Ministry of Education and Science of Ukraine
V. N. Karazin Kharkiv National University

APPROVED BY
Deputy Chairperson of the Admission Commitee
Vice-Rector of V. N. Karazin Kharkiv National University
_____Oleksandr HOLOVKO

THE PROGRAMME
**of the oral entrance examination in Mathematics
for foreign citizens applying to study
on the basis of Complete General Secondary Education**

Kharkiv 2024

This programme is based on the current programme of external independent evaluation in mathematics for the year 2024.

THE LIST OF TOPICS COVERED IN THE EXAM

1. ARITHMETICS, ALGEBRA AND BASICS OF MATHEMATICAL ANALYSIS

1. Properties of operations with real numbers. Rules for real number comparison.

2. Natural numbers and zero. Divisibility of natural numbers. Divisors and multiples of a natural number. Even and odd numbers. Divisibility rules for numbers 2, 3, 4, 5, 6, 9 and 10. Division with remainder. Prime and composite numbers. Decomposition of a natural number into its prime factors. The greatest common divisor, the least common multiple.

3. Common fractions. Comparison of common fractions. Proper and improper fraction. Integer and fractional part of a number. Basic properties of fractions. Fraction reduction. Arithmetic mean. Basic fraction problems.

4. Rational and irrational numbers, their comparison and operations with these numbers.

5. Definition of percentage. Rules for percentage calculating. Proportions.

6. Powers with natural, integer and rational exponents, their properties. Arithmetic root and its properties.

7. Logarithms and their properties. Basic logarithmic identity.

8. Monomials and polynomials. Operations with them. Formulas of abridged multiplication.

9. Polynomials in one variable. Roots of polynomials. Decomposition of a polynomial into factors.

10. The notion of a function. Methods for specifying a function. Domain

and range of a function. Inverse function.

11. Graph of a function. Increasing and decreasing functions. Periodic functions. Even and odd functions.

12. Sufficient condition for a function to be increasing/decreasing on an interval. The concept of extremum of a function. A necessary condition for extremum of a function. Maximum and minimum values of a function on a closed interval.

13. Definitions and basic properties of linear, quadratic, power, exponential, logarithmic, and trigonometric functions.

14. Equations. Solving equations, roots of equations. Equivalent equations. Graph of an equation with two variables.

15. Inequalities. Solving inequalities. Equivalent inequalities.

16. Systems of equations and systems of inequalities. Solving systems. System solutions. Equivalent systems of equations and inequalities.

17. Numerical sequences. Arithmetic and geometric progressions. Formulas for the nth term and the sum of the first n terms of progressions.

18. Dependence between trigonometric functions of the same angle. Trigonometric functions of sum and difference of two angles. Half and double angle formulas. Trigonometric reduction formulas.

19. Definition of the derivative, its mechanical and geometric interpretation.

20. Derivative of a sum, difference, product, and quotient. Table of derivatives. Chain rule.

21. Antiderivative and definite integral. Table of antiderivatives. Rules for finding antiderivatives. Newton-Leibniz formula.

22. Permutations (without repetitions), number of permutations. Variations (without repetitions), number of variations. Combinations (without repetitions).

23. Simplest cases for calculating probabilities of random events.

24. Statistical characteristics of datasets.

II. GEOMETRY

1. Line, ray, line segment, broken line. Length of a line segment. Angle, value of an angle. Vertical and adjacent angles. Parallel lines. Equality and similarity of geometric figures. Ratio of the areas of similar figures.

2. Examples of transformation of geometric figures, types of symmetry.

3. Cartesian coordinates. Vectors. Vector operations.

4. Polygons. Vertices, sides, and diagonals of a polygon. Polygons inscribed in a circle and circumscribed around a circle.

5. Triangles. Median, bisector, and altitude of a triangle, their properties. Types of triangles. The relationship between the sides and angles of a right-angled triangle. Law of cosines.

6. Quadrilaterals: parallelogram, rectangle, rhombus, square, trapezoid; their properties.

7. Circles and disks. Centre, diameter, radius, chord, secant. Line segment relationships in circles. Tangent lines to circles. Circular arcs. Sectors and segments.

8. Central and inscribed angles, their properties.

9. Formulas for the areas of geometric figures: triangle, parallelogram, rectangle, rhombus, square, trapezoid.

10. Circumference of a circle. Length of a circular arc. Radian measure of an angle. Area enclosed by a circle. Area of a circular sector.

11. Plane. Parallel planes and intersecting planes.

12. Parallel line and plane.

13. Angle between a line and a plane. Line perpendicular to a plane.

14. Dihedral angles. Linear angle of a dihedral angle. Perpendicular planes.

15. Polyhedra. Vertices, edges, and faces of a polyhedron. Right and oblique prisms. Pyramids. Right pyramids. Parallelepipeds, their types.

16. Solids and surfaces of revolution. Cylinders, cones, spheres, and balls. Centre, diameter, and radius of a sphere and a ball. Planes tangent to a sphere.

17. Formulas for surface areas and volumes of prisms, pyramids, cylinders, and cones.

18. Formulas for the surface area of a sphere and the volume of a ball.

The structure of exam

The examination paper consists of two parts. The first part contains three problems on the following topics:

- Solving linear equations;
- Transformation of algebraic expressions (expanding brackets, factoring by grouping, simplifying expressions, etc.);
- Percentages and proportions (finding the percentage of a given number and the number by its percentage, expressing one number as a percentage of another; finding unknown terms of a proportion);
- Simplest functions (computing the value of a function given by a formula; finding the domain of a function);
- Area of a rectangle. Area enclosed by a circle. Surface area and volume of a right prism and a right circular cylinder (finding the area or volume, taking into account the units of measurement);
- Graphs and diagrams (finding intervals, where a function, given in graphical or tabular form, is increasing/decreasing, finding maximum and minimum points of this function, etc.; giving examples of graphs of functions for which conditions for some values and some intervals of increasing/decreasing are given; analysing data presented as a diagram);
- Word problems that may include previous topics.

The second part contains one more complex problem on the topics from the list, which does not require much time to solve.

Rating criteria

Rating criteria for the first part:
- The entrant solved the problems correctly and justified the solution during the oral interview: 60 points.
- The entrant solved the problems correctly, but made minor mistakes, which he/she corrected during the oral interview: 55-59 points.
- The entrant generally solved most of the problems correctly, but made mistakes that he/she corrected during the oral interview: 50-54 points.
- The entrant fails to solve the problems or the solution contains serious errors that were not corrected during the oral interview: 0-49 points.

Rating criteria for the second part:

- The entrant solved the problem correctly and justified the solution during the oral interview: 40 points.
- The entrant solved the problem correctly, but made minor mistakes, which he/she corrected during the oral interview: 21-39 points.
- The entrant generally solved the problem correctly, but made mistakes that he/she corrected during the oral interview: 1-20 points.
- The entrant fails to solve the problem or the solution contains serious errors that were not corrected during the oral interview: 0 points.

The maximum amount of points for all problems is 100 points.

If the entrant got less than 10 points, he/she is not allowed to participate in the competitive examination.

If the entrant got 10 points or more, the total amount of points is calculated as the sum of points for all problems + 100 points.

The maximum total amount of points is 200 points.

Head of the Subject
Examination committee
and Mathematics interview commission   _____ Olena SHUGAILO

Approved at the meeting of the Admission Committee
of V. N. Karazin Kharkiv National University,

Meeting Minutes № 2 of April 15, 2024

Secretary of
the Admission committee   _____ Serhiy ELTSOV