in day-to-day life (the basics of healthy living), in high risk and emergency situations;

- risk and safety theories;

- the government policy of the Russian Federation in the field of security, civil defense, and protection of the population and economy in emergency situations;

- correlation between Health and Safety requirements and effective professional activity.

Tasks of the course:

- introducing students to the theoretical foundations and practical implications of health and safety;

- gaining practical knowledge of system analysis methods to solve complex, interdisciplinary issues related to health and safety;

- acquiring basic knowledge of concepts, patterns, ideas, methods, and models in the field of health and safety;

- enabling the students to use humanitarian, social, economic and natural scientific, qualitative and quantitative approaches and methods for analysis and problem-solving in the field of health and safety, to develop these concepts and approaches;

- providing the students with the knowledge, practical skills, and abilities in the field of health and safety;

- developing students' understanding of the correlation between health and safety requirements and effective professional activity;

- developing students' understanding of the value of their outlook and attitude towards individual and collective security, including such relevant aspects as combating terrorism and corruption, promoting environmental security and sustainable development.

This education program will cover the fundamentals of risk and safety theories, including various hazards and threats that can cause vital damage to human interests and the natural environment. Knowing potential hazards and safety rules can reduce the probability or prevent emergencies caused by human factors and mitigate their adverse effects. The education program includes a brief overview of the basic rules for maintaining individual health (ensuring a healthy lifestyle), sanitary and hygiene requirements, and rules of conduct under normal and extreme conditions. The program also addresses social and economic issues related to security and sustainable development, including such important issues for Russia as combating corruption. Implementing this knowledge will enable students to ensure safety at home, in their professional activities, and maintain their work capacity and health for a long time. The program will help students improve their skills in working with information, including in a foreign language.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

- natural-scientific and socioeconomic foundations of Health & Safety;
- the fundamentals of risk and safety theory, sustainable development, environmental, technological, socio-economic and health and demographic security;
- rules of conduct in normal and extreme situations and first-aid techniques for accidents, emergencies, disasters;
- basic principles of technological and social risk management, forecasting, prevention and relief of accidents, emergencies, disasters, and their consequences;
- government policy, bodies, and management system in Health and Safety, civil defense, and population and economy protection in emergencies, including legal concepts and modern terminology.

be able to:

- to analyze anthropogenic activities and their connection with environmental, economic, and Health & Safety issues;
- to find, analyze, and summarize information on specific Health and Safety issues;
- to find and analyze the connection between professional tasks and tasks related to ensuring Health & Safety;
- to apply individual Health and Safety knowledge at home, in day-to-day life, and in emergencies;
- to apply individual Health & Safety knowledge in professional settings;
- to apply basic methods of protecting operational staff, population, and economy from potential adverse effects of accidents, emergencies, disasters;

- to execute effective managerial and organizational decisions and other measures in the field of Health & Safety in strict accordance with the law.

master:

- a systematic approach to analyzing contemporary Health and Safety issues;
- basic methods of protecting operational staff, population, and economy from potential adverse effects of accidents, emergencies, disasters;
- principles and basic safety skills in day-to-day life and in professional settings, in particular, in case of accidents and emergencies;
- knowledge of physical fitness and health conditioning to promote and maintain a healthy lifestyle;
- basic legal skills of various law branches to ensure provision of Health and Safety, as well as combating corruption and terrorist threats.

Content of the course (training module), structured by topics (sections):

1. Systematic approach to the analysis of current Health & Safety related issues, including safe environmental interaction and protection from external hazards.

1.1. Introduction. Systematic approach to the analysis of current Health & Safety related issues.

Systematic approach to the analysis of the current Health & Safety issues and their various aspects:

- Health & Safety as a motivated human and social activity;
- Health & Safety, biosphere, technosphere, social sphere, anthropogenic activity, environmental protection, and ecological safety;
- Health & Safety, production and consumption, industrial and operational safety, and labor protection;
- Health & Safety, sustainable development, environmental, and socioeconomic security;
- Health & Safety as a scientific field and information security;
- Health & Safety, individual and collective behavior, security algorithms and systems, civil defense, protection of population and economy in emergencies;
- Health & Safety as an academic discipline. History, objectives, structure, and the organization of the Health & Safety program at MIPT.

Ecology, physics, economics, Health & Safety.

1.2. Natural scientific foundations of Health & Safety. Conditions for the existence of life. Anthropogenic activity. Biosphere, Technosphere, social sphere and security.

Conditions for the existence of life. Natural and artificial environments and Health & Safety. Biosphere.

Interaction of biosystems and modern industrial human societies with various components of the surrounding environment - biosphere, technosphere, and social environment. Man, nature and economy. Ecological approach to analyzing human needs. Humanity and Man as large systems. Classification and hierarchy of human needs.

Ecology, physics, economics and Health & Safety. Concepts of substance flow, free energy, information as the basis for analysis of security and sustainable existence of living systems, including socioeconomic systems.

1.3. Chemical and biological factors affecting Health and Safety.

Conditions for ensuring chemical and biological safety. Quality of air, water, soil, and food.

Chemical hazards and chemical safety. Harmful chemicals, rationing: maximum permissible concentrations and emissions (LOAEL and emission limits). Sources of chemical pollution. Control, elimination, and protection methods.

Highly toxic and carcinogenic substances, their specific side effects on human health.

Chemical and environmental hazards of modern technologies, industrial and municipal waste, standard and emergency discharges. Modern means of liquid, gas, and solid waste management. Monitoring of the chemical composition of the environment.

Occupational safety. Work area. Approximate safe levels of impact (ASLI).

Complex indicators of air and water supply quality. Environmental quality standards and environmental impact levels. Biomonitoring of environmental conditions and test objects.

Biological hazards and biological safety: infectious and invasive diseases, epizootics, epidemics. Monitoring of biological contamination of the environment. Epidemiology and medical safety.

SARS-CoV-2 pandemic.

1.4. Physical factors affecting Health & Safety.

Ionizing radiation and radioactive substances, electromagnetic radiation, sonic and mechanical impact. Examples of specific ways the human body may be physically affected: radiation (ionizing radiation fluxes), electromagnetic fields, noise, artificial lighting, etc. The human body's response to such impact.

Rationing and permissible exposure limits. Control and safety measures.

1.5. Socioeconomic and technological aspects, processes and factors affecting Health & Safety.

Social, economic, and technological safety, and security aspects, including:

- national security
- military security
- economic and financial security
- industrial and technological safety
- scientific safety
- energy and information security
- food safety
- demographic security
- epidemic security

Social and economic threats, events and processes that affect safety and security, including military threats; terrorist threats; corruption; information threats; threats to state sovereignty.

Countering social and economic threats is one of the most important factors in ensuring the socio-economic and national security of Russia and its citizens.

1.6. End-of-section offline testing assignments (or online written survey and face-to-face tutorial).

2. Health and Safety and the internal environment of the human body. Basics of a healthy lifestyle and safe individual and collective behavior in high-risk situations.

2.1. Homeostasis and nonspecific body reactions to adverse effects and stress.

Homeostasis. Dynamic condition of the human body characterized by complete psychophysical and social harmony in normal conditions.

Extreme conditions. The human body's adaptation mechanisms to variations in energy, substance, information flow and survival limits.

Nonspecific reactions of the human body to external factors. Stress. Mechanisms and stages of stress development.

2.2. Healthy living and methods to increase stress resistance.

Stress management and increasing the body's resistance to external factors. Ways to increase the body's stress resistance under short-term and chronic stresses.

The role of active lifestyle and self-preservation for maintaining Health & Safety.

Healthy living and life safety.

2.3. Express diagnostics of the human body condition. Effective stress monitoring methods.

Vital systems of the human body that ensure effective substance, energy, and information flow, as well as the body's normal functioning.

Heart rhythm variability (HRV) - a non-invasive technology that allows real-time assessment of the patient's regulatory systems and solution of numerous prognostic, diagnostic, therapeutic, and preventive tasks.

2.4. Harmful household factors and bad habits: biological, medical, and socio-economic aspects.

Harmful household factors and bad habits: biological, medical, and socio-economic aspects:

- Alcoholism
- Drug abuse
- Metabolic disorders and lack of physical activity;
- Personal and social hygiene, infections, and microbiota of the body;
- Information technologies and society, an objective worldview and information hygiene.

2.5. Individual handling of emergencies and providing first aid.

Self-preservation and handling extreme and dangerous situations.

Providing first aid to oneself and others in case of illness, accidents, emergencies, and disasters.

2.6. End-of-section offline testing assignments (or online written survey and face-to-face tutorial).

3. Foundations of risk and safety theory.

3.1. Hazards: concept, factors, origins, and classification.

Hazards are natural, anthropogenic, social, military, economic or other types of threats, which can harm one's health or cause death, as well as damage the environment.

Classification of hazards:

- by origin: natural, social, military, anthropogenic, ecological, and mixed;

- by nature of its implementation: physical, chemical, biological, and psychophysiological

(according to the official standard (Unified government standard 12.1.0.003-74));

- by a form of manifestation: natural disasters (earthquakes, mudflows, hurricanes, tornados, etc.), industrial and transport accidents, accidental poisoning, etc.

- by type: natural, fire, chemical, radiation, industrial, demographic, social, asteroid, and comet, etc.

- by a zone of occurrence: lithosphere, hydrosphere, atmosphere, and space hazard.

- by type of damage: social, technical, environmental, etc.

- by its scope and amount of damage caused.

3.2. Risk as a hazard. Classification of risks.

Risks classification and ways to determine risk levels: engineering, model, expert, sociological. Factors that determine the ranking level of a hazard (risk): controlled, uncontrolled, visible, invisible risks, selection of risk assessment systems. Voluntary and involuntary hazard, acceptable risks.

Classification of risks: by origin; by type of hazard; by risk nature and amount of risk sources; by risk recipients; by size of the affected area; by risk measurement units. Anthropogenic individual and social (group) risks. Hazard (risk) levels and their quantitative assessment.

Structure of death risks. Criteria for evaluation of hazards related to the quality of life.

Strategic risks of Russia.

3.3. Issues related to quantitative hazard analyses and disaster statistics.

Traditional approach to risk assessments and disaster statistics. Applying laws of probability to estimate the occurrence of accidents, catastrophes, and crises. Heavy-tailed distribution. The Pareto distribution and the truncated Pareto distribution.

Examples of variability and low information value of average figures illustrating the amount of damage caused by a catastrophe, examples of repeatability estimates and the scope of the greatest damage suffered.

3.4. Security and its quantitative analysis.

Security measurement, types, and conditions.

Objectives and methods of security management. Algorithms of personal security and general action plans of government security systems.

Criteria to determine security level: population and environmental approaches. Medical and demographic security: average life expectancy, health indexes, DALY, QALY, etc.

3.5. Classic and modern security concepts and tools.

- The absolute safety concept ("As low as practically achievable", ALAPA), security tools and specific features of the regulatory framework related to this concept: maximum permissible concentrations (MPC), maximum permissible impact levels (MPL), maximum permissible emissions and dumps (MPE and PDS), safety requirements for economic infrastructure assets. Advantages and limitations of the absolute safety concept.

- Cost-benefit concept in traditional monetary theory: advantages, main issues, and disadvantages. Tools and regulatory framework related to this concept.

- The acceptable risk concept ("As low as reasonably achievable," ALARA). Acceptable risk approval and its legal regulation. Optimization of life expectancy and sustainability of environmental systems.

- The concept of natural capital.

- Concepts of sustainable development and environmental security. Sustainable development and environmental security concepts, and concepts based on substance, energy, and information flow analysis. Understanding priorities and ways to ensure sustainable development: technocratic, resource, technological, energy, environmental and cultural paradigms.

3.6. End-of-section offline testing assignments (or online written survey and face-to-face tutorial).

4. Government policy of the Russian Federation in the field of security, civil defense, and protection of the population and economy in emergencies

4.1. Emergency situations: terms and basic concepts. Natural and anthropogenic emergencies; military emergencies and security.

Basic concepts and definitions. Classification of emergencies and components of economic infrastructure by potential hazard. Wartime emergencies and weapons of mass destruction. Natural and anthropogenic accidents and disasters: causes and consequences. Emergency situations: development phases, adverse effects of natural, anthropogenic, and military emergencies and their features. Classification of natural disasters and catastrophes. Natural and anthropogenic emergencies in Russia.

