MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
KHERSON STATE MARITIME ACADEMY

Approved by

Head of Selection Committee

Viktor Husiev

PROGRAM OF ENTRANCE EXAMINATIONS IN MATHEMATICS

for foreign citizens and stateless persons

Faculty:	Navigation, Marine engineering
Higher Education Degree:	Bachelor
Branch of knowledge:	J "Transport"
Specialty:	J5 "Sea and River Transport"
Specialization:	J5.01 Navigation and Ship Handling at Sea J5.02 Ship Technical Systems and Complexes Operation
Form of study:	Full-time / Part-time

Kherson – 2025

The program is composed on the basis of the sample program in Mathematics for secondary education institutions approved by the Ministry of Education and Science of Ukraine (№1/11-6611 dd. 23.12.2004).

The program was developed by Tetiana Spychak, Candidate of Pedagogical Sciences, Associate Professor of the Department of Natural Science, and approved by minutes №12 at the meeting of the Department of Natural Science on 23 June 2025.

Head of exam Committee Tetiana SPYCHAK

GENERAL INFORMATION

The program of entrance examinations in Mathematics for applicants with a basic secondary education is developed in accordance with the Laws of Ukraine "On Education", "On Higher Education", the Conditions of Admission to Higher Educational Institutions of Ukraine. The program is composed on the basis of the sample program in Mathematics for secondary education institutions approved by the Ministry of Education and Science of Ukraine (№1/11-6611 dd. 23.12.2004) and includes all sections of school curricula.

An entrance examination and interview at Kherson State Maritime Academy in Mathematics is held for admission of the applicants who are entitled to participate in competitive selection in accordance with the results of entrance examinations. Category of the persons is defined in the Regulations of Admission to KSMA.

The object of an entrance examination is the estimation of the level of applicants' knowledge in Mathematics to participate in competitive selection.

The program consists of 6 sections. The 1st section contains a list of basic mathematical notions and facts to be known by an applicant (to be able to use them during solving mathematical problems). The 2nd section is composed of theorems and formulas which are the basis of the examination theoretical part. Mathematical skills to be known by an applicant are enumerated in the 3rd section. In order to prepare better for an interview, a list of typical mathematical problems for applicants' self-preparation are provided in the 4lh section. The 5lh section contains criteria of applicants' knowledge and skills assessment. Proposed list of reference for preparation for an examination and interview is provided in the 6th section. Moreover, while preparing for entrance examinations, all textbooks and manuals in Algebra and Geometry recommended by the current program and developed for regular schools in Mathematics can be used.

The aim of entrance examination and interview in Mathematics is to estimate applicants' knowledge and skills. An applicant should demonstrate:

- precise knowledge of definitions, mathematical notions, terms, statements of rules, theorems provided by the program; ability to prove them;

- ability of accurate expressing mathematical opinion in oral and written form by using necessary mathematical symbols;
- confident practical mathematical skills provided by the program, ability to use it while mathematical problems solving.

I. FUNDAMENTAL MATHEMATICAL NOTIONS AND FACTS. ARITHMETIC. ALGEBRA AND PRECALCULIJS

1. Natural numbers and null. Reading and writing of natural numbers. Natural numbers congruence. Addition, subtraction, multiplication and division of natural numbers.

2. Natural numbers divisibility. Divisors and multiples of a natural number. Paired and unpaired numbers. Divisibility by 2,3,5,9,10. Division with a remainder. Prime and composite numbers. Natural number factorization. Greatest common divisor, lowest common multiple.

3. Common fractions. Common fractions comparison. Proper and improper fraction. An integral and fractional part of a number. Fractional property. Reduction of fractions. Arithmetic average of a few numbers. Basic mathematical fractional problems.

4. Percentage. Rules of percentage calculations. Simple and compound percentage formulas.

5. Numerical inequality properties.

6. Arithmetic and geometric progression. N-th term formula and a sum of progression first terms. Formula of sum to geometric series terms with a denominator.

