

MINISTRY OF SCIENCE AND HIGHER EDUCATION OF THE RUSSIAN FEDERATION
Federal State Budgetary Educational Institution of Higher Education
Togliatti State University



Vice Director of Admissions
of Togliatti State University

E.S. Baboshina

«*сентябрь*» 2020

ENTRANCE EXAMINATION PROGRAMME

Mathematics

Togliatti 2020

1 GENERAL PROVISIONS

1.1 The entrance examination in information science is held by Togliatti State University.

1.2 The entrance examination is a 90 minutes test containing 30 questions.

1.3 The candidates' results of all entrance examinations are assessed using a 100-mark grading scale.

2. CONTENTS

2.1. Arithmetic, algebra, introduction to analysis

Arithmetic

Natural numbers (N). Primes and composite numbers. Integer factorisation. Division with a remainder. Power of a number. Divisors and multiples. GCD. LCM. Divisibility by 2, 3, 5, 9, 10.

Whole numbers (Z). Coordinate axis.

Rational numbers (Q). Comparison of rational numbers. Arithmetic operations with rational numbers. Properties of addition and multiplication of rational numbers. Coordinate plane. Opposite numbers. Modules.

Simple fractions. General properties of fractions. Finding a fraction of a whole number. Finding a number based on its fraction. Proper and improper fractions. Compose fraction. Comparison of and arithmetic operations with simple fractions and compose numbers. Decimals. Comparison and rounding of decimals. Arithmetic operations with decimals. Approximation of calculation results. Conversion of decimals into simple fractions and vice versa. Periodical fraction. Decimal approximation of a simple fraction. Ratio. Percentage ratio of two numbers. Division of a number in a ratio. Proportion. General properties of a proportion. Direct and inverse proportion. Percentage. Finding percentage of a number and vice versa.

Algebra

Numeric and literal expressions. Value of a numeric expression. Order of operations. Removal of brackets.

Expressions with variables and their properties. Identical equation. Identical transformations. Proof of identity.

Power of a number. Monomials. Standard monomials. Power of monomials. Polynomials. Standard polynomials. Power of polynomials. Addition, subtraction and multiplication of polynomials. Formulae of abridged multiplication. Polynomial factoring. Grouping terms. Difference of two squares. Sum and difference of two cubes. Square trinomial. Radical of square trinomial. Square trinomial properties.

Rational expressions. Whole expressions. Fractional expressions. Rational fraction, its properties. Addition, subtraction, division, and multiplication of

rational fractions. Raising of rational fractions to the power. Identical transformation of rational expressions.

Square roots and their properties. Identical transformations of square root expressions.

Equations. One-variable equations and their properties. Equation root. Equivalent equations. Equation as a mathematical model of a real-life situation. Linear equations. Square equations. Square root equation formulae. Vieta theorem. Rational equations. Solving rational equations transformed into linear or square equations. Equations with two variables and their graphs. Linear equations with two variables and their graphs.

Systems of equations with two variables. Graphic method of solving equations with two variables. Method of substitution. Method of addition. Systems of equations with two variables as a mathematical model of a real-life situation.

Inequalities and their properties. Addition and subtraction of inequalities. Inequality with one variable. Equivalent inequalities. Evaluation of an expression. Numeric intervals. Linear and square inequalities with one variable. Systems of inequalities with one variable.

Functions. Numeric functions. Functional dependencies. The concept of a function. Function as a mathematical model of a real-life process. Ranges. Function representation. Graphs. Function zeroes. Function intervals.

Linear function, square function, inverse proportion, $y = \sqrt{x}$, their properties and graphs.

The concept of numerical sequences, their properties. Finite and infinite sequences. Representation of sequences. Arithmetic and geometric progressions, the properties of their terms. Formulae of general terms of progressions. Formulae of sums of terms. Sum of an infinite geometric progression with $|q| < 1$. Periodical decimal fraction as a simple fraction.

Algebra and introduction to analysis

Power function, its properties and a graph. Reciprocal functions. Equivalent equations and inequalities. Irrational equations and inequalities.

Exponent function, its properties and a graph. Exponent equations and inequalities. Systems of exponent equations and inequalities.

