

Ministry of Education and Science of Ukraine  
V.N. Karazin Kharkiv National University

Educational and Scientific Program

(освітньо-професійна / освітньо-наукова)

Pure Mathematics (the English language of instruction)

(назва програми)

second (master's) level of higher education

(перший (бакалаврський), другий (магістерський), третій (освітньо-науковий))

Field of knowledge 11 Mathematics and Statistics

(код, назва галузі)

Major 111 Mathematics

(шифр, назва спеціальності)

Specialization (in the presence) \_\_\_\_\_

(назва спеціалізації (спеціалізацій))

APPROVED by  
The Academic Council  
V.N. Karazin Kharkiv National University  
“\_\_\_” \_\_\_\_\_ of 2024,  
protocol № \_\_\_\_\_

Effectuated from the 2024/2025 school year

by order \_\_\_\_\_ .2024 № \_\_\_\_\_

Vice-rector for scientific and pedagogical work

\_\_\_\_\_ Oleksandr HOLOVKO

Kharkiv 2024

# APPROVAL

The educational and scientific program Pure Mathematics of the second (master's) level of higher education was reviewed and approved at by:

1. Scientific and Methodological Council of V.N. Karazin Kharkiv National University

\_\_\_\_\_ № \_\_\_\_\_

Chairman of the Scientific and Methodological Council,  
Vice-Rector for Scientific and Pedagogical Studies

\_\_\_\_\_ Oleksandr HOLOVKO

2. Academic Council of the Faculty of Mathematics and Informatics:

\_\_\_\_\_ № \_\_\_\_\_

Head of the Academic Council of the faculty

\_\_\_\_\_ Hryhoriy Zholtkevych

3. Scientific and methodological commission of the Faculty of Mathematics and Informatics: \_\_\_\_\_ No. \_\_\_\_\_

Head of the scientific and methodical commission Faculty

\_\_\_\_\_ Olha ANOSCHENKO

4. Departments of Fundamental Mathematics: \_\_\_\_\_ № \_\_\_\_\_

Acting as Head of the Department  
candidate of physical and mathematical sciences,  
Associate Professor

\_\_\_\_\_ Sergiy GEFTER

## PREFACE

**The educational and scientific program was developed by a working group consisting of:**

<b>Head of the working group (guarantor of the educational program)</b>	
<b>Fastovska</b> Tamara Borysivna	Associate Professor of the Department of Fundamental Mathematics, Faculty of Mathematics and Informatics, Kharkiv National University named after V.N. Karazin, candidate of physical and mathematical sciences, associate professor
<b>Members of the working group:</b>	
<b>Yampolskyi</b> Oleksandr Leonidovych	Professor of the Department of Fundamental Mathematics, Faculty of Mathematics and Informatics, Kharkiv National University named after V.N. Karazin, doctor of physical and mathematical sciences, professor
<b>Ignatovich</b> Svitlana Yuriiivna	Professor of the Department of Applied Mathematics, Faculty of Mathematics and Informatics, Kharkiv National University named after V.N. Karazin, doctor of physical and mathematical sciences, associate professor

The Program was developed with participation of:

**Representatives of the students community:** Dmytro SELUTIN, student of educational program “Philosophy Doctor”.

**Representatives of stakeholder:** Dmitry SHEPELSKY, Doctor of Sciences, Head of department of Differential Equation and Geometry of the B. Verkin Institute of Low Temperatures Physics and Engineering of the National Academy of Sciences of Ukraine.

**Representatives of scientists:** Artem DUDKO, professor of the Institute of Mathematics of the Polish Academy of Sciences, invited researcher of Kharkiv National University named after V.N. Karazina for the 2023/2024 academic year.

When developing the project of the Program, the following requirements were taken into account: the National Qualifications Framework of Ukraine for the 7th qualification level - master's degree. <https://zakon.rada.gov.ua/laws/show/1341-2011-%D0%BF#Text>, temporary standard of higher education of the Kharkiv National

University named after V.N. Karazin, approved by the Academic Council of the University “\_27\_” 06\_\_2022, minuet No.\_10\_, which was put into effect by the rector’s order № 0208-1/262 of «\_06\_»\_07\_2022.