7. Power with natural and rational exponent. Arithmetical root.

8. Monomial and polynomial. Operations on it. Abridged multiplication formulas.

9. Polynomial with one variable. Root of polynomial (by quadratic trinomial).

10. An equation. Solution of the equation, roots of the equation. An equivalent equation. A graph of a binary equation.

11. Inequality. Solution of inequalities. Equivalent inequalities.

12. Systems of equations and inequalities. Systems solution. Roots of systems. Equivalent systems of equations.

13. Formula of quadric equation roots.

14. Quadratic trinomial factorization into linear multipliers.

15. Function. Representation of function. Domain, range of function. Reciprocal function.

16. Graph of function. Function increase and falling; periodicity, parity, oddity of function.

17. Function properties, its graph.

18. Function properties, its graph.

19. Function properties, its graph.

20. Definition and properties of functions. Functions graphs.

21. Reduction formulas.

22. Dependence between trigonometric functions of the same argument.

23. Sine and cosine of 2 arguments sum and difference (formulas).

24. Trigonometric functions of double argument.

25. Productization.

26. Solution of an equation.

27. Definition and properties of functions: power and exponential function.

28. A logarithm and its properties. Main logarithmic identity.

29. The logarithm of product, power and quotient.

30. Definition and properties of the logarithmic function.

31. Definition of a derivative, its mechanical and geometric content.

32. Derivative of sum, product and quotient of 2 functions.

33. Derivative of blending function.

34. Derivatives of trigonometric functions.

35. Derivatives of power, exponential and logarithmic functions.

36. Tangent equation to a graph of function.

37. Sufficient condition of function increase (decrease) on the interval.

Extremum of function. Necessary condition for extremum. The largest and the smallest value of function on the interval.

38. Primitive and definite integral. Table of primitive elementary functions. Rules of antiderivation. Newton-Leibniz formula.

39. Permutations (without repetitions), rule of permutation. Arrangements (without repetitions), number of arrangements. Combinations (without repetitions).

40. Newton binomial. Probability of an accidental event. Elementary cases of probabilities count.

41. Static characteristics of data sequences.

GEOMETRY

1. Line, ray, segment, kinked curve; length of line. Equality and similarity of geometric figures. Relation of similar figures areas.

2. Angle, amount of angle. Vertical and contiguous angles. Parallel lines.

3. Triangle. Median, bisectrix, altitude of triangle, their characteristics. Types of triangles.

4. Features of triangles equality.

5. Characteristics of isosceles triangle.

6. Sum of angles of triangle. Sum of interior angles of convex polygon.

7. Features of parallel lines in the plane.

8. Circumference and circle. Center, diameter, radius, chords, secants of circumference.

9. Circumference circumscribed about triangle.

10. Circumference inscribed in triangle.

11. Tangent to circumference and its characteristic.

12. Characteristics of the points equidistant from the endpoints of segment.

13. Quadrangle: parallelogram, rectangle, rhomb, square, trapezium; their main characteristics.

14. Features of parallelogram.

15. Pythagorean theorem, conclusions of Pythagorean theorem.

16. Relation between sides and angles of right-angled triangle.

17. Distance formula between two points of plane. Circumference equation.

18. Examples of geometric figures transformations, types of symmetry.

19. Vectors. Operations with vectors.

20. Features of similarity of triangles.

21. Central and inscribed angles; their characteristics. Measurement of angle inscribed in circumference.

22. Polygon. Vertices, sides, diagonals of polygon.

23. Dependence between segments in circumference. Arc of circumference. Sector, segment.

24. Length of circumference and length of arc of circumference. Radian measure of angle. Area of circle and area of sector.

25. Formulas of areas of geometric figures: triangle, rectangle, parallelogram, square, rhomb, trapezium.

26. Plane. Parallel planes and intersecting planes.

27. Parallelism of straight line and plane.

28. Feature of planes parallelism.

29. Parallelism of straight lines and planes.

30. Features of parallelism of straight line and plane.

31 .Perpendicularity of straight lines and planes.

32. Theorem on perpendicularity of straight line and plane.

33. Perpendicularity of two planes.

34. Angle of straight line to plane. Perpendicular to plane.

35. Dihedral angles. Linear angle of dihedral angle. Perpendicularity of two planes.

36. Polygons. Vertices, edges, faces, diagonals of polygon. Straight line and inclined line of prism. Pyramid. Regular prism and regular pyramid

37. Bodies of revolution: cylinder, cone, sphere, ball. Center, diameter, radius of sphere and ball. Plane tangent to sphere.