Logarithm. Logarithmic equivalence. Logarithm of a product, quotient, power; change of base of logarithms. Decimal and natural logarithms, mathematical constant e . Properties of logarithms. Logarithmic function, its properties and a graph. Logarithmic equations. Logarithmic inequalities.

Trigonometric formulae. Radian measure. Rotating a point around the origin. Definition of a sine, cosine, tangent. Signs of sine, cosine, tangent. Dependency between a sine, cosine, and tangent of the same angle. Trigonometric equivalencies. sine, cosine, and tangent of α and $-\alpha$. Addition formulae. Sine, cosine, and tangent of a double angle. Sine, cosine, and tangent of a half angle. Reduction formulae. Sum and difference of sines. Sum and difference of cosines. Trigonometric equations. Equations $\sin x = a$, $\cos x = a$, $\tan x = a$ Solving trigonometric equations. Examples of solutions of basic trigonometric inequalities.

Trigonometric functions. Range and value set of trigonometric functions. Parity, oddness, and periodicity of trigonometric functions. Trigonometric functions of numeric arguments: sine, cosine, and tangent. Properties and graphs of trigonometric functions. Inverse trigonometric functions.

Definition of a derivative. Derivative of a power function. Differentiation rules. Derivatives of some basic functions. Geometric meaning of a derivative. Applying derivatives in studying functions. Function increase and decrease. Extremes of function. Maximum and minimum value of a function. Derivative of order two, function convexity, and points of inflexion. Construction of a graph.

Antiderivative. Rules of antiderivation. Area of curvilinear trapezium. Integral. Fundamental theorem of calculus.

Elements of statistics. Elements of probability. Combinatorial problems. Data representation in tables, pie and bar charts, graphs. Arithmetic average. Medium of value. Accidental event. Persistent event. Impossible event. Probability of accidental event.

Geometry. Plane geometry.

Geometric figures. Geometric measurements. Point. Line. Line segment. Ray. Angle. Types of angles. Adjacent angles. Vertical angles. Angle bisector. Length of a segment. Length of a line. Intersecting and parallel lines. Perpendicular lines. Conditions for parallel lines. Properties of parallel lines. Perpendicular and oblique lines.

Polygons. Triangles. Types of triangles. Median, bisector, altitude of a triangle. Equality of triangles. Isosceles triangle, conditions and properties. Perpendicular bisector. Angular sum. Exterior angles. Triangle inequality. Sides and angles ratio. The Pythagorean theorem. Triangle perimeter.

Similar triangles and their conditions. Intersection points of medians, bisectors, altitudes. Property of a bisector. The intercept theorem. Metric ratios in right-angle triangles. Sine, cosine, tangent, cotangent of an acute angle, of angles from 0 to 180 degrees. Formulae of relations between sine, cosine, tangent, and cotangent of an angle. Solution of triangles. Sine and cosine theorem.

Tetragons. Parallelogram, its properties. Rectangle, rhombus, square, their properties. Trapezium. Trapezium bisector and its properties.

Polygons. Convex polygons. Sum of angles of a convex polygon. Regular polygon.

Circle and its periphery, their elements (center, radius, diameter, chord, tangent line). Central and inscribed angles. Tangent line to a circle, its properties. Relative positions of a circle and a line. Inscribed and circumscribed circles of a triangle. Inscribed and circumscribed tetragons, their properties. Inscribed and circumscribed polygons.

Geometric measurements. Length of a line segment. Distance between two points. Distance between a point and a line. Distance between two parallel lines. Polygon perimeter. Circumference. Arc length. Grade measure. Measuring inscribed angles.

Area of a polygon. Figures of equal area. Finding the area of a square, rectangle, parallelogram, triangle, and trapezium.

Area of a circle. Area of a sector. Ratio of areas of similar figures.

Cartesian coordinates on a plane. Formula of distance between two points. Coordinates of a midpoint of a segment. Figure equation. Circle and line equation. Angle coefficient of a line.

Vectors. Concept of a vector. Vector module (length). Equality of vectors. Vector addition and subtraction. Multiplication of a vector by a number. Cosine of an angle between vectors. Vector coordinates. Collinear vectors. Scalar product of vectors.

