

MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
SUMY STATE UNIVERSITY



PROGRAM
entrance test in mathematics during admission
to study for a bachelor's degree
(for foreign citizens)

The purpose of the entrance test in mathematics is to assess the degree of preparation of applicants in mathematics for competitive selection to study at Sumy State University.

The task of the entrance exam in mathematics is to assess the knowledge and skills of the entrants:

- build mathematical models of real objects, processes and phenomena and investigate these models by means of mathematics;
- perform mathematical calculations (perform operations with numbers presented in various forms, operations with percentages, compose and solve proportion problems, approximate calculations, etc.);
- perform transformation of expressions (understand the content value of each element of the expression, place the permissible values of the variables, place the numerical values of the expressions with the given values of the variables, etc.);
- будувати й аналізувати графіки найпростіших функціональних залежностей, досліджувати їхні властивості;
- build and analyze graphs of the simplest functional dependencies, investigate their properties;
- find geometric shapes in drawings and establish their properties;
- find several characteristics of geometric figures (lengths, angle sizes, areas, volumes);
- solve the simplest combinatorial problems and calculate the probabilities of random events;
- analyze information presented in graphic, tabular, text and other forms.

80 minutes are allotted for the exam.

Name of the section, topics	The student must know	Subject skills and methods of educational activity
ALGEBRA AND THE BEGINNINGS OF ANALYSIS		
Section: NUMBERS AND EXPRESSIONS		
Real numbers (natural, whole, rational and irrational), their comparison and actions with them. Numerical sets and relations between them	<ul style="list-style-type: none"> - properties of actions with real numbers; - rules for comparing real numbers; - signs of divisibility of natural numbers by 2, 3, 5, 9, 10; - rules for rounding whole numbers and decimal fractions; - definition of the root of the nth power and the arithmetic root of the nth power; - properties of power; - definition of power with natural, whole and rational indicators, their properties; - numerical intervals; - the module of a real number and its properties 	<ul style="list-style-type: none"> - distinguish types of numbers and numerical intervals; - compare real numbers; - perform actions with real numbers; - use signs of divisibility; - find an incomplete number and leave from dividing one natural number by another; - convert ordinary small to decimal and infinite cycle decimal small to ordinary; - round whole numbers and decimal fractions; - use the properties of the module to

		solve problems
Relationships and proportions. Percentages. Basic percentage problems	<ul style="list-style-type: none"> - relationship, proportions; - the main property of proportion; - definition of percentage; - rules for performing interest calculations 	<ul style="list-style-type: none"> - find the ratio of numbers in the form of a percentage, a percentage of a number, a number by the value of its percentage; - solve problems on percentage calculations and proportions
Rational, irrational, power, exponential, logarithmic, trigonometric expressions and their transformations	<ul style="list-style-type: none"> - definition of the area of admissible values of the variables of the expression with variables; - definition of identically equal expressions, identical transformation of an expression, identity; - definition of monomial and polynomial; - rules of addition, subtraction and multiplication of monomials and polynomials; - abbreviated multiplication formulas; - decomposition of the polynomial into factors; - definition of an algebraic fraction; - rules for performing actions with algebraic fractions; - definition and properties of logarithms, decimal and natural logarithms; - basic logarithmic identity; - definition of sine, cosine, tangent, cotangent of a numerical argument; - the basic trigonometric identity and its consequences; - summary formulas; - addition formulas and their consequences 	<ul style="list-style-type: none"> - carry out identical transformations of rational, irrational, exponent, exponential, logarithmic, trigonometric expressions and find their numerical value at given values of variables
Section: EQUATIONS, INEQUALITIES AND THEIR SYSTEMS		
Linear, quadratic, rational, irrational, exponential, logarithmic, trigonometric equations, discontinuities and their systems. 3 application of equations, inequalities and their systems to solving text problems	<ul style="list-style-type: none"> - an equation with one variable, definition of the root (solution) of an equation with one variable; - discontinuity with one variable, definition of solution of discontinuity with one variable; - determination of the solution of the system of equations with two variables and methods of their solutions; - equivalent equations, inequalities and their systems; - methods of solving rational, irrational, exponential, logarithmic, trigonometric equations 	<ul style="list-style-type: none"> - solve equations and inequalities of the first and second degrees, as well as equations and inequalities reduced to them; - to solve systems of equations and inequalities of the first and second degrees, as well as those reduced to them; - solve equations and inequalities containing power, exponential, logarithmic and trigonometric expressions; - solve equations containing trigonometric expressions; - solve irrational equations; - apply general methods and techniques (factoring, variable substitution, application of function properties) in the process of solving equations, inequalities and systems; - use the graphic method of solving and researching equations, inequalities and systems; - apply equations, inequalities and systems to solve text problems; - solve equations and inequalities containing a variable under the modulus sign; - to solve equations, inequalities and systems with parameters

