

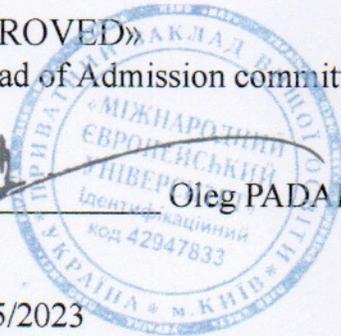


INTERNATIONAL EUROPEAN UNIVERSITY

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«APPROVED»  
The Head of Admission committee

  
Oleg PADALKA



17/05/2023

MATH PROGRAM

for specialized entrance examination for foreign citizens  
and stateless persons desiring to receive higher education based on  
secondary education

Kyiv - 2023

## CONTENT

No.	Section, topic	Knowledge	Subject skills and methods of training activities
<b>I. Algebra</b>			
<b>1. Rational expressions, equations and inequalities, numerical sequences.</b>			
1.1	Rational expressions.	Rational expressions. Rational fractions. Key property of rational fraction. Arithmetic operations with rational fractions. Integral index and its properties. Conventional number. Arithmetic square root. Properties of arithmetic square root. Rational numbers. Irrational numbers. Real numbers.	<p><i>To give examples of:</i> rational expression; rational fraction; integral index;</p> <p><i>to recognize:</i> integral rational expressions; fractional rational expressions;</p> <p><i>to explain</i> how to simplify a fraction; how to trace the fraction to a new denominator; how to trace the fraction to a common denominator; what the conventional number means;</p> <p><i>to formulate:</i> fraction properties, integral index; rules of addition, subtraction, multiplication, division of fractions, bringing a fraction to the degree; condition of fraction equality to zero;</p> <p><i>to resolve problems.</i></p>
1.2	Linear equations and systems.	Linear equation with one variable. Linear equation with two variables and its graph. System of two linear equations with two variables. Resolution of systems of two linear equations with two variables: in a graphical manner; using a substitute method; using an adding method.	<p><i>To give examples of:</i> linear equations with one and two variables; system of two linear equations with two variables;</p> <p><i>to explain:</i> what the system of two linear equations with two variables means;</p> <p><i>to formulate</i> the definition of: linear equations with one and two variables;</p> <p><i>to draw</i> graphs of linear equations with two variables;</p> <p><i>to describe:</i> ways of resolving systems of two linear equations with two variables;</p> <p><i>to work out:</i> equations and equation systems according to the word problem;</p> <p><i>to solve:</i> linear equations with one variable and equations reducing to them; word problems using linear equations with one variable; system of two linear equations with two variables.</p>

1.3	Quadratic equations.	Quadratic equations. Quadratic formula. Vieta theorem. Quadratic trinomial. Decomposition of quadratic trinomial into linear factors. Solution of equations reducing to quadratic ones. Quadratic equation and equations reducing to quadratic ones as mathematical models of applied problems.	<i>To give examples of:</i> quadratic equations; quadratic trinomials; <i>to formulate:</i> the definition of quadratic equation and quadratic trinomial; quadratic equation root; Vieta theorem; <i>to write down:</i> quadratic formula; formula for decomposition of quadratic trinomial into linear factors; <i>to work out</i> quadratic equations; <i>to resolve problems.</i>
1.4	Numerical inequalities.	Numerical inequalities. Key properties of numerical inequalities. Inequalities with variables. Linear inequalities with one variable. Numerical intervals. Equivalent inequalities. Systems of linear inequalities with one variable.	<i>To give examples of:</i> numerical inequalities; <i>To explain</i> what integration and intersection of numerical intervals mean; <i>to formulate:</i> properties of numerical inequalities, properties of inequalities with one variable; the definition of: solving linear inequalities with one variable, equivalent inequalities; <i>to display</i> on the coordinate line: integration and intersection of numerical intervals; <i>to write down:</i> solutions of inequalities and their systems as numerical intervals or corresponding inequalities; <i>to resolve:</i> linear inequalities with one variable; systems of linear inequalities with one variable.
1.5	Numerical sequences.	Numerical sequences. Arithmetical and geometrical progressions, their properties. Formulas for $n$ - term of arithmetical and geometrical progressions. Formulas for the sum of the first $n$ - terms of arithmetical and geometrical progressions.	<i>To give examples of:</i> numerical sequence; arithmetical and geometrical progressions; <i>to formulate</i> the definition and properties of arithmetical and geometrical progressions; <i>to write down and explain:</i> formulas for $n$ - term of arithmetical and geometrical progressions; the sum of the first $n$ - terms of these progressions; <i>to resolve problems</i> aimed at calculating $n$ - term of arithmetical and geometrical progressions.