4.2. Civil defense. Warning signals. Ways to improve infrastructure security during emergencies, including wartime. Basic methods of protecting operational staff and population during peacetime and wartime.

Emergency situations and adverse effects of wartime emergencies. Types of weapons of mass destruction, their features, and the consequences of their use. Forecasting and assessing emergency situations. Civil defense. Warning signals.

Sustainability of economic infrastructure in emergency situations. Ways to improve infrastructure security in emergency situations. Individual and collective actions in emergency situations.

Basic methods of protecting operational staff and population during peacetime and wartime. Basic methods of protecting operational staff and population from adverse effects of accidents, catastrophes, natural disasters, and military emergencies. Protective structures and their classification. Evacuation of people and personnel from emergency zones. Medical safety measures. Personal protective equipment and its use.

Basics of rescue and other emergency operations in emergency situations.

4.3. Government policy and management system for protection of the population. Government system for relief of emergencies and their consequences.

Basic principles of government policy aimed to ensure the protection of the population.

Legislative and organizational framework of ensuring Health & Safety of the population.

Ensuring technological safety and labor protection. Ways in which government and businesses can prevent, reduce, and eliminate the adverse effects of emergencies, and ensure technological safety and labor protection.

Government bodies and programs in the field of security and socio-economic development of Russia.

Unified system of prevention and elimination of emergency situations in Russia.

4.4. Combating corruption as a key socioeconomic security task for Russia. Building up a mindset against corruption.

Combating corruption as a key socioeconomic national security task for Russia. Building up a mindset against corruption. Corruption as a social and economic phenomenon that implies that officials and managers at various levels abuse their rights and powers related to their official position, opportunities, authority, and existing connections for personal benefit. The systematic nature of corruption in Russia and the causes and conditions under which corruption occurs and

develops in federal and local government bodies. Forms of corruption. Social, economic, and political consequences of corruption.

Legal aspects of combating corruption. The concept of corruption in Russian legislation. Federal Law dated 25.12.2008 No. 273-FZ “On Combating Corruption.” Federal Law dated 17.07.2009 No. 172-FZ “On Anti-corruption Assessment of Legislation and Draft Legislation.” Defining the essence and traits of corruption as a social, economic, and legal phenomenon. Anti-corruption system in the Russian Federation. Presidential Decree dated 13.04.2010 No. 460 “On National Anti-Corruption Strategy and the National Anti-Corruption Plan for 2010-2011," Presidential Decree dated 21.07.2010 No. 925 “On Implementation of Certain Provisions of the Federal Law On Combating Corruption.” The current vectors of the government anti-corruption policy of the Russian Federation. The essence and implementation of the National Anti-Corruption Strategy. Practical aspects of anti-corruption policy in the Russian Federation.

Public policy of other countries and international cooperation in the fight against corruption. International experience of leading foreign countries in preventing and combating corruption. Participation of the Russian Federation in international cooperation on preventing and combating corruption.

4.5. Terrorist threats and combating terrorism as one of the key objectives facing the world today in the sphere of security.

Terrorism as a political, social, and economic phenomenon, as a tool to achieve political goals, and as a specific type of crime. Factors for the emergence of terrorism including economic inequality, limitation of political and religious freedoms, constraints for development, and ostracism of certain segments of the population (groups, classes, nationalities, religious confessions, and entire states) from participation in government, social and economic life on a national, regional, or global level. Financial, organizational, and other types of terrorism support provided by certain political forces and countries used for achieving their political and economic goals. Historical, ideological, and organizational aspects of the emergence of terrorism as the gravest threat to modern civilization; concepts of extremism and terrorism.

The Russian Federation's government policy in the field of combating terrorism and extremism, rules of conduct, and course of action for civilians in case of a terrorist threat. Social, economic, political, and ideological traits of modern terrorism. Measures to counteract terrorism.

Legal aspects and measures to counter terrorism and extremism in the Russian Federation. Concept of terrorism and extremism in Russian legislation, terrorism as a political phenomenon, and a specific type of crime. The Russian Federation's legal framework in the field of combating terrorism and extremism: Presidential Decree No. 116 dated 15.02.2006 "On Measures to Counteract Terrorism," Federal law No. 115-FZ dated 07.08.2001 "On Combating Money Laundering and Financing of Terrorism" (in part concerning the basic concepts used in this Federal Law; expanding the legal scope of recognizing persons or entities as participants of extremist activity; determining the legal grounds for including certain foreign and international organizations into the list of entities, transactions with which are subject to mandatory government control in case they are recognized as terrorist organizations by Russian courts). Federal law No. 114-FZ dated 25.07.2002 "On Combating Extremist Activity," Federal law No. 153-FZ dated 27.07.2006 "On Amendments to Specific Laws of Russian Federation related to the Enactment of Federal law "On Ratification of the European Convention on the Suppression of Terrorism" and Federal law "On Combating Terrorism" (the purpose of which is the continuous improvement of

the government system of combating terrorism and offer far and wide complex solutions to prevent terrorism threats). The government system of combating terrorism and extremism: government bodies and programs to counteract terrorism and extremism on international, federal, and regional levels (economic, political, organizational, etc.). Preventive measures to counteract terrorism: the experience of the Soviet Union and the Russian Federation.

Public policy of other countries and international cooperation in the field of combating terrorism and extremism. International experience of leading foreign countries in preventing and combating terrorism and extremism. International cooperation and international agreements related to combating terrorism and Russia's participation in this area.

Rules of conduct and course of action for civilians in case of a terrorist threat.

4.6. End-of-section offline testing assignments (or online written survey and face-to-face tutorial).

5. Current Health & Safety issues in professional settings (elective, depending on the chosen specialization), includes a course project (term paper)

Term paper requirements

1. The term paper topic shall be proposed by the lecturer to each student individually or to a small team of two or three students (who will each prepare a separate part of the essay as its co-author), or suggested by the students themselves with prior approval from the lecturer.

2. The term paper shall be submitted in printed form and the electronic version shall be sent to the e-mail address specified by the lecturer (in Word format using Times New Roman size 12 font).

3. The term paper must include a title page and a list of references, including all web links with the indication of the authors and titles of used sources and their time of publication.

4. All quantitative, illustrative, and factual data in the essay shall be documented and provided with appropriate source references.

5. It is required to include recent period publications in the term paper (which were made in the last two years).

5.1. Average life expectancy and other health and demographic factors recognized as criteria for measuring the level of development and security in a society.

Health and demographic criteria for measuring the level of development and security in a society: definitions, examples, historical, country, social, economic, and cultural differences and similarities. Infant mortality. Links between demographic statistics, economic conditions, and socio-cultural traditions and concepts – historical and country patterns and specific features.

5.2. Population reproduction. Demographic and national security, its correlation with death and birth rates.

Reproduction of population and demographic security as critical components of national security. Demographic transition. Targeted attempts at birth rate control. Global demographic security issues.

5.3 Demographic security of Russia.

History and issues of demographic development in Russia. Russian population decline; birth rate and demographic security programs in Russia.

5.4. Biology of the human lifespan.

Mortality rates, hypothetical causes, and dependencies: genetic, ecological, sociocultural, and adaptive determinants. Age as a mortality rate factor, its quantitative and parametric descriptions: the Gompertz function, the Gomperz-Makeham law of mortality, etc. Mortality rates and its variations by species, gender, geographic location, and sociocultural factors. Historical changes in age mortality and life expectancy in human society. Relationship of mortality rates and age structure with the crude figures for mortality rate and life expectancy. Relationship between mortality and specific biological traits, economic, social, political conditions, cultural and health care levels.

5.5. Factors and models of population reproduction.

The birth rate in biological populations and human society. Relationship of birth and mortality rates with other demographic, social, economic, and environmental factors. Demographic models and population change scenarios. Birth rate and its link to economic, cultural, social, political, and environmental conditions. Birth rate, age structure, and its historical evolution. Fertility and demographic transition. Economic and demographic models of population reproduction.

5.6 Prospects for extending active lifespan.

Social and biological aspects of life expectancy. "Immortality" and age-dependent mortality rates.

Social, economic, ecological, and biological determinants of age-dependent mortality rates and life expectancy. Programmed lifespan, mortal deterioration of metabolic processes resulting from the body's continual growth and development ("biological clock" hypothesis), or failure of the body's functions due to various defects accumulated in the process of life activity. Mortality rate models. Modern medicine and life extension prospects. Protection of motherhood and childhood and average life expectancy increase. Healthy living as a genuinely effective way to increase life expectancy. Issues related to the monitoring of the human body condition.

5.7. System analysis of Health & Safety and human development. Sustainable development and environmental security.

Ensuring environmental security and development, international affairs, documents, conventions, and treaties in this area. International cooperation and joint analysis of development and security

problems. The United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro, 1992: the agenda and the members' stance on the discussed issues. Outcomes and documents. Sustainable development - two views on the same problem. Protecting the interests of developed countries or the need to shift to noosphere thinking? Public policies of different countries and international cooperation on sustainable development and environmental security after the Rio de Janeiro summit (UNCED).

5.8. Physical approach for describing developing systems, their sustainable development and safety.

Free energy as a feature of the system's development capabilities. Free energy analysis and empirical generalizations of developing systems. Optimization criteria for their evolution. Developing ecological systems and biosphere. Concepts of ecological costs and their types - biospheric costs, their properties. The concept of biospheric (ecological) costs as a modification of the sustainable development and security concept, which implies a physical approach to analyzing ecological and socioeconomic systems' evolution. Relationship between the biospheric (ecological) cost concept with other security concepts and socioeconomic development criteria. Empirical, physical, and economic approaches to modeling the future.

5.9. Mathematical modeling in the field of Health & Safety.

5.10. Topics mentioned in section 5 and other topics depending on the specialization and the students' interest.

6. Test preparation

Topics for mandatory independent study

Topic 1

Ensuring individual safety: rules of conduct in dangerous, extreme, and emergency situations, first aid rules and techniques, including self-care.

Topic 2

Radiation safety standards, methods, and techniques.

Topic 3

Chemical and biological hazards. Highly toxic substances. Normalization of environmental conditions. Monitoring and ensuring chemical and biological safety.

Topic 4

Government security management policy, bodies, systems, and methods.

Topic 5

Civil defense and emergency situations. Warning signals. Ways to improve the protection of population and economic infrastructure in emergency situations.

Topic 6

Issues related to Health and Safety and sustainable development in Russia.

Topic 7

Countering corruption and building up a mindset against corruption.

Topic 8

Terrorism as a socioeconomic phenomenon and combating terrorism.

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Linear Algebra/Линейная алгебра

Purpose of the course:

familiarization of students with the basics of linear algebra and preparation for the study of other mathematical courses – differential equations, the theory of functions of complex variables, equations of mathematical physics, functional analysis, analytical mechanics, theoretical physics, methods of optimal control, etc.

Tasks of the course:

- students acquire theoretical knowledge and practical skills in the field of matrix algebra, the theory of linear spaces;

- preparing students for the study of related mathematical disciplines;

- acquisition of skills in the application of analytical methods in physics and other natural sciences.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

- operations with matrices, systems of linear algebraic equations matrices and determinants;

- theorems on systems of linear Kronecker-Capelli and Fredholm equations, Kramer rule, General solution of a system of linear equations;

- basic definitions and theorems on linear spaces and subspaces, on linear maps of linear spaces;

- definitions and basic properties of eigenvectors, eigenvalues, characteristic polynomial;

- reduction of the quadratic form to the canonical form, the law of inertia, the Sylvester criterion;

- coordinate recording of the scalar product, the basic properties of self-adjoint transformations;

- fundamentals of the theory of linear spaces in the volume that provides the study of analytical mechanics, theoretical physics and optimal control methods.

be able to:

- to produce a matrix, finding inverse of a matrix, to compute determinants;

- find a numerical solution to a system of linear equations. find eigenvalues and eigenvectors of linear transformations, bring the quadratic form to the canonical form, find the orthonormal basis of the eigenvectors of the self-adjoint transformation;

- operate with elements and concepts of linear space, including the main types of dependencies: linear operators, bilinear and quadratic forms.

master:

- general concepts and definitions related to matrix algebra;

- geometric interpretation of systems of linear equations and their solutions;

- concepts of linear space, matrix notation of subspaces and maps;

- conduct about the use of spectral problems;

- applications of quadratic shapes in geometry and analysis;

- concepts of conjugate and orthogonal transformation;

- applications of Euclidean metrics in geometry and analysis problems, various applications of the symmetric spectral problem;

- the ability to use the necessary literature to solve problems of increased difficulty (in the variable part of the course).

