MINISTRY OF SCIENCE AND HIGHER EDUCATION
OF THE RUSSIAN FEDERATION
Federal State Autonomous Educational Institution of Higher Education "Kazan (Volga Region) Federal University"
Nikolai Lobachevsky Institute of Mathematics and Mechanics

APPROVED BY
Vice-Rector for Educational Activities
_____ E.A. Tigieva
28. 10. 2024

PROGRAM OF ENTRANCE EXAMINATION IN MATHEMATICS

2024

Entrance examination program approval sheet

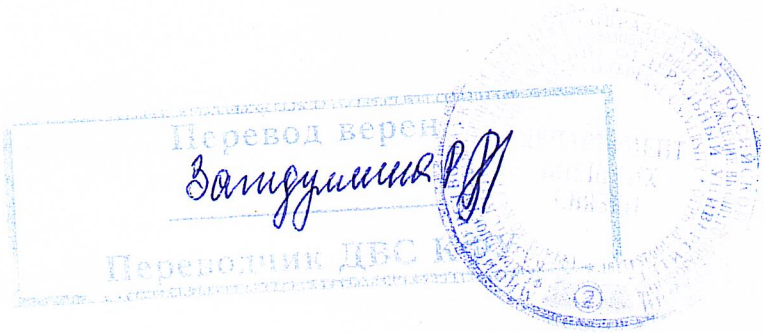
The program developed by:

Vice-Rector for Educational Activities,
Head of the Department of Mathematical Statistics,
Nikolai Lobachevsky Institute of Mathematics and Mechanics _____ E.A. Turilova

Chair of the Examination Comission _____ I.B. Garipov

By the decision of the Educational and Methodological Commission of the Nikolai Lobachevsky Institute of Mathematics and Mechanics, the entrance examination program is recommended for approval by the Academic Council, Minutes № 1 dated October 08, 2024

The program of the entrance examination was approved at the meeting of the Academic Council of the Nikolai Lobachevsky Institute of Mathematics and Mechanics, Minutes №2 of October 10, 2024



Algebra

Numbers, roots and degrees, integers, degree with natural exponent, fractions, percentages, rational numbers, power with integer exponent, root of $n > 1$ and its properties, power with rational exponent and its properties, properties of power with real exponent.

Fundamentals of Trigonometry

Sine, cosine, tangent, cotangent of an arbitrary angle; radian measure of an angle; sine, cosine, tangent and cotangent of a number; basic trigonometric identities; reduction formulas; sine, cosine and tangent of the sum and difference of two angles; sine and cosine of a double angle.

Logarithms

Logarithm of a number, logarithm of a product, the quotient, an exponent, decimal and natural logarithms, the number e.

Conversion of Expressions

Conversions of expressions involving arithmetic operations; conversions of expressions involving exponentiation; conversions of expressions involving roots of a natural power; conversions of trigonometric expressions; conversions of expressions involving the operation of logarithm; modulus (absolute value) of a number.

Equations and Inequalities

Equations

Quadratic equations; rational equations; irrational equations; trigonometric equations; exponential equations; logarithmic equations; equivalence of equations, systems of equations; simple systems of equations with two unknowns; basic techniques for solving systems of equations: substitution, algebraic addition, introduction of new variables; use of properties and graphs of functions when solving equations; representation on the coordinate plane of the set of solutions to equations with two variables and their systems; application of mathematical methods to solve meaningful problems from various fields of science and practice; interpretation of results, considering real-world constraints.

Inequalities

Quadratic inequalities; rational inequalities; exponential inequalities; logarithmic inequalities; systems of linear inequalities; systems of inequalities with one variable; equivalence of inequalities, systems of inequalities; use of properties and graphs of functions when solving inequalities; interval method; representation on the coordinate plane of the set of solutions to inequalities with two variables and their systems.

Functions

Definition and Graph of a Function

Function, domain of a function; range of a function; graph of a function. Examples of functional dependence in real-life processes and phenomena, inverse function. Graph of an inverse function; graph transformations: parallel shift, axial symmetry.

Elementary Study of Functions

Monotonicity of a function. Increasing & decreasing intervals; even and odd functions; periodicity of a function; bounded function; points of extremum (local maximum and minimum) of a function; highest and lowest values of a function.

Basic Elementary Functions

Linear function, its graph; inversely proportional function, its graph; quadratic function, its graph; power function with natural exponent, its graph; trigonometric function, its graph; exponential function, its graph; logarithmic function, its graph; pre-calculus.

Derivative

Concept of the derivative of a function, geometric significance of a derivative; physical significance of a derivative, finding the rate for a process given by a formula or a graph; equation of the tangent to the graph of a function; derivatives of sum, difference, product, quotient; derivatives of basic elementary functions; second derivative and its physical significance.

Study of Functions

Application of derivative in study of functions and graphing; examples of the use of derivative to find the best solution in applied, including social and economic, problems.