**1.Profile of the educational program in the specialty 111 Mathematics  
(the English language of instruction)**

<b>1 - General information</b>	
<b>Full name of the higher educational institution and structural division</b>	V.N. Karazin Kharkiv National University, Faculty of Mathematics and Informatics
<b>Official name educational program</b>	Fundamental mathematics (English language of instruction). Educational and scientific program « <b>Pure mathematics</b> ” (the English language of instruction)
<b>Degree of higher education and the name of the qualification in the original language</b>	Master's degree in mathematics
<b>Type of diploma and scope of the educational program</b>	Master's degree, single, 120 ECTS credits, study period 1 year 9 months
<b>Availability of accreditation</b>	Ministry of Education and Science of Ukraine, certificate of accreditation of specialty 111 Mathematics at the master's level № HД 2189565 until 01.07.2024.
<b>Prerequisites</b>	Having a bachelor's degree
<b>Language(s) of instruction</b>	English
<b>The term of validity of the educational program</b>	until 31.05.2025
<b>Internet address of the permanent site of the educational program</b>	<a href="http://puremath.univer.kharkov.ua/">http://puremath.univer.kharkov.ua/</a>
<b>2 - The purpose of the educational program</b>	
Formation and development of general and professional competences in mathematics, which contribute to the social stability and mobility of the graduate in the labor market; obtaining a higher professional education, which will allow the graduate to successfully perform the functions and typical tasks of a mathematician in various fields of human activity, national economy and production, conduct research and obtain new scientific results	
<b>3 – Characteristics of the educational program</b>	
<b>Subject area (field of</b>	11 Mathematics and statistics, 111 Mathematics

<b>knowledge, specialty)</b>	
<b>Orientation of the educational program</b>	Educational and scientific, academic. Provides mastery of a complex of general and professional competencies necessary for specialists to perform professional tasks and duties in the field of mathematics, in particular, fundamental mathematical training, the basics of skills for performing fundamental research in mathematics and its application in other sciences.
<b>The main focus of the educational program and (specializations)</b>	Special education in the field of mathematics, which includes thorough mathematical training, familiarization with the practice of independent scientific work in mathematics and the application of mathematical theories in fundamental research. <i>Keywords:</i> Mathematics, fundamental research
<b>Features of the program</b>	Thorough mathematical training with a focus on independent scientific research, development of mathematical theories and their application in various fields of science, education and various subject areas.
<b>4 – Suitability of graduates for employment and further education</b>	
<b>Suitability for employment</b>	Types of economic activity (according to DK 009:2010): 72.1 Scientific research and development 72.1 Research and experimental developments in the field of natural and technical sciences 72.19 Research and experimental developments in the field of other natural and technical sciences 85.32 Vocational and technical education 85.41 Vocational preliminary higher education 85.42 Higher Education <i>Possibilities of professional certification</i> Professional job titles (according to DK 003:2010): 2121.1 Research staff (mathematics) 2121.2 Mathematics
<b>Further education</b>	Continuation of studies at the next level of higher education to obtain the degree of Doctor of Philosophy in a compatible specialty.
<b>5 – Teaching and assessment</b>	

<b>Teaching and training</b>	The main approaches to learning are competence-based, active, student-centered, and problem-oriented. The leading methods of learning are problem-based, partially research-based and research-based. Teaching and learning is conducted in the form of lectures, including interactive and multimedia lectures, practical classes, laboratory work, independent study, course research. Design, graphic educational modeling and interactive and communicative learning technologies are used	
<b>Assessment</b>	Four-level and two-level, 100-point evaluation system through the following types of control with the accumulation of points received: current (oral and written survey) control, intermediate (defense of practical, independent works), final (written exams, credit works, defense of practical reports), self-control, attestation (preparation and public defense of a master's thesis).	
<b>6 – Program competencies</b>		
<b>Integral competence</b>	The ability to solve complex mathematical problems and practical problems in professional activities or in the learning process, which involves conducting research and/or implementing innovations and is characterized by complexity and/or uncertainty of conditions.	
<b>General competences (GC)</b>	GC -01	Ability to abstract thinking, analysis and synthesis
	GC -02	Ability to apply knowledge in practical situations
	GC -03	Knowledge and understanding of the subject area and understanding of professional activity
	GC -04	Knowledge and understanding of the subject area and understanding of professional activity
	GC -05	Ability to learn and master modern knowledge
	GC -06	Ability to search, process and analyze information from various sources
	GC -07	Ability to work in a team
	GC -08	Ability to generate new ideas (creativity).
	GC -09	Ability to develop and manage projects
<b>Professional Competences (PC)</b>	PC -01	Knowledge and understanding of fundamentals methods and applications of algebra,