Content of the course (training module), structured by topics (sections):

1. Matrices and systems of linear equations

1.1. Solving systems of linear equations by the Kramer method. The rank of a matrix. Basic minor theorem. Theorem on the rank of the matrix.

1.2. Linear equation system. Kronecker-Capelli Theorem. Fundamental system of solutions and General solution of a homogeneous system of linear equations. The General solution of the inhomogeneous system. Gauss method. The Theorem OfFredholm.

2. Linear space

2.1. The axioms of a linear space. Linear dependence and linear independence of element systems in linear space. Dimension and basis. Subspaces and linear shells in linear space. Sum and intersection of subspaces. Direct sum. The formula for the dimension of the sum of subspaces. Derivation of the dimension formula of the sum of subspaces. Hyperplanes.

2.2. The expansion of the basis in a linear space. Coordinate representation of linear space elements and operations with them. Theorem on isomorphism. The coordinate form of the necessary and sufficient condition of the linear dependence of the elements.

2.3. Change of coordinates when changing the basis in linear space. Transition matrix and its properties. The coordinate form of the task subspaces and hyperplanes.

3. Linear dependences in linear spaces

3.1. Linear mappings and linear transformations of linear space. Operations on linear transformations. Inverse transformation. Linear space of linear maps. Algebra of linear transformations.

3.2. Linear mapping and linear transformation matrices for finite dimensional spaces. Operations on linear transformations in coordinate form. The change of the matrix of the linear display when changing bases. Isomorphism of the space of linear maps and the space of matrices.

3.3. Invariant subspaces of linear transformations. Eigenvectors and eigenvalues. Own subspaces. Linear independence of eigenvectors belonging to different eigenvectors.

3.4. Finding eigenvalues and eigenvectors of linear transformation of finite-dimensional linear space. Characteristic equation. Evaluation of the dimension of the private subspace. Diagonalizability conditions of the linear transformation matrix. Reduction of the matrix of linear transformation to a triangular form.

3.5. Linear form. Conjugate (dual) space. Biorthogonal basis. Secondary conjugate space.

4. Nonlinear dependences in linear spaces

4.1. Bilinear and quadratic forms. Their coordinate representation in a finite-dimensional linear space. Changing the matrices of bilinear and quadratic forms when changing the basis.

4.2. Reduction of the quadratic form to the canonical form by the Lagrange method. Inertia theorem for quadratic forms. Sign-definite quadratic forms. Sylvester's Test. Reduction of the quadratic form to the diagonal form by elementary transformations. FormulationofJordan'stheorem.

5. Eucledean space

5.1. Axiomatics of Euclidean space. The Cauchy-Schwarz Inequality. Triangle inequality. Gram matrix and its properties.

5.2. Finite-dimensional Euclidean space. Orthogonalization of the basis. Transition from one orthonormal basis to another. The orthogonal complement of the subspace.

5.3. Linear transformations of Euclidean space. Orthogonal projection on the subspace. Conjugate transformations, their properties. The coordinate form of the conjugation of the finite-dimensional Euclidean space transformation.

5.4. Self-conjugate transformations. Properties of their eigenvectors and eigenvalues. Existence of a basis from eigenvectors of a self-adjoint transformation.

5.5. Orthogonal transformations. Their properties are a Coordinate sign of orthogonality. Properties of orthogonal matrices. Polar decomposition of linear transformations of Euclidean space. Canonical form of the orthogonal transformation matrix. Singular decomposition.

5.6. Construction of an orthonormal basis in which the quadratic form has a diagonal form. Simultaneous reduction to the diagonal form of a pair of quadratic forms, one of which is sign-definite.

6. Unitary space

6.1. Unitary space and its axiomatics. Unitary and Hermitian matrices. Unitary and Hermitian transformations. Hermitian form. Properties of unitary and Hermitian transformations. Properties of Hermitian forms.

6.2. The concept of tensors. Basic tensor operations. Tensors in Euclidean space. Tensors in orthonormal basis.

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Machine Learning/Машинное обучение

Purpose of the course:

To learn data analysis concepts and methods

Tasks of the course:

Learn mathematical basics of data analysis

Learn programming tools for data processing and analysis

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

Mathematical foundations of data analysis

be able to:

To prepare source data

To find key features

To choose proper method to process

master:

Data processing methods and tools

Data analysis methods and tools

Content of the course (training module), structured by topics (sections):

1. Basic concepts. Python

Basic concepts: objects, features, answers, supervised and unsupervised learning.

Python Classification. Simplest classification algorithms

Python. Scikit-learn. Matplotlib

2. Quality of classification. Generalizing ability

Quality of classification. Generalizing ability

Overfitting and underfitting. Feature selection

Decision tree. Decision tree ensemble

3. Linear models

Linear models

Regularization

Support Vector Machine

4. Regression. Linear regression

Regression. Linear regression

Quality of regression. Regularization

Dimensionality reduction techniques

5. Artificial neural networks

Artificial neural networks

Unsupervised learning. Clustering

Quality of clustering

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Mathematical Analysis – Functions of One Variable/Математический анализ – функции одной переменной

Purpose of the course:

Formation of basic knowledge in mathematical analysis for further use in other areas of mathematical knowledge and disciplines with natural science content; the formation of a mathematical culture, research skills and the ability to apply knowledge in practice.

Tasks of the course:

- Acquisition of theoretical knowledge and practical skills by students in the field of the theory of limits, differential and integral calculus, the theory of series;

- preparing students for the study of related mathematical disciplines;

- the acquisition of skills in the application of methods of mathematical analysis in physics and other natural science disciplines.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

- basic properties of the limits of sequences and functions of a real variable, derivative, differential, indefinite integral; properties of functions that are continuous on a segment;

- basic "remarkable limits", tabular formulas for derivatives and indefinite integrals, differentiation formulas, basic expansions of elementary functions according to Taylor's formula;

- basic formulas of differential geometry;

- definition and properties of definite and indefinite integrals, their relationship;

- convergence criteria for improper integrals with power, logarithmic and exponential singularities.

be able to:

- write down statements using logical symbols;

- calculate the limits of sequences and functions of a real variable;

- calculate the derivatives of elementary functions, expand elementary functions according to the Taylor formula; calculate the limits of functions using the Taylor formula and L'Hôpital's rule;

- build graphs of functions using the first and second derivatives; explore functions for local extremum, as well as find their largest and smallest values at intervals;

- calculate the curvature of plane and spatial curves;

- calculate the indefinite and definite integral;

- use a certain integral to solve applied problems.

master:

- the subject language of classical mathematical analysis, used in the construction of the theory of limits;

- the apparatus of the theory of limits, differential and integral calculus for solving various problems arising in physics, technology, economics and other applied disciplines.

Content of the course (training module), structured by topics (sections):

1. Taylor's formula

1.1. Basic rules for differentiation. Fermat's theorem (a necessary condition for a local extremum). Rolle, Lagrange, Cauchy mean theorems.

1.2. Derivative of an inverse and complex function.

1.3. Higher order derivatives. Leibniz's formula for the n-th derivative of the product. Differential of the second order. The lack of invariance of its form with respect to the change of variable. Higher-order differentials.

2. Application of the derivative to the study of functions

2.1. Taylor's formula with remainder in the Peano and Lagrange forms.

2.2. L'Hôpital's rule for disclosing species uncertainties.

3. Differential geometry elements

3.1. Sufficient conditions for monotonicity, sufficient conditions for a local extremum in terms of the first and second derivatives. Convexity, inflection points. Sufficient conditions for a local extremum in terms of higher derivatives.

3.2. Plotting functions - asymptotes, studying the intervals of monotonicity and points of local extremum, intervals of convexity and points of inflection. Study for convexity and concavity. Plotting functions.

4. Indefinite integral

4.1. Curves on the plane and in space. Smooth curves tangent to a smooth curve.

4.2. Lagrange's theorem for vector functions, arc length of a curve.

4.3. Derivative of variable arc length. Natural parameter. Curvature of a curve, formulas for its calculation. Accompanying trihedron of the space curve.

5. Definite integral

5.1. Antiderivative and indefinite integral. Linearity of the indefinite integral, integration by substitution and by parts. Integration of rational functions.

5.2. Basic techniques for integrating irrational and transcendental functions.

6. Improper integral

6.1. The definite Riemann integral. Riemann sums, Darboux sums, integrability criterion.

6.2. Integrability of a continuous function, integrability of a monotone function, integrability of a bounded function with a finite number of discontinuity points.

6.3. Properties of integrable functions: additivity of an integral over segments, linearity of an integral, integrability of a product, integrability of the modulus of an integrable function, integration of inequalities, mean value theorem.

6.4. Integral properties with variable upper limit - continuity, differentiability. Newton-Leibniz formula. Integration by substitution and by parts in a definite integral.

6.5. Geometric applications of a definite integral - area of a curved trapezoid, volume of a body of revolution, length of a curve, surface area of revolution.

7. Derivatives of functions

7.1. Improper integral (the case of an unbounded function and the case of an infinite limit of integration). Cauchy's criterion for the convergence of an integral.

7.2. Integrals of functions of constant sign, criteria for comparing convergence. Integrals of alternating functions; absolute and conditional convergence. Dirichlet and Abel signs.

8. Number series

8.1. Number series. Cauchy's criterion for convergence of a series. Sign-constant series: criteria for comparing convergence, d'Alembert and Cauchy criteria, integral criterion. Alternating series: absolute and conditional convergence. Dirichlet and Abel signs.

8.2. The independence of the sum of an absolutely convergent series on the order of the terms. Riemann's theorem on the permutation of the terms of a conditionally convergent series. The product of absolutely converging series.

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Mathematical Analysis – Sequences and Series of Functions, Functions of Several Variables/Математический анализ – функциональные последовательности и

Purpose of the course:

further familiarization of students with the methods of mathematical analysis, the formation of their evidence-based and logical thinking.

Tasks of the course:

• formation of students' theoretical knowledge and practical skills in the problems of searching for unconditional and conditional extrema of a function of many variables, measure and integral theory, field theory;

• preparing students for the study of related mathematical disciplines;

• acquisition of skills in the application of methods of mathematical analysis in physics and other natural science disciplines.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

- the implicit function theorem;

- determination of the extremum of a function of many variables and the conditional extremum of a function of many variables in the presence of connections, necessary and sufficient conditions in the problems of finding an unconditional, as well as a conditional extremum in the presence of connections;

- signs of convergence of functional sequences and series.

be able to:

- to investigate functions of many variables for extremum;

- to solve problems on conditional extremum by the method of Lagrange multipliers;

- to investigate functional sequences and series for convergence;

- find the region of convergence of the power series;

- expand regular functions into power series.

master:

Logical thinking, methods of proving mathematical statements.

The skills of calculating integrals and the skills of applying field theory theorems in mathematical and physical applications.

Ability to use the necessary literature to solve problems.

Content of the course (training module), structured by topics (sections):

1. Metric space and topology

1.1. Point n-dimensional Euclidean space. Distance between points, its properties. Limit of a sequence of points in n-dimensional Euclidean space. Bolzano-Weierstrass theorem and Cauchy's criterion for convergence of a sequence. Internal, limit, isolated points of the set; points of contact. Open and closed sets, their properties. Interior, closure and boundary of a set.

2. Limit and continuity of a function of several variables

2.1. Limit of a numeric function of several variables. Definitions according to Heine and Cauchy, their equivalence. Repeated limits and directional limits. Investigation of the limit of a function of two variables using the transition to polar coordinates. Limit of a function over a set.

2.2. Continuity of a function of several variables at a point and over a set. Continuity of a complex function. The properties of functions that are continuous on a compactum are boundedness, achieving exact upper and lower bounds, uniform continuity. A theorem on intermediate values of a function that is continuous in a domain.

3. Differential calculus of functions of several variables

3.1. Partial derivatives of functions of several variables. Differentiability of a function of several variables at a point, differential. Necessary conditions for differentiability, sufficient conditions for differentiability. Differentiability of a complex function. Invariance of the form of the differential under a change of variables. Gradient, its independence from the choice of a rectangular coordinate system. Directional derivative.