Section: FUNCTIONS		
Linear, quadratic, power, exponential, logarithmic and trinomial functions, their main properties. Numerical sequences	<ul style="list-style-type: none"> - function definition, definition domain, function value domain, function graph; - methods of specifying functions, basic properties and graphs of functions specified in the title of the topic; - definition of the inverse function; - definition of arithmetic and geometric progression; - formulas of the nth term of arithmetic and geometric progressions; - formulas for the sum of n first terms of arithmetic and geometric progressions; - the formula of the sum of an infinite geometric progression with a denominator $q < 1$ 	<ul style="list-style-type: none"> - find the domain of definition, the domain of function values; - investigate the parity (oddity), periodicity of the function; - build graphs of elementary functions specified in the title of the topic; - set the properties of numerical functions given by a formula or graph; - use transformation of graphs of functions; - solve arithmetic and geometric progression problems
The derivative of a function, its geometric and physical meaning. Derivatives of elementary functions. Differentiation rules	<ul style="list-style-type: none"> - the equation of the tangent to the graph of the function at the point; - definition of the derivative function at a point; - physical and geometric content of the derivative; - table of derivatives of elementary functions; - rules for finding the derivative sum, product, quotient of two functions; - the rule for finding the derivative of a composite function 	<ul style="list-style-type: none"> - find the angular coefficient and the angle of inclination of the tangent to the graph of the function at the point; - find derivatives of elementary functions; - find the numerical value of the derivative function at the point for the given value of the argument; - find the derivative of the sum, product and quotient of two functions; - find the derivative of a composite function; - solve problems using the geometric and physical content of the derivative
Studying a function using the derivative. Construction of graphs of functions	<ul style="list-style-type: none"> - a sufficient condition for the growth (decrease) of the function on the interval; - extremes of the function; - determination of the largest and smallest values of the function 	<ul style="list-style-type: none"> find intervals of monotonicity of the function; - find extrema of a function using the derivative, the largest and smallest value of the function; - investigate functions using the derivative and plot their graphs; - solve applied problems for finding the largest and smallest values
Primitive and definite integral. Application of the definite integral to the calculation of the areas of curved trapezoids	<ul style="list-style-type: none"> - definition of the primary function, definite integral, curvilinear trapezoid; - table of primitive functions; - rules for finding primitives; - the Newton-Leibnitz formula 	<ul style="list-style-type: none"> find the original, using its main properties; - apply the Newton-Leibnitz formula to calculate the definite integral; - calculate the area of a curved trapezoid using the integral; - to solve the simplest applied problems, which boil down to finding the integral
Section: ELEMENTS OF COMBINATORICS, BEGINNINGS OF PROBABILITY THEORY AND ELEMENTS OF STATISTICS		
Permutations (no repetitions). Combinatorial rules of sum and product. The probability of a random event. Selective characteristics	<ul style="list-style-type: none"> - definition of permutation (without repetitions); - combinatorial rules of sum and product; - the classical definition of the probability of an event, the simplest cases of calculating event probabilities; - determination of sample characteristics of data series (sample size, mode, median, average value); - graphical, tabular, textual and other forms of presentation of statistical information 	<ul style="list-style-type: none"> - to solve the simplest combinatorial problems; - calculate the probabilities of random events in the simplest cases; - calculate and analyze sample characteristics of data series (sample size, mode, median, average value)