		mathematical logic, category theory; ideas about the axiomatic construction of mathematical theories
	PC -02	The ability to formulate and prove mathematical statements, obtain conclusions, establish the correctness of solving problems and reasoning
	PC -03	Knowledge and understanding of fundamental methods of mathematical, complex and functional analysis, geometry, topology, etc. and the ability to use them in theoretical research and solving specific applied problems
	PC -04	Understanding of applied problems that can be investigated using modern mathematical methods, knowledge and understanding of methods of construction and qualitative and quantitative analysis of mathematical models of natural, man-made, economic and social objects and processes
	PC -05	The ability to use existing software tools to perform calculations, search for information, design work results, etc
	PC -06	The ability to choose an adequate mathematical apparatus, to use known theoretical concepts and facts to solve specific research problems
	PC -07	The ability to teach, present and formalize the obtained results, in particular, in the form of scientific articles and reports at scientific conferences
	PC -08	The ability to put forward, formulate and prove new theoretical statements and explore the possibilities of their application to solve specific theoretical and applied problems
	PC -09	The ability to conduct scientific research, set and solve new theoretical and applied problems, develop new innovative methods of solving and analyzing results
	PC -10	The ability to navigate new scientific directions in the field of mathematics, the latest developments and achievements.

## 7 – Program learning outcomes

	PO.01	To know the classification and essence of modern global problems, the main directions of their solution, their reflection on the Ukrainian reality. To be able to apply this knowledge and methodologies in the study of modern political, economic and social processes in the world and in Ukraine.
	PO.02	To know the main types of linear differential equations with partial derivatives, methods of researching solutions. Be able to apply these methods to the study of general elliptic, parabolic and hyperbolic equations of the second order, including equations arising in physical models, use methods of constructing approximate solutions
	PO.03	Know the definitions, examples and basic properties of groups, rings, fields, modules and linear spaces, their (homo)morphisms, categories and functors. To be able to apply these concepts and methods for the study of algebraic objects in problems from various branches of mathematics and its applications.
	PO.04	Know the basic concepts and theorems of differential topology related to smooth manifolds and mappings, tangent spaces, forms and integration, basic concepts of Riemannian and metric geometry. Be able to study smooth manifolds and geometric structures on them and use them in theoretical and practical problems.
	PO.05	Know the theorems and methods of modern sections of functional and complex analysis, in particular the basic facts about Banach and Hilbert spaces and operators in them, elements of the spectral theory of operators, the theory of Fourier series in Hilbert space and basic facts about the Fourier transform, properties of holomorphic functions, zeros of entire functions, conformal equivalence of domains, basic theorems of complex analysis. To be able



		to explore spaces and operators by methods of functional analysis, different classes of functions by methods of complex analysis
	<i>PO.06</i>	To know the statements of the main problems of modern control theory, the main research methods of linear and some nonlinear controlled systems, the formulation of the Pontryagin maximum principle, the methods of solving the synthesis problem for linear systems based on the controllability function method. To be able to apply these methods, build mathematical models and investigate them for the simplest applied problems of control theory
	<i>PO.07</i>	To demonstrate the ability to self-study, to be able to organize one's own activities and safe working conditions
	PO.08	Demonstrate communication skills with other people, the ability to present research results in the form of a speech at a scientific seminar, the ability to work in a team
	PO.09	Be able to use existing knowledge in mathematics and other areas of knowledge, research sources (including in foreign languages), systematize and process the information received, make reviews and teach at a seminar, use known information to obtain new results, build examples, prove new theorems based on existing or for the construction and research of new mathematical models of objects and processes of the real world. Be able to present research results in the form of a completed work, present and defend its content
	PO.10	To be able to apply existing knowledge of mathematical theories for setting new problems, proposing hypotheses, formulating and proving new mathematical results and their analysis

	PO.11	To be able to organize one's work and the work of a team of performers when conducting scientific research or implementing a practical project
	PO.12	Be able to carry out a scientific and technical search in modern sources of information, analyze and correlate results from various sources, navigate in the latest scientific directions and their applications