3.2. Partial derivatives of higher orders. Independence of the mixed partial derivative from the order of differentiation. Differentials of higher orders, lack of invariance of their form under a change of variables. Taylor's formula for functions of several variables with a remainder in Lagrange and Peano forms.

4. Implicit functions

4.1. System of implicit functions.

4.2. Differentiable mappings.

5. Extrema of functions of several variables

5.1. Local extremum.

5.2. Conditional local extremum.

6. Number series

6.1. Number series. Cauchy's criterion for convergence of a series. Sign-constant series: criteria for comparing convergence, d'Alembert and Cauchy criteria, integral criterion. Alternating series: absolute and conditional convergence. Dirichlet and Abel signs. The independence of the sum of an absolutely convergent series on the order of the terms. Riemann's theorem on the permutation of the terms of a conditionally convergent series. The product of absolutely converging series.

7. Functional sequences and ranks

7.1. Uniform convergence of functional sequences and series. Cauchy's criterion for uniform convergence. Continuity of the sum of a uniformly converging series of their continuous functions. Term-by-term integration and differentiation of functional series. Weierstrass test for uniform convergence of functional series. Dirichlet and Abel signs.

8. Power series

8.1. Power series with complex members. Abel's first theorem. Circle and radius of convergence. The nature of the convergence of a power series in the circle of convergence. Cauchy-Hadamard formula for the radius of convergence. Abel's second theorem. Continuity of the sum of a complex power series.

8.2. Power series with full members. Preservation of the radius of convergence in term-by-term integration and differentiation of a power series. Infinite differentiability of the sum of a power series in the circle of convergence. Uniqueness of the expansion of a function in a power series; Taylor series. Taylor's formula with remainder in integral form. An example of an infinitely differentiable function that does not expand in a power series. Taylor series expansion of basic elementary functions. Power series expansion of a complex function.

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Mathematical Thinking/Математическое мышление

Purpose of the course:

- mastering general mathematical terminology (sets, relationships, functions).

Tasks of the course:

• Develop the skill of structured logical thinking.

• Learn to give formal definitions and give examples of defined objects.

• Learn to build formal records of mathematical statements and their proofs and work with these records.

• Learn to conduct mathematical reasoning, not based on the specific properties of the objects under consideration.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

 fundamental concepts, laws, theories of a part of discrete mathematics;

 modern problems of the corresponding sections of discrete mathematics;

 concepts, axioms, methods of proofs and proofs of the main theorems in the sections included in the basic part of the cycle;

 basic properties of the corresponding mathematical objects.

be able to:

 understand the task at hand;

 use your knowledge to solve fundamental and applied problems;

 evaluate the correctness of the problem setting;

 strictly prove or disprove the statement;

 independently find algorithms for solving problems, including non-standard ones, and analyze them;

 independently see the consequences of the results obtained;

 Accurately present mathematical knowledge in the field orally and in writing.

master:

 skills of mastering a large amount of information and solving problems (including complex ones);

 skills of independent work and mastering new disciplines;

 culture of formulation, analysis and solution of mathematical and applied problems that require the use of mathematical approaches and methods for their solution;

 the subject language of discrete mathematics and the skills of competently describing the solution of problems and presenting the results obtained.

Content of the course (training module), structured by topics (sections):

1. Statements and logical connectives

Truth tables, tautologies, logical equivalence. Predicates and quantifiers. Vacuous truths. Structural induction for lists (strings, words). Inductive and recursive definitions.

2. Induction Principle: equivalent forms and applications

Graphs. Vertex degree. Isomorphism. Bipartite graphs. Matchings. Connected components. Trees. Spanning tree. Directed graphs.

3. Sets and elements

Specifying new sets. Russell's paradox. Algebra of sets. Ordered pair and Cartesian product. Tuples and Cartesian power.

4. Binary relations

Algebra of binary relations. Special binary relations. Functions. Set equivalence and embedding. Cantor's theorem. Cantor-Schr¨oderBernstein theorem. The equivalence N 2 ∼ N. 'Basic' equivalences like (AB) C ∼ AC×B. Cardinalities of sets N2, Z,Q, R2, NN, R N. Indicator function. The equivalences 2A ∼ P(A) and An ∼ An.

5. Pigeonhole Principle

Finite and countable sets. Rules of sum and product. Counting functions, injections, bijections, subsets. Binomial coefficients and their properties. Inclusion–exclusion principle. Various applications.

6. Special binary relations

Partial orders. Maxima and minima. Suprema and infima. Equivalence relations. Quotient set and partitions. Counting partitions. Boolean functions and circuits. Clones. Functional completeness. Counting functions of various classes.

7. Formal propositional logic

Natural deduction. Completeness and compactness. Algorithms. Computable functions, decidable and recursively enumerable sets. Turing machines. Halting problem. Untyped lambda calculus. Programming therein

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Matlab/Matlab

Purpose of the course:

The course is devoted to the implementation of mathematical models based on MATLAB.

The main goal is to master the practical aspects of choosing suitable modeling approaches, numerical methods and applied tools for effective software implementation.

Tasks of the course:

The main features of MATLAB for scientific calculations will be demonstrated, the most commonly used numerical methods and criteria for their selection will be considered.

To consolidate the knowledge gained at the seminars, it is proposed to solve computational problems.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

The main tools for scientific computing language MATLAB and their functionality.

be able to:

Use the basic means of scientific computing of the MATLAB language to solve typical applied problems and adapt them to your needs during the implementation of research.

master:

Tools for creating applications on MATLAB, the basic principles of computing using MATLAB.

Content of the course (training module), structured by topics (sections):

1. The simplest symbolic and numerical calculations.

Visualization, export and import of data, interaction with external libraries.

2. Numerical solution of boundary and initial-boundary value problems for equations of mathematical physics.

MATLAB tools for solving hypothetical boundary value problems in partial derivatives (hyperbolic, elliptic, parabolic equations).

3. Numerical solution of ODE systems.

Different ways to solve homogeneous differential equations.

4. Time Series Analysis.

Time series analysis. Scheduling

5. Solution of systems of linear equations.

Systems of linear equations. Solving optimization problems.

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Multiple Integrals and Field Theory/Кратные интегралы и теория поля

Purpose of the course:

further familiarization of students with the methods of mathematical analysis, the formation of their evidence-based and logical thinking.

Tasks of the course:

• formation of students' theoretical knowledge and practical skills in the problems of searching for unconditional and conditional extrema of a function of many variables, measure and integral theory, field theory;

• preparing students for the study of related mathematical disciplines;

• acquisition of skills in the application of methods of mathematical analysis in physics and other natural science disciplines.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

- definition of a multiple Riemann integral, a criterion for the integrability of a function, a sufficient condition for the integrability of a function, properties of integrable functions, a theorem on the reduction of a multiple integral to a repeated one, physical applications of the integral;

- basic facts and formulas of field theory (formulas of Green, Ostrogradsky-Gauss, Stokes), physical meaning of formulas of field theory.

be able to:

- calculate the integral of a function of many variables over a set;

- be able to solve applied physical problems: calculate body mass, moments of inertia, volumes, etc.

- apply field theory formulas for solving mathematical problems: calculating integrals, finding areas and volumes of bodies, areas of surfaces;

- to apply the formulas of field theory for solving physical problems: checking the potentiality and solenoidality of the field, finding the work of the field when a material point moves, etc .;

- be able to carry out calculations with the nabla operator.

master:

Logical thinking, methods of proving mathematical statements.

The skills of calculating integrals and the skills of applying field theory theorems in mathematical and physical applications.

Ability to use the necessary literature to solve problems.

Content of the course (training module), structured by topics (sections):

1. Curvilinear integrals. Green's formula

1.1. Definition of multiple integral and integrability criterion. Multiple integral properties.

1.2. Reduction of a multiple integral to a repeated one.

1.3. The geometric meaning of the modulus of the Jacobian of a mapping. Change of variables in multiple integrals.

1.1. Definition of multiple integral and integrability criterion. Multiple integral properties.

1.2. Reduction of a multiple integral to a repeated one.

1.3. The geometric meaning of the modulus of the Jacobian of a mapping. Change of variables in multiple integrals.

2. Surfaces. Surface integrals

Green's formula. Potential vector fields on the plane. Condition of independence of a curvilinear integral of the second kind from the path of integration.

3. Field theory: Ostrogradsky-Gauss and Stokes formulas

3.1. Plain smooth surface. Surface integral of the first kind. Independence of the expression of the integral through the parametrization of the surface from the admissible parameter change Surface area.

3.2. Orientation of a simple smooth surface. Surface integral of the second kind, expression in terms of surface parametrization. Piecewise smooth surfaces, their orientation and integrals over them.

4. Multiple integrals

4.1. Gauss-Ostrogradsky formula. Divergence of a vector field, its independence from the choice of a rectangular coordinate system and geometric meaning. Solenoidal vector fields. Connection of solenoidality with turning the field divergence into the rudder. The concept of vector potential.

4.2. Stokes formula. The rotor of a vector field, its independence from the choice of a rectangular coordinate system and its geometric meaning. Potential vector fields. Conditions for the independence of the curvilinear integral from the path of integration. Connection of potentiality with the vanishing of the rotor of the field.

4.3. Vector "nabla" and actions with it. Basic relations containing the nabla vector. Laplacian and vector gradient for scalar and vector fields.

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Operating Systems I/Операционные системы I

Purpose of the course:

The purpose of the course is the development of fundamental knowledge in the field of operating systems by students.

Tasks of the course:

• formation of a general idea of the basic concepts in the field of operating systems and methods of their design;

• the formation of basic knowledge about the main objects of operating systems and how to work with them;

• teaching students examples of practical implementation of operating systems.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

• main types of objects of operating systems;

• methods for implementing objects of operating systems;

• structure of operating systems using Linux as an example;

• means of parallelization of calculations of the POSIX standard;

• methods of real-time implementation in the OS;

• methods of organizing OS design work;

• testing methods for large software systems.

be able to:

• use the basic mechanisms of OS such as Linux;

• synchronize parallel computing.

master:

• basic mechanisms for working with large software systems.

Content of the course (training module), structured by topics (sections):

1. UNIX-like basics. Command line usage and developer tools

Hardware, operating system and programming system. Their interaction.

2. Integers in computing. One's complement negative integers representation and bitwise operations

Types implemented by hardware, operating system tools, user programs. Methods for implementing types (type control): dynamic control, control at compile time. Hardware requirements for efficient type implementation.

3. ARM assembly basics. QEMU usage and cross-compilation

Pointers to objects, virtual memory, and the problem of stuck pointers.

4. Structure packing and field access. IEEE754 floating point representation

Realization of exceptional situations as objects. Organization of emergency completion of procedures.

5. Pointers. Memory access, stack and static variables

Address space Executable program. Library of functions. Branch of calculations (call stack). File; file system. User; task, session.

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Operating Systems II/Операционные системы II

Purpose of the course:

The purpose of the course is the development of fundamental knowledge in the field of operating systems by students.

Tasks of the course:

• formation of a general idea of the basic concepts in the field of operating systems and methods of their design;

• the formation of basic knowledge about the main objects of operating systems and how to work with them;

• teaching students examples of practical implementation of operating systems.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

• main types of objects of operating systems;

• methods for implementing objects of operating systems;

• structure of operating systems using Linux as an example;

• means of parallelization of calculations of the POSIX standard;

• methods of real-time implementation in the OS;

• methods of organizing OS design work;

• testing methods for large software systems.

be able to:

• use the basic mechanisms of OS such as Linux;

• synchronize parallel computing.

master:

• basic mechanisms for working with large software systems.

Content of the course (training module), structured by topics (sections):

1. Process intercommunication using pipe channels

Understanding RPC and passing parameters through the universal XDR view. Libdoor library

2. FIFO channels and file locks

Using the make utility to build large software systems.

GNU make recommendations.

3. Signals and theirs handling

Svn utility

4. Process intercommunication using mapped memory regions

Test requirements. Testing Management Systems.

5. POSIX shared memory and POSIX semaphores

Software packages as software delivery units. Organization of distributions on the example of Debian.

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Ordinary Differential Equations/Дифференциальные уравнения

Purpose of the course:

familiarization of students with the basics of differential equations and preparation for the study of other mathematical courses – the theory of functions of complex variables, equations of mathematical physics, optimization and optimal control, functional analysis, etc.