GEOMETRY		
Section: PLANIMETRY		
The simplest geometric figures on the plane and their properties	<ul style="list-style-type: none"> - concepts of point and straight line, beam, segment, refracted, angle; - axioms of planimetry; - adjacent and vertical angles, angle bisector; - properties of adjacent and vertical angles; - angle bisector property; - parallel and perpendicular lines; - perpendicular and inclined, middle perpendicular, distance from a point to a straight line; - signs of parallelism of lines; - Thales theorem, generalized Thales theorem 	- apply the definitions, signs and properties of the simplest geometric shapes to solve planimetric problems and problems of practical content
Circle and circle	<ul style="list-style-type: none"> - circle, circle and their elements; - central, inscribed angles and their properties; - properties of two intersecting chords; - tangents to the circle and its properties 	- apply the acquired knowledge to solving planimetric problems and problems of practical content
Triangles	<ul style="list-style-type: none"> - types of triangles and their main properties; - signs of equality of triangles; - median, bisector, height of a triangle and their properties; - the theorem on the sum of the angles of a triangle; - triangle inequality; - the middle line of the triangle and its properties; - a circle circumscribed around a triangle and a circle inscribed in a triangle; - Pythagoras theorem, proportional segments of a right triangle; - the ratio between the sides and angles of a right triangle; - theorem of sines; - the theorem of cosines 	<ul style="list-style-type: none"> - classify triangles by sides and angles; - solve triangles; - apply definitions and properties of various types of triangles to solve planimetric problems and problems of practical skill; - find the radii of the circle circumscribed around the triangle and the circle inscribed in the triangle
Quadrangle	<ul style="list-style-type: none"> - quadrilateral and its elements; - parallelogram and its properties; - signs of a parallelogram; - rectangle, rhombus, square, trapezoid and their properties; - the middle line of the trapezoid and its property; - quadrilaterals inscribed in a circle and described around the circle 	- apply definitions, signs and properties of various types of quadrilaterals to solve planimetric problems and problems of practical content
Polygons	<ul style="list-style-type: none"> - polygon and its elements, convex polygon; - the perimeter of the polygon; - the sum of the angles of a convex polygon; - regular polygon and its properties; - polygons inscribed in a circle and described around the circle 	- determining the definition and properties of polygons for solving planimetric problems and problems of practical content.
Geometric quantities and their measurements	<ul style="list-style-type: none"> - length of segment, circle and its arc; - angle size, angle measurement; - the perimeter of the polygon; - formulas for calculating the area of a triangle, parallelogram, rhombus, square, trapezoid, regular polygon, circle, circular sector 	<ul style="list-style-type: none"> - to find the lengths of segments, diagonal and radian measures of angles, areas of geometric figures; - calculate the length of a circle and its arcs, the area of a circle, circular sector; - use area formulas of geometric figures to solve planimetric problems and problems of practical content
Coordinates and vectors on the plane	<ul style="list-style-type: none"> - rectangular coordinate system on the plane, point coordinates; - the formula for calculating the distance between 	- find the coordinates of the middle of the segment and the distance between two points;

	<p>two points and the formula for calculating the coordinates of the middle of the segment;</p> <ul style="list-style-type: none"> - equations of a straight line and a circle; - concept of vector, vector length, collinear vectors, equal vectors, vector coordinates; - addition, subtraction of vectors, multiplication of a vector by a number; - expansion of a vector by two non-collinear vectors; - scalar product of vectors and its properties; - the formula for finding the angle between the vectors given by the coordinates; - conditions of collinearity and perpendicularity of vectors given by coordinates 	<ul style="list-style-type: none"> - make the equation of a straight line and the equation of a circle; - perform actions with vectors; - find the scalar product of vectors; - use coordinates and vectors to solve planimetric problems and problems of practical content
Geometric transformations	<ul style="list-style-type: none"> - the main types and content of geometric transformations on the plane (motion, symmetry relative to a point and relative to a line, rotation, parallel transfer, similarity transformation, homothety); - signs of similarity of triangles; - the ratio of the areas of similar figures 	<p>use the properties of the main types of geometric transformations, signs of similarity of triangles to solve planimetric problems and problems of practical content</p>
Section: STEREOOMETRY		
Lines and planes in space	<ul style="list-style-type: none"> - axioms and theorems of metrology; - mutual placement of straight lines in space, a straight line and a plane in space, planes in space; - signs of parallelism of straight lines, straight line and plane, planes; - parallel design; - signs of perpendicularity of a straight line and a plane, two planes; - projection of an inclined plane, orthogonal projection; - direct and inverse theorems about three perpendiculars; - the distance from a point to a plane, from a point to a line, from a line to a plane parallel to it, between parallel lines, between parallel planes, between passing lines; - a sign of the passing of straight lines; - the angle between straight lines, a straight line and a plane, planes 	<ul style="list-style-type: none"> - apply definitions, signs and properties of parallel and perpendicular lines and planes to solve stereometric problems and problems of practical content; - to find the specified distances and angles in space
Polyhedra, bodies and surfaces of revolution	<ul style="list-style-type: none"> - dihedral angle, linear angle of a dihedral angle; - polyhedra and their elements, main types of polyhedra: prism, parallelepiped, pyramid, truncated pyramid; - bodies and surfaces of rotation and their elements, main types of bodies and surfaces of rotation: cylinder, cone, truncated cone, sphere, sphere; - sections of polyhedra and solids of rotation in a plane; - combinations of geometric bodies; - formulas for calculating surface areas, volumes of polyhedra and bodies of revolution 	<ul style="list-style-type: none"> - solve problems for calculating surface areas and volumes of geometric bodies; - set the type of geometric body by scanning the surface; - apply the definitions and properties of the main types of polyhedra, solids and surfaces of rotation to solving stereometric and practical problems
Coordinates and vectors in space	<ul style="list-style-type: none"> - rectangular system of coordinates in space, coordinates of a point; - the formula for calculating the distance between two points and the formula for calculating the coordinates of the middle of the segment; 	<ul style="list-style-type: none"> - find the coordinates of the middle of the segment and the distance between two points; - perform actions with vectors; - find the scalar product of vectors;

