

**MINISTRY OF EDUCATION AND SCIENCE OF THE RUSSIAN
FEDERATION
FEDERAL STATE BUDGETARY EDUCATIONAL INSTITUTION
OF HIGHER EDUCATION
“PENZA STATE UNIVERSITY”
(FSBEI HE Penza State University)**

**APPROVED BY
Chairman of the Admission
Committee,
Rector of the University**



Entrance examination program
in mathematics
for enrollees on study fields and specialties in 2019

Penza, 2018

The entrance examination program in mathematics is designed for enrollees. It embraces available knowledge envisaged by the school curriculum.

Requirements for enrollees training

The enrollee should:

know:

- key definitions, properties of geometric figures and shapes;
- major theorems and axioms;
- formulas in geometry, algebra and fundamentals of mathematical analysis;

be able to:

- operate (without a calculator) numbers and numeric expressions; convert letter expressions; process vectors (addition, multiplication, dot product); convert measurement values into others;
- compare numbers and find their approximate values (without a calculator); prove identities and inequalities for letter expressions;
- solve equations, inequalities, systems (including those with parameters) and find their solutions;
- explore functions; build graphs of functions and sets of points on the coordinate plane, which are defined by equations and inequalities;
- depict geometric figures and shapes in drawings; make additional constructions; build segregates; explore the relative position of figures; apply signs of equality, similarity of figures and their affiliation to a particular type;
- use properties of numbers, vectors, functions and their graphs, as well as properties of arithmetic and geometric progressions;
- apply properties of geometric figures and shapes, their characteristic points, lines and parts, as well as properties of equality, similarity and relative position of figures and shapes;
- use ratios and formulas containing modules, powers, roots, logarithmic and trigonometric expressions, angles, lengths, areas, and volumes;
- compile equations, inequalities and find values based on the conditions of the task;
- suggest and come up with logically correct, full and consistent solutions and substantiate them;
- apply acquired knowledge in practice;

obtain and apply:

- key theoretical methods;

- methods of analyzing obtained information.

Content of the entrance examination program

No.	Name of the section	Content of the section
1.	Algebra	Natural numbers. Divisor, multiple. Greatest largest divisor. Least common multiple. Whole numbers. Rational numbers. Real numbers, their representation as decimal fractions. Modulus of real number, its geometric meaning. Formulas of abridged multiplication. Power with natural and rational indicator. Arithmetic root. Transformation of the simplest expressions, including arithmetic operations, as well as exponentiation.
2.	Fundamentals of mathematical analysis. Logarithm.	Logarithm of number. Basic logarithmic identity. Logarithm of product, quotient, power; transition to new radix. Common and natural logarithms, number e . Logarithm operation.
3.	Fundamentals of mathematical analysis. Fundamentals of trigonometry.	Sine, cosine, tangent and cotangent of angle. Radian measure of angle. Major trigonometric identities. Reduction formulas. Sine, cosine and tangent of sum and difference of two angles. Sine and cosine of double angle. Half angle formulas. Conversion of trigonometric functions sum into product form and product form into sum. Expression of trigonometric functions through tangent of half argument. Transformations of the simplest trigonometric expressions. The simplest trigonometric equations and inequalities. Arcsine, arccosine, arctangent of number.
4.	Fundamentals of mathematical analysis. Functions.	Domain and value sets. Graph function. Plotting graphs of functions defined in various ways. Properties of functions. Intervals of increase and decrease, the largest and smallest values, extrema points. Graphic interpretation. Power function with natural indicator, its properties and graph. Trigonometric functions, their properties and graphs; periodic behavior, main period. Exponential function, its properties and graph. Logarithmic function, its properties and graph.

5.	Fundamentals of mathematical analysis. Differential calculus.	Concept of derivative function, physics and geometry essence of derivative. Equation of tangent to function graph. Derivative sums, differences, product form, and quotient. Derivatives of major elementary functions. Application of derivative to studying functions and drawing graphs.
6.	Fundamentals of mathematical analysis. Integral calculus.	Concept of definite integral as area of curvilinear trapezoid. Anti-derivative. Newton-Leibniz formula. Examples of using derivative to find the best solution. Finding speed.
7.	Algebra. Equations and inequalities.	Solving rational, exponential, logarithmic equations and inequalities. Solving irrational and trigonometric equations. Basic techniques for solving equations systems: substitution, algebraic addition, introduction of new variables. Solving the simplest equations systems with two unknowns. Solving inequalities systems with one variable. Intervals method. Drawing the set of solutions of equations and inequalities with two variables and their systems on the coordinate plane. Arithmetic and geometric progression.
8.	Probability theory.	Probability and statistical frequency of events. Solution of practical tasks using probability methods.
9.	Planimetrics.	Straight line, ray, segment, polygonal chain; length of segment. Angle, value of angle. Vertical and adjacent angles. Circle, disk. Parallel straight lines. Parallel straight lines axiom. Types of symmetry. Transformation of similarity and its properties. Convex polygon, its vertices, sides, diagonals. Triangle. Its medians, bisectors, heights. Types of triangles. Ratios between sides and angles of right triangle. Signs of equality of triangles. Various formulas for triangle area (including through radii of inscribed and circumscribed circles). Quadrangles: parallelogram, rectangle, rhombus, square, and trapezoid. Circle and disk. Center, chord, diameter, and radius. Tangent to circle and its properties. Arc of circle. Sector and segment. Length of circle and length of circle arc. Central angle and its

		measurement. Degree and radian measure of angle. Circle area and sector area. Similarity. Similar figures. Ratio of areas of such figures.
10.	Stereometry. Space figures.	Prism, its bases, edges, height, lateral surface. Triangular pyramid. Right pyramid. Truncated pyramid. Segregate of cube, prism, and pyramid. Cylinder and cone. Truncated cone. Base, height, lateral surface, generatrix, and cut-out shape. Axial segregates and segregates parallel to base. Ball and sphere, their segregates, tangent plane to sphere. Formulas for finding volume of cube, rectangular parallelepiped, prism, and cylinder. Formulas for finding volume of pyramid and cone. Formulas for finding surface area of cylinder and cone. Formulas for finding volume of ball and area of sphere.

References

1. Kulabukhov S.Yu., Avilov N.I., Voyta Ye.A. Mathematics. Solutions and Methodological Guidelines. Preparing for 2016 Unified State Examination. Field-specific level. 352 p.
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3. Sedova Ye.A., Sitkin Ye.L., Baban L.G. 2017 Unified State Examination. Mathematics. Training tasks. Eksmo-Press, 2016.
4. Lappo L.D., Popov M.A. 2014 Unified State Examination. Mathematics. Practice on completing typical test tasks of Unified State Examination. 2014, 72 p.
5. Prokofyev A.A. Guide on Geometry for Preparatory Courses (Planimetrics). 4th edition, revised and enlarged. Moscow: MIET, 2007, 232 p.
6. Panferov V.S., Sergeyev I.N. Otlichnik YeGE. Mathematics. Solving complex tasks. Moscow: Intellekt-Tsent, 2010.
7. Zverovshchikova N.V., Moyko N.V. 2016 Unified State Examination. Mathematics: Active Training. Basic and high complexity tasks.
8. www.mathege.ru – Unified State Examination in Mathematics (open tasks).

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