### **8 – Resource support for program implementation**

<b>Specific characteristics of personnel support</b>	Complies with license terms. All teachers are full-time teachers of KhNU named after V.N. Karazin, have a scientific degree and/or academic title corresponding to the main profile of the taught discipline. All teachers undergo advanced training every five years.
<b>Specific characteristics of material and technical support</b>	Equipment and equipment, technical teaching aids (boards-screens; multimedia projectors, laptops, printers, scanners, personal computers with software) for the formation of subject competencies in the process of training the applicant. There are classrooms, laboratories, computer classes, a dormitory, food outlets, wireless Internet access points, gyms, etc.
<b>Specific characteristics of information and educational and methodological support</b>	The official site of KhNU named after V.N. Karazin, unlimited access to the Internet, printed (funds of the National Central Bank named after V.N. Karazin, repository, own libraries of educational laboratories, cartographic works) and Internet sources (including the Center for Electronic Learning of the KhNU) information; study and work plans (with explanatory notes to them), educational programs, work programs of disciplines and practices, educational and methodological complexes of disciplines, including lecture material, tasks of practical work, questions of seminar classes, tasks of independent work, questions, problems, tasks for current and final control. Complies with license terms, 100%

### **9 – Academic mobility**

<b>National credit mobility</b>	Faculty of Mathematics and Informatics of Kharkiv National University named after V.N. Karazina, which includes the Department of Fundamental Mathematics,
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	is a partner member of the Erasmus+ Program and participates in academic mobility projects.
<b>International credit mobility</b>	<p>Faculty of Mathematics and Informatics of Kharkiv National University named after V.N. Karazina, which includes the Department of Fundamental Mathematics, is a partner member of the InterMaths Consortium - the International Joint Master's Program in the Field of "Applied and Interdisciplinary Mathematics", which was created</p> <ul style="list-style-type: none"> <li>• UAQ - University of L'Aquila (Italy)</li> <li>• BUT - Brno University of Technology (Czech Republic)</li> <li>• US - University of Silesia in Katowice (Poland)</li> <li>• LNU - Lviv Ivan Franko National University (Ukraine)</li> </ul>
<b>Education of foreign students of higher education</b>	Citizens of other countries are admitted to study on the basis of international agreements on the terms defined by these agreements, as well as agreements concluded by the educational institution with foreign educational institutions, organizations, or individual agreements, contracts.

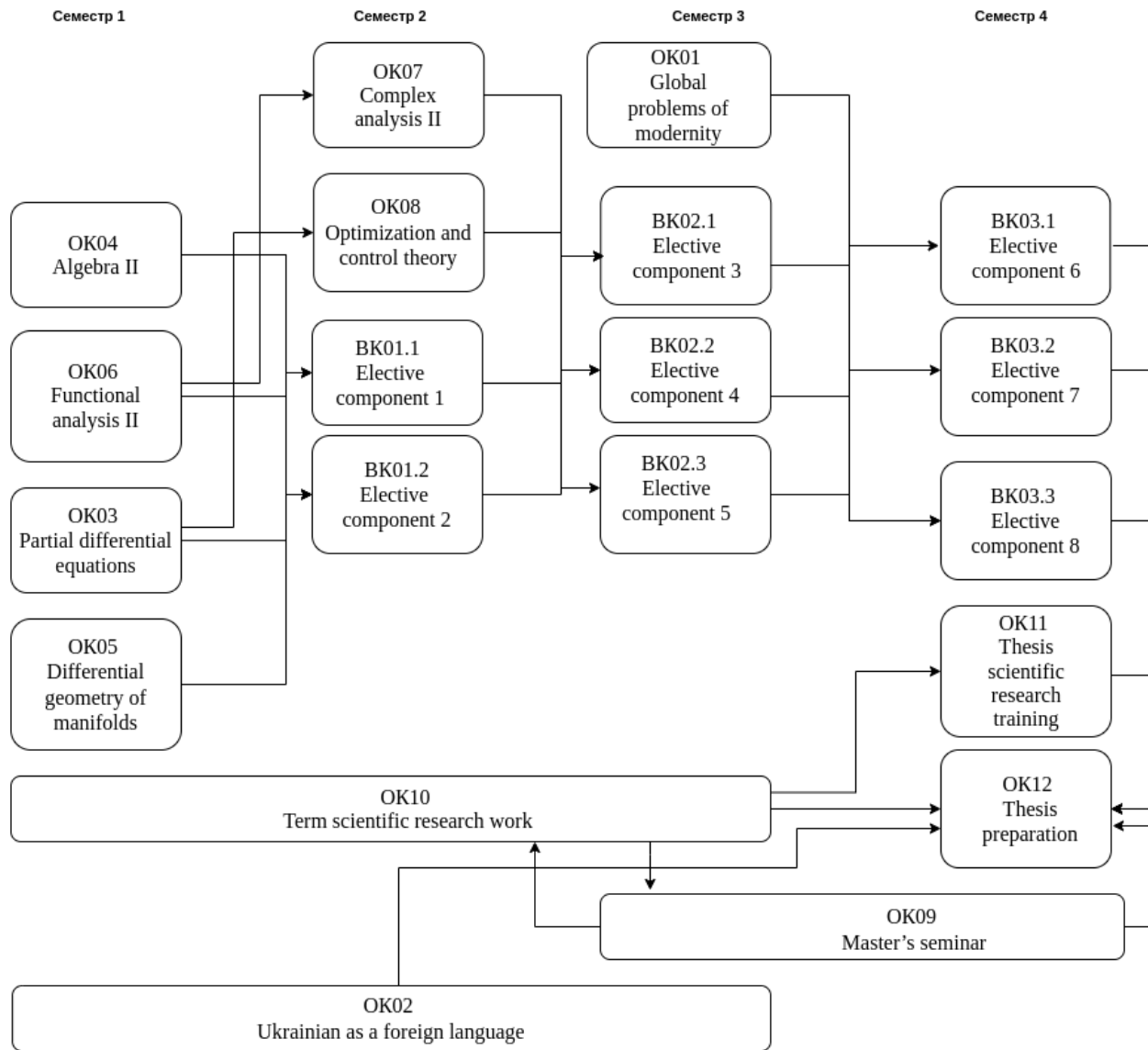
## 2. List of components of the educational and professional program and their logical sequence