Antiderivative and Integral

Перевод верен
Переводчик ДВС КФУ

Antiderivatives of elementary functions; examples of applications of integral in physics and geometry.

Geometry

Plane Geometry

Triangle; parallelogram, rectangle, rhombus, square; trapezium; circumference and circle; circumference inscribed in a triangle and circumcircle circumscribed around a triangle; polygon. Sum of angles of a convex polygon; regular polygons. Inscribed circle and circumscribed circle of a regular polygon.

Lines and Planes in Space

Intersecting, parallel and crossing lines; perpendicularity of lines; parallelism of lines and planes, signs and properties; parallelism of planes, signs and properties; perpendicularity of a line and a plane, signs and properties; perpendicular line and inclined line; theorem of three perpendiculars; perpendicularity of planes, signs and properties; parallel projection. Representation of spatial figures.

Polyhedrons

Prism, its base, lateral edges, height, lateral surface; right prism; regular prism; parallelepiped; cube; symmetry in cube, in parallelepiped; pyramid, its base, lateral edges, height, lateral surface; triangular pyramid; regular pyramid; cross sections of a cube, a prism, a pyramid; concept of regular polyhedrons (tetrahedron, cube, octahedron, dodecahedron and icosahedron).

Solids and Surfaces of Rotation

Cylinder. Base, height, lateral surface, generator, net; Cone. Base, height, lateral surface, generator, net; Ball and sphere, their cross sections.

Measurement of Geometric Quantities

Measure of an angle, degree of an angle, correspondence between an angle measure and the arc length of a circle; angle between straight lines in space; angle between line and plane, angle between planes; length of segment, polyline, circle, perimeter of polygon; distance from point to line, from point to plane; distance between parallel and crossing lines, distance between parallel planes; area of triangle, parallelogram, trapezoid,

circle, sector; surface area of cone, cylinder, sphere; volume of cube, rectangular parallelepiped, pyramid, prism, cylinder, cone, sphere.

Coordinates and Vectors

Cartesian coordinates on plane and in space; formula for distance between two points; equation of a sphere; vector, modulus of a vector, equality of vectors; addition of vectors and multiplication of vector by number; collinear vectors. Decomposition of a vector by two non-collinear vectors; coplanar vectors. Decomposition by three non-coplanar vectors; vector coordinates; dot product of vectors; angle between vectors; elements of combinatorics, statistics and probability theory.

Elements of Combinatorics

Alternating and simultaneous choices; formulae for the number of combinations and permutations. Binomial Theorem.

Elements of Statistics

Tabular and graphical representation of data; numerical characteristics of data series.

Elements of Probability Theory

Probabilities of events; examples of the use of probabilities and statistics in solving applied problems.

Requirements (skills) to be tested by the tasks in the examination paper

Ability to perform calculations and conversions

- Perform arithmetic operations, combining oral and written techniques; find root value of a natural exponent, a rational exponent, a logarithm
- Calculate the values of numeric and alphabetic expressions, making necessary substitutions and conversions
- Convert literal expressions involving powers, radicals, logarithms, and trigonometric functions using known formulas and rules
- Know how to solve equations and inequalities
- Solve rational, irrational, exponential, trigonometric and logarithmic equations and their systems

- Solve equations, simple systems of equations using the properties of functions and their graphs; use the graphical method for approximate solutions of equations and inequalities
- Solve rational, exponential and logarithmic inequalities and their systems

Know how to perform actions with functions

- Determine the value of a function from the value of its argument when using different ways of representations of a function; describe the behaviour and properties of a function using the graph; find the maximum and minimum values of a function using the graph; draw graphs of functions
- Find derivatives and antiderivatives of elementary functions
- Examine functions for monotonicity in the simplest cases, find maximum and minimum values of a function

Be able to perform operations with geometric shapes, coordinates, and vectors

- Solve planimetric problems to find geometric quantities (lengths, angles, areas)
- Solve simple stereometric problems to find geometric quantities (lengths, angles, areas, volumes); use planimetric facts and methods when solving stereometric problems
- Determine the coordinates of a point; perform operations on vectors, find the length and coordinates of a vector, and the angle between vectors

Be able to build and investigate simple mathematical models

- Model real-world situations in algebraic language, formulate equations and inequalities based on problem statement; investigate constructed models using the apparatus of algebra
- Model real-world situations in the language of geometry, investigate constructed models using geometric concepts and theorems, algebra apparatus; solve practical problems related to finding geometric quantities
- Give evidentiary reasoning when solving problems, assess the logical correctness of reasoning, and recognize logically incorrect reasoning

Be able to use the acquired knowledge and skills in practical activities and everyday life

- Analyze real numerical data; perform practical calculations using formulas; use estimation and guess method in practical calculations
- Describe various real-world relationships between quantities using functions and interpret their graphs; retrieve information presented in tables, charts, and graphs

Solve applied problems, including those of a socio-economic and physical nature, to find the maximum and minimum values, to find velocity and acceleration

Literature

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