38. Formulas of surface area and volumes of prism, pyramid, cylinder, cone.

39. Formulas of surface area of sphere, volume of ball.

II. MAIN FORMULAS AND THEOREMS (Algebra)

1. Formula of n-th term of arithmetical and geometrical progression.
2. Formula of sum of first terms of arithmetical and geometrical progression.
3. Function, its characteristics and graph.
4. Function, its characteristics and graph.
5. Function, its characteristics and graph.
6. Function, its characteristics and graph.
7. Formula of roots of quadratic equation.
8. Expansion of quadratic trinomial to linear multipliers.
9. Formulas of abridged multiplication.
10. Properties of numerical inequalities.
11. Formulas of logarithms.
12. Functions, their definitions, characteristics and graphs.
13. Functions, their definitions, characteristics and graphs.
14. Formulas for solution of main trigonometrical equations.
15. Formulas of dependence between trigonometrical functions of the same argument, trigonometrical functions of double argument.
16. Reduction formulas.

INTRODUCTION TO ANALYSIS

1. Derivative of sum, product and quotient of two functions.
2. Derivatives of power, trigonometrical, exponential and logarithmic function.
3. Equation of tangent to function graph.
4. Main formulas of integration.
5. Applying the definite integral to calculate area of plane figure. Newton-Leibniz formula.
6. Calculation of combinations without repetition.
7. Newton's binomial formula.

8. Main theorems on probability of events. Bernoulli's formula.

GEOMETRY

1. Characteristics of triangle. Equality and similarity, sides of triangle, angles of triangle, area of triangle - formulas of calculation, right-angled triangle, isosceles triangle, altitude of triangle.

2. Correlation between sides and angles of right-angled triangle.

3. Quadrangle. Main characteristics, formulas and theorems.

4. Circumference circumscribed about triangle and inscribed in triangle. Tangent to circumference and its characteristics. Theorem on angle inscribed in circumference.

5. Rectangular coordinate system. Formula of distance between two points of the plane. Equation of circumference.

6. Features of parallelism: straight line and plane, planes.

7. Theorem on perpendicularity of straight line and plane. Perpendicularity of two planes.

8. Formulas of areas of surface and volume of prism, pyramid, cylinder, cone.

9. Formulas of area of sphere and volume of ball.

III. STRUCTURE OF THE INTERVIEW TASKS

The interview is conducted orally after the applicant has had time to prepare for the examiners' questions.

The structure of each mathematics interview includes 3 tasks:

1. A theoretical question in algebra and geometry – **4 points**

2. An open-ended problem in algebra – **4 points**

3. An open-ended problem in geometry or algebra – **4 points**

(Tasks 2 and 3 require detailed solutions with reference to specific mathematical concepts.)

If the examiner deems it necessary when assigning a score, they may ask additional questions — no more than two per examiner.

If needed, to better convey the essence of the task or question to the applicant, the examiner may display it on the screen.

IV. MAIN KNOWLEDGE AND SKILLS

The entrant must be able to:

- carry out arithmetic operations with natural numbers, decimal fractions, simple fractions;
- carry out identical transformations of main algebraic expressions (polynomials, rational expressions which include power, exponential, logarithmic and trigonometric functions);
- construct and read graphs of linear, quadratic, power, exponential, logarithmic and trigonometric functions;
- solve equations and inequalities of first and second power as well as equations and inequalities reduced to them. Simplest equations and inequalities which have power, exponential, logarithmic and trigonometric functions;
- solve problems on addition of equations and systems of equations;
- have practical skills of basic mathematical analysis, use derivative while investigating functions, use integral for calculation of areas of plane figures;
- carry out operations with vectors and use them when solving practical problems and exercises.

V. TYPICAL INTERVIEW TASKS.

CALCULATIONS AND SIMILAR TRANSFORMATIONS

1. ***Simplify the expression***

а) $\left(\dfrac{b^{-\frac{5}{6}}b^{\frac{1}{3}}}{b^{\frac{7}{18}}}\cdot\dfrac{b^{\frac{2}{7}}}{b^{-\frac{5}{7}}}\right)^{9}$; б) $\dfrac{\cos(\alpha+\beta)+\sin\alpha\sin\beta}{\sin(\alpha-\beta)-\sin\alpha\sin\beta}$.

2. ***Calculate:***

а) $\left(\dfrac{8^{\frac{1}{2}}\cdot 9^{\frac{4}{3}}}{27^{-\frac{1}{9}}\cdot 4^{\frac{1}{4}}}\right)^{-1}$; б) $\dfrac{\log_9 27+\log_9 3}{2\log_2 6-\log_2 9}$; в) $\log_7 x=\log_7 2{,}5+4\log_7 2-\log_7 10$;

г) $\cos\left(\frac{\pi}{6}+\alpha\right)$, if $\sin\alpha=-\frac{\sqrt{3}}{3}; \pi<\alpha<\frac{3\pi}{2}$.