## 2. Functions, their properties and graphs

2.1	Power functions.	Numerical functions and their properties. Representation of functions. Paired and unpaired functions. N-th root. N-th arithmetic root, its properties. Degree with a rational exponent, its properties. Power functions, their properties and graphs. Quadratic function, its graph and properties. Function, its graph and properties.	<i>To use</i> different ways of function representation; <i>to find</i> the range of definition of functional relationship; value of functions at the given values of argument and value of argument, at which the function acquires this value; <i>to define</i> function's key properties due to its graph; <i>to calculate and compare</i> the value of expressions containing degrees with rational exponents, roots; <i>to recognize and sketch out</i> graphs of power functions; <i>to model</i> real processes using power functions.
2.2.	Trigonometric functions and equations.	Sine, cosine, tangent of the angle. Radian angle measure. Trigonometric functions of a numeric argument. Key correlations between trigonometric functions of one argument. Reduction formulas. Periodicity of functions. Properties and graphs of trigonometric functions. Addition formulas for trigonometric functions and their consequences. The simplest trigonometric equations.	<i>To be able</i> to shift from radian angle measure to degree measure and vice versa; <i>to define</i> the correlation between real numbers and points on the unit circle; <i>to recognize and draw</i> graphs of trigonometric functions; <i>to transform</i> complex trigonometric expressions; <i>to apply</i> trigonometric functions while describing real processes; <i>to resolve</i> the simplest trigonometric equations.
2.3	Exponential and logarithmic functions, equations and inequalities.	Properties and graphs of the exponential function. Logarithms and their properties. Properties and graph of the logarithmic function. The simplest exponential and logarithmic equations and inequalities.	<i>to recognize and draw</i> graphs of exponential and logarithmic functions; <i>to illustrate</i> properties of exponential and logarithmic functions using graphs; <i>to apply</i> exponential and logarithmic functions while describing real processes; <i>to resolve</i> the simplest exponential and logarithmic equations and inequalities.
<b>2. Mathematical analysis basics</b>			
3.1	Derivative and its application.	Function derivative, its geometrical and physical meaning. Differentiation rules.	<i>To understand</i> the definition of derivative while describing real processes, particularly mechanical motion;

		Function constancy criterion. Sufficient conditions for function increase and decrease. Extremums of function. Application of derivative while exploring functions and drawing their graphs. The largest and the least value of function in the interval.	<i>to differentiate</i> functions using the derivative table and differentiation rules; <i>to apply</i> the derivative while finding monotonicity intervals and extremums of function, drawing graphs; <i>to find</i> the largest and the least value of function; <i>To resolve</i> simple applied problems aimed at finding the largest and the least values.
3.2	Integral and its application.	Primitive and its properties. Definition of integral, its geometrical meaning. Calculation of plane areas.	<i>To find</i> primitives using the table of primitives and their properties; <i>to calculate</i> the integral using the table of primitives and their properties; <i>to find</i> curvilinear trapezoid areas.

#### 4. Combinatorics elements, probability theory and mathematical statistics

4.1	Combinatorics elements.	Combinatorics elements. Displacement, placement, combinations (without repetitions).	<i>To understand</i> the meaning of displacement, placement, combinations (without repetitions), conventional definition of probability, the meaning of general population and selection, average value, mode and median of selection; <i>to calculate</i> the relevant frequency of the event; the amount of displacements, placements, combinations; probability of the event using its definition and combinatorial schemes; <i>to explain</i> the content of average figures and characteristics of selection; <i>to find</i> numerical characteristics of data selection.
4.2	Probability theory basics	Frequency and probability of an accident event. Conventional definition of probability of the accident event.	
4.3	Mathematical statistics basics.	Selective characteristics: sample range, mode, median, average value. Graphic presentation of information about selection.	

## II. Geometry

### 1. Geometric figures and their properties.

1.1	Geometric figures.	Geometric figures. Point, line, segment, ray, angle. Measurement of segments and angles. Angle bisector. Equation of geometric figures.	<i>To give examples of</i> geometric figures specified in the content;
1.2	Triangles.	Triangle and its elements. Height, bisector and median of	<i>to explain</i> the definition of: point, line, to belong to, to lie between,