Tasks of the course:

- the acquisition by students of theoretical knowledge and practical skills in the field of solutions of elementary differential equations, linear differential equations and systems, problems in calculus of variations, the study of Cauchy problems, the study of special solutions for the construction and study of phase trajectories of Autonomous systems, finding the first integrals and solutions with their help and nonlinear systems of equations, solving linear equations and systems with variable coefficients;

- preparation of students for the study of related mathematical disciplines;

- acquisition of skills in the application of methods of differential equations in physics and other natural Sciences.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

The simplest types of differential equations, methods of lowering the order of differential equations.

Basic formulas of General and particular solutions of linear systems and equations with constant coefficients, definition and properties of the matrix exponent.

Conditions of existence and uniqueness of the solution of the Cauchy problem for normal systems of differential equations and for the n-th order equation in the normal form, the nature of the dependence of the solutions on the initial conditions. The concept of a special solution.

Formulation of problems of variational calculus.

Basic concepts and properties of phase trajectories of Autonomous systems, classification of equilibrium positions of linear Autonomous systems of the second order.

The concept of the first integral of nonlinear systems of differential equations, their application to the solutions of partial differential equations of the first order, the conditions of existence and uniqueness of the solution of the Cauchy problem for the equation in the first order partial products.

Structure of the General solution of linear systems with variable coefficients, properties of the Vronsky determinant, Liouville-Ostrogradsky formula. Properties of zeros of solutions of differential equations of the second order (Sturm's theorem).

be able to:

To solve the simplest differential equations, to apply methods of order reduction.

Solve linear equations and systems with constant coefficients, apply the matrix exponent to the solution of systems of linear equations with constant coefficients.

Investigate the Cauchy problem. Find special solutions of the equation of the first order, not resolved with respect to the derivative.

To investigate various problems of variational calculus.

Find the equilibrium position, to build the linearized system in a neighborhood of an equilibrium, to determine the type of equilibrium and to construct the phase trajectories of linear systems of second order.

Find the first integrals of systems of differential equations, apply them to solve simple nonlinear systems. Solve first order linear partial differential equations.

Apply the Liouville-Ostrogradsky formula and the method of variation of constants to solve second-order equations with variable coefficients. To investigate the properties of solutions of differential equations of the second order using the theorem of Sturm.

master:

Logical thinking, methods of proof of mathematical statements.

Skills in solving and researching differential equations and systems in mathematical and physical applications.

The ability to use the necessary literature.

Content of the course (training module), structured by topics (sections):

1. The simplest types of differential equations

Basic concept. The simplest types of equations of the first order: equations with separating variables, homogeneous, linear, equations in complete differentials. Integrating factor. A method for introducing a parameter for a first-order equation that is unsolved with respect to a derivative. Methods of decreasing the order of differential equations. Using one-parameter transformation groups to lower the order of differential equations.

2. Linear differential equations and systems with constant coefficients

The formula for the General solution of a linear homogeneous equation of the n-th order. Finding solutions of linear inhomogeneous in the case when the right-hand side of the equation is a quasi multinomial. Euler equation. Study of boundary value problems for the second-order linear equation (in particular, in the presence of a small parameter for the highest derivative). The formula for the General solution of a linear homogeneous system of equations in the case of simple eigenvalues of the coefficient matrix of the system. Theorem on reduction of the matrix of linear transformation to Jordan form (without proof). The formula for the General solution of a linear homogeneous system in the case of multiple eigenvalues of the matrix of coefficients of the system. Finding a solution to a linear inhomogeneous system in the case where the free terms of the equations are vector-quasi-polynomials. Matrix exponent and its use to obtain the General solution formula and solution of the Cauchy problem for linear homogeneous and inhomogeneous systems. Laplace transform and its application to solving linear differential equations with constant coefficients.

3. Elements of variational calculus

Basic concept. The simplest problem of variational calculus. A problem with free ends; a problem for functionals depending on several unknown functions, and a problem for functionals containing higher order derivatives. Isoperimetric problem. Lagrange's Task.

4. The study of the Cauchy problem

Theorem of existence and uniqueness of the solution of the Cauchy problem for normal systems of differential equations and for the n-th order equation in the normal form. Theorem on continuation of solutions of normal systems. The nature of the dependence of the Cauchy problem solution on the parameters and initial data: continuity, differentiability. The Cauchy problem for the first order equation unsolved with respect to the derivative. Special solution.

5. Autonomous systems of differential equations

Basic concepts and properties of phase trajectories. Classification of equilibrium positions of linear Autonomous systems of equations of the second order. The behavior of phase trajectories in the vicinity of the equilibrium position of Autonomous nonlinear systems of second-order equations. Stability and asymptotic stability of the equilibrium position of an Autonomous system. Sufficient conditions for asymptotic stability.

6. First integrals and linear homogeneous partial differential equations of the first order

Basic concepts and properties of phase trajectories. Classification of equilibrium positions of linear Autonomous systems of equations of the second order. The behavior of phase trajectories in the vicinity of the equilibrium position of Autonomous nonlinear systems of second-order equations. Stability and asymptotic stability of the equilibrium position of an Autonomous system. Sufficient conditions for asymptotic stability.

7. Linear differential equations and linear systems of differential equations with variable coefficients

The existence and uniqueness theorem of the Cauchy problem solution for normal linear systems of equations and for the n-th order equation in the normal form. Fundamental system and fundamental matrix of solutions of linear homogeneous system of equations. The structure of the General solution of a linear homogeneous and inhomogeneous system of equations. Vronsky's Determinant. Liouville-Ostrogradsky Formula. The method of variation of constants for a linear

inhomogeneous system of equations. Consequences for linear equations of n-th order. Theorem of Assault and its consequences.

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Parallel and Disrtibuted Computing I/Параллельные и распределённые вычисления I

Purpose of the course:

To acquaint students with the basics of multiprocessor computing systems and give practical experience in working with such systems. The course consists of two modules, dedicated to parallel and distributed systems, respectively. The first module examines systems in almost "ideal" conditions, where computing nodes and connections between them are reliable and fast. The second module examines ways to build reliable systems from unreliable components.

Tasks of the course:

During the course, students gain practical skills in working with both parallel and distributed systems.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

● types and classification of multiprocessor computing systems;

● principles of building distributed data warehouses;

● principles of building distributed ecosystems (Hadoop / Spark);

● the difference between (single-) server databases and distributed databases;

● model of asynchronous computation and relationship with the degree of transaction isolation;

● the Fisher-Lynch-Paterson theorem (FLP-theorem);

● know the basic principles of Paxos / Raft;

● know time synchronization algorithms (NTP, Cristian's Algorithm)

● standard distributed computing tasks (Multicasts, Failure Detectors, Membership, Consensus, RSM)

be able to:

● use the library for parallel computations OpenMP;

● use the library for parallel computations MPI;

● use the distributed file system HDFS;

● use a distributed computing framework Hadoop;

● use the distributed data storage Hive;

● be able to use the primitives of distributed computing Lamport Timestamps, Vector Clocks

● solve the problem of consensus in a synchronous system;

● use Paxos / Raft algorithms.

master:

● skills in working with multiprocessor computing systems (parallel and distributed computing systems in particular)

● horizons in choosing an architectural solution to the task.

Content of the course (training module), structured by topics (sections):

1. Distributed computing theory (transaction isolation levels, CRDT, CAP, FLP, Paxos, Raft)

● Classification of multiprocessor computing systems, failure models;

● Difference between parallel computing and distributed computing;

● Databases: ACID, isolation levels. Distributed databases: CAP, CRDT. AP and CP systems;

● Algorithms of time synchronization (NTP, Cristian's Algorithm);

● standard distributed computing tasks (Multicasts, Failure Detectors, Membership, Consensus, RSM);

● Fisher-Lynch-Paterson theorem (FLP-theorem);

● Basic principles of Paxos / Raft;

2. GPU computing. CUDA technology

GPU architecture.

Device (graphics processing unit) and Host. Data exchange between them.

Optimization of computing on GPUs.

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Parallel and Disrtibuted Computing II/Параллельные и распределённые вычисления II

Purpose of the course:

To acquaint students with the basics of multiprocessor computing systems and give practical experience in working with such systems. The course consists of two modules, dedicated to parallel and distributed systems, respectively. The first module examines systems in almost "ideal" conditions, where computing nodes and connections between them are reliable and fast. The second module examines ways to build reliable systems from unreliable components.

Tasks of the course:

During the course, students gain practical skills in working with both parallel and distributed systems.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

● types and classification of multiprocessor computing systems;

● principles of building distributed data warehouses;

● principles of building distributed ecosystems (Hadoop / Spark);

● the difference between (single-) server databases and distributed databases;

● model of asynchronous computation and relationship with the degree of transaction isolation;

● the Fisher-Lynch-Paterson theorem (FLP-theorem);

● know the basic principles of Paxos / Raft;

● know time synchronization algorithms (NTP, Cristian's Algorithm)

● standard distributed computing tasks (Multicasts, Failure Detectors, Membership, Consensus, RSM)

be able to:

● use the library for parallel computations OpenMP;

● use the library for parallel computations MPI;

● use the distributed file system HDFS;

● use a distributed computing framework Hadoop;

● use the distributed data storage Hive;

● be able to use the primitives of distributed computing Lamport Timestamps, Vector Clocks

● solve the problem of consensus in a synchronous system;

● use Paxos / Raft algorithms.

master:

● skills in working with multiprocessor computing systems (parallel and distributed computing systems in particular)

● horizons in choosing an architectural solution to the task.

Content of the course (training module), structured by topics (sections):

1. Parallel computing on MPI and OpenMP

What is Parallel Computing?

Device and basic structures in MPI Queue system SLURM.

Features of OpenMP

Using MPI and OpenMP in one program.

2. Distributed computing on large amounts of data (HDFS, MapReduce, Hive, Spark)

Distributed file systems (GFS, HDFS). Its components. Their advantages, disadvantages and scope. Reading and writing to HDFS. HDFS APIs: WebUI, shell, Java API

The MapReduce paradigm. Main idea, formal description. Overview of implementations. API for working with Hadoop (Native Java API vs. Streaming), examples

Types of Joins and their implementation in the MR paradigm. MR design patterns (pairs, stripes, composite keys). PageRank in MR. Task Scheduler in YARN.

SQL over BigData. Hive framework

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Philosophy/Философия

Purpose of the course:

ntroduce students to the highest achievements of world philosophical thought, give a clear understanding of the specifics of philosophy, introduce them to the main stag-es and directions of its development, the peculiarities of modern philosophy and its role in culture, instill general theoretical and philosophical thinking skills, contribute to the formation and improvement of independent analyt-ical thinking in the field of humanitarian knowledge, mastery of the principles of a rational philosophical ap-proach to information processes and trends in modern so-ciety

Tasks of the course:

The tasks of the course are:

- formation of a holistic worldview system with natu-ral science, logical-mathematical, philosophical and socio-humanitarian components
- mastering the skills of rational discussion, rational reflection and critical analysis of a theoretical text
- the study of various styles of philosophical think-ing, basic philosophical categories and concepts.
- study of general scientific and philosophical re-search methods

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

The main sections and directions, categories and con-cepts of the history of philosophy and philosophical analysis of social, scientific and general cultural prob-lems to the extent necessary for professional activities and the formation of a citizen's worldview.

be able to:

Organize a system of their activities aimed at solving practical and theoretical problems, taking into account the historical, cultural and philosophical context of their occurrence.

Remove in their practical activities the barriers of nar-row specialization, think interdisciplinarily, identify the epistemological sources of problems and put them in the value context of human culture.

master:

Skills of demonstrative presentation of one's own point of view; skills in public speaking, argumentation, discussion and debate; logical methods of text analysis and reasoning; abilities of critical assessment of infor-mation.

Content of the course (training module), structured by topics (sections):

1. Philosophy, its subject and significance

The historical diversity of the definitions of philosophy. Sections of philosophy. "Being" as a philosophical con-cept and ontology as a doctrine of being. Epistemology. Ethics. Aesthetics. Philosophical Anthropology. The question of man as a philosophical problem. Man / indi-vidual / individuality / personality. Man and society. The nature of man and his essence. Man and his freedom. The problem of the meaning of life. Social philosophy. Man as a social being. Man in society and society in man. So-cium as a system of extra- and supra-individual forms, connections and relations

Man, society and the state. The philosophy of history: the subject of history and its driving forces. Personality – so-ciety – history. The focus of history and its meaning.