3. Prove identity:

а) $\frac{\sin\alpha}{1+\cos\alpha}+\frac{1+\cos\alpha}{\sin\alpha}=-\frac{2}{\sin\alpha}$; б) $\sin(\alpha-\pi)+tg(\alpha-\pi)+\cos\left(\frac{3\pi}{2}+\alpha\right)=tg\alpha$.

EQUATIONS AND SYSTEMS OF EQUATIONS

4. $\sqrt{x+78}-x=6$; 5. $5^{x+2}+5^x=130$; 6. $3^{2x+1}+8\cdot3^x-3=0$;

7. $\lg(2x-1)+\lg(x-9)=2$; 8. $\log_7^2 x-\log_7 x^2-3=0$;

9. $\sin^2 x+2\sin x\cos x-3\cos^2 x=0$; 10. $\sin 3x+\sin x=0$.

11. $\begin{cases}\frac{x}{y}-\frac{y}{x}=\frac{16}{15}\\ x-y=2\end{cases}$; 12. $\begin{cases}\sqrt[3]{x}-\sqrt[3]{y}=2\\ x-y=56\end{cases}$; 13. $\begin{cases}3^{2x-y}=81\\ \lg xy=1+\lg 3\end{cases}$.

INEQUALITIES AND SYSTEMS OF INEQUALITIES

14. $\sqrt{x^2-x}>2\sqrt{3}$; 15. $\left(\frac{1}{3}\right)^x<\frac{1}{81}$; 16. $2^{x^2-8x+19}>16$;

17. $\log_3(x-3)>0$; 18. $\log_{\frac{1}{5}}(3x-5)>\log_{\frac{1}{5}}(x+1)$;

19. $\sin x<\frac{1}{2}$; 20. $\frac{x^2-x-2}{x^2-25}\le 0$; 21. $\begin{cases}x^2-7x-18\ge 0\\ 2x+3>0\end{cases}$.

INTRODUCTION TO ANALYSIS

22. *Find function domain:*

а) $f(x)=\frac{\sqrt{5-4x-x^2}}{x+2}$; б) $f(x)=\sqrt{\frac{(x+4)(3-x)}{\lg(x^2+1)}}$.

23. *Find derivative value in a point:*

а) $f(x)=\frac{1}{x^4}-\frac{2}{x^5}, x_0=1$; б) $f(x)=\cos 6x, x_0=\frac{\pi}{12}$.

24. *Find monotony intervals and extremum points of function:*

а) $f(x)=\frac{x^2+7x}{x-9}$; б) $f(x)=2x^4-2x^3-x^2+2$.

25. ***Find the largest and the smallest function value*** $f(x)=\frac{x^3}{3}-3x^2+5x-7$ ***on the interval*** $[-1;3]$.

26. ***Find equation of tangent line to graph of function*** $f(x)=4x-\frac{x^3}{3}$ ***at the point*** $x_0=3$.

27. ***Find the original of function*** $f(x)=5x^4+3x^2-4$ ***at the point*** $A(-1;12)$.

28. ***Evaluate the integral:***

а) $\int_{-1}^{2}\left(x^2-4x+5\right)dx$;

б) $\int_{0}^{\frac{\pi}{2}}\left(2\cos 2x+\frac{1}{3}\sin\frac{x}{3}\right)dx$.

29. ***Evaluate the area of the figure bounded by given*** $y=x^2-4x+5,\ y=5-x$.

SOLUTION OF TRIANGLES

30. ***Solve a right-angled triangle by a hypotenuse and an acute angle. Given:*** $c=12,6, A=64^0 30'$. ***Find*** B,b,a.

31. ***Solve a right-angled triangle by two legs. Given:*** $a=56,2; b=29,8$. ***Find*** A,B,c.

32. ***Solve a triangle by the two sides and the angle between them. Given:*** $a=76,8; b=56,4; C=62^0 20'$. ***Find*** B,A,c.

33. ***Solve a triangle by two angles and a side. Given:*** $a=6,15; A=36^0 8'; C=62^0 20'$. ***Find*** B,b,c.