Geometric transformation. The concept of figure transformation. Movement of figures. Types of movement: parallel shift, axial symmetry, central symmetry, pivot. Equality of figures. Homothetic dilation. Similar figures.

Geometry. Solid geometry.

Lines and planes in space. Basic concepts of solid geometry (points, lines, planes, space). Intersecting, parallel, and skew lines. The angle between two lines in space.

Perpendicular lines. Properties and conditions for lines parallel and perpendicular to planes. The three perpendicular theorem. Perpendicular line and plane. Oblique line and plane. The angle between a line and a plane.

Parallel planes, perpendicular planes, their properties and conditions. Dihedral angle, linear angle of a dihedral angle.

Distance of a point from a plane. Distance of a line from a plane. Distance of parallel planes. Distance of skew lines.

Polygon. Polygon vertices, edges, faces. Polyhedral angles. Convex polygons.

Prism. Prism bases, lateral edges, altitude, lateral surface. Right-angle and oblique prism. Regular prism. Parallelepiped. Cube.

Pyramid. Pyramid bases, lateral edges, altitude, lateral surface. Triangular pyramid. Regular pyramid. Truncated pyramid.

Polygon sections. Building sections.

Bodies and surfaces of revolution. Cylinder and cone. Truncated cone. Base, altitude, lateral surface, generatrix, net.

Orb and sphere, their sections. Ellipse, hyperbola, parabola as a conic section. Tangent plane to a sphere. Sphere inscribed in a polygon. Sphere circumscribed about a polygon.

Volumes of bodies and surface areas. Volume ratio of similar bodies. Volume of a cube, parallelepiped, prism, cylinder. Volume of a pyramid, cone. Surface area of a cylinder, cone. Volume of an orb, sphere.

Coordinates and vectors. Cartesian coordinates. Formula of a distance between two points. Equation of sphere and plane. Formula of distance between a point and a plane.

Vectors. Vector module. Equality of vectors. Vector addition. Multiplication of a vector by a number. Angle between vectors. Vector coordinates. Scalar product of vectors. Collinear vectors. Resolution of a vector in two non-collinear vectors. Coplanar vectors. Resolution of a vector in three non-coplanar vectors.

3. LIST OF RECOMMENDED LITERATURE

1. Antonio Caminha Muniz Neto . An Excursion through Elementary Mathematics. Volume I: Real Numbers and Functions. 2017
<https://link.springer.com/book/10.1007/978-3-319-53871-6>
2. Antonio Caminha Muniz Neto. An Excursion through Elementary Mathematics. Volume II: Euclidean Geometry. 2018
<https://link.springer.com/book/10.1007/978-3-319-77974-4>
3. Antonio Caminha Muniz Neto. An Excursion through Elementary Mathematics. Volume III: Discrete Mathematics and Polynomial Algebra. 2018
<https://link.springer.com/book/10.1007/978-3-319-77977-5>
4. 4. Radmila Bulajich Manfrino, José Antonio Gómez Ortega, Rogelio Valdez Delgado Topics in Algebra and Analysis : Preparing for the Mathematical Olympiad. 2015.
<https://link.springer.com/book/10.1007/978-3-319-11946-5>.



Перевод Берен

Вм

О.В. Битнова

начальник ОМС

ASSESSMENT

All entrance examinations arranged by Togliatti State University for candidates applying for a **bachelor's, specialist's, or master's degree**, have a maximum score of 100.

$$\text{Marks of the candidate} = \frac{\text{Number of correct answers}}{\text{Number of questions } \in \text{ the test session}} 100$$

where:

Marks of the candidate stands for the marks obtained by the candidate in the test session (a maximum of 100 marks);

Number of correct answers is the number of correct answers given by the candidate in the test session;

Number of questions in the test session is the number of tasks the candidate has to perform during the entrance examination according to the entrance examination programme.

The minimum passing score is specified by the entrance examination programme or/and by the university's internal regulations (List of entrance examinations stating the priority ranking of entrance examinations; on minimum admission score; on arrangement of entrance examinations held by Togliatti State University).