The emergence of philosophy and pre-philosophy. Phi-losophy and mythology. The specifics of the philosophy of Ancient China and Ancient India.

The Ancient World and the Genesis of Ancient Greek Philosophy: Social and Epistemological Prerequisites

2. History of ancient philosophy, its role for the development of the world philosophical thought

Periodization of ancient philosophy. The value of ancient philosophical tradition for the development of world philosophical thought.

The period of the pre-Socratics. Antique cosmocentrism, the arche problem, the natural philosophy of the pre-Socratics. Miletus school. Pythagoras and Pythagorean-ism. The philosophical teachings of Heraclitus and the Elean school. Teaching Parmenides about being. The thesis of the identity of being and thinking. Ancient Greek atomism.

Sophists and features of their philosophical position. Socrates, his place and role in the history of European philosophy. A new orientation of philosophy in Socrates. Mayevtica of Socrates.

Plato, his works, the basic principles of philosophical doctrine. Ontology of Plato: being as a hierarchy of ei-dos, the world of being and the world of becoming, the doctrine of matter. Anthropology and social philosophy of Plato. Academy. The meaning of platonism.

Encyclopedic system of Aristotle. Aristotle's doctrine of being: a categorical analysis of existence. Threefold defi-nition of metaphysics as a science of the first principles, of the existing as such and of the divine. Criticism of the Platonic theory of ideas. Essence as a subject of philoso-phy. The problem of the ratio of unit and total. The con-cepts of form and matter, actual and potential. The doc-trine of the Mind as a form of form. Eudaimonic ethics of Aristotle. Man as a social being. Likey. The peripatetic school.

Philosophical teachings of the Hellenistic era, their ethi-cal orientation. Cynics, skeptics, stoics. Epicurus Ploti-nus and the Neoplatonic synthesis of the basic ideas and intuitions of ancient philosophy

.

3. Medieval and Renaissance philosophy

The philosophy of the Middle Ages, its periodization and specificity. Theocentrism and creationism. Philosophy and theology. Relation to the ancient philosophical herit-age. Christian apologetics.

Medieval ontology: God as an absolute being. The main topics of medieval philosophy: faith and reason, anthro-pological ideas, the question of free will, the debate about universals. Greek and latin patristics. Christian an-thropology: man is the image and likeness of God. The concept of "inner man." The concept of "sacred history" in Christianity, eschatologism.

Scholasticism as a philosophy of schools and universi-ties. Platonic orientation of the early scholasticism: real-ism. Arabic philosophy, medieval Aristotelianism, Latin Averroism. Thomas Aquinas and its significance. Nomi-nalism. The tradition of voluntarism in the teachings of Duns Scotus and Occam. Late scholasticism. East Chris-tian theological thought. Doctrine of sv. Gregory Pala-mas about energies. Hesychasm. Philosophical knowledge in Ancient Russia.

Anthropocentrism and Renaissance humanism. The spec-ificity of the philosophy of the Renaissance. The individ-ualistic interpretation of man in the Renaissance. Meta-physics of Nicholas of Cusa. Florence Academy. Panthe-istic ideas D. Bruno.

The Reformation and its influence on the philosophical process of the New Time.

4. Philosophy of the Modern Times

New European philosophy. Criticism of the previous tra-dition, the problems of “experience” and “method”, justi-fication of the project of modern science, innovations in the formulation of epistemological problems. Empiri-cism: F. Bacon, sensationalism of T. Hobbes, D. Locke, D. Berkeley, skepticism of D. Hume. The tradition of ra-tionalism: the main ideas of R. Descartes, B. Spinoza, G. Leibniz and others. The place of ontology in the philoso-phy of the New Time. The idea of substance. The mecha-nistic anthropology of the New Time: man is the “body” and man is the “machine”. Pascal: man is a “thinking reed”.

Social philosophy of the New time. Basic concepts: the idea of "natural law", the theory of social contract, the principle of separation of powers. The mechanistic inter-pretation of society in T. Hobbes's “Leviathan” (the con-cept of “natural state”).

The Age of Enlightenment and the cult of the mind. So-cio-political doctrines of the Enlightenment. Enlighten-ment Ideas in Germany: G. Lessing, I. Herder and others. Features of the reception of educational ideas in Russian philosophical culture of the eighteenth century.

Kant as the founder of German classical philosophy and the creator of transcendental idealism. Key Points Critics of Pure Reason. The doctrine of the antinomies of the mind. Ethical doctrine of I. Kant. The concepts of auton-omous and heterogeneous ethics. Categorical imperative. The concept of debt. The definition of personality and its difference from a thing. The concept of freedom in Kant's philosophy. Post-Kant German idealism: I. Fichte, F. Schelling, romance. The absolute idealism of G. Hegel.

The main directions of 19th-century European philoso-phy: positivism, neo-Kantianism, and others. The Marx-ist theory of class society.

Russian philosophy of the XIX century. Socio-political ideals of the Slavophiles and Westerners. Vl. Soloviev, K. Leontyev and others.

5. Problematic and main trends in the XX century philosophy and of the contemporary philosophical thought

UGHT.

New directions in European philosophy at the beginning of the XX century. Existentialism and its varieties. The fundamental ontology of M. Heidegger: the history of European philosophy as a “history of oblivion of being." Return to ontology: Russian metaphysics, neo-Thomism, etc. Russian philosophical thought in the XX century. Social philosophy of I.A. Ilyin. Anthropological issues in Western European and Russian personalism.

Berdyaev on social inequality, aristocracy, revolution, democracy and anarchy. Phenomenology. Analytical philosophy. Structuralism. Socio-philosophical topics in the philosophical thought of the XX century. Modern discussions in the philosophy of consciousness. Postmodernism and its critics. Contemporary philosophical issues. The problems of the meaning of history, the “end of history” and posthistory, multiculturalism and the “clash of civilizations” in contemporary philosophical discussions.

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Probability Theory/Теория вероятностей

Purpose of the course:

mastering the basic modern methods of probability theory.

Tasks of the course:

• students mastering basic knowledge (concepts, concepts, methods and models) in probability theory;

• acquisition of theoretical knowledge and practical skills in probability theory;

• providing advice and assistance to students in conducting their own theoretical research in probability theory.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

 fundamental concepts, laws of probability theory;

 modern problems of the corresponding sections of probability theory;

 concepts, axioms, methods of proof and proof of the main theorems in the sections included in the basic part of the cycle;

 basic properties of the corresponding mathematical objects;

 analytical and numerical approaches and methods for solving typical applied problems of probability theory.

be able to:

 understand the task;

 use your knowledge to solve fundamental and applied problems;

 evaluate the correctness of the problem statements;

 strictly prove or disprove the statement;

 independently find algorithms for solving problems, including non-standard ones, and conduct their analysis;

 independently see the consequences of the results;

 accurately represent mathematical knowledge in probability theory in oral and written form.

master:

 skills of mastering a large amount of information and solving problems (including complex ones);

 skills of independent work and mastering new disciplines;

 the culture of the formulation, analysis and solution of mathematical and applied problems that require the use of mathematical approaches and methods for their solution;

 the subject language of probability theory and the skills of competent description of problem solving and presentation of the results.

Content of the course (training module), structured by topics (sections):

1. Discrete probability spaces.

Discrete probability spaces. The classic definition of probability. Examples.

2. Independence of an arbitrary set of random variables.

Independence of an arbitrary set of random variables. Independence criterion, a theorem on the independence of Borel functions from disjoint sets of independent random variables.

3. Random variables in discrete probability spaces.

Random variables in discrete probability spaces. Independence of random variables. The mathematical expectation of a random variable, its basic properties. Dispersion, covariance and their properties.

4. Bernoulli test design

Mathematical model, limit theorems: Poisson and Muavre-Laplace

5. Random elements, random variables and vectors.

Random elements, random variables and vectors. A sufficient condition for the measurability of a mapping, a corollary for random variables and vectors. Actions on random variables.

6. Systems of sets (semirings, rings, algebras, sigma-algebras)

Minimal ring containing a half ring. The concept of the smallest ring, algebra, sigma-algebra containing a system of sets. Measures on half rings. The classical Lebesgue measure on the half ring of spaces and its sigma additivity.

7. Carathéodory's theorem on the continuation of a probability measure (proof of uniqueness).

Carathéodory's theorem on the continuation of a probability measure (proof of uniqueness). Lebesgue theorem on distribution function

8. Completeness and continuity of measures

Theorems on the relation between continuity and sigma additivity. Borel measure. Lebesgue-Stieltjes measures on the line and their sigma additivity.

9. Immeasurable sets.

Theorem on the structure of measurable sets. Measurable functions. Their properties. Measurable functions and passage to the limit.

10. Convergence. Cauchy Convergence Criterion

Convergence in measure and almost everywhere. Their properties (Cauchy criterion for convergence in measure, arithmetic, connection of convergence, Riesz theorem). Theorems of Egorov and Luzin.

11. Conditional probabilities.

Conditional probabilities. The formula for total probability. Bayes formula. Examples

12. Lebesgue integral

The Lebesgue integral and its properties. Definition of the Lebesgue integral in the general case. The main properties of the Lebesgue integral.

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Python/Язык программирования Python

Purpose of the course:

To introduce students to the Python programming language and prepare them for practical activities in the positions of analysts and software programmers.

Tasks of the course:

* Build knowledge about the correct use of the Python language in development

* Build knowledge about popular Python libraries and frameworks

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

Python programming language syntax generally accepted methods for solving basic problems using language features core Python libraries and frameworks

The principle of execution of programs in Python;

Python data types

flow control in Python;

features of the standard library;

rules for working with exceptions;

the internal structure of the containers of the standard library and the time complexity of operations with them;

how garbage collection works in Python;

encodings used when storing text data (ASCII, Windows-1250/1251, UTF-8, UTF-16).

be able to:

implement a general-purpose library in Python using the specified interfaces;

solve data processing tasks in Python.

master:

core Python libraries and developer tools.

Content of the course (training module), structured by topics (sections):

1. Python programming language syntax

Variables Expressions. Functions Conditional statements and loops.

Collection Methods. Enumeration of collections. Conditional expressions and collections. Comparison of collections.

Garbage collector.

2. Python libraries and tools

Syntax errors. Exceptions Throwing and catching exceptions. Keywords try, except, finally, raise. The thread of execution when throwing and catching an exception. The open and close methods. Construction with as.

Reading and writing data in various encodings.

Directories.

Writing variables to a file (pickle module).

Reading and writing in csv format.

Read and write in json format.

3. Modules and Packages

Connecting modules with the import statement. Various import syntaxes.

Execution of the module as a script. Search paths. dir ()

"Compilation" of modules.

Packages. Import inside the module (. And ..)

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Russian as a Foreign Language/Русский язык как иностранный

Purpose of the course:

The Russian as a foreign language (A2+) course is aimed at the formation of intercultural professionally oriented communicative competence from the zero level to the Pre-Intermediate level (according to the European scale of foreign language proficiency levels) for solving social and communicative tasks in various areas of everyday, cultural, professional and scientific activities in the Russian language, as well as for further self-education.