		<p>triangle. Features of triangle equation. Properties of right triangles. Triangle types.</p> <p>Isosceles triangle, its properties and features. Triangle inequality. Sum of triangle angles. Exterior angle of triangle and its properties. Similar triangles. Triangle similarity features. Property of triangle median and bisector. Intercept theorem. Average of triangle line, its properties. Sine, cosine, tangent of acute angle of right triangle. Pythagorean theorem. Perpendicular and oblique, their properties. Correlation between sides and angles of right triangle. Value of sine, cosine, tangent of some angles. Calculation of right triangles.</p>	<p>segment, ray, angle, segment length, degree measure of angle, congruent segments, congruent angles, angle bisector, distance between points;</p> <p><i>to formulate:</i> properties of: point placement on the line; measurement and laying of segments and angles; definition of: polygon fitted in the circle; polygon circumscribed about the circle;</p> <p><i>theorem:</i> about the area of rectangle, parallelogram, triangle and trapezoid;</p> <p><i>properties</i> of perpendicular and oblique;</p> <p><i>definition</i> of sine, cosine, tangent of acute angle of right triangle; Pythagorean <i>theorem</i>;</p> <p><i>correlation</i> between sides and angles of right triangle;</p>
1.3	Circle.	<p>Circle. Tangent to circle and its property. Primary problems for constructing: triangle construction due to three sides; construction of an angle equal to the given one; bisector construction of this angle; segment division in half; construction of a line perpendicular to the given one. Circle circumscribed about the triangle. Circle fitted in the triangle. Circle length. Length of a segment of the circle. Area of circle and its parts.</p>	<p><i>to write down and explain</i> formulas for the area of geometric figures specified in the content;</p> <p><i>to classify</i> angles (acute, right, obtuse, straight), triangles, polygons;</p> <p><i>to calculate and measure:</i> length of a segment, circle, degree measure of the angle using their measurement properties;</p> <p><i>to show and find</i> geometric figures specified in the content on Figures;</p>
1.4	Quadrangles.	<p>Quadrangle, its elements. Sum of quadrangle angles. Parallelogram, its properties and features. Rectangle, rhombus, square and their properties. Trapezoid. Circumferential and central angles. Inscribed and circumscribing quadrangles. Average trapezoid line, its</p>	<p><i>to apply</i> examined definitions and properties while resolving problems.</p>

		properties.	
1.5	Polygons.	Polygon and its elements. Polygon fitted in the circle and polygon circumscribed about the circle. Definition of polygon area. Area of rectangle, parallelogram, rhombus, triangle and trapezoid.	
1.6	Polyhedrons.	Polyhedron and its elements. Convex polyhedron. Prism. Right and regular prism. Parallelepiped. Pyramid. Regular pyramid. Polyhedron section. Areas of side and total surfaces of prism, pyramid. Volumes of prism, parallelepiped, pyramid.	<i>To recognize</i> key types of polyhedrons and their elements; <i>to depict</i> key types of polyhedrons and their elements; <i>to have an idea of</i> polyhedron section by surface; <i>to formulate</i> the definition of polyhedrons specified in the content;
1.7	Rotation bodies.	Cylinder, cone, their elements. Cylinder and cone section: axial sections of cylinder and cone; cylinder and cone section by planes parallel to the base. Sphere. Sphere section by the plane. Volumes of side and total surfaces of cylinder, cone. Sphere area.	<i>to write down</i> formulas for calculating the area of side and total surfaces of prism and pyramid; formulas for calculating volumes of parallelepiped, prism, pyramid, cylinder, cone, sphere; areas of of side and total surfaces of cylinder, cone; sphere area; <i>to calculate</i> values of core polyhedron elements; <i>to apply</i> explored formulas and properties while resolving problems, including applied ones.
<b>2. Mutual arrangement of lines and planes</b>			
2.1	Mutual arrangement of lines and planes.	Adjacent and vertical angles, their properties. Parallel and perpendicular lines, their properties. Perpendicular. Distance from the point to the line. Angle between two intercrossing lines. Angles created during intercrossing of two lines by the section. Features of line parallelism. Properties of angles created during intercrossing of parallels by the section.	<i>To explain the concept of:</i> theorem, definition, feature, consequence, condition and requirement of the theorem, direct and converse proposition, theorem proving, concept of proof by contradiction; <i>to formulate</i> the definition of: adjacent and vertical angles, parallel and perpendicular lines, perpendicular, distance from the point to the line; <i>properties of:</i> adjacent and vertical angles; features of line parallelism; <i>to measure and calculate</i> distance from the point to the line; <i>to display and find on Figures:</i> parallel perpendicular lines;