	<ul style="list-style-type: none"> - concept of vector, vector length, collinear vectors, equal vectors, vector coordinates; - addition, subtraction of vectors, multiplication of a vector by a number; - scalar product of vectors and its properties; - the formula for finding the angle between the vectors given by the coordinates; - conditions of collinearity and perpendicularity of vectors given by coordinates 	<ul style="list-style-type: none"> - apply coordinates and vectors to solve stereometric problems and problems of practical content
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ASSESSMENT CRITERIA FOR THE ENTRANCE EXAMINATION IN MATHEMATICS

The examination paper consists of 20 questions of a test nature. All questions have *only one correct answer option*.

The commission evaluates the entrant's written answers to test tasks on a 100-200-point scale. Entrants who scored less than 100 points receive an "unsatisfactory" rating and are not allowed to further participate in the competitive selection. Entrants who scored 100 or more points are allowed to participate in the competitive selection.

In order to receive a positive grade from the entrance test, the applicant needs to pass the minimum acceptable test threshold of 20% of the total number of test points.

Test points are awarded for each correct answer to the task, 0 points are awarded for an incorrect answer. The obtained test scores for the entrance test are converted into a 100-200 point scale (with rounding to the nearest whole, according to the rules of mathematical rounding) according to the following algorithm:

$$O = O_{\min} + k \cdot (N - r \cdot T),$$

where

- O – assessment from the entrance test on a scale of 100-200 points;
- O_{\min} – the minimum score from the entrance test on a scale of 100-200 points, at which the entrant is allowed to participate in the competitive selection;
- k – the coefficient of transfer of test points to a scale of 100-200 points, while

$$k = 100 / (T \cdot (1 - r)),$$

- r – the minimum acceptable test threshold with an accuracy of 0,01, which is set in the range from 0 to 1, but not less than 0,10;
- T – the total number of test points that the entrant can receive during the entrance test;
- N – the number of test points that the entrant received during the entrance test.

Provided that the number of test points that the entrant received during the entrance test (N) is «0», then the entrant receives an "unsatisfactory" grade and is not allowed to further participate in the competitive selection.

Calculation of test points.

Types of tasks and the scheme of awarding test points for completing tasks:

Form / task description	Test scoring scheme
Tasks with the choice of one correct answer (№1–10). The task has a framework and five answer options, of which only one is correct. The task is considered completed if an answer is selected and marked in the answer sheet.	0 or 1 point: 1 point if the correct answer is indicated; 0 points if an incorrect answer is given, or more than one answer is given, or no answer to the task is given.
Matching tasks («logical pairs») (№11-12). The task has a base and two columns of information marked with numbers (left) and letters (right). Completing the task	0, 1, 2, 3,4 or 5 point: 1 point – for each correctly established correspondence («logical pair»); 0 points - for any «logical pair» if

involves establishing correspondence (forming "logical pairs") between information marked with numbers and letters. The task is considered completed if marks are made at the intersections of rows (numbers 1 to 5) and columns (letters A to F) in the table of the answer sheet.

more than one mark is made in a row and/or column; 0 points - for the task, if no correct match («logical pair») is indicated or the answer to the task is not provided.

The total number of test points (T) that an applicant can receive during the entrance test is 20 test points.

Approved at a meeting of the admissions committee
protocol № 11 of 08 04 2024 yr.

Responsible secretary
admissions committee



(signature)

Roj I. O.
(surname, initials)

Head of subject
examination commission



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