Tasks of the course:

The tasks of the formation of intercultural, professionally oriented communicative competence consist of the gradual mastery by students of a set of competences, the main of which are:

– linguistic competence, i.e. the ability to adequately perceive and correctly use language units based on knowledge of phonological, grammatical, lexical, stylistic features of the studied language;

– sociolinguistic competence, i.e. the ability to adequately use realities, background knowledge, situationally conditioned forms of communication;

– sociocultural competence, i.e. the ability to consider during the communication speech and behavioral models adopted in the relevant culture;

– social competence, i.e. the ability to interact with communication partners, to make contact and maintain it, owning the necessary strategies;

– strategic competence, i.e. the ability to apply different strategies to maintain successful interaction in oral/written communication;

– discursive competence, i.e. the ability to understand and generate foreign language discourse considering cultural differences;

– general competence, including, along with knowledge about the country and the world, about the features of the language system, also the ability to expand and improve their own picture of the world, to be guided by the media sources of information;

– intercultural competence, i.e. the ability to achieve mutual understanding in intercultural contacts, using the entire set of skills to realize the communicative intention;

– compensatory competence, i.e. the ability to avoid misunderstandings, to overcome the communication barrier through the use of well-known speech and metalanguage means.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

– The main facts, realities, names, attractions, traditions of Russia;

– some achievements, discoveries, events in the field of Russian science, culture, politics, social life;

– basic phonetic, lexical-grammatical, stylistic features of the Russian language and its difference from the native language;

– the main differences in writing and speaking.

be able to:

– Generate adequate oral and written texts in a specific communication situation;

– to realize the communicative intention with the purpose of influencing the communication partner;

– adequately understand and interpret the meaning and intention of the author in the perception of oral and written authentic texts;

– identify similarities and differences in the systems of native and foreign languages;

– show tolerance, empathy, openness and friendliness when communicating with representatives of another culture.

master:

– Intercultural professionally oriented communicative competence in different types of speech activity at the level of A2+;

– socio-cultural competence for successful mutual understanding in terms of communication with representatives of another culture;

– various communication strategies;

– learning strategies for organizing your learning activities;

– strategies of reflection and self-evaluation for self-improvement of personal qualities and achievements;

– different methods of memorization and structuring digestible material;

– Internet technologies to select the optimal mode of obtaining information.

Content of the course (training module), structured by topics (sections):

1. Nice to meet you!

Communicative tasks. To get acquainted. To introduce yourself and other people. To ask for a phone number. To ask for repetition. To start conversation with a person.

Vocabulary. Common phrases for meeting people, saying goodbye etc. Occupation. Professions. Numbers 0-9. People (man, woman, etc.).

Grammar. Construction "Who is this?" Personal pronouns (subject): я, ты, он, она, мы, вы, они. Personal pronouns (object): меня, тебя, его, её, нас, вас, их.

Phonetics. Pronunciation of sounds (т, к, м, а, о, е, э, я, б, п, в, ф, ж, д, р, з, с, ш, щ, ч).

2. My World

Communicative tasks. To talk about your everyday activity. To tell the time. To make an appointment. To talk about your family. To fill the registration form.

Vocabulary. Verbs describing everyday activity. Time. Parts of the day. Numbers 10 – 100. Events. Family. Registration form.

Grammar. 1st conjugation of verbs. 1 час, 2-4 часа, 5-20 часов. Consolidate conjugation of verbs. Possessive adjectives: мой/моя, твой/твоя.

Phonetics. Pronunciation of sounds (т, ть). Pronunciation of [ц], unstressed «я», «е». Pronunciation of [ж], [ш]. Devocalization of sound «ж» at the end of words.

3. Our Lesson

Communicative tasks. To understand your teacher's instructions in Russian. To ask people if they have something. To indicate something. To set a meeting. To talk about your plans for a week.

Vocabulary. Verbs describing activities at the lesson. Personal things. Numbers 100-1000. Days of week. Events.

Grammar. Imperative form of verbs (читайте, слушайте etc.). Construction "у меня есть". Gender of nouns. Construction "У меня + событие". Nouns in plural. Days of week.

Phonetics. Pronunciation of "о" in unstressed position. [ж], [ш]. Devocalization of sound «ж» at the end of words. Pronunciation of у, г.

4. In the City

Communicative tasks. To talk about your city. To ask where to go. To understand signs of a city. To buy a ticket for metro. To order in a restaurant. To refuse an offer. To say where were you yesterday.

Vocabulary. Places in town (parks, restaurants, museums etc.). Words for ordering in a café or buying a ticket for metro. Russian way to say "last/next week".

Grammar. Endings of adjectives. Possessive pronouns. The prepositional case for locations. The past tense of the verb "to be".

Phonetics. Devocalization "д" at the end of words and in front of voiced consonants. Practicing the phrase "к сожалению". Words where "ч" is pronounced as [ш].

5. Countries and Nationalities

Communicative tasks. To ask a person where he he is from. To talk about countries. To talk about the weather. To talk about the season. To talk about traditions and nationalities.

Vocabulary. Countries. Months. Weather. Season. Verbs (to love, to call, to speak). Traditions and nationalities.

Grammar. Months in the prepositional case (when?). 2nd conjugation of verbs. Nationalities.

Phonetics. Pronunciation of р, рь, ю. Pronunciation of the names of nationalities.

6. My Home

Communicative tasks. To describe your house. To call for a master to fix broken things at home. To explain location of things in the house. To talk about your free time and ways to rest at home.

Vocabulary. Furniture. Rooms. Verbs (to sleep, to want, to see, to watch, to hate). Parts of a house (wall, floor etc.). Outside the house (garden, forest). Verbs describing activities at home.

Grammar. Neuter gender nouns in plural. Masculine gender nouns in plural. Exceptions. The prepositional case, exceptions. The past tense. The accusative case for objects.

Phonetics. Pronunciation of the names of the rooms. Pronunciation of words with a change of stress in the prepositional case (в лесу, на полу, etc.). Pronunciation of [х]. Being surprised by the word “ух ты!”.

7. Tasty Food

Communicative tasks. To explain what you need to buy. To talk about food preferences. To order and pay in a restaurant. To talk about recipes. To invite friends for dinner. To express admiration or criticism.

Vocabulary. Phrases for shopping. Phrases for restaurants. Phrases for inviting and accepting invitations.

Grammar. Personal pronouns with “нужно”, “надо”, “нравится”. The instrumental case after the preposition “с”. The future tense.

Phonetics. Pronunciation [ы], [и]. Devocalization of the voiced consonants at the end of words (б, д, в, з, ж, г). Intonation of admiration: “Как хорошо!”.

8. Health

Communicative tasks. To talk to a doctor. To talk about health. To give recommendations. To talk about mood (I am sad, happy etc.). To agree/disagree.

Vocabulary. Parts of body. Health. Можно/нельзя. Emotions. Mood.

Grammar. Construction “у меня был”. Personal pronouns of with age, “можно”, “нельзя”. Short forms of adjectives.

Phonetics. Intonation of the interjection "ай!" when expressing pain. Pronunciation of ь, ъ.

9. People

Communicative tasks. To talk about people’s character. To describe appearance. To compare things. To buy clothes. To agree to do something.

Vocabulary. Adjectives. Describing a person. Adjectives. Appearance. Clothes. Colours. Size.

Grammar. Endings of adjectives. The comparative and superlative degree. The genitive case in possessive constructions. Endings of adjectives.

Phonetics. Pronunciation of [ш], [щ]. Combination «дж». Intonation of admiration urprise using the word “так”. Pronunciation of “ё” after the hushing sounds.

10. Transport

Communicative tasks. To talk with a taxi driver (price, address, etc.). To order a taxi. To cancel, reschedule or confirm a meeting. To talk about your trip. To describe cities.

Vocabulary. Transport. Dates. Verbs: перенести, отменить, подтвердить, прийти/приехать, уйти/уехать. The compass. Words for travelling.

Grammar. The prepositional case for transport. Ordinal numbers. The accusative case for directions with prepositions “в”, “на”.

Phonetics. Practicing the difference of pronunciation between "е" and "ё" in the conjugation of the verbs "идти", "ехать". Words where the letter "г" is pronounced as "в" (его, сегодня). Devocalization "з" in the preposition "из".

11. My Family

Communicative tasks. To talk about family. To accept the invitation. To talk about hobbies. To refuse the invitation. To ask and tell about biography.

Vocabulary. Family. Relatives. Activities during the holidays. Verb “уметь”. Verbs: пожениться, родиться, случиться, познакомиться.

Grammar. The genitive case. Possession. Reflexive verbs (the present tense). Заниматься + the instrumental case. Reflexive verbs (the past tense).

Phonetics. Devocalization of sound “ж” at the end of words. Pronunciation of тс, тьс = [ц]. Pronunciation of и = [ы] after ш, ж, ц.

12. Holidays

Communicative tasks. To congratulate with holidays. To tell about traditions. To sign postcards. To say wishes. To suggest the idea of gifts. To express surprise.

Vocabulary. Name of the holidays. Verbs: праздновать, поздравлять, прощаться, гулять. Wishes (happiness, love, luck, etc.). Gifts.

Grammar. Поздравлять + the instrumental case. The genitive case with the verb желать. The genitive case after prepositions.

Phonetics. Words with an unpronounceable "д". Words where г = [в]. Intonation of the phrase "Да ладно?!".

13. Shopping

Communicative tasks. To understand the information on the labels of cosmetic products. To buy groceries. To communicate in the store. To buy clothes.

Vocabulary. Body parts. Cosmetic. Stores. Numbers and time. Fruits and vegetables. Clothes, shoes, accessories. In the store.

Grammar. The genitive case. Plural. The genitive case with numbers. The genitive case. Lack.

Phonetics. Devocalization of "в" at the end of words. Devocalization of paired voiced consonants before voiceless consonants. The difference in pronunciation between "большой" and "больше".

14. Vacation

Communicative tasks. To ask about vacation. To book. To change the booking dates. To offer to do something together.

Vocabulary. Nature. At the hotel. Verbs forming the perfective aspect differently.

Grammar. Aspects of verb. The past tense. The genitive case. Dates. Aspects of verbs. The future tense. Perfective aspect. The future tense. New verbs: открыть, закрыть, продать, купить, выбрать, встретить, сказать, рассказать.

Phonetics. Reduction. Unstressed "о" = [а]. The end of the ordinal numerals in the genitive case г = [в]. Pronunciation of new verbs.

15. Our House

Communicative tasks. To talk about your dream home. To expressing outrage. To talk what are different things in the house are for. To talk about the location of different things in the house.

Vocabulary. House. Tidy up. Verbs мыть, убирать, чистить, стирать. Necessary things for cleaning. Appliances. Verb пользоваться.

Grammar. The prepositional case. Location. Preposition “для” and conjunction “чтобы”. The instrumental case after prepositions “над”, “под”, “за”, “перед”, “между”, “рядом с”. The instrumental case with the verb “пользоваться”.

Phonetics. Intonation in the expression of perturbation.

16. At Work

Communicative tasks. To talk about your work. To pass an interview. To make phone calls (to order, to book, etc.). To write emails.

Vocabulary. Professions. Job interview. On the phone. The structure of a letter.

Grammar. The instrumental case with verbs “работать”, “стать”, “быть”. The instrumental case of pronouns. Prepositions “за” and “что” in constructions “спасибо за + noun”, “извините / простите за + noun”, “спасибо, что + verb”, “извините/простите, что + verb”. The dative case. Addressee. The dative case of pronouns, nouns and adjectives.

Phonetics. Names of professions.

17. Leisure

Communicative tasks. To talk about hobbies (movies, music, literature). To tell and understand the story of the film or the book, to call of the director, actors, etc. To tell about where you usually go, where you went yesterday. To chat in the park with other dog owners.

Vocabulary. Hobby, books, movie, music. Genres. Event guide.

Grammar. Verb “нравиться”. Difference between “зовут” and “называется”. The accusative case + “зовут”. The prepositional case after the preposition “о”. The prepositional case of personal pronouns. Verbs of motions ходить, ездить in the past tense.

Phonetics. Pronunciation of “о / обо”. Vowel assimilation зж = [жж], зш = [шш].

18. Cities

Communicative tasks. To tell and understand information about interesting places. To navigate the city. To explain your location. To buy a ticket. To find out the necessary information at the station / airport. To say what year.

Vocabulary. Tourist attractions. Roads. At the city. At the airport (вылет, посадка, стойка регистрации, etc.).

Grammar. Direction and location. The dative case after the prepositions “к”, “по”. Verbs “лететь / полететь / летать”. Verbs of motions with prefixes.

Phonetics. Soft consonants.

19. Routine

Communicative tasks. To talk about your day. To call the time. To learn the details before going on a tour. To express disappointment.

Vocabulary. Verbs of statics and dynamics (стоять – встать). Time designation. Verbs of everyday activity.

Grammar. Repetition (reflexive verbs, types of verb). Time (half past eight, five to five). Passive voice (reflexive verbs). Passive design + the instrumental case. Reflexive verbs (subject and object). Imperfective and perfective verbs after the phrase "я хочу".

20. Bon appetit!

Communicative tasks. To understand information on grocery packaging. To talk about diets. To explain how to cook, serve and eat different dishes. To buy the groceries. To refine the order. To explain the composition of dishes.