			<p>perpendicular: angles created during intercrossing of two lines by the section;</p> <p><i>to prove:</i> properties of adjacent and vertical angles; parallel lines; perpendicular lines;</p> <p><i>to apply</i> explored definition and properties while resolving problems.</p>
2.2	Parallelism of lines and planes in space.	<p>Basic concepts, axioms of stereometry and the simplest consequences of them.</p> <p>Mutual placement of lines in space. Parallel design and its properties. Images of figures in stereometry. Parallelism and plane. Parallelism of planes.</p>	<p><i>To name</i> the basic concepts of stereometry; <i>to distinguish</i> denoted and non-denoted concepts, axioms and theorems; <i>to formulate</i> axioms of stereometry and their consequences;</p> <p>definition of the angle between straight lines, line and plane, planes; the theorem on three perpendiculars;</p> <p><i>to apply</i> the axioms of stereometry and their consequences while resolution of simple problems; relationship between lines and planes in space, distances and angles in space while describing the objects of the surrounding world;</p> <p><i>to classify</i> according to certain features the mutual placement of lines, lines and planes, planes in space by the number of their common points;</p> <p><i>to establish</i> the parallelism of straight lines, straight lines and planes, two planes;</p> <p>perpendicularity of straight lines, straight lines and planes, two planes;</p> <p>find out if two lines are incidental;</p> <p><i>to depict</i> shapes in space.</p>
2.3	Perpendicularity of lines and planes in space.	<p>Perpendicularity of lines.</p> <p>Perpendicularity of a line and a plane. Theorem on three perpendiculars. Perpendicularity of planes. Dihedral angle.</p> <p>Measurement of distances in space: from a point to a plane, from a line to a plane, between planes. Measurement of angles in space: between lines, between a line and a plane, between planes.</p>	
<b>3. Coordinates and vectors</b>			
3.1	Coordinates and vectors on the plane.	<p>Vector. Module and direction of the vector. Equality of vectors.</p> <p>Vector coordinates. Addition and subtraction of vectors.</p> <p>Multiplying a vector by a number. Collinear vectors.</p> <p>Scalar product of vectors.</p>	<p><i>To give examples of:</i> equal, opposite, collinear vectors;</p> <p><i>To explain the concept of:</i> vector; module and direction of the vector; unit vector; zero vector; collinear vectors; opposite vectors; vector coordinates; the sum and</p>

		Rectangular coordinate system. The distance between two points with the given coordinates. Equation of circle and line.	difference of vectors; product of vector by number; <i>how to set</i> the vector; <i>how to postpone</i> the vector from the given point;
3.2	Coordinates and vectors in space.	Rectangular coordinates in space. Coordinates of the middle of the segment. The distance between two points. Vectors in space. Operations on vectors. Formulas for calculating the length of a vector, the angle between vectors, the distance between two points. Symmetry with respect to the origin and coordinate planes.	<i>To formulate the definition of:</i> vectors; scalar product; properties of actions on vectors; <i>to calculate:</i> coordinates of the vector, the sum (difference) of vectors, the product of the vector by number; the length of the vector, the angle between the two vectors; the distance between two points, the coordinates of the middle of the segment, the coordinates of the points symmetrical about the origin and coordinate planes; <i>to substantiate:</i> equality, collinearity of vectors; <i>to apply</i> the explored definitions and properties while solving problems.

### Recommended reading list and references

1. Algebra. Class 7. / Bevz G.P., Bevz V.G. / K.: Zodiac – EKO, 2007. – 305 p.
2. Algebra. Class 8. / Bevz G.P., Bevz V.G. / K.: Zodiac – EKO, 2008. – 256 p.
3. Algebra. Class 9. / Bevz G.P., Bevz V.G. / K.: Zodiac – EKO, 2009. – 288 p.
4. Algebra and analysis basics. Class 10. / Nelin E.P. Dolgova O.E. / Gymnasium, 2011. – 448 p.
5. Algebra. Class 11. / Nelin E.P. Dolgova O.E. / Gymnasium, 2010. – 416 p.
6. Geometry. Class 7. / Bevz G.P., Bevz V.G. / Vladimirova N.G. / Vezha, 2007. – 208 p.
7. Geometry. Class 8. / Bevz G.P., Bevz V.G. / Vladimirova N.G. / Vezha, 2008. – 256 p.
8. Geometry. Textbook for Class 9 of secondary educational institutions / Burda M.I., Tarasenkova N.A. / K.: Zodiac – EKO, 2009. – 238 p.
9. Geometry. Class 10. / Burda M.I., Tarasenkova N.A. / K.: Zodiac – EKO, 2010. – 176 p.

10. Geometry. Class 11. / Bevz G.P., Bevz V.G. / Vladimirova N.G., Vladimirov V.M. / Heneza, 2011. – 336 p.
11. Mathematics. Class 11. / Afanasiieva O.M., Brodskiy Y.S., Pavlov O.L., Slipenko A.K. / Heneza, 2011. – 480 p.
12. Training materials to pass external independent testing./  
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