Code of academic discipline	Components of the educational program (study subjects, course projects (works), practices, qualification work)	Number of credits	Grading
1	2	3	4
<b>I. Mandatory components</b>			
OK01	Global problems of modernity	3	test
OK02	Ukrainian as a foreign language	6	examination
OK03	Equations with partial derivatives	6	examination
OK04	Algebra II	6	examination
OK05	Differential geometry of manifolds	6	examination
OK06	Functional analysis II	6	examination
OK07	Complex analysis II	5	examination
OK08	Optimization and control theory	5	examination
<b>Research part</b>			
OK09	Master's seminar	4+9+6=19	test
OK10	Scientific research coursework	3+3=6	test

OK11	Pre-diploma research practice	7	test
OK12	Preparation of qualification work	5	examination
<b>The total amount of mandatory components</b>		<b>80 credits</b>	
<b>II. Elective component</b>			
<i>8 disciplines are chosen according to the catalog of professional optional disciplines of the Department of Pure Mathematics (puremath.univer.kharkov.ua) total of 40 ECTS credit</i>			
BK01.1	Elective 1	5	examination
BK01.2	Elective 2	5	examination
BK02.1	Elective 3	6	examination
BK02.2	Elective 4	6	examination
BK02.3	Elective 5	6	examination
BK03.1	Elective 6	4	examination
BK03.2	Elective 7	4	examination
BK03.3	Elective 8	4	examination
<b>The total amount of elective OP components</b>		<b>40</b>	
<b>TOTAL</b>		<b>120</b>	

*According to the Law of Ukraine "On Higher Education", students have the right to "choose academic disciplines within the limits provided by the relevant educational program and work curriculum, in the amount of at least 25 percent of the total number of ECTS credits provided for a given level of higher education At the same time, students of a certain level of higher education have the right to choose academic disciplines offered for other levels of higher education by the head of the corresponding faculty or unit."*

### 3. Structural and logical scheme of PO



### 4. Form of attestation of applicants of higher education

Attestation of higher education applicants in a specialty is carried out in the form of defense of a master's qualification thesis. Attestation is carried out by the Examination Commission, which was approved by order of the rector of V.N. Kharkiv National University. Karazin. The examination board makes a decision on awarding the graduate student with the qualification of master of mathematics and issues a state diploma. This diploma is a legal document that allows a specialist to occupy primary positions in accordance with their list and the corresponding nomenclature of positions in force in Ukraine. Students who have fully met the requirements of the curriculum are admitted to attestation.



PO02			+			+						
PO03				+	+							
PO04			+	+	+		+					
PO05						+	+	+				
PO06						+		+				
PO07									+	+	+	+
PO08		+							+		+	+
PO09	+	+							+	+	+	+
PO10									+	+	+	+
PO11									+	+	+	+
PO12									+	+	+	+



**Guarantor of the program**

**Tamara FASTOVSCA**