Vocabulary. Tastes. Product composition. Table setting. Crockery. Preparation of dishes. Kind of meat. Packaging.

Grammar. Formation of an adjective from a verb. “Приходиться/удаваться” + the dative case. The instrumental case in the expression of the instrument. The genitive case (definition). The formation of adjectives.

21. Friendship

Communicative tasks. To tell about childhood, friends, relationships. To ask and tell about interests. To know how to say, “Я буду то же самое”. To talk about feelings and reactions, to quote famous people.

Vocabulary. Relations. Interests. Hobby. Reactions and behavior (upset, happy, etc.).

Grammar. Reflexive verbs. Reciprocal action. The "I want you to do something" construction. “Одинаковый / такой же” and “разный/другой”. Quantitative numerals in the genitive case (одного, одной, двух, трех, четырех, пяти).

22. It's never too late to learn

Communicative tasks. To talk about your favorite subjects and studies. To talk about your learning experience and the education system in your country. To tell, what you learn now, what you have learned before. Sign up for courses.

Vocabulary. Verbs: учить, учиться, изучать. Disciplines. Types of subjects. The verb “поступать”. Schedule. Services of sports clubs.

Grammar. Difference between “учиться”, “учить” and “изучать”. Phrases with the verb “иметь”. Conditional mood. “If I were you” construction. The dative case. Preposition “по”. Construction of “У меня получилось”.

23. Amazing Planet

Communicative tasks. To ask and tell about the animals, the area in which they live and feed. To keep the conversation going with phrases of astonishment. To describe daily movements. To keep talking about camping and surviving in the wild. To discuss what you need to take along with you.

Vocabulary. Animals. Birds. Fishes. Phraseological units: animals. Phrases of surprise to keep the conversation going. Things you need to travel. Verb брать/взять. Type of cars.

Grammar. Verbs of motion (ходить, ездить, бегать, плавать, летать, ползать). Verbs of motion with prefixes. Transportation verbs (transitive verbs): носить, возить, водить.

24. Communication

Communicative tasks. To talk about people, describe their character. To express their opinion. To meet, ask and answer: как дела? To thank, to respond to an apology. To speak in public. To give instructions and advice.

Vocabulary. Human character. Comparisons with animals. Etiquette phrases. Dating and maintaining conversation. Words and phrases for presentations.

Grammar. Formation of nouns from adjectives. Imperative mood (2nd person). Imperative mood (1st and 3rd person). Types of verb in the imperative mood.

25. On the Internet

Communicative tasks. To discuss applications, technologies and websites. To communicate with people online. To talk about people and things without naming them. To make online purchases. To leave feedback.

Vocabulary. On the Internet. Verbs of thought processes. Informal phrases for online communication. Online store.

Grammar. Oppositions (хотя, несмотря на, иначе). Indefinite pronouns (кто-то, кто-нибудь, кое-кто) and the word "угодно". “Кто” and “что” in all cases.

26. Around the World

Communicative tasks. To talk about geography, different places, the history of their discoveries. To discuss the itinerary. To understand figurative names of countries and cities. To tell more fully about countries. To understand the regional division of the Russian Federation and the system of state car numbers.

Vocabulary. Geographical name. Periphrases of toponyms. Regions and territories.

Grammar. “Какой / какая / какое / какие” in all cases. “Это” and “то” in all cases. Reflexive pronoun “себя”.

27. Thoughts

Communicative tasks. To ask and tell about the achievements. To talk about desires and goals. To support other people. To tell about dreams, about fears and experiences. To maintain the theme of tradition and superstition. To understand Russian subjects.

Vocabulary. Goals and achievements. Verbs: стараться, пробовать, гордиться, любоваться, добиваться, являться, наслаждаться, бояться, расстраиваться. Dreams, fears, phobias. Signs, superstitions and traditions.

Grammar. Verbs + instrumental case. Reflexive possessive pronoun “свой”. "Бояться" + the genitive case. “Из-за” + the genitive case, “благодаря” + the dative case. The verb “везти” in the sense of luck.

28. Mass Media

Communicative tasks. To understand the basic information when watching the news (focus on policy). To quote, transmit requests and wishes of other people. To express emotionally disagreement. To understand the basic information when you view ads. To convince.

Vocabulary. Media, news. TV shows, television vocabulary. Purchasing, profit, price, convenient, advantage, disadvantage.

Grammar. Conjunction “который”, in all cases. The repetition of the reflexive verbs in a passive sense. Direct and reported speech. “за” + goal. Active participle in the present tense.

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Statistics/Статистика

Purpose of the course:

studying the mathematical and theoretical foundations of modern statistical analysis, as well as preparing students for further independent work in the field of analysis of statistical problems in applied mathematics, physics and economics.

Tasks of the course:

 studying the mathematical foundations of mathematical statistics;

 acquisition of theoretical knowledge in the field of modern statistical analysis by students.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

 basic concepts of mathematical statistics;

 basic approaches to comparing estimates of parameters of an unknown distribution;

 asymptotic and non-asymptotic properties of estimates of parameters of an unknown distribution;

 basic methods for constructing estimates with good asymptotic properties: method of moments, method of maximum likelihood, method of sample quantiles;

 the concept of effective estimates and inequality of information by Rao-Cramer;

 definition and main properties of the conditional mathematical expectation of a random variable relative to sigma-algebra or other random variable;

 definition of a general linear regression model and least squares method;

 multivariate normal distribution and its basic properties;

 basic concepts of the theory of testing statistical hypotheses;

 Neumann - Pearson lemma and monotonic likelihood ratio theorem;

 Pearson chi-square test for testing simple hypotheses in the Bernoulli scheme.

be able to:

 justify the asymptotic properties of estimates using the limit theorems of probability theory;

 construct estimates with good asymptotic properties for the parameters of an unknown distribution for a given sample from it;

 find Bayesian estimates for a given prior distribution;

 calculate conditional mathematical expectations using conditional distributions;

 find optimal estimates using complete sufficient statistics;

 build exact and asymptotic confidence intervals and areas for the parameters of the unknown distribution;

 find optimal estimates and confidence regions in a Gaussian linear model;

 build uniformly the most powerful criteria in the case of a parametric family with a monotonic likelihood ratio;

 Build an F-test to test linear hypotheses in a linear Gaussian model.

master:

 the main methods of mathematical statistics for constructing point and confidence estimates: the method of moments, sampling quantiles, maximum likelihood, the method of least squares, the method of central statistics.

 skills of asymptotic analysis of statistical tests;

 skills of applying the theorems of mathematical statistics in applied problems of physics and economics.

Content of the course (training module), structured by topics (sections):

1. Probabilistic-statistical model.

Examples of unbiased and consistent estimates (moments, variance); biased but consistent estimates; inconsistent but unbiased estimates. Estimates of functions from parameters. An example of a situation in which there is no unbiased estimate for some function of a parameter.

2. The main task of mathematical statistics.

Bayesian and minimax strategies. Minimaxity of Bayesian strategy with constant risk.

3. Various kinds of convergence of random vectors.

Theorems on the asymptotic normality of the sample mean and median in a symmetric distribution model with an unknown shift parameter.

4. Statistics and estimates.

A reminder of the Three Sigma Rule and an explanation in terms of this rule. Example with "mixed" normal distribution (median vs. sample mean).

5. Empirical distribution and empirical distribution function.

Maximum likelihood estimates (m.p.) and their properties (consistency, asymptotic normality, and efficiency). Omp for the shift parameter in the Laplace distribution as an example of an asymptotically normal omp in an irregular pattern.

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Web-graphs/Веб-графы

Purpose of the course:

mastering the basic concepts of the theory of webgraphs.

Tasks of the course:

• mastering by students of basic knowledge (concepts, concepts, methods and models) in the field of web graphs;

• acquisition of theoretical knowledge and practical skills in the field of web graphs;

• providing advice and assistance to students in conducting their own theoretical research in the field of webgraphs.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

 fundamental concepts, laws, theories of random hypergraphs;

 modern problems of the corresponding sections of random hypergraphs;

 concepts, axioms, methods of proofs and proofs of the main theorems in the sections included in the basic part of the cycle;

 basic properties of the corresponding mathematical objects;

 analytical and numerical approaches and methods for solving typical applied problems of random hypergraphs.

be able to:

 understand the task at hand;

 use your knowledge to solve fundamental and applied problems of random hypergraphs;

 evaluate the correctness of the problem setting;

 strictly prove or disprove the statement;

 independently find algorithms for solving problems, including non-standard ones, and analyze them;

 independently see the consequences of the results obtained;

 Accurately present mathematical knowledge in the area of complex calculations, orally and in writing.

master:

 skills of mastering a large amount of information and solving problems (including complex ones);

 skills of independent work and mastering new disciplines;

 culture of formulation, analysis and solution of mathematical and applied problems requiring the use of mathematical approaches and methods of random hypergraphs for their solution;

 the subject language of complex calculations and the skills of competently describing the solution of problems and presenting the results.

Content of the course (training module), structured by topics (sections):

1. Local Gallai-Erdös theorems on the number of vertices

Turan's problem. Motzkin-Strauss theorem. Generalizations for hypergraphs. Turanian-type problems for classes of graphs and hypergraphs from combinatorial geometry.

2. Generalizations of Turan's Problem for Graphs and Hypergraphs

The extremal problem on graphs without cycles of length 4 and finite projective planes.

3. Basic definitions and concepts

Graphic sequences. Algorithm of determination, graphic sequences and the Gallai-Erdös theorem.

4. The simplest problems of extremal graph theory

Independence number and click number. Ramsey's theorem (reminder) and the (p, q) property.

Graph independence function. Bipartition criterion and independence function. Ramsey-type problems for classes of graphs and hypergraphs from combinatorial geometry.

5. Connectivity. Spanning tree.

Various spanning tree problems.

6. Transversal in a graph and the independence number

Edge graphs and Gallai's maximum paracombination theorem.

Annotation

Major: 03.03.01 Прикладные математика и физика

specialization: Computer Science/Информатика

Workshop on Software Development/Практикум по разработке программ

Purpose of the course:

Obtaining primary professional skills and professional experience in the field of web application development. The practice is carried out for the purpose of practical training of students and is aimed at the formation, consolidation, development of practical skills and competencies in the profile of the educational program. During the internship, students gain experience in their specialty, close to real work in industrial projects.

Tasks of the course:

Students are given the following tasks:

- study of technologies required for the implementation of the project;
- learning the best practices for writing code in the programming language used;
- studying the best approaches to building the architecture of web applications;
- development of a web application, according to the description of the project;
- preparation of a report on the results of practice.

List of the planned results of the course (training module)

As a result of studying the course the student should

know:

- have an idea of modern technologies in the field of web application development;
- different approaches to building the architecture of web applications;
- technologies for deploying applications on remote servers and cloud platforms;
- up-to-date tools for storing source code and controlling its versions.

be able to:

- conduct a review of the available libraries and technologies that can be used to implement the project;

- to use the selected technologies and be able to combine them in solving the assigned task;

- apply modern guidelines for code style and architecture;

- to build activities based on the fulfillment of technological requirements and standards, to adhere to legal and ethical standards adopted in professional activities;

–to draw up and present the results of the work performed.

master:

- skills to search for technical documentation for various technologies and libraries;

- the skill of converting technical specifications for a project into specific tasks for implementation.

Content of the course (training module), structured by topics (sections):

1. Preparatory stage

Acquaintance with the topic and goals of the practice. Selection of individual projects by students, development of technical specifications.

2. Review and analysis of modern tools and technologies

Study of available technologies, tools, libraries for project implementation. Selection and justification of the technologies used. Formulation of tasks for the implementation of the project. Planning the timing of their implementation.

3. Implementation of the project

Work directly on the implementation of the project: writing the source code C++, deploying the application on the cloud platform.

4. Results presentation

Preparation of a report on the work performed in presentation format, presentation of a report at the final lesson.

5. Preparatory stage

Selection of individual projects by students, development of technical specifications.

6. Review and analysis of modern tools and technologies

Study of available technologies, tools, libraries for project implementation. Selection and justification of the technologies used. Formulation of tasks for the implementation of the project. Planning the timing of their implementation.

7. Implementation of the project

Work directly on the implementation of the project: writing the source code Python, deploying the application on the cloud platform.

8. Results presentation

Preparation of a report on the work performed in presentation format, presentation of a report at the final lesson.