PLANE VECTORS AND COORDINATES

34. ***Determine the inner product of vectors*** $3\vec{a}+2\vec{b}$ ***and*** $\vec{a}-\vec{b}$, *if* $\vec{a}(0;1)$, $\vec{b}(2;1)$.

35. ***Check if the points*** $A(-4;-4), B(-3;4), C(4;5), D(10;-2)$ ***are vertices of trapezium?***

36. ***Determine the angle*** **A** ***of triangle*** **ABC**, ***if the coordinates of the vertices are known:*** $A(1;3), B(4;6), C(3;1)$.

GEOMETRIC OBJECTS ANS SURFACES

37. ***The right-angled parallelepiped have sides 7 and 24 dm, its height is 0,8 meters. Determine the area of diagonal section.***

38. **Cylinder inscribed into right triangular prism have sides 13, 14 and 15 cm, the height is 20 cm. Evaluate the cross-section of cylinder.**

39. **Lateral edge of the right four-cornered pyramid is 5 cm and its height is 3 cm. Find the volume of the pyramid.**

40. **The area base of cone is square** 9π **cm2 and the area of its total lateral surface is square** 24π **cm2. Find the volume of the cone.**

41. **The surface area of a sphere is square** 225π **cm2. Determine its volume.**

VI. EVALUATION CRITERIA

The mathematics interview for applicants is assessed using a cumulative system based on a 12-point scale.
The score is then converted to a 100–200 point scale according to a score conversion table.
The total interview score consists of the points accumulated during the applicant's response.
Additional questions are not assessed separately; they serve only to help examiners understand the level of the applicant's knowledge on specific topics.

The structure of the interview program covers the entire content of the school mathematics curriculum.

The assessment of applicants' mathematical preparation is conducted in two key areas:

- the level of theoretical knowledge mastery, and
- the quality of practical skills and the ability to apply learned material when solving problems.

Score	Assessment criteria for the second and third tasks of the applicant's interview
0	The applicant: – does not possess the required conceptual framework; – is unable to explain problem-solving methods, even with external assistance; – has no understanding of the factual content.
1	The applicant: demonstrated weak command of conceptual and terminological knowledge; - is able to explain problem-solving methods only with the instructor's assistance.
2	The applicant: – answers individual questions; – independently but incompletely recalls the learning material; – generally uses mathematical terms correctly; – solves basic and standard mathematical problems.
3	The applicant: – demonstrates knowledge of factual material but makes some inaccuracies; – solves the given problems, though may make arithmetic errors; - is able to correct the mistakes made.
4	The applicant: – demonstrates confident command of conceptual and terminological knowledge; – shows the ability to solve the proposed problems accurately and efficiently; - provides justification and proof for all statements.

TABLE

Conversion of the average score calculated on a 12-point scale to the 200-point scale

1	100	4	120	8	160
1,1	100	4,1	121	8,1	161
1,2	100	4,2	122	8,2	162
1,3	100	4,3	123	8,3	163
1,4	100	4,4	124	8,4	164
1,5	100	4,5	125	8,5	165
1,6	100	4,6	126	8,6	166
1,7	100	4,7	127	8,7	167
1,8	100	4,8	128	8,8	168
1,9	100	4,9	129	8,9	169
2	100	5	130	9	170
2,1	101	5,1	131	9,1	171
2,2	102	5,2	132	9,2	172
2,3	103	5,3	133	9,3	173
2,4	104	5,4	134	9,4	174
2,5	105	5,5	135	9,5	175
2,6	106	5,6	136	9,6	176
2,7	107	5,7	137	9,7	177
2,8	108	5,8	138	9,8	178
2,9	109	5,9	139	9,9	179
3	110	6	140	10	180
3,1	111	6,1	141	10,1	181
3,2	112	6,2	142	10,2	182
3,3	113	6,3	143	10,3	183
3,4	114	6,4	144	10,4	184
3,5	115	6,5	145	10,5	185
3,6	116	6,6	146	10,6	186
3,7	117	6,7	147	10,7	187
3,8	118	6,8	148	10,8	188
3,9	119	6,9	149	10,9	189
		7	150	11	190
		7,1	151	11,1	191
		7,2	152	11,2	192
		7,3	153	11,3	193
		7,4	154	11,4	194
		7,5	155	11,5	195
		7,6	156	11,6	196
		7,7	157	11,7	197
		7,8	158	11,8	198
		7,9	159	11,9